ARLINGTON COUNTY, VIRGINIA
OFFICE OF THE PURCHASING AGENT
2100 CLARENDON BOULEVARD, SUITE 500
ARLINGTON, VIRGINIA 22201

CONTRACT AWARD COVERPAGE

TO:	PC CONSTRUCTION COMPANY DBA PCEO, INC.	DATE ISSUED:	JANUARY 20, 2024
	193 TILLEY DRIVE	CONTRACT NO:	22-DES-RFPPW-672
	SOUTH BURLINGTON, VA 05403	CONTRACT TITLE:	ARLINGTON WATER POLLUTION CONTROL PLANT PHASE 10C/D – COMPREHENSIVE BIOSOLIDS UPGRADE PROJECT (SHORT TITLE: BIOSOLIDS UPGRADES)

THIS IS A NOTICE OF AWARD OF CONTRACT AND NOT AN ORDER. NO WORK IS AUTHORIZED UNTIL THE VENDOR RECEIVES A VALID COUNTY PURCHASE ORDER ENCUMBERING CONTRACT FUNDS.

The contract documents consist of the terms and conditions of AGREEMENT No. 22-DES-RFPPW-672 including any attachments or amendments thereto.

EFFECTIVE DATE: DATE OF EXECUTION
EXPIRES: MAY 10, 2030, SUBJECT TO DATES SPECIFIED IN THE NOTICE TO PROCEEDS
RENEWALS: N/A
COMMODITY CODE(S): 90644, 92567, 90630, 96177, 92517, 92531, 91815, 92522, 90607, 90616, 91438, 91450, 90682, 90625, 91220, 90610, 91359, 90674, 90638, 90612, 91356, 91360, 92546, 92588, 91468.
LIVING WAGE: N

ATTACHMENTS:
AGREEMENT NO. 22-DES-RFPPW-672

EMPLOYEES NOT TO BENEFIT:
NO COUNTY EMPLOYEE SHALL RECEIVE ANY SHARE OR BENEFIT OF THIS CONTRACT NOT AVAILABLE TO THE GENERAL PUBLIC.

VENDOR CONTACT:	IAN MACDOUGALL	VENDOR TEL. NO.:	(804) 456-6158
		EMAIL ADDRESS:	IMACDOUGALL@PCCONSTRUCTION.COM
COUNTY CONTACT:	MARY STRAWN	COUNTY TEL. NO.:	(703) 228-6829
		EMAIL ADDRESS:	MSTRAWN@ARLINGTONVA.US

PURCHASING DIVISION AUTHORIZATION

Meloni Hurley **Title: Assistant Purchasing Agent** **Date: 1/20/2024**

ARLINGTON COUNTY, VIRGINIA
OFFICE OF THE PURCHASING AGENT
SUITE 500, 2100 CLARENDON BOULEVARD
ARLINGTON, VA 22201

AGREEMENT NO. 22-DES-RFPPW-672

THIS AGREEMENT ("Agreement") is made, on the date of execution by the County, between **PC Construction Company dba PCEO, Inc.** ("Contractor"), a Vermont corporation located at 193 Tilley Drive, South Burlington, VT 05403, authorized to do business in the Commonwealth of Virginia, and the County Board of Arlington County, Virginia ("County"). The County and the Contractor, for the consideration hereinafter specified, agree as follows:

1. <u>CONTRACT DOCUMENTS</u>

The Contract Documents consist of:

- Agreement No. 22-DES-RFPPW, and all modifications properly incorporated into the Agreement
- Exhibit A – Scope of Work and Design and Preconstruction Rate Tables
- Exhibit B – RFP Plans
- Exhibit C – Arlington County Construction General Conditions
- Exhibit D – Virginia Department of Labor And Industry Wage Determination Decision
- Exhibit E – Guaranteed Maximum Price
- Exhibit F – Drawings, Specifications and Construction Notes (the Issued for Construction Documents)
- Exhibit G – Negotiated Project Schedule
- Exhibit H – Insurance Requirements

Where the terms and provisions of this Agreement vary from the terms and provisions of the other Contract Documents, the order of precedence of the Contract Documents shall be as follows:

Exhibits A, B, D, E, F, G, and H are considered complementary documents, what is in one shall be considered as in all; where the terms of these Contract Documents vary the most stringent shall apply; and Exhibits A, B, D, E, F, G, and H shall prevail over Exhibit C.

The Contract Documents set forth the entire agreement between the County and the Contractor. The County and the Contractor agree that no representative or agent of either party has made any representation or promise with respect to the parties' agreement that is not contained in the Contract Documents. The Contract Documents may be referred to below as the "Contract" or the "Agreement".

2. PROJECT OFFICER

The performance of the Contractor is subject to the review and approval of the County Project Officer who will be appointed by the Director of the Arlington County department or agency requesting the Work under the Contract.

The County has authorized the consultant identified below to act as the County representative for specific purposes to perform specified duties and responsibilities, and to have the rights and authorities as assigned in connection with completion of the Work in accordance with the Contract Documents until such time as the County may notify the Contractor otherwise:

- **HDR Engineering, Inc.** (the "Program Manager")

The County will notify the Contractor after contract award of the specific roles and responsibilities of the Consultant(s). Neither the Program Manager nor any other consultant retained by the County, has any duties, responsibilities, or authorities with respect to the Contractor, unless expressly provided in this Contract. The Program Manager and such other consultants shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction or the safety precautions and programs incident thereto. The Program Manager and such other consultants shall not be responsible for any failure of Contractor to comply with applicable laws or regulations applicable to the furnishing or performance of the Work. The Program Manager and such other consultants will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

3. SCOPE OF WORK

The Project shall proceed in two phases: the Design Confirmation Phase and the Implementation Phase, all as more specifically set forth in Exhibit A: Scope of Work.

During the Design Confirmation Phase, the Contractor will meet with County representatives and other stakeholders to discuss the RFP Plans and incorporate any revisions to the RFP Plans that may be requested by the County or recommended by the Contractor and agreed to by the County. At the conclusion of the Design Confirmation Phase, the County and the Contractor will have agreed on a Basis of Design, which will form the basis for the iterative design process that will follow during the Implementation Phase.

The Implementation Phase will have three stages: the Early Work Design Implementation Stage, Design Implementation Stage, and the Construction Implementation Stage (the "Implementation Stages"). During the Design Implementation Stages the Contractor will: (i) advance the design and budget for the Project in iterative steps, each involving the review and input of the Project Officer, such that at the end of this stage the Contractor will have produced, and the Project Officer will have approved, a full set of plans and specifications necessary to construct the Project in accordance with the requirements of the Contract (such approved documents will be the "IFC Set"); and (ii) submit for and receive all necessary permits and approvals from local, state and federal authorities, (the "Code Officials"). During the Construction Implementation Stage, the Contractor shall construct the Project in accordance with the IFC Set and the Contract Documents.

The Work shall be performed according to the standards established by the Contract Documents, all of which are incorporated by reference and are to be read together as a single specification. If there is any discrepancy between the terms of a Contract Document and the terms set forth in this Agreement, the terms set forth in this Agreement shall control. It shall be the Contractor's responsibility, at solely the Contractor's cost, to provide sufficient services to fulfill the purposes of the Work. Nothing in the Contract Documents shall be construed to limit the Contractor's responsibility to manage the details and execution of its Work.

4. REPRESENTATIONS AND WARRANTIES OF THE CONTRACTOR.

A. The Contractor is fully qualified to act as the Design-Builder and perform the Work for the Project and has, and shall maintain, any and all licenses, permits, or other authorizations necessary to act as the Design-Builder for construction of the Work.

B. The Contractor has thoroughly examined the terms of the Contract Documents and has found them in all respects to be complete, accurate, and sufficient for design and construction of the Project for an amount that does not exceed the GMP. The Contractor will not be compensated for the performance of any additional or change order Work or for any delays arising from any errors, omissions or conflicts or other issues in the Contract Documents that the Contractor should reasonably have discovered as a result of such review.

C. The Contractor has been provided with an opportunity to visit the Site and is familiar with local conditions under which the Work is to be performed. By entering into the Agreement, the Contractor assumes the following risks: (1) the nature of the land and subsoil unless such conditions constitute a Differing Site Condition that was not discovered during inspections and reviews completed by the Contractor conducted with Customary Standard of Care as mandated by A3.5 of the Scope of Work and Section 6 of this Contract; (2) the form and nature of the Site and surrounding areas; (3) details and levels of existing pipe lines, conduits, sewers, drains, cables or other existing services; (4) the quantities, nature and availability of the materials, tools, equipment and labor necessary for the completion of the Work; (5) the means of access to the Site and any accommodation that may be required; (6) uncertainties of weather and physical conditions at the Site; and in general to have itself obtained all necessary information as to risk contingencies, climatic, hydrological and natural conditions and other circumstances which may influence or affect his performance of the Work.

5. CODE AND REGULATORY COMPLIANCE

The Contractor is responsible for completing the design work and administering the Construction Implementation Phase of the Project in accordance with all applicable federal, state, and/or local regulatory requirements.

6. STANDARD OF CARE

The County is entering into this Contract in reliance on the Contractor’s experience and abilities with respect to performing the services hereunder. In performing the Work hereunder, the Contractor will ensure that it and all its agents and employees exercise the degree of skill and care that is normally accepted by members of the same profession currently practicing under similar conditions in the same locality (“Customary Standard of Care”). The Contractor will re-perform without additional compensation, any services not meeting this Customary Standard of Care.

The Contractor will be responsible for the professional quality, completeness, technical accuracy and coordination of all designs, drawings, specifications, costs estimates and other services or materials provided, regardless of whether such drawings and documents are prepared by the Contractor or the

Contractor's sub-consultants. The plans, drawings, specifications and other documents that the Contractor prepares must be free from material errors, plans, drawings, specifications and other documents will be structurally sound, and a complete and properly functioning facility that is suitable for the purposes for which it is intended.

The County's review, approval or acceptance of or payment for any services required under this Contract does not release the Contractor from any liability or operate as a waiver by the County of any rights or of any cause of action arising out of the Contract.

7. TIME FOR COMPLETION

The Design Confirmation Phase has an expected duration of one hundred fifty (150) calendar days. At no additional cost to the County, the County may, in its sole discretion, increase the duration of the Design Confirmation Phase by up to sixty (60) calendar days by giving written notice to the Contractor of such election. The County may exercise such extension in one or more notices provided the total of all such extensions does not exceed sixty (60) calendar days.

All Work required during the Implementation Phase shall achieve Substantial Completion no later than one thousand nine hundred ninety (1990) calendar days after the Notice to Proceed for the Implementation Phase is issued by the County, subject to any modifications made as provided for in the Contract Documents. Such period shall be the Period of Performance for Substantial Completion. No Work shall be deemed Substantially Complete until it meets the requirements of Substantial Completion set forth in the Design Criteria Documents. Final Completion of the Work shall be achieved by the Contractor no later than ninety (90) calendar days after the date of acceptance of Substantial Completion by the County Project Officer. Work will not reach Final Completion until it meets the requirements set forth in the Design Criteria Documents.

Unless otherwise provided, no claims for early completion are allowed.

8. CONTRACT AMOUNT

The Contract Amount is the total of two Guaranteed Maximum Prices (GMPs), comprised of a Design-Build Fee; a General Conditions Fee; and the Cost of the Work, which includes the Design Cost, for a total Guaranteed Maximum Price as set forth in Exhibit E. Exhibit E will be amended at the conclusion of each of the Design Implementation Phases. For Design Confirmation and Design Implementation, the County will pay the Contractor up to $18,011,248 in accordance with Exhibit A. For completed Design Confirmation and Design Implementation work, the County will pay the Contractor a proportionate Design-Build Fee of up to $1,994,204 in accordance with Exhibit A.

The Guaranteed Maximum Price for the Project shall be the maximum amount payable to the Contractor to achieve Final Completion of the Work as required by the Contract Documents.

The County will pay the Contractor for its services under this Agreement in accordance with the terms of the Progress Payments and Retainage and Payment Terms sections below.

9. PROGRESS PAYMENTS AND RETAINAGE

The County will make progress or partial payments to the Contractor in accordance with the Contract Documents. However, 5% of each progress payment made during the Construction Implementation Stage will be retained by the County until Final Acceptance of all the Work covered by the Agreement.

All material and work covered by partial payments will become the property solely of the County at the time the partial payment is made. However, the Contractor will have the sole responsibility, care and custody for all materials and work upon which payments have been made until Substantial Completion.

10. PAYMENT TERMS

The Contractor must submit invoices to the County's Project Officer, who will either approve the invoice or require corrections. The County will pay the Contractor within forty-five (45) days after approval of an invoice for completed work which is reasonable and allocable to the Contract. The number of the County Purchase Order pursuant to work has been performed must appear on all invoices.

11. REIMBURSABLE TRAVEL-RELATED EXPENSES

The County will not reimburse the Contractor for travel-related expenses for employees located within the greater Baltimore-Washington Metropolitan Area, as defined by the United States Office of Management and Budget. For employees located outside this area, the County will reimburse for pre-approved travel-related expenses, documented with receipts, as follows:

Meals: The County will reimburse at the U.S. General Services Administration's ("GSA") per diem rates for the destination, current for the date of travel, with the first and last days of travel counted at 75% of the per diem rate.

Lodging: The County will reimburse for actual lodging costs at a reasonably priced commercial facility in the immediate area of where the Work is performed, up to the GSA's daily rates for the destination, current for the date of travel. Receipts for lodging must be itemized. Only room and tax charges will be reimbursed; no reimbursement will be made for additional expenses, including but not limited to, room service, laundry, telephone and in-room movies. If the Contractor or its employee shares a room with another person who is not connected with the performance of the Work, including a spouse, the County will reimburse for only the cost of a single room.

The applicable GSA per diem rates can be obtained at http://www.gsa.gov/portal/content/104877.

Transportation:

General
Reservations must be made in advance whenever possible to take advantage of all available discounts.

Ground Transportation
Use of public transportation is encouraged. The County will reimburse for the business use of personal or company vehicles, if allowed, at the GSA's mileage rates current at the time of travel. The Contractor's request for reimbursement may not include any personal use of the vehicle.

The County may approve reimbursement for rental of vehicles or use of taxicabs if the Contractor can demonstrate that to be the most economical option. Any reimbursement will cover only those rental charges, insurance and/or fuel fees allocable to work on the Contract and will not cover the purchase of liability insurance and/or collision/comprehensive insurance if the Contractor's or the employee's existing insurance coverage provides such protection.

Air Travel
The County will reimburse for air travel at the lowest available fare, typically economy. Tickets must be purchased at least seven days in advance, unless otherwise approved by the County.

Time limit: The County will not honor requests for travel reimbursement that are submitted more than 60 days after completion of the travel.

Non-reimbursable Expenses: The County will never reimburse for the following expenses:

1. Alcoholic beverages
2. Personal phone calls
3. Entertainment (e.g., pay TV, movies, night clubs, health clubs, theaters, bowling)
4. Personal expenses (e.g., laundry, valet, haircuts)
5. Personal travel insurance (e.g., life, medical, or property insurance) for airfare or rental cars
6. Auto repairs, maintenance and insurance costs for personal vehicles

12. PAYMENT OF SUBCONTRACTORS

The Contractor is wholly responsible for the entire amount owed to any subcontractor with which the Contractor contracts in the performance of this Agreement, regardless of whether the Contractor has received payment from the County. The Contractor is not liable for amounts that are not owed as a result of the subcontractor's breach of its agreement with the Contractor, in which case the Contractor must notify the subcontractor in writing of its intention to withhold payment, in full or in part, and the reason for doing so.

The Contractor is obligated to take one of the two following actions within seven days after receipt of payment by the County for work performed by any subcontractor under this Contract:

a. Pay the subcontractor for the proportionate share of the total payment received from the County attributable to the work performed by the subcontractor under this Contract; or

b. Notify the County and the subcontractor, in writing, of the Contractor's intention to withhold all or a part of the subcontractor's payment with the reason for nonpayment.

The Contractor is obligated to pay interest to the subcontractor on all amounts owed by the Contractor to the subcontractor that remain unpaid after seven days following receipt by the Contractor of payment from the County for work performed by the subcontractor under this Contract, except for amounts withheld as allowed in subsection b., above. Unless otherwise provided under the terms of this Contract, interest will accrue at the rate of 1% per month.

The Contractor must include in each of its subcontracts, if any are permitted, a provision requiring each subcontractor to include or otherwise be subject to the same payment and interest requirements with respect to each lower-tier subcontractor.
The Contractor's obligation to pay an interest charge to a subcontractor pursuant to this section may not be construed to be an obligation of the County. A Contract modification may not be made for the purpose of providing reimbursement for such interest charge. A cost reimbursement claim may not include any amount for reimbursement for such interest charge.

13. PREVAILING WAGE CONTRACT REQUIREMENTS

A. Section 4-104 of the Arlington County Purchasing Resolution (regarding "Prevailing Wage") applies to this Contract. All employees of the Contractor who perform construction services and any subcontractors who perform construction services shall be paid wages, salaries, benefits, and other remuneration at or above the craft or trade category prevailing wage rate indicated by Virginia Commissioner of Labor and Industry (DOLI) and as listed in the contract.

The Contractor and its subcontractors shall submit all certified payrolls and statements of compliance weekly through the eComply website. If the Contractor or any subcontractor does not have an eComply profile, a one-time registration process immediately following the Notice of Award or Notice of Intent to Award and training on system functionality are required for each non-registered entity. The Contractor shall also be responsible for reviewing subcontractor payrolls and ensuring that contract requirements are met.

In addition to applying the prevailing wage rates to its own employees, the Contractor shall include the provisions of this Article 4-104 in every subcontract so that such provisions will be binding upon each subcontractor. The Contractor agrees to assume the obligation that the wage requirements will be observed in fulfilling the requirements of the Contract. The appropriate enforcement sanctions will be invoked against the Contractor and any such subcontractor in the event of such subcontractor's failure to comply with any of the provisions of this Article 4-104.

All wage rates to be used are listed in this Contract in Exhibit D. While DOLI maintains a list of wage determinations online for reference purposes, only the wage determinations made in an official Wage Determination Decision, sent by DOLI to Arlington County, can be used to ascertain the exact rates to be paid for this Contract.

All rates are determined by DOLI and any appeals of specific classification may be made through the Wage Determination Appeal form available at http://www.doli.virginia.gov/wp-content/uploads/2021/04/Appeal-for-Wage-Determination-Clarification.pdf.

B. Upon award of the Contract, the Contractor shall certify, under oath, to the Virginia Commissioner of Labor and Industry and to the County Prevailing Wage Compliance Manager, the pay scale for each craft and trade to be employed for, or to provide labor for, in the Work by the Contractor and any subcontractors. The Contractor's certification shall include all information required by the Code of Virginia § 2.2-4321.3G.

C. The Contractor shall ensure that each individual providing labor as a mechanic, laborer, worker or equivalent shall be accurately classified in confirmation with the Wage Determination.

D. The Contractor shall post the prevailing wage rate for each craft and classification involved as determined by DOLI, including the effective date, in a prominent and easily accessible place at the work site during the time work is being performed. The posting must be in English and any other language that is primarily spoken by the individuals at the work site. Within 10 days of such posting the Contractor shall certify to the County Prevailing Wage Compliance Manager and DOLI its compliance with this subsection at https://www.doli.virginia.gov/wp-content/uploads/2021/04/PW_Posting_Compliance_Form.pdf;

E. The Contractor must fully cooperate with the County Prevailing Wage Compliance Manager to ensure contract compliance requirements, including but not limited to site visits, wage rate signage, contractor employee interviews, and the submission of certified payroll records.

F. The Contractor must submit to the County Prevailing Wage Compliance Manager and DOLI, within five (5) working days of the end of each month, certification for each craft or trade employed on the project, specifying the total hourly amount paid to employees, including wages and applicable fringe benefits using the Pay Scale Certification Form at https://www.doli.virginia.gov/wp-content/uploads/2021/04/DOLI-Pay-Scale-Certification-for-Public-Works-Projects.pdf. The certification must itemize the amount paid in wages and each applicable benefit and list the names and addresses of any third party fund, plan or program to which benefit payments will be made on behalf of employees.

G. The Contractor shall indemnify and hold harmless the County from any fines, demands, claims, suits, and damages, including attorney's fees, resulting from the Contractor's or any subcontractor's failure to pay the Prevailing Wage.

H. The Contractor and its subcontractors shall keep, maintain, and preserve (i) records relating to the wages paid to and hours worked by each individual performing the work of any mechanic, laborer, or worker; and (ii) a schedule of the occupation or work classification at which each individual performing the work of any mechanic, laborer, or worker on the construction project is employed each work day and week. The Contractor and its subcontractors shall make such records available to the Prevailing Wage Compliance Manager within 10 days of a request or per a regular schedule established in the Contract, and shall certify that records reflect the actual hours worked and the amount paid to its workers for whatever time period is requested. The Contractor and its subcontractors must preserve these records for a period of six (6) years after the expiration or earlier termination of the applicable contract.

I. Any Contractor or subcontractor who pays any mechanic, laborer, or worker for services under this Contract less than the Prevailing Wage shall be liable to such individuals for the payment of all wages due, plus interest at an annual rate of eight percent (8%) from the dates wages were due; and shall be disqualified from bidding on public contracts with any public body until the Contractor or subcontractor has made full restitution. A willful violation of Article 4-104 is a Class I misdemeanor.

J. For questions regarding Prevailing Wage, please email prevailingwage@arlingtonva.us.

14. <u>RELEASE AND REQUEST FOR FINAL PAYMENT</u>

In order to receive final payment upon Final Completion of the Project and before Final Acceptance, the Contractor must submit to the Project Officer a signed original notarized copy of the Arlington County Release and Request for Final Payment form per the Design Criteria Documents.

15. SELF-PERFORMANCE BY THE CONTRACTOR

The Contractor shall not perform work with its own forces unless the Project Officer provides written authorization for the Contractor to perform any portion of the Work as self-performed work; provided, however, that in no event shall the Contractor self-perform more than 40% of the construction work (measured by cost of the work). All work which the Contractor is not authorized to self-perform shall be performed by subcontractors of the Contractor which the Contractor shall procure by competitive sealed bidding or competitive negotiations as specified in the Contract Documents.

As used in this section, self-performed work shall mean trade work performed by employees of (1) the Contractor; (2) any entity comprising the Contractor; (3) any entity that controls, is controlled by or is under common control with the Contractor; or (4) any entity that controls, is controlled by, or is under common control with any entity that is part of the Contractor.

16. LIQUIDATED DAMAGES

The Project must achieve Substantial Completion within the Time for Completion. The County and the Contractor agree that damages for failure to achieve Substantial Completion of the Work by the date specified under Time for Completion are not susceptible to exact determination but that **$12,000** per calendar day is in proportion to the actual loss that the County would suffer from such delay. Therefore, the Contractor will pay the County as liquidated damages **$12,000** per day for each and every day beyond the time for Substantial Completion that the County determines Substantial Completion has not been achieved. The County and the Contractor also agree that damages for failure to achieve Final Completion of the Work by the date specified under Time for Completion are not susceptible to exact determination but that **$6,700** per calendar day is in proportion to the actual loss the County would suffer from such delay. Therefore, the Contractor will pay the County as liquidated damages **$6,700** per day for each and every day beyond the time for Final Completion until Final Completion is achieved.

The County will be entitled to deduct liquidated damages against any sums owed by the County to the Contractor under this Contract. The Contractor hereby waives any defense as to the validity of any liquidated damages on grounds that such liquidated damages are void as penalties or are not reasonably related to actual damages.

17. COUNTY PURCHASE ORDER REQUIREMENT

County purchases are authorized only if the County issues a Purchase Order in advance of the transaction, indicating that the ordering County agency has sufficient funds available to pay for the purchase. If the Contractor provides goods or services without a signed County Purchase Order, it does so at its own risk and expense. The County will not be liable for payment for any purchases made by its employees that are not authorized by the County Purchasing Agent.

18. LIEN

It is expressly agreed that after any payment has been made by the County to the Contractor for work done, or labor or material supplied under the Contract, the County will have a lien upon all material delivered to the Site either by the Contractor or any subcontractor, or for the Contractor, which is to be used in the performance of the Contract. Upon County’s request, the Contractor shall provide a bill of sale stating that the County is the owner of the materials and equipment purchased by the Contractor under this Contract.

19. EMPLOYMENT DISCRIMINATION BY CONTRACTOR PROHIBITED

During the performance of its work pursuant to this Contract:

A. The Contractor will not discriminate against any employee or applicant for employment because of race, religion, color, sex, sexual orientation, gender identity, national origin, age, disability or on any other basis prohibited by state law. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of this nondiscrimination clause.

B. Notices, advertisements and solicitations placed in accordance with federal law, rule or regulation will be deemed sufficient for meeting the requirements of this section.

C. The Contractor will state in all solicitations or advertisements for employees that it places or causes to be placed that such Contractor is an Equal Opportunity Employer.

D. The Contractor will comply with the provisions of the Americans with Disabilities Act of 1990 ("ADA"), which prohibits discrimination against individuals with disabilities in employment and mandates that disabled individuals be provided access to publicly and privately provided services and activities.

E. The Contractor must include the provisions of the foregoing paragraphs in every subcontract or purchase order of more than $10,000.00 relating to this Contract so that the provisions will be binding upon each subcontractor or vendor.

20. EMPLOYMENT OF UNAUTHORIZED ALIENS PROHIBITED

In accordance with §2.2-4311.1 of the Code of Virginia, as amended, the Contractor must not during the performance of this Contract knowingly employ an unauthorized alien, as that term is defined in the federal Immigration Reform and Control Act of 1986.

21. DRUG-FREE WORKPLACE TO BE MAINTAINED BY CONTRACTOR

During the performance of this Contract, the Contractor must: (i) provide a drug-free workplace for its employees; (ii) post in conspicuous places, available to employees and applicants for employment, a statement notifying employees that the unlawful manufacture, sale, distribution, dispensation, possession, or use of a controlled substance or marijuana is prohibited in the Contractor's workplace and specifying the actions that will be taken against employees for violating such prohibition; (iii) state in all solicitations or advertisements for employees placed by or on behalf of the Contractor that the Contractor maintains a drug-free workplace; and (iv) include the provisions of the foregoing clauses in every subcontract or purchase order of more than $10,000.00 relating to this Contract so that the provisions will be binding upon each subcontractor or vendor.

For the purposes of this section, "workplace" means the site(s) for the performance of the work required by this Contract.

22. SEXUAL HARASSMENT POLICY

If the Contractor employs more than five employees, the Contractor shall (i) provide annual training on the Contractor's sexual harassment policy to all supervisors and employees providing services in the Commonwealth, except such supervisors or employees that are required to complete sexual harassment training provided by the Department of Human Resource Management, and (ii) post the Contractor's sexual harassment policy in (a) a conspicuous public place in each building located in the Commonwealth that the Contractor owns or leases for business purposes and (b) the Contractor's employee handbook.

23. REPLACEMENT OF PERSONNEL AND SUBCONTRACTORS

The County has the right to reasonably reject staff or subcontractors whom the Contractor assigns to the Project. The Contractor must then provide replacement staff or subcontractors satisfactory to the County in a timely manner and at no additional cost to the County. The day-to-day supervision and control of the Contractor's and its subcontractors' employees is the sole responsibility of the Contractor.

The Contractor may not replace key personnel or subcontractors identified in the Agreement without the County's written approval. The Contractor must submit any request to remove or replace key personnel or subcontractors to the County Project Officer at least 15 calendar days in advance of the proposed action. The request must contain a detailed justification, including identification of the proposed replacement and his or her qualifications.

If the approved Project Manager must be absent for an extended period, the Contractor must provide an interim Project Manager, subject to the County's written approval.

If the approved Project Manager resigns or is terminated by the Contractor, the Contractor will replace the Project Manager with an individual with similar qualifications and experience, subject to the County's written approval.

24. FAILURE TO DELIVER

If the Contractor fails to deliver the Work in accordance with the Contract terms and conditions, the County, after notice to the Contractor and the Contractor's failure to cure within a reasonable time as reasonably determined by the County, may procure the Work from other sources and hold the Contractor responsible for any resulting additional purchase and administrative costs. The County shall be entitled to offset such costs against any sums owed by the County to the Contractor. However, if public necessity requires the use of nonconforming materials or supplies, they may be accepted at a reduction in price to reflect any diminution in value as reasonably determined by the County.

25. UNSATISFACTORY WORK

If any of the work done, or material, goods, or equipment provided by the Contractor does not fully comply with the requirements of the Issued for Construction set the Contractor must, upon notice from the County, promptly remove or repair at the Contractor's expense such unsatisfactory work, material, goods, or equipment and replace the same with work, material, goods, or equipment that comply with the Issued for Construction set. If the Contractor fails to commence cure within seven (7) days and thereafter diligently pursue cure at all times, the County shall have the right to remove or replace the rejected work, material, goods, or equipment at the expense of the Contractor and offset the expense and administrative costs against any sums owed to the Contractor. This provision applies during the Contract term and during any warranty or guarantee period. At the Project Officer's discretion, rather than correction or replacement of the work, an appropriate adjustment to the Contract Amount may be made.

26. TERMINATION FOR CAUSE, INCLUDING BREACH AND DEFAULT; CURE

The County may terminate this Contract at any time as follows: (1) for cause, if, the Contractor is in breach or default as described in Paragraph 26.A.1 and by the process described in this Section 26; or (2) for the convenience of the County.

Upon receipt of a notice of termination, the Contractor must not place any further orders or subcontracts for materials, services or facilities; must terminate all vendors and subcontracts, except as are necessary for the completion of any portion of the Work that the County did not terminate; and must immediately deliver all documents related to the terminated Work to the County.
Any purchases that the Contractor makes after the notice of termination will be the sole responsibility of the Contractor, unless the County has approved the purchases in writing as necessary for completion of any portion of the Work that the County did not terminate.

If any court of competent jurisdiction finds a termination for cause by the County to be improper, then the termination will be deemed a termination for convenience.

A. <u>TERMINATION FOR CAUSE, INCLUDING BREACH AND DEFAULT; CURE</u>

1. Termination for Unsatisfactory Performance. If the Contractor fails to perform the Work in accordance with the Contract Documents, including but not limited to (i) failure to provide a sufficient number of skilled workers, (ii) failure to supply the materials required by the Contract Documents, (iii) failure to comply with applicable law, (iv) failure to timely pay subcontractors or Suppliers, (v) failure to prosecute the Work with promptness and diligence in accordance with the Progress Schedule, as such times may be adjusted, (vi) abandonment of the Work or a defined portion thereof, (vii) refusal to remove and replace defective Work at its own cost, (vii) failure to comply with applicable safety requirements, or (viii) failure to perform obligations under the Contract Documents, then the County, in addition to any other rights and remedies provided in the Contract Documents or by law, shall have the rights set forth in Sections 26.2 and 26.3 below.

2. If the Contractor has failed to perform as described in Section 26.1 above, then the County will give the Contractor written notice of such failure(s) and the opportunity to cure them within 15 days or, if cure within such 15-day period is not feasible, such longer period as is required to provide a complete cure, all as reasonably determined by the County ("Cure Period"). If the Contractor fails to cure within the Cure Period, the County may terminate the Contract for failure to provide satisfactory performance by providing written notice with a termination date. The Contractor must submit any request for termination costs, with all supporting documentation, to the County Project Officer within 30 days after the expiration of the Cure Period. The County may accept or reject the request for termination costs, in whole or in part, and may notify the Contractor of its decision within a reasonable time.

   In the event of termination by the County for failure to perform satisfactorily, the Contractor must continue to provide its services as previously scheduled through the termination date, and the County must continue to pay all fees and charges incurred through the termination date.

3. <u>Termination for Breach or Default</u>. If the County terminates the Contract for default or breach of any Contract provision or condition, then the termination will be immediate after notice of termination to the Contractor (unless the County provides for an opportunity to cure), and the Contractor will not be permitted to seek termination costs.

   Upon any termination pursuant to this section, the Contractor will be liable to the County for costs that the County must expend to complete the Work, including costs resulting from any related delays and from unsatisfactory or non-compliant work performed by the Contractor or its subcontractors. The County will deduct such costs from any amount due to the Contractor; or if the County does not owe the Contractor, the Contractor must promptly pay the costs within 15 days of a demand by the County. This section does not limit the County's recovery of any other damages to which it is entitled by law.

Except as otherwise directed by the County, the Contractor must stop work on the date of receipt the notice of the termination.

27. TERMINATION FOR THE CONVENIENCE OF THE COUNTY

A. TERMINATION FOR THE CONVENIENCE OF THE COUNTY
The County may terminate this Contract in whole or in part whenever the Purchasing Agent determines that termination is in the County's best interest. The County will give the Contractor at least 15 days' notice in writing. The notice must specify the extent to which the Contract is terminated and the effective termination date. The Contractor will be entitled to payment for all Work properly executed and for termination costs, including demobilization costs and amounts due in settlement of terminated contracts with subcontractors and Design Consultants, plus any other reasonable amounts that the parties might negotiate; but no amount will be allowed for anticipatory profits.

Except as otherwise directed by the County, the Contractor must stop work on the date of receipt of the notice of the termination.

28. INDEMNIFICATION

The Contractor covenants for itself, its employees and its subcontractors to save, hold harmless and indemnify the County and all of its elected and appointed officials, officers, current and former employees, departments, agencies, boards and commissions (collectively the "County Indemnitees") from and against any and all claims made by third parties for any and all losses, damages, injuries, fines, penalties, costs (including court costs and attorneys' fees), charges, liability, demands or exposure to the extent resulting from, arising out of or in any way connected with the Contractor's negligent or intentionally wrongful acts or omissions, including the negligent or intentionally wrongful acts or omissions of its employees, vendors, delivery drivers and/or subcontractors, in performance or nonperformance of the Contract. This duty to save, hold harmless and indemnify will survive the termination of this Contract. If the Contractor fails or refuses to fulfill its obligations contained in this section, the Contractor must reimburse the County for any and all resulting payments and expenses, including reasonable attorneys' fees. The Contractor must pay such expenses upon demand by the County, and failure to do so may result in the County withholding such amounts from any payments to the Contractor under this Contract.

The Contractor agrees to indemnify, and hold harmless County from any and all damages, costs, claims, expenses, suits, losses, liabilities, or obligations of any kind including without limitation, environmental assessments, evaluations, remediations, fines, penalties, and clean-up costs which may be asserted against or imposed upon, or incurred by the County arising from the Contractor's discharge or disposal of any hazardous or toxic materials, trash, debris, refuse, waste or other materials ("Materials") related in any way to the Contractor's performance of this Contract, except that this indemnity and hold harmless obligation shall not extend to indemnification based upon disposal of hazardous or toxic materials if the Contractor reasonably, after the exercise of due diligence, had no reason to know such materials were hazardous or toxic.

29. ENVIRONMENTAL SERVICES INDEMNIFICATION

A. INSPECTION OF PROPERTY; CONTROL OF HAZARDOUS SUBSTANCES

Before performing any Work under this Agreement, the Contractor will inspect the property that is the subject of the Agreement to determine the existence of any substance or hazardous nature and will take all necessary steps to control any such substance that must be disturbed for Contractor to perform the Work, including clean-up, whether or not on property owned or controlled by the Contractor or the County, in accordance with all applicable laws and regulations.

B. INDEMNIFICATION RELATED TO DISCHARGE OR DISPOSAL OF HAZARDOUS MATERIAL AND GENERAL ENVIRONMENTAL WORK

The Contractor agrees to defend, indemnify and hold harmless the County and all its elected and appointed officials, officers, current and former employees, agents, departments, agencies, board, and commissions (collectively the "County Indemnities") from and against any and all claims for any and all losses, damages, injuries, fines, penalties, costs (including court costs and attorneys' fees), charges, liability, demands or exposure to the extent caused by the Contractor's negligent or intentionally wrongful acts or omissions, including the negligent or intentionally wrongful acts or omissions of its employees and/or subcontractors, in performance or nonperformance of the Contract, including without limitation, environmental assessments, evaluations, remediations, fines, penalties, and clean-up costs that may be asserted against, imposed upon, or incurred by the County arising from the Contractor's discharge or disposal of any hazardous or toxic materials, trash, debris, refuse, waste or other materials ("Materials") related in any way to the Contractor's performance of this Contract. The Contractor agrees that it will dispose of all Materials in strict compliance with local, County, state, and federal statutes, laws, ordinances, codes, rules, regulations, orders, or decrees, and shall provide evidence of such disposal satisfactory to the County on a weekly basis to the County's designated representative. This duty to save, defend, hold harmless and indemnify will survive the termination of this Agreement.

In the event that the Contractor fails to comply with this section, and upon discovery of a failure or violation related to its disposal operations, the Contractor shall immediately report such failure or violation to all applicable governmental agencies having jurisdiction and to the County, and the Contractor shall, at is sole cost and expense, promptly commence and diligently pursue any required investigation, assessment, cleanup, remediation, restoration, and monitoring of any waters and lands affected by the Contractor's failure to comply and restore the damaged water and/or land to the condition existing immediately prior to the occurrence that caused the damage. The provisions of this paragraph shall survive the termination or expiration of this Agreement.

C. ENVIRONMENTAL SERVICES SAFETY

The Contractor shall take reasonable precautions for the safety of and shall provide all reasonable protection to prevent damage, injury or loss to, its employees on the job, and others. The Contractor shall comply with all applicable provisions of federal, state and municipal safety laws, insurance requirements, standard industry practices, the requirements of the operations and this Agreement. The Contractor or its subcontractors shall erect and properly maintain at all times, as required by the conditions and progress of the Work, necessary safeguards for site safety and protection of the public, including securing areas, posting signs, placarding, labeling or posting other forms of warnings against hazards.

D. REMEDIATION OF PRE-EXISTING HAZARDOUS MATERIALS
In no event shall the Contractor be required to take any action that would result in the Contractor being deemed a co-generator of pre-existing hazardous materials. The County shall assume all duties pertaining to the Waste Generator.

30. INTELLECTUAL PROPERTY INDEMNIFICATION

The Contractor warrants and guarantees that in providing services under this Contract neither the Contractor nor any subcontractor is infringing on the intellectual property rights (including, but not limited to, copyright, patent, mask and trademark) of third parties.

If the Contractor or any of its employees or subcontractors uses any design, device, work or material that is covered by patent or copyright, it is understood that the Contract Amount includes all royalties, licensing fees, and any other costs arising from such use in connection with the Work under this Contract.

The Contractor covenants for itself, its employees and its subcontractors to save, hold harmless, and indemnify the County Indemnitees, as defined above, from and against any and all claims, losses, damages, injuries, fines, penalties, costs (including court costs and attorneys' fees), charges, liability or exposure for infringement of or on account of any trademark, copyright, patented or unpatented invention, process or article manufactured or used in the performance of this Contract. This duty to save, hold harmless and indemnify will survive the termination of this Contract. If the Contractor fails or refuses to fulfill its obligations contained in this section, the Contractor must reimburse the County for any and all resulting payments and expenses, including reasonable attorneys' fees. The Contractor must pay such expenses upon demand by the County, and failure to do so may result in the County withholding such amounts from any payments to the Contractor under this Contract.

31. COPYRIGHT

By this Contract, the Contractor irrevocably transfers, assigns, sets over and conveys to the County all rights, title and interest, including the sole exclusive and complete copyright interest, in any and all copyrightable works created pursuant to this Contract. The Contractor will execute any documents that the County requests to formalize such transfer or assignment.

The rights granted to the County by this section are irrevocable and may not be rescinded or modified, including in connection with or as a result of the termination of or a dispute concerning this Contract.

The Contractor may not use subcontractors or third parties to develop or provide input into any copyrightable materials produced pursuant to this Contract without the County's advance written approval and unless the Contractor includes this Copyright provision in any contract or agreement with such subcontractors or third parties related to this Contract.

Any re-use by the County of copyrightable works on other projects or for an extension or expansion of the Project without Contractor's involvement, shall be at the sole risk of the County.

32. OWNERSHIP OF WORK PRODUCT

This Contract does not confer on the Contractor any ownership rights or rights to use or disclose the County's data or inputs.

All work product, in any form, that results from this Contract is the property of the County and must be provided or returned to the County upon completion, termination, or cancellation of this Contract. The

Contractor will not use or allow others to use the work product for any purpose other than performance of this Contract without the written consent of the County.

The work product is confidential, and the Contractor may neither release the work product nor share its contents. The Contractor will refer all inquiries regarding the status of any work product to the Project Officer. At the County's request, the Contractor will deliver all work product, including hard copies of electronic files, to the Project Officer and will destroy all electronic files except where required to keep by law or to meet Corporate obligations, such as audits.

The Contractor must include the provisions of this section as part of any contract or agreement related to this Contract into which it enters with subcontractors or other third parties.

The provisions of this section will survive any termination or cancellation of this Contract.

33. CONFIDENTIAL INFORMATION

The Contractor and its employees, agents and subcontractors will hold as confidential all County information obtained under this Contract. Confidential information includes, but is not limited to, nonpublic personal information; personal health information (PHI); social security numbers; addresses; dates of birth; other contact information or medical information about a person; and information pertaining to products, operations, systems, customers, prospective customers, techniques, intentions, processes, plans and expertise. The Contractor must take reasonable measures to ensure that all of its employees, agents and subcontractors are informed of and abide by this requirement.

34. ETHICS IN PUBLIC CONTRACTING

This Contract incorporates by reference Article 9 of the Arlington County Purchasing Resolution, as well as all state and federal laws related to ethics, conflicts of interest or bribery, including the State and Local Government Conflict of Interests Act (Code of Virginia § 2.2-3100 et seq.), the Virginia Governmental Frauds Act (Code of Virginia § 18.2-498.1 et seq.) and Articles 2 and 3 of Chapter 10 of Title 18.2 of the Code of Virginia, as amended (§ 18.2-438 et seq.). The Contractor certifies that its bid was made without collusion or fraud; that it has not offered or received any kickbacks or inducements from any other offeror, supplier, manufacturer or subcontractor; and that it has not conferred on any public employee having official responsibility for this procurement any payment, loan, subscription, advance, deposit of money, services or anything of more than nominal value, present or promised, unless consideration of substantially equal or greater value was exchanged.

35. COUNTY EMPLOYEES

No Arlington County employee may share in any part of this Contract or receive any benefit from the Contract that is not available to the general public.

36. FORCE MAJEURE

Neither party will be held responsible for delay in performance or failure to perform the duties and responsibilities imposed by this Contract if such failure is due to a fire, riot, rebellion, natural disaster, war, act of terrorism or act of God or other cause that is beyond the control of the party (excluding strikes or other labor disputes at the Project Site), provided that the affected party gives notice to the other party as soon as practicable after the force majeure event, including reasonable detail and the expected duration of the event’s effect on the party.

37. AUTHORITY TO TRANSACT BUSINESS

The Contractor must, pursuant to Code of Virginia § 2.2-4311.2, be and remain authorized to transact business in the Commonwealth of Virginia during the entire term of this Contract. Otherwise, the Contract is voidable at the sole option of and with no expense to the County.

38. RELATION TO THE COUNTY

The Contractor is an independent contractor, and neither the Contractor nor its employees or subcontractors will be considered employees, servants or agents of the County. The County will not be responsible for any negligence or other wrongdoing by the Contractor or its employees, servants or agents. The County will not withhold payments to the Contractor for any federal or state unemployment taxes, federal or state income taxes or Social Security tax or for any other benefits. The County will not provide to the Contractor any insurance coverage or other benefits, including workers' compensation.

39. ANTITRUST

The Contractor conveys, sells, assigns and transfers to the County all rights, title and interest in and to all causes of action under state or federal antitrust laws that the Contractor may have relating to this Contract.

40. REPORT STANDARDS

The Contractor must submit all written reports required by this Contract for advance review in a format approved by the Project Officer. Reports must be accurate and grammatically correct and should not contain spelling errors. The Contractor will bear the cost of correcting grammatical or spelling errors and inaccurate report data and of other revisions that are required to bring the report(s) into compliance with this section.

Whenever possible, reports must comply with the following guidelines:

- printed double-sided on at least 30% recycled-content and/or tree-free paper
- recyclable and/or easily removable covers or binders made from recycled materials (proposals with glued bindings that meet all other requirements are acceptable)
- avoid use of plastic covers or dividers
- avoid unnecessary attachments or documents or superfluous use of paper (e.g., separate title sheets or chapter dividers)

41. AUDIT

The Contractor must retain all books, records and other documents related to this Contract for at least five (5) years, unless otherwise specified in the Contract, or such period of time required by the County's funding partner(s), if any, whichever is greater, after the final payment and must allow the County or its authorized agents to examine the documents during this period and during the Contract Term. The Contractor must provide any requested documents to the County for examination within 15 days of the request, at the Contractor's expense. Should the County's examination reveal any overcharging by the Contractor, the Contractor must, within 30 days of County's request, reimburse the County for the overcharges and for the reasonable costs of the County's examination, including, but not limited to, the services of external audit firm and attorney's fees; or the County may deduct the overcharges and examination costs from any amount that the County owes to the Contractor. If the Contractor wishes to destroy or dispose of any records related to this Contract (including confidential records to which the County does not have ready access) within five (5) years after the final payment, unless otherwise specified in the Contract, or such period of time required by the County's funding partner(s), if any, whichever is greater, the Contractor must give the County at least 30 days' notice and must not dispose of the documents if the County objects.

The Purchasing Agent may require the Contractor to demonstrate that it has the necessary facilities, ability, and financial resources to comply with the Contract and furnish the service, material or goods specified herein in a satisfactory manner at any time during the term of this Contract.

42. ASSIGNMENT

The Contractor may not assign, transfer, convey or otherwise dispose of any award or any of its rights, obligations or interests under this Contract without the prior written consent of the County.

43. AMENDMENTS

This Contract may not be modified except by written amendment executed by persons duly authorized to bind the Contractor and the County.

44. ARLINGTON COUNTY PURCHASING RESOLUTION AND COUNTY POLICIES

Nothing in this Contract waives any provision of the Arlington County Purchasing Resolution, which is incorporated herein by reference, or any applicable County policy.

45. DISPUTE RESOLUTION

All disputes arising under this Agreement or concerning its interpretation, whether involving law or fact and including but not limited to claims for additional work, compensation or time, and all claims for alleged breach of contract must be submitted in writing to the Project Officer as soon as the basis for the claim arises. In accordance with the Arlington County Purchasing Resolution, claims denied by the Project Officer may be submitted to the County Manager in writing no later than 60 days after the final payment. The time limit for a final written decision by the County Manager is 30 days. Procedures concerning contractual claims, disputes, administrative appeals and protests are contained in the Arlington County Purchasing Resolution. The Contractor must continue to work as scheduled pending a decision of the Project Officer, County Manager, County Board or a court of law.

46. APPLICABLE LAW, FORUM, VENUE, AND JURISDICTION

This Contract is governed in all respects by the laws of the Commonwealth of Virginia; and the jurisdiction, forum and venue for any litigation concerning the Contract or the Work is in the Circuit Court for Arlington County, Virginia, and in no other court.

47. ARBITRATION

No claim arising under or related to this Contract may be subject to arbitration.

48. NONEXCLUSIVITY OF REMEDIES

All remedies available to the County under this Contract are cumulative, and no remedy will be exclusive of any other at law or in equity.

49. NO WAIVER

The failure to exercise a right provided for in this Contract will not be a subsequent waiver of the same right or of any other right.

50. SEVERABILITY

The sections, paragraphs, clauses, sentences, and phrases of this Contract are severable; and if any section, paragraph, clause, sentence or phrase of this Contract is declared invalid by a court of competent jurisdiction, the rest of the Contract will remain in effect.

51. ATTORNEY'S FEES

In the event that the County prevails in any legal action or proceeding brought by the County to enforce any provision of this Contract, the Contractor will pay the County's reasonable attorney's fees and expenses

52. CONSEQUENTIAL DAMAGES

Except as set forth in this section, neither the Contractor nor the County shall be liable to the other for any consequential losses or damages, whether arising in contract, warranty, tort (including negligence), strict liability or otherwise, including but not limited to losses of use, profits, business, reputation or financing. The consequential damages limitation set forth in this section is not intended to affect the payment of liquidated damages set forth in the contract documents, even if such liquidated damages might otherwise be deemed to be consequential.

53. SURVIVAL OF TERMS

In addition to any statement that a specific term or paragraph survives the expiration or termination of this Contract, the following sections also survive: INDEMNIFICATION; INTELLECTUAL PROPERTY INDEMNIFICATION; RELATION TO COUNTY; OWNERSHIP AND RETURN OF RECORDS; AUDIT; COPYRIGHT; DISPUTE RESOLUTION; APPLICABLE LAW AND JURISDICTION; ATTORNEY'S FEES, AND CONFIDENTIAL INFORMATION.

54. HEADINGS

The section headings in this Contract are inserted only for convenience and do not affect the substance of the Contract or limit the sections' scope.

55. AMBIGUITIES

The parties and their counsel have participated fully in the drafting of this Agreement; and any rule that ambiguities are to be resolved against the drafting party does not apply. The language in this Agreement is to be interpreted as to its plain meaning and not strictly for or against any party.

56. NOTICES

Unless otherwise provided in writing, all legal notices and other communications required by this Contract are deemed to have been given when either (a) delivered in person; (b) delivered by an agent, such as a delivery service; or (c) deposited in the United States mail, postage prepaid, certified or registered and addressed as follows:

TO THE CONTRACTOR:
Matthew W. Cooke, President/CEO
PC Construction Company
193 Tilley Drive
South Burlington, VT 05403
Office Phone: (802) 651-1248
Cell: (802) 316-37409
Email: mcooke@pcconstruction.com

<u>AND</u>

Ian MacDougall, Vice President/Employee Owner
PC Construction Company
193 Tilley Drive
South Burlington, VT 05403
Cell: (804) 456-6158
Email: imacdougall@pcconstruction.com

TO THE COUNTY:
Mary Strawn, Project Officer
Arlington County, Virginia
3402 S Glebe Road
Arlington, VA 22202
Phone: (703) 228-6829
Email: mstrawn@arlingtonva.us

<u>AND</u>

Dr. Sharon T. Lewis, LL.M, MPS, VCO, CPPB
Purchasing Agent
Arlington County, Virginia
2100 Clarendon Boulevard, Suite 500
Arlington, Virginia 22201
Phone: (703) 228-3294
Email: slewis1@arlingtonva.us

TO COUNTY MANAGER'S OFFICE (FOR PROJECT CLAIMS):

County Manager
Arlington County, Virginia
2100 Clarendon Boulevard, Suite 318
Arlington, Virginia 22201

57. <u>NON-DISCRIMINATION NOTICE</u>
Arlington County does not discriminate against faith-based organizations.

58. <u>INSURANCE, PAYMENT AND PERFORMANCE BONDS</u>
As a condition of executing the Agreement, the Contractor will be required to furnish payment and performance bonds in the amount of the GMP. The Contractor shall maintain the insurance coverage required in Exhibit H to the Agreement, as well as and payment and performance bonds, through completion of the Contract, including all warranty and guarantee periods.

In the event the Contractor is insured with limits in excess of those specified in the Exhibit H, the Contractor's said obligation shall extend up to but not exceed the limits of the insurance. The Contractor's costs to undertake the duty or obligation to defend the County in connection with such liabilities shall not be limited by or be subject to the aforesaid limits for damages for injuries, deaths, and property damage.

Should any provisions of this Agreement be determined by a court of competent jurisdiction to be illegal or in conflict with any applicable law, the validity of the remaining provisions shall not be impaired.

59. MATERIAL CHANGES

The Contractor shall notify Purchasing Agent within seven days of any material changes in its operation that relate to any matter attested regarding certifications in its Request for Qualifications.

60. SUSPENSION OF WORK

If the County suspends the Work, in whole or in part, pursuant to Article C(7) of the General Conditions, the Contractor may submit a request for an Excusable Compensable Delay, which will be reviewed per the terms of the Agreement. No Excusable Compensable Delay will be provided for suspensions resulting from work that is proven to be non-conforming.

61. SEPARATE CONTRACTS

This Section 61 is intended to supplement the provisions regarding Separate Contract in Article C(14) of the General Conditions. All provisions of Article C(14) of the General Conditions not amended by this Section shall remain in effect.

A. The County reserves the right to let other contracts in connection with this Project. The Contractor shall afford other contractors reasonable access to the Project including storage of their materials and the execution of their work, and shall properly connect and cooperate with the County in the County's coordination of the Work of the Contractor and the work of other such contractors.

B. The Contractor's inspection obligation shall be limited to visual inspection unless otherwise agreed by the Contractor and the County.

C. The County shall include in its contracts with separate contractors in connection with the Project an indemnification clause that would require the separate contractor to indemnify the County against any claims arising from that contractor's actions or omissions in its contracts with separate contractors in connection with the Project.

62. USE OF COMPLETED PORTIONS

If the County exercises its right to take possession and use of completed or partially completed portions of the Work under Article F(5) of the General Conditions, then prior to the County taking possession and use of any such portion of the Work, the County and Contractor shall agree in writing on the responsibilities assigned to each of them for payments, retainage release, if any, warranty, security, maintenance, heat, utilities, damage to the Work and insurance. Immediately prior to such partial occupancy or use, the County, Contractor, and Engineer shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work. Warranties for completed or partially completed portions of the Work shall not occur prior to successful completion of required Demonstration and Performance Tests as specified in General Requirements Section 01 75 00, as may be modified by the GMP Amendment.

63. TITLE TO MATERIALS

The Contractor must provide reasonable proof that it has title to materials or supplies (i.e., an invoice from the supplier is provided as part of the pay application to the County, etc.) as a condition to invoicing or receiving payment from the County for such materials or supplies. The Contractor may invoice for stored materials regardless of the scheduled time for incorporation into the Project, including invoicing and payment for materials stored off-site, provided the requirements of Article G(2) of the General

Conditions are met (other than providing bills of sale). The requirement for evidence of insurance shall be satisfied if Contractor provides evidence of temporary storage coverage under Contractor's builder's risk insurance.

64. COUNTERPARTS

This Agreement may be executed in one or more counterparts and all of such counterparts shall together constitute one and the same instrument. Original signatures transmitted and received via facsimile or other electronic transmission (e.g., PDF or similar format) are true and valid signatures for all purposes hereunder and shall be effective as delivery of a manually executed original counterpart.

WITNESS these signatures:

THE COUNTY BOARD OF ARLINGTON COUNTY, VIRGINIA	PC CONSTRUCTION COMPANY DBA PCEO, INC.
AUTHORIZED SIGNATURE: DocuSigned by: Sharon Lewis C4DE3DF7EC1D421...	AUTHORIZED SIGNATURE: DocuSigned by: Matthew W. Cooke AE213CDC16694C4...
NAME: Dr. Sharon T Lewis	NAME: Matthew W Cooke
TITLE: Purchasing Agent	TITLE: President / CEO
DATE: 1/31/2024	DATE: 1/25/2024

EXHIBIT A

SCOPE OF WORK

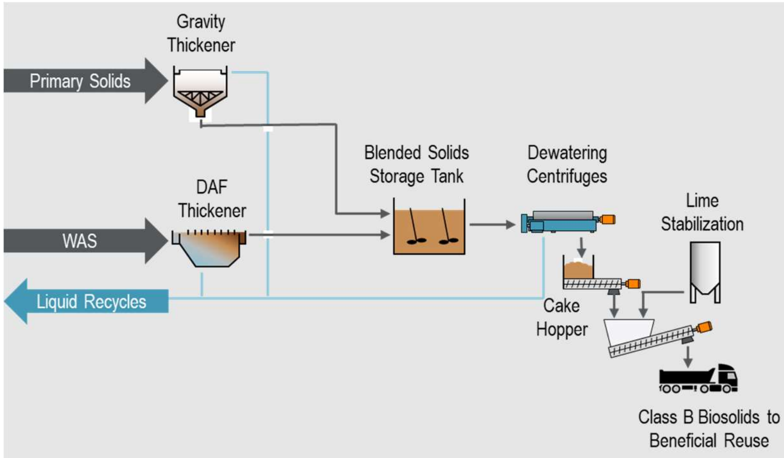
This Scope of Work defines the Work required for the successful Design-Builder (hereinafter referred to as "Contractor") to implement the new biosolids management facilities (hereinafter referred to as the "Project" or "Biosolids Upgrades") at the Arlington County Water Pollution Control Plant (WPCP) located at 3402 S. Glebe Road, Arlington, VA 22202. The County has developed conceptual documents (hereinafter named "RFP Plans") for the Biosolids Upgrades as Exhibit B. The RFP Plans represent 5-10% design documents for the Project. The County seeks to work collaboratively with the Contractor to make decisions, finalize the design, implement construction, and commission the Biosolids Upgrades. Arlington County's current proposed Capital Improvement Program value for this Project (Phase 10 C/D) is approximately $175 million.

A1. GENERAL INTENT

A1.1 Project Background. Arlington County has an advanced wastewater treatment plant with enhanced nutrient removal to meet stringent discharge permit limits. The permitted capacity of the WPCP is 40 million gallons per day (mgd) with a current average daily flow of approximately 21 mgd. The existing Arlington WPCP liquid treatment process generally includes:

- Preliminary treatment (screenings and grit removal)
- Primary settling with ferric chloride addition for phosphorus removal
- Primary effluent flow equalization
- Step-feed activated sludge process for nutrient removal
- Secondary clarification
- Effluent denitrification filters
- Sodium hypochlorite disinfection
- Sodium bisulfite dechlorination
- Associated wet weather facilities
- Associated ancillary facilities

Solids are produced from the primary settling tanks and waste activated sludge (WAS) from the activated sludge process. The existing solids handling processes include thickening, dewatering, and Class B lime stabilization as depicted in the figure below.

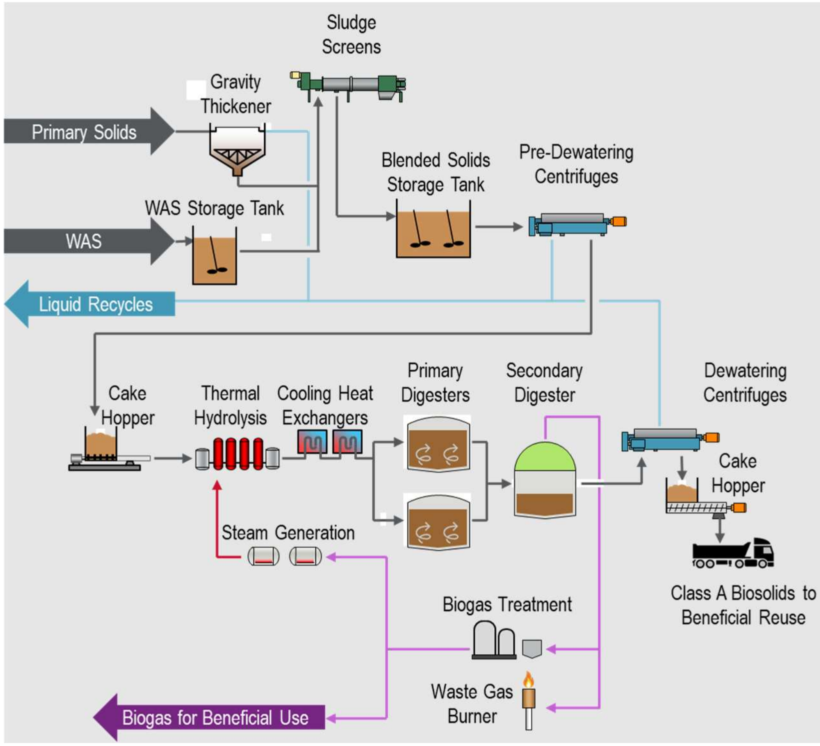


A1.2 Project Description. The Biosolids Upgrades includes the following key components. The Biosolids Upgrades shall be constructed within a constrained site with limited areas for laydown, staging, and contractor parking. The existing treatment processes will need to remain in operation during construction, or temporary facilities will need to be put in place.

- Liquid solids storage tanks
- Solids screens
- Pre-dewatering facility in either new building or repurposed existing dewatering building
- Thermal hydrolysis process (THP) (equipment to be pre-selected by Arlington County)
- Primary and secondary anaerobic digesters
- Final dewatering facility to be housed in a new building
- Biogas treatment
- Steam generation
- Odor control
- All ancillary (electrical, HVAC, plumbing, fire protection, instrumentation, etc.) facilities to make a complete and functional operating facility.

The Contractor shall include all work required to implement the Biosolids Upgrades including, but not limited to, the engineering, design, construction, startup, and initial maintenance and operation for a mutually agreed to scope, price and duration, necessary to add sustainable equipment and systems to effectively recover the County's renewable resources, produce a Class A biosolids product, and most efficiently utilize the biogas. The Contractor shall be responsible for the performance of the new solids handling processes, including meeting pre-defined performance metrics.

The overall process flow diagram for the Biosolids Upgrades is shown in the figure below.



The Biosolids Upgrades shall run efficiently at expected start-up process conditions. The following flows and solids production have been established for the new solids handling processes:

- **Start-up, 2028:** 23.0 mgd, 30.7 dry tons per day (dtpd) average pre-dewatered solids
- **Design year, 2052:** 30.8 mgd, 41.1 dtpd average pre-dewatered solids
- **Build-out:** 40.0 mgd, 56.1 dtpd average pre-dewatered solids

The Biosolids Upgrades shall be designed to process the expected design year (2052) solids production, with space allocated for additional facilities to process the solids production at build-out conditions.

A1.3 Project Mission Statement and Goals. The Contractor shall adhere to the following mission statement for the Project:

> *Upgrade resource recovery facilities to produce Class A biosolids and renewable energy, maximizing sustainability and community acceptance. Collaborate with team members to select and implement processes that are safe, reliable, and financially responsible throughout planning, design, construction, operations, and maintenance.*

The County has established the following overarching goals for the project. The Contractor shall consider the goals throughout the implementation of the Project.

1. **Produce a Class A Exceptional Quality (EQ) end product:** high-quality, low-odor product suitable for beneficial use and reduced risk of regulatory impact for land application. **Note:** the County will separately be developing marketing plans for the Class A EQ end product.

2. **Recover biogas for beneficial use:** recovering and beneficially using renewable resources to help achieve County-wide sustainability goals

3. **Provide ease of maintenance and repairs:** easy to work with equipment, updated technology with high efficiency, and long-term ability to find replacement parts

4. **Keep safety in mind:** throughout process, design, construction, and ongoing operations

5. **Apply proper process selection and configuration:** appropriate choice of processes, well-designed and coordinated across the entire system, reliable with adequate redundancy

6. **Implement an open, transparent, and collaborative process between all team members**

7. **Achieve and maintain community acceptance:** maintain “good neighbor” status, including during construction, and produce an outcome that is an asset to the community

8. **Implement cost-effective solutions:** make the most out of the investment

9. **Develop operator friendly solutions**: comprehensive training on reliable and accessible equipment with clear operations and maintenance (O&M) and troubleshooting guidance

10. **Design for long-term reliability:** eliminate nuisance-causing, aging equipment and processes

11. **Actively engage staff throughout process:** during design, construction, startup, and training

12. **Ensure that staff are well prepared to operate and maintain the new processes:** via comprehensive training, ample transition time, and appropriate staffing levels for new systems

A1.4 RFP Plans and Reference Package. The RFP Plans (Exhibit B) are included with this solicitation. The RFP Plans establish the technical scope, minimum design criteria, County preferences, and County requirements for the Work. The RFP Plans furnished by the County are preliminary and subject to stated limitations and reservations.

The RFP Plans include the following:

1. Facilities Plan and Drawings: The Facilities Plan (FP) establishes the technical scope and design criteria for the Project. The FP Appendices document all of the evaluations provided to date. The FP is an all-encompassing document for the Arlington Re-Gen Program. Work associated with the Gravity Thickeners described in the FP will be completed by others.

2. Early Work Documents: The Early Work Documents provide additional details on the projected scope of the Early Work to facilitate development of a preliminary guaranteed maximum price (GMP) for this work. The following are included with these documents:
    a. Preliminary Drawings
    b. Preliminary Specifications
    c. Preliminary Geotechnical Report, with a focus on information needed to design supported excavation
    d. AutoCAD survey file
3. General Requirements: The General Requirements include specifications that define specific aspects of the Design-Build work.
4. Virginia Pollutant Discharge Elimination System (VPDES) Permits
5. WPCB Contractor Safety Standard

The RFP Plans further specify that the Contractor must implement the following Biosolids Upgrades scope requirements:

Item	Notes	RFP Plans and Scope Reference
Utility Relocation	Relocation of drain and chemical facilities to allow for demolition of abandoned structures.	FP Section 17 FP Section 22 Early Work Documents
Demolition of Abandoned Facilities	Demolition of existing Bio-Building and abandoned digesters.	FP Section 22 Early Work Documents
Site Preparation and Supported Excavation	Preparation for construction while maintaining access for operations, taking into account the topography of the site.	FP Section 17 Early Work Documents
Site Investigations	Geotechnical exploration and site survey to confirm design conditions.	FP Section 17 Early Work Documents Design Confirmation
Solids Storage Tanks	Un-thickened and thickened solids storage (four separate tanks).	FP Section 7
Solids Screening	Screening of all solids and collection of screenings for disposal.	FP Section 6
Pre-Dewatering	Pre-dewatering centrifuges and associated equipment. The Contractor shall work with County on the final determination if these should be in a new building or within the existing dewatering building.	FP Section 8
Pre-Dewatered Cake Storage and Thermal Hydrolysis Process (THP) Feed	Cake storage to allow for wide spot between pre-dewatering and THP feed, with progressive cavity pumps for feeding the THP system.	FP Section 8 FP Section 9
Thermal Hydrolysis Process (THP)	THP including all relevant interconnections and steam generation facilities. Arlington County will be pre-selecting the THP equipment vendor concurrently with this	FP Section 9 FP Section 10

Item	Notes	RFP Plans and Scope Reference
	solicitation.	
Anaerobic Digestion (AD) Facilities	Two primary digesters and one secondary digester, with biogas membrane storage. Provisions for a fourth digester in the future. Final site location is to be developed.	FP Section 11 FP Section 12
Final Dewatering Facilities	New building with final dewatering centrifuges and associated equipment, with cake storage and drive-through truck loading.	FP Section 13
Biogas Handling Systems	All components to safely convey biogas and treat for ultimate beneficial use.	FP Section 14
Odor Control Facilities	Best available technology to maintain good neighbor status.	FP Section 15

Additionally, the RFP Plans further include, but do not limit, the following design and construction disciplines for the Biosolids Upgrades.

Item	Notes	RFP Plans and Scope Reference
Civil/site	Grading, supported excavation, utilities, stormwater, surveying	FP Section 17
Geotechnical	Investigation, deep foundation design, and installation	FP Section 17 Design Confirmation
Architectural	Match existing architectural character, code compliance, sustainability	FP Section 18
Structural	Foundations, water-containing structures, multi-story construction, code compliance	FP Section 18
Process mechanical	Hydraulics, pumping, mixing, dewatering, biogas handling, steam handling, material handling, pipe design	FP Sections 5-15 General Requirements
Heating, ventilation and air conditioning	Code compliance, determination of conditioned spaces, sustainability	FP Section 18
Plumbing	Code compliance	FP Section 18
Life-safety and fire protection	Code compliance	FP Section 18
Electrical	Medium-voltage distribution, low-voltage distribution, electrical systems design, code compliance	FP Section 19

Item	Notes	RFP Plans and Scope Reference
Instrumentation and process control	Instruments, process control, system integration services, startup and testing	FP Section 20

The RFP Reference Package (Attachment C) is included with this solicitation and includes the following:

1. As-Built Drawings
2. 31st Street South Parking Lot Site Plan
3. THP/AD Pilot Study Documentation
4. Previous Hazardous Materials Investigations
5. FRP Inspection Report dated August 23, 2022
6. Arlington Plant Data
7. WPCB Contractor Safety Brochure
8. WPCB Stormwater Pollution Prevention Plan
9. WPCB Spill Prevention, Control and Countermeasures Plan

Note: The RFP Reference Package is for information only and is not to be considered Contract Documents. The Contractor shall conduct its own research into the existing facilities and sub-surface conditions prior to completing design.

A1.5 Design Standards. The design and construction work for the Project shall be performed in accordance with the RFP Plans, applicable federal and state laws, and Arlington County Standards, Specifications, and Reference Materials to include, but to not be limited to, the documents listed herein. The Contractor must verify and use the latest version of the documents listed herein as of the date of the issuance of this RFP or the latest RFP Addenda. Where conflicts exist between the Design Standards listed below, the most stringent requirement shall apply. The Contractor may consult with the Project Officer to provide necessary interpretation when conflicts between the Design Standards are not readily resolvable.

If during the course of the design, the Contractor determines that a specific Standard, Specification, or Reference Material is required but is not listed herein, it is the responsibility of the Contractor to identify the pertinent Standard, Specification, or Reference Material and submit it to the County, as applicable, for review and approval prior to inclusion in the Contract Documents.

The standards and references for the Project are listed below in the following order: (a) Standards and Specifications; (b) Reference Materials. Items (a) and (b) are published references that are available publicly, for which copies are not provided to the Offerors in Exhibit B, but these items are to be used as manuals for design and construction.

(a) Standards and Specifications

- Arlington County Code
- Arlington County Zoning Ordinance
- Arlington County DES Construction Standards and Specifications
- Arlington County Stormwater Management Ordinance
- Arlington County Stormwater Manual

- [Arlington County CADD Standards and Guidelines]
- [Arlington County Land Disturbing Activities (LDA) Permit Information]

(b) Reference Materials

- American Concrete Institute (ACI)
- American Iron and Steel Institute (AISI)
- American National Standards Institutes (ANSI)
- American Society of Heating, Refrigerating and Air Conditioning Engineers(ASHRAE)
- American Society of Mechanical Engineers (ASME)
- American Society for Testing and Materials (ASTM)
- American Welding Society (AWC)
- Institute of Electrical and Electronics Engineers (IEEE)
- InterNational Electrical Testing Association (NETA)
- National Electric Code (NEC)
- National Electrical Manufacturer's Association (NEMA)
- National Fire Protection Agency (NFPA)
- National Institute of Standards and Technology (NIST)
- Society for Protective Coating (SSPC)
- Standards of Hydraulic Institute (HI)
- Standards of American Water Works Association (AWWA)
- Underwriters Laboratories (UL)
- Other Codes, Standards and Reference Manuals as referenced in the Facilities Plan and General Requirements

A1.6 Contractor's Duties. The Contractor's work shall be divided into two phases: (i) the Design Confirmation Phase and (ii) the Implementation Phase.

Phase 1: Design Confirmation Phase. During the Design Confirmation Phase, the Contractor will meet with County representatives and other stakeholders to discuss the RFP Plans and incorporate any revisions to the RFP Plans that may be requested by the County or recommended by the Contractor and agreed to by the County. At the conclusion of the Design Confirmation Phase, the County and the Contractor will have agreed on a Basis of Design, which will form the basis for the iterative design process that will follow during the Implementation Phase.

Phase 2: Implementation Phase. The Implementation Phase will have three stages: the Early Work Design Implementation Stage, Design Implementation Stage (including Pre-Construction Services), and the Construction Implementation Stage (the "Implementation Stages").

During the Early Work Design Implementation Stage, the Contractor will: (i) finalize the design and budget for the Early Work; and (ii) develop, negotiate, and agree on a GMP for the Early Work.

During the Design Implementation Stage the Contractor will: (i) advance the design and budget for the Main Project in iterative steps, each involving the review and input of the Project Officer, such that at the end of this stage, the Contractor will have produced, and the Project Officer will have approved, a full set of plans and specifications necessary to construct the Project in accordance with the requirements of the Contract (such approved documents will be the "Issued for Construction (IFC) Set"; (ii) submit for and receive all necessary permits and approvals from local, state, and federal authorities (the “Code Officials”); and (iii) provide pre-construction services, including development of various Construction Management Plans and development, negotiation, and agreement of a Guaranteed Maximum Price (GMP) for each phase of the work.

During the Construction Implementation Stage, the Contractor shall construct, start-up, and commission the Project (Early Work and Main Project) in accordance with the IFC Sets and the Contract Documents.

A1.7 Design Professionals. The Contractor shall, in a manner consistent with applicable state licensing laws, provide the necessary design services, including architectural, engineering, and other design professional services, during all project phases through its use of qualified and licensed design professionals employed or subcontracted by Contractor (“Design Professionals”). The Contractor shall be responsible for the quality and soundness of the Design Professional services, including responsibility for all acts and omissions of the Design Professionals.

A1.8 Order of Work. The Contractor has been selected, in part, based on its experience with managing design-build projects and managing the design process. It is understood that with respect to any specific element of Work, such element of Work will proceed sequentially through the Implementation Stages in the order described herein (i.e., each such element of Work shall proceed through the Design Confirmation Stage, Design Implementation Stage, and then the Construction Implementation Stage). It is understood, however, that different elements of Work may be in different Implementation Stages at the same time, and in this sense, the Work which the Contractor performs may overlap the Implementation Stages.

A1.9 Guaranteed Maximum Price Contract. This Agreement is a guaranteed maximum price (GMP) contract. Adjustments to the GMP can only be made in accordance with the terms of this Agreement. See Section A5.3 for further details.

A1.10 Compliance with Design Criteria Documents. The Contractor must design and construct the Project in accordance with all Contract Documents, which includes the RFP Plans (Exhibit B) and Scope of Work as described herein. Accordingly, all of the documents required to be produced during the Design Confirmation Phase and Design Implementation Stage must conform to the Design Criteria, unless otherwise approved in writing by the County.

A2 PROJECT MANAGEMENT

A2. 1 General. The Contractor shall manage and administer the Project in accordance with the below requirements.

1. Manage and administer the Project to provide oversight of the design, value engineering, construction reviews, permitting, scheduling, cost estimating, invoicing, and progress reports.
2. *Monthly Progress Reports.* Prepare and submit reports with application for payment for Work completed during the prior pay period. Include an earned value analysis with the monthly progress reports. Compare the earned value to actual expenditures for the pay period and overall duration for each major work area.

3. *Draft Design submittals:* Provide seven (7) printed copies to County and one electronic copy in Adobe PDF format saved to e-Builder. Provide notice to the County when documents are submitted for review.
   a. The County will review draft submittals and consolidate review comments.
   b. Review comments and record responses and/or actions shall be resolved within seven (7) calendar days of receiving comments. Comments requiring further discussion or work to resolve shall be brought to the attention of the County within the same seven (7) calendar days.
4. *Final Design Submittals:* Provide seven (7) printed copies and an electronic copy in Adobe PDF format saved to e-Builder.
5. *Documents and Formats*
   a. Reports and Specifications provided in the latest versions of Microsoft Word and Adobe Acrobat.
   b. Drawings provided in the latest versions of AutoCAD and Revit, Navisworks and Adobe Acrobat.
   c. Schedule provided in the latest version of Microsoft Project and Primavera P6 scheduling software.
   d. Cost Estimates provided in the latest version Adobe Acrobat and native file shall be used to develop the estimate.
6. *Scheduling and Conducting Meetings:* The Contractor shall schedule meetings a minimum of 21 days in advance, provide an agenda one week in advance, and provide draft presentation materials for the meeting 48 hours in advance. Non-substantive updates to the draft may be developed by the Contractor during the 48 hours in advance timing. During the presentation, the Contractor will identify non-substantive updates made. Non-substantive updates for the purpose of this provision are defined as items that do not affect the major topics of the meeting nor impact decision-making. The Contractor shall record meeting notes and distribute draft notes within seven (7) days after the meeting for review and comment to the County.
7. Utilize e-Builder for functions as directed by the County. Functions include, but are not limited to, uploading the following:
   a. Deliverables
   b. Monthly progress reports
   c. Invoicing
   d. Construction submittals, requests for information, and other documentation

A2.2 Project Management Plans. The Contractor shall submit Project Management Plans for the Project in accordance with the below requirements. All Project Management Plans shall be submitted to the County for review within 90 days of the Notice to Proceed (NTP) and revised per County comments. The Contractor shall document all responses to County comments in a comment response log.

1. *Project Management Plan (PMP).* The Contractor shall develop a plan that clearly shows how the Project will be managed and executed. Plan should include a Quality Management Plan (QMP) that describes the design QA/QC program as discussed in Section A2.3.

2. *Communications Plan.* The Contractor shall develop a plan that clearly shows how the Project communication will be conducted. The Communications Plan shall include a procedures and escalation matrix for issue resolution.
3. *Cost Modeling Plan*. The Contractor shall develop and maintain a Cost Model Plan for the overall Project budget. The Cost Model Plan shall be updated and tracked to ensure Project is tracking within budget.
4. *Building Information Modeling (BIM) and Asset Management Plan*. The Contractor shall develop a BIM execution plan.
   a. At a minimum, all discipline design work excluding civil shall be completed in BIM (Revit software system, 2020 or later). Some drawings that are generated using 2D AutoCAD in nature are acceptable, such as General, Demolition, Process and Instrumentation Diagrams (P&IDs), etc. All civil design work shall be completed in AutoCAD Civil 3D.
   b. The Contractor shall identify key staff roles and responsibilities, including the BIM model manager and key design staff with BIM responsibilities.
   c. The Contractor shall assign facility numbering convention with input and approval of County.
   d. The Contractor shall identify asset management and data requirements.
   e. The Contractor shall describe electronic and hard copy deliverable requirements.
   f. The Contractor shall identify how 3-D models will be reviewed and provided to the County for review.
5. *Change Management Register.* The Contractor shall document scope and schedule changes associated with completion of Work by using a Decision Log, which describes the major issues that arise during the Design Confirmation and Implementation Stages, and provide a status of each item for County to review during the core team meetings.
6. *Risk Register.* The Contractor shall develop and maintain a risk register. The Contractor shall update the risk register monthly and submit it with the monthly progress report for review in every other core team meeting.
7. *Permitting Plan.* The Contractor shall develop a permitting and regulatory approval plan that identifies all necessary information required for permit approval, including but not limited to applications, permits, documents, and forms as required by Governmental Bodies, Utilities, and other authorities with jurisdiction. The Contractor shall incorporate the approval times for permits (as defined in the Permitting Plan) in the schedule.

A2.3 Design Quality Assurance and Quality Control (QA/QC). Notwithstanding any quality assurance provided by the County or its agents, the Contractor is responsible for the design quality of the Project. The Contractor shall ensure design documents are professionally reviewed and checked to ensure quality. The Contractor shall provide a QMP that details the Contractor's QA/QC Program to include:

1. Design review processes
2. Design QC tasks, including technical review, checking of calculations, and review of drawings and specifications
3. Approval process to release IFC Set
4. Incorporation of County review comments. **Note:** The County reviews shall not relieve the Contractor of its contractual obligations.

5. Design review techniques and cross discipline reviews, including inter-milestone reviews and formal milestone reviews
6. Schedule and resources for QA/QC activities

A2.4 Core Team Meetings. In addition to workshops detailed later in this document, the Contractor shall conduct weekly core team meetings during the Design Confirmation and Implementation Stages with key County leadership and project management staff. The Contractor's core team shall include the Contractor's Project Manager, Design Manager, Pre-Construction Manager and Construction Manager at minimum. The core team for the County will include key County and County Program Manager leadership and project management staff. Core team meetings shall have a standing agenda and shall be limited to one hour in duration.

A2.5 Executive Committee Meetings. The parties agree to establish an executive committee, consisting of the Contractor executive leadership, the WPCB Chief, the Project Officer, and the County Program Manager. This executive committee shall meet quarterly to review project issues and develop resolutions. The executive committee shall also be responsible for creating a resolution ladder for escalating and resolving issues in the event such issues arise.

A2.6 Partnering. Partnering is a formal management process in which all parties to a project voluntarily agree at the outset to adopt a cooperative, team-based approach to project development and problem resolution. The parties agree that partnering or other tools will be utilized to promote collaboration with the goal of achieving successful performance. The County and the Contractor shall use good faith efforts to promote the formation of a successful formal partnering relationship. This partnering relationship will be implemented through formal partnering workshops. The County, the County Program Manager, and Contractor will participate in partnering workshops as they mutually agree is necessary and appropriate (no less frequently than every four months). The purpose of the partnering workshops will be to deepen working relationships, develop common goals and objectives for the Project, achieve a cooperative partnership environment, address critical issues and team collaboration, and develop a successful partnering relationship. The scheduling of partnering workshops and selection of facilitator and location will be managed by the County.

The preceding paragraph expresses the intent and spirit of the partnering process, and nothing stated herein or in any formal partnering statements developed shall change in any way the rights, responsibilities, and obligations set forth in the Agreement. Any formal partnering statement developed will not be a part of the Agreement and will not modify any defense, claim, obligation, or right that otherwise exists.

A2.7 Community Outreach. The County has implemented a robust community engagement process for the upgrades. The community engagement process includes outreach to neighboring civic associations and other organizations, a dedicated website, and an advisory stakeholder group with periodic meetings where feedback is received on the overall project. The Contractor may be called upon to make presentations, provide written updates to the website or community listservs, or conduct other outreach as requested by the County.

A2.8 Subcommittees. Below is an initial list of potential subcommittees to be utilized on this project. The purpose of the subcommittees is to encourage collaboration by aligning the Contractor subject matter experts with the County to discuss specific topics or issues, develop potential solutions

or concepts that are then brought forward to the larger project team. Some of these committees will have very specific scopes with a short lifespan such as the Initial Estimate and Digester Mixing Committees. Other subcommittees will be ongoing groups that will remain active through construction, like Instrumentation & Controls, and Startup and Commissioning.
With the exception of the Community Relations group, all subcommittees will be administered by the member of the Contractor team. The asterisk (*) below indicates that the work of the subcommittee will likely result in a workshop with the larger team to discuss and approve recommendations.

Technical Topics

- Biogas Upgrading System / WGL Integration*
- Existing Dewatering Building Disposition*
- Dewatering Building Programming (New/Existing/Combination)*
- Instrumentation & Controls (I&C)
- Electrical Power Feed
- Permitting
- Site Plan / Digester Configuration / Current and Future*
- Digester Mixing*
- THP Cooling Arrangement*
- Plant Effluent Water Modeling*
- Early Work Development / Centrate Line

Other

- MOPO
- Startup and Commissioning/PGs/Testing*
- Initial Estimate/Budget Determination
- Inflation Reduction Act (IRA), Water Infrastructure Finance and Innovation Act (WIFIA) and State Revolving Loan Fund (SRLF) Funding
- Early Equipment Procurement*
- Community Relations (Led by Arlington County/HDR)

A2.9 Coordination with Other and Interrelated Projects On Site. It is understood that other projects will be taking place on-site, near and related to the biosolids improvements project. The Contractor will work collaboratively with the County and other contractors to ensure cooperation and communication between these projects. The Contractor will develop Maintenance of Plant Operations (MOPO) plans as defined in A5.2.4. The plan will specifically identify the delineation points between the projects and the work necessary to maintain plant operations. Those projects are as follows:

1. Gravity Thickener Rehabilitation: It is understood that this project will be designed by one of Arlington County's on-call engineers. The Contractor shall be responsible for identifying a suitable tie-in location for connecting the Gravity Thickeners to new Solids Storage Tanks as a part of the Main Project.
2. Renewable Natural Gas Interconnection: It is understood that there will need to be significant coordination with Washington Gas to finalize the connection details and location of the interconnection. The Contractor will be responsible for Work up to the point of interconnection with the natural gas utility.
3. Connection of the Centrate Drain Line to Potomac Interceptor: It is understood that the manhole for the connection to the interceptor will be provided by others. The contractor is responsible for the demolition of the existing centrate line and to route and tie-in a new

centrate drain line to that manhole. Additionally, the Contractor will provide means to periodically pump centrate to the primary clarifier effluent box.

A3. DESIGN CONFIRMATION PHASE

A3.1 General Understandings. The RFP Plans provide preliminary design criteria for the Project. The purpose of this phase of work is to work collaboratively to further define and value engineer the project at the conceptual stage, finalize the design criteria established in the Facilities Plan, establish additional design criteria, develop and understand engineering standards and best practices for equipment layout, develop equipment and material preferences, and understand and plan for any Site impacts discovered during geotechnical investigations. The Facilities Plan and Early Work Documents were prepared by the County. The Facilities Plan represents a 5-10% level of design and the Early Work Documents represent a 20-30% level of design (*reference Exhibit B)*.

A3.2 Meetings and Workshops. The following are the anticipated meetings and workshops during this phase. Where appropriate and with agreement of the Project Officer, multiple workshops across different phases can be combined into single meetings. The Contractor shall prepare all materials and meeting notes for the presentation. Meeting presentations shall be distributed to attendees 48 hours prior to the meeting.

- Project Kickoff/Visioning Workshop
- Facilities Plan Review Workshop
- Site Plan Selection Workshop
- Additional Studies Workshop
- Value Engineering Workshop 1
- Value Engineering Workshop 2

A3.3 Baseline Milestone Schedule. Within 30 days of issuance of the NTP for the Design Confirmation Stage, the Contractor shall prepare and submit a detailed baseline milestone schedule for all significant milestones to take place during the Project (the "Baseline Milestone Schedule") that is consistent with the requirements of the RFP Plans. The Contractor shall provide the County with regular updates to the Baseline Milestone Schedule on a monthly basis. Schedule shall be prepared in accordance with Exhibit B General Requirements Section 01 32 16.

A3.4 Design Confirmation Process to Achieve Basis of Design. The RFP Plans form the foundation of the design confirmation work and provide preliminary design criteria for the Project. Through meetings, workshops and written documents, the Contractor shall develop and refine the design for the Project set forth in the RFP Plans in coordination with the County. The Contractor shall include alternatives and value engineering recommendations in workshops as part of this verification process. The Contractor shall conduct evaluations, calculations, conceptual cost estimating, scheduling, workshops, and other services to establish and document the final "Basis of Design".

The parties mutually agree that firm decisions should be made during the Design Confirmation Phase meetings. To that end, the Contractor shall provide all necessary information, in the form of presentation materials, to make decisions prior to the meeting, with an explanation of their recommendation at the meeting. The County will provide attendance of County personnel at the meetings to facilitate decision-making. Should decisions fail to be made in the allotted meetings, the Project Officer and the Contractor Project Manager will confirm the approach to finalize the decisions.

A3.4.1 **Additional Studies.** The Contractor shall conduct the following additional studies in accordance with the Facilities Plan:

- Final Site Plan Configuration
- Disposition of Existing Dewatering Building
- Digester Mixing Type
- THP Cooling Arrangement
- Gas Upgrade Equipment Evaluation including Redundancy Approach
- Plant Effluent Water Modeling for confirmation of Plant Effluent Water distribution

A3.4.2 **Value Engineering.** After the Contractor has completed the initial review of the RFP Plans, the Contractor and County shall meet in a two-day workshop setting to review the RFP Plans and evaluate value engineering (VE) concepts. The Contractor shall develop value engineering concepts based on their review of the RFP Plans. Agreed upon concepts for further review or implementation shall be documented in meeting minutes by the Contractor. A second 1-day workshop shall be conducted to finalize the design criteria and modifications to concepts provided in the RFP Plans.

A3.4.4 **Design Confirmation Memorandum.** Upon completing the Design Confirmation Phase, the Contractor shall prepare a Design Confirmation Memorandum that summarizes the design criteria for each process and facility. The Design Confirmation Memorandum shall serve to document concurrence with the RFP Plans or clearly identify any changes or deficiencies in the RFP Plans. The purpose of the memorandum is to finalize all project design criteria necessary to proceed with 30% design.

A3.4.5 **Control Budget.** At the end of the Design Confirmation Phase, the Contractor shall prepare and submit for the County's review and approval a detailed line-item budget for the Project based on the Design Confirmation Memorandum (the "Control Budget"). The Control Budget estimate shall be organized in accordance with Section A5.2.6.

A3.5 **Site Conditions Review and Verification.** The Contractor shall complete a comprehensive review of the Site and contiguous areas, including regulatory requirements that may impact the Project. The Contractor shall verify all existing conditions that may be affected by the design, even if record drawings exist. All field investigations at the Site shall be coordinated with the County. The Contractor shall accumulate and review applicable data, criteria, codes, standards, regulations, and other information pertinent to the Project.

A3.5.1 **Information Provided by or on Behalf of the County.** The County makes no representation or warranty with respect to any information provided to the Contractor on behalf of the County, except as provided in the paragraph below. The Contractor shall assess all risks related to the Project and independently verify and confirm all information required for the completion of the Project.

The Contractor is entitled to reasonably rely on the following information provided by the County:

1. Raw Solids Projections (Section 3 of the Facilities Plan). The Contractor shall review the

historical raw solids projections, but shall use its own process models for projecting overall system performance and capabilities;

2. All other sections of the RFP Plans, as it relates to the Design Confirmation Phase only;
3. Project Site Survey, with limitations noted in the survey documents;
4. Geotechnical Evaluation Report, as it relates to the Early Work Design Implementation Stage only; and
5. VPDES Permits.

A3.5.2 Existing Conditions and Survey. The Contractor shall review existing conditions information about the Site provided by the County, including record drawings, previous geotechnical information, hazardous materials studies, and other information as appropriate. The Contractor shall make provisions to obtain additional information regarding subsurface and physical conditions as they specifically relate to the Site and as necessary to properly design and construct the Work.

The Contractor may also complete Light Detection and Ranging (LiDAR) 3-D surveys of the existing facilities, as needed to support their design efforts.

A3.5.3 Underground Utilities. The Contractor shall engage the services of a utility location subcontractor to identify, designate, locate, and map existing and abandoned utility infrastructure for the Project. The results of the utility infrastructure mapping shall be provided in a summary report to the County.

A3.5.4 Geotechnical Investigations. The geotechnical report provided in the RFP Plans was completed to inform the design of potential supported excavation for the Early Work Package and may be relied upon for that purpose only. The Contractor shall conduct additional geotechnical investigations at the Site to develop geotechnical and structural design criteria for the facilities not covered in the Early Work Package, as well as may be needed for stormwater Best Management Practices (BMPs). All geotechnical evaluations shall be planned and performed under the direct supervision of a Professional Geotechnical Engineer registered in the Commonwealth of Virginia, working under the Design Professional.

The following prerequisites are required prior to initiating any geotechnical investigations:

1. Submit a detailed work plan to the County, including boring plan and emergency procedures.
2. Complete a utility conflict investigation prior to finalizing the boring plan.
3. Survey and stake boring locations with a licensed surveyor.
4. Clear the boring location with a utility locating firm to confirm that not utilities exist in the area of the planned borings.
5. Conduct a field meeting to review boring locations prior to drilling. Representatives from the Professional Geotechnical Engineer, Contractor, and County shall be present at this meeting.

The Contractor shall summarize the results of the geotechnical investigations in a Geotechnical Report, describing soil and groundwater conditions. The geotechnical reports shall make specific recommendations on soil parameters, foundation types (including deep foundations), allowable loadings, and dewatering during construction. **Note:** Due to the proximity of neighbors and the requirement that the County facilities must remain in operation, there is a preference for drilled piles over driven piles, should deep foundations be required. The Contractor shall meet with the County to summarize the recommendations from the Geotechnical Report and finalize the report after receipt of County comments.

A3.5.5 Hazardous Materials Investigations. Hazardous Materials surveys have been completed most recently at the WPCP in 2003. These surveys are included with the RFP Reference Package, and indicate the presence of non-friable asbestos-containing materials in the Bio-Building, and identify a number of surfaces coated with lead-based paint.

The Contractor shall complete additional Hazardous Materials surveys for facilities and equipment to be demolished. The Contractor shall survey for all reasonably anticipated Constituents of Concern, including but not limited to lead-based paint, asbestos-containing materials, polychlorinated biphenyls (PCBs), mercury, and chlorofluorocarbons. The Contractor shall develop a site-specific sampling plan, including access to interstitial spaces, mechanical chases, and incinerator equipment evaluation. Existing as-built drawings are provided with the RFP Reference Package.

As the majority of the Bio-Building has been abandoned since the late 1990’s and the safety of existing access points, stairs, ladders, landings, etc. are not guaranteed, the Contractor shall include safety requirements and confined space entry procedures as part of the site-specific sampling plan.

The Contractor shall submit a summary report to the County with the results of the survey and recommended management procedures for removing and disposing of all Constituents of Concern demolition waste in compliance with all Federal, State, and local regulations.

A3.6 End of Design Confirmation Phase. The Design Confirmation Phase shall conclude when the parties (i) agree upon the Basis of Design through the Design Confirmation memo (which shall replace the RFP Plans as the basis from which further design documents shall be produced); (ii) establish, in the Baseline Milestone Schedule, the revised Substantial and Final Completion Dates for the Project, if needed; and (iii) execute a Contract amendment, if necessary.

A4. – A5.4.3 IMPLEMENTATION PHASE

The Implementation Phase shall consist of the Design Implementation Stage and the Construction Implementation Stage. The Implementation Phase shall commence when the County issues a Notice to Proceed for the Design Implementation Stage (the “Implementation NTP”).

A4. EARLY WORK DESIGN IMPLEMENTATION STAGE

A4.1 Early Work Design Implementation Stage General Understandings. Preliminary Early Work requirements are provided in the RFP Plans and include the design and construction of the following:

1. Installation of buried, relocated thickened sludge lines to avoid areas of Biosolids Upgrades construction, with tie-ins to existing sludge lines outside of the sludge storage tanks and inside

the Dewatering Building. The RFP Plans show potential relocation for the Renovate Dewatering Building option. This option is shown not as a preference but as an example of potential sludge line rerouting. Final relocation shall be coordinated with the site configuration confirmed during the Design Confirmation Phase.

2. Relocation of the centrate drain to the Potomac Interceptor. Arlington County will contract separately to install a new manhole to the Potomac Interceptor on the Site, as shown on the RFP Plans. The Contractor shall tie a new centrate drain line to this manhole and shall be responsible for twice per year pump-around (during construction) of the centrate to primary clarifier effluent channel as described in Exhibit B: General Requirements Section 01 14 16.
3. New chemical fill stations for polymer and sodium hypochlorite at the Dewatering Building, including all necessary power and controls.
4. Conversion of existing Polymer Blend Tank No. 3 to bulk polymer storage, including all necessary fill, drain, vent, transfer, and instrument connections.
5. New polymer transfer pump (including shelf spare) with associated piping and controls for transferring from new bulk storage tank to existing Polymer Bend Tank Nos. 1 and 2, including all necessary power and controls. New system shall integrate with existing process controls for polymer fill and dilution.
6. Demolition of existing polymer and sodium hypochlorite bulk storage systems in the Bio-Building.
7. Demolition of all abandoned facilities in the existing Bio-Building, including abandoned ferric chloride storage tanks, abandoned incinerators and associated equipment, abandoned HVAC facilities, and all electrical facilities.
8. Abandonment of all utilities to and from the existing Bio-Building.
9. Temporary construction to allow for continued safe use of the tunnel between the Bio-Building and Dewatering Building.
10. Hazardous material abatement of facilities and structures to be demolished. Hazardous materials surveys are included with the Design Confirmation Phase and an allowance is included in the Cost Proposal for abatement costs.
11. Demolition of the Bio-Building structure and all internal components, including foundations.
12. Demolition of remaining foundation and walls of abandoned digesters.
13. Earth retention systems as necessary to support the demolition and prepare the site for future work.
14. Protection of existing structures during demolition and construction activities, including vibration and movement monitoring as specified in Exhibit B: General Requirements Section 01 71 33.
15. Site backfill and stabilization after demolition to prepare the site for future construction while also allowing for proper site drainage.
16. All necessary electrical and instrumentation work to maintain existing Dewatering Building

operations.

17. All necessary sediment and erosion control and construction stormwater management to facilitate the Work.

The Work shall comply with the Arlington County DES Standard Specifications and the RFP Plans, as may be modified through the design process. The final scope and design requirements of the Early Work shall be determined by the Contractor, in consultation with the County based on the results of the Design Confirmation Phase and expected benefits to the project. The Contractor shall obtain approval from the County Project Officer to proceed with the Early Work Design Implementation Stage through a written Notice-to-Proceed. Pre-construction Services and GMP Development as referenced in Section A5.2 are applicable to Early Work Design Implementation and shall be completed as necessary in parallel to Early Work Design to inform the overall Early Work Design Implementation Stage.

A4.2 Design Development (65% Design Document). The Contractor shall submit a set of Design Development documents to the Project Officer for review and approval. The Design Development documents shall be a logical development of the RFP Plans and the Design Confirmation Phase. The Design Development shall be an iterative and collaborative process, involving the Contractor and County. Operational and shutdown considerations shall be fully established. The overall level of percent completion for each discipline drawings and specification shall be agreed upon at the completion of the Design Confirmation Memorandum and be based on evaluation of the risk register. The Design Development documents shall serve as the basis for the Early Work GMP.

A4.2.1 Design Development Package Requirements. The Design Development package shall include the following drawings, specifications, documents, and BIM model:

1. Drawings
   a. Cover Sheets
   b. General Drawings
      i. List of Drawings
      ii. Overall site plan
      iii. Drawing symbols, numbering & tagging conventions, symbols, and abbreviations
   c. Demolition Drawings
      i. Demolition limits
      ii. Protection of existing structures
   d. Civil Drawings:
      i. General Notes
      ii. Details
      iii. Overall site key plans for site plan, grading plans, erosion and sediment control plans, and yard piping plans.
      iv. Erosion and sediment control and phasing drawings
      v. Yard piping, paving, grading, and stormwater drawings
   e. Structural Drawings
      i. General notes
      ii. Plans, and sections

iii. Details

f. Process Mechanical Drawings

i. Plans, sections, and details

g. Electrical Drawings

i. General notes, symbols, abbreviations

ii. Single line diagrams

iii. Project Facility electrical plans

h. Instrumentation Drawings

i. Legends and symbols

ii. P&IDs

iii. Instrumentation control diagrams

2. Specifications

a. Table of contents

b. Major Equipment Specifications

c. Concrete Specifications

d. Electrical Specifications

e. Instrumentation Specifications

f. Piping and valve specifications

g. Functional descriptions

A4.2.1.2 County Review of and Response to Design Development Package. The County will submit review comments within twenty-eight (28) calendar days to the Contractor. Review comments will be consolidated for the Contractor's review and response. The Contractor shall respond to the comments and record responses and/or actions required to resolve items within seven (7) calendar days of receiving comments. The Contractor's responses requiring further discussion shall be brought to the attention of the County within the same seven (7) calendar days.

A4.2.1.3 Early Work Guaranteed Maximum Price. After resolving County comments on the Design Development submittal, the Contractor shall submit a GMP Proposal to the Project Officer for review. The basis for the Early Work GMP shall be the Design Development Documents with County comments addressed, resulting in the Contractor development of a set of Early Work GMP Drawings and Specifications. Adjustments to the GMP Proposal can only be made in accordance with the terms of this Agreement. Refer to Section A5.3 for additional information.

A4.3 Design Completion. With written approval of the County, the Contractor shall complete the design per the requirements of this section.

A4.3.1 Construction Documents (95% Design Document). The Contractor shall submit Construction Documents to the Project Officer for review and approval. The Construction documents shall be consistent with and a logical development of the Early Work GMP Drawings and Specifications and represent 95% design completion. The Construction Documents shall include all adjustments and decisions made by the parties during negotiation of the GMP.

A4.3.2 Construction Documents County Review and Response. The County will submit consolidated review comments within twenty-eight (28) calendar days to the Contractor. Review of Construction Documents by the County shall be for compliance with the GMP Drawings and Specifications and not subject to design concept changes by either party without formal change authorization from the County.

A4.3.3 Issued for Construction (IFC) Set (100% Design Document). The Contractor shall submit an IFC Set to the Project Officer for review and approval. The IFC Set shall be consistent with and a logical development of the Construction Documents, the Permit Set, and the County's comments from the Construction Documents. The IFC Set shall represent 100% design, inclusive of all design necessary for receipt of all permits, and be prepared, signed and sealed by a professional engineer registered in the Commonwealth of Virginia. The County will review the IFC set for compliance with the GMP Drawings and Specifications and will not subject the design to concept changes without formal change authorization from the County. Within fourteen (14) days after the IFC Design Documents submission, the Project Officer will meet with the Contractor and provide any comments on the IFC Set. The Contractor shall make such revisions as necessary to incorporate comments, feedback and other direction provided by the Project Officer. The Project Officer shall have the right to disapprove the IFC Set for any reason. Notwithstanding the design-build nature of this Contract, the Contractor shall be required to fully and faithfully implement the IFC Set unless the Contract is amended and such amendment to the IFC Set is approved by the Project Officer.

A4.3.4 Design Changes. If unforeseen circumstances beyond the control of the Contractor or changes required by the County make it necessary to amend any of the approved IFC Set, the Contractor shall prepare an amendment to the IFC Set and submit such amendment to the County for review and approval. In this submittal, the Contractor shall highlight (or bubble) any aspect of the design in the IFC Set that represent a material deviation and shall address in a narrative format the impact, if any, such departure shall have on the Project's aesthetics, functionality, or performance. Refer to Exhibit B: General Requirements Section 01 33 00 – Submittal Procedures for additional information.

A4.4 Meetings and Workshops. The following are the anticipated meetings and workshops during the Early Work Design Implementation Stage to allow the County to review the progress of design and provide feedback prior to GMP submission. The Contractor shall prepare all materials and meeting notes for the presentation. Meeting presentations shall be distributed to attendees 48 hours prior to each meeting.

1. Design Development Progress Workshop

2. Design Development Review Workshop

A5.1. DESIGN IMPLEMENTATION STAGE

A5.1.1 General Understandings. The Design Implementation Stage includes development of all design documents for the remaining work (not including Early Work) herein after referred to as the Main Project. Pre-construction Services (Section A6) applicable to Design Implementation shall be completed as necessary in parallel to inform the overall Design Implementation Stage.

A5.1.2 Schematic Design (30% Design Document). The Contractor shall submit a set of Schematic Design Documents to the Project Officer for review. The Schematic Design documents shall be consistent with and a logical development of the Design Confirmation Memorandum and the RFP Plans and represent 30% design completion. The Schematic Design shall be an iterative and collaborative process, involving the Contractor and County. Review of the Schematic Design will focus on function and overall layout of the new facilities. To that end, operating descriptions and process and instrumentation diagrams (P&IDs) shall be fully developed. In addition, the overall site plan and building footprints shall be established.

A5.1.2.1 Schematic Design Package Minimum Requirements. The Schematic Design package shall include the following:

1. Site surveys (as described in Section A3.5)
2. Geotechnical Report
3. Equipment data sheets for all major equipment
4. Drawings:
    a. General Drawings
        i. List of Proposed Drawings
        ii. Overall Site Plan
        iii. Solids process flow diagram
        iv. Solids mass balance diagram
        v. Design criteria
    b. Civil Drawings:
        i. Site key plans
        ii. Existing site plan
        iii. Future site plan
        iv. Preliminary yard piping, paving, grading, and stormwater drawings
    c. Structural Drawings:
        i. Floor plans
    d. Architectural Drawings:
        i. Floor plans
        ii. Elevations
    e. Process Mechanical Drawings
        i. Plans and sections
    f. Plumbing, Heating, Ventilation and Air Conditioning (HVAC) and Fire Protection

Drawings:

   i. Schedules

g. Electrical Drawings
   i. Main switchgear single line diagram
   ii. Load schedules
   iii. Preliminary single line diagrams
   iv. Preliminary electrical distribution site plan
h. Instrumentation Drawings
   i. Control system block diagrams/network architecture
   ii. P&IDs

5. Specifications:
   a. Complete list of specifications in a table of contents
   b. Identification of standard Contractor specifications intended for use
   c. Functional descriptions
   d. Pipe material schedule
   e. Valve and gate schedules
6. Three-dimensional BIM model
7. Special studies
   a. *Noise study during construction and operations.* The Contractor shall evaluate noise impacts from construction and operations on the surrounding community. The Contractor shall provide recommendations for noise mitigation.
   b. *Vibration study during construction and operations.* The Contractor shall evaluate vibration impacts from construction and operations on the surrounding community. The Contractor shall provide recommendations for vibration mitigation.
   c. *Electrical loads and load shedding.* It is anticipated that load shedding may be required during peak loads when the WPCP's current existing generators are operating at peak WPCP demands. The Contractor shall confirm solids handling electrical loads and identify loads that could be shed, if needed, during generator operation.

A5.1.2.2 County Review of and Response to Schematic Design Package. The County will submit Schematic Design review comments within twenty-eight (28) calendar days to the Contractor. Review comments will be consolidated in Microsoft Excel file and uploaded to e-Builder for the Contractor's review and response. The Contractor shall respond to the comments and record responses and/or actions required to resolve items within seven (7) calendar days of receiving comments. The Contractor's responses requiring further discussion shall be brought to the attention of the County within the same seven (7) calendar days.

A5.1.2.3 Meetings and Workshops. The following are the anticipated meetings and workshops during development of the Schematic Design deliverables. The Contractor shall prepare all materials and meeting notes for the presentation. Meeting presentations shall be distributed to attendees 48 hours prior to each meeting.

- BIM/Asset Management Workshop
- Equipment and Material Preference Workshop
- Discipline Specific Workshop(s)
- Major Facility Layout Workshop
- Site Plan Layout Workshop
- Three Miscellaneous Workshop to be scheduled as needed
- Schematic Design Handoff Workshop
- Schematic Design Review Workshop

A5.1.3 **Value Engineering.** The Contractor and County shall conduct a value engineering (VE) review of the Schematic Design over a five-day work session. The County (or designated representative) will lead and facilitate the VE proceedings as described herein. The VE review shall include the following subtasks.

A5.1.3.1 **VE Team.** The Contractor shall nominate three (3) members within their organization(s) that are not directly involved with project execution. The County will select one Contractor team member for the VE Team from this list of candidates and name members of its own staff, County Program Manager's staff, and outside consultants' staff to participate.

A5.1.3.2 **Attend Initial and Final VE Sessions.** The Contractor shall attend one half-day session at the commencement of the VE workshop intended to present the Schematic Design to the VE team. The initial session will be attended by the Contractor project manager, design manager, construction manager, lead estimator, lead scheduler, lead engineers, and other key members as deemed necessary. The VE Team will meet for another 3.5 days to develop value engineering ideas. The Contractor project team shall be available for consultation throughout the workshop. The Contractor shall attend one half-day session at the conclusion of the VE workshop where the findings of the VE team will be presented to the Contractor and County team. The conclusion session will be attended by the same individuals identified for the initial session.

A5.1.3.3 **Assistance in VE Alternatives Analysis and Report Preparation.** The VE Team will present the results of the VE analysis in a VE report. The Contractor and County shall review the report and assist in evaluation of and response to each item raised by the VE Team. The analysis will be discussed with the County in a follow-up workshop. After this follow-up workshop, the final disposition of value engineering recommendations and associated cost savings will be documented by the Contractor for incorporation into the design accordingly.

A5.1.4 **HAZOP Workshop.** The County Program Manager will facilitate a four (4) day Hazard and Operability (HAZOP) Workshop with the Contractor. The HAZOP study is a critique of the design as it stands with respect to its ability to meet its design intent in a safe and efficient manner. It will consider materials of construction and plant layout. The HAZOP study will identify potential hazards and failure modes but does not quantify the frequency or likelihood of such hazards occurring. The study will identify deviations from the design intent that may lead to poor operational performance, may lead to process failure, may adversely affect the safety of personnel operating the installation (and third parties), or may affect the environment. It is up to the Contractor's Design Professional to implement mitigation for these deviations, as appropriate. Not all deviations may require mitigation. At a minimum, the Contractor shall make available the following personnel to participate in the HAZOP:

1. Design Build Project Manager
2. Design Manager
3. Pre-Construction Manager
4. Lead process engineers for each facility
5. Lead electrical engineer
6. Lead instrumentation and controls engineer
7. Commissioning and Operations Start-up Manager

Fourteen (14) days prior to the HAZOP workshop, the Contractor shall provide updated P&IDs and electrical one-line diagrams to the County. The County will provide a facilitator and appropriate process experts. The County's engineering, operations, and maintenance personnel will also attend. The County will document the results of the workshop in a series of worksheets, including deviations identified and possible mitigation. The Contractor shall finalize these worksheets with final mitigation techniques and recommendations. The worksheets will be used throughout the completion of design to track compliance with the recommendations. The date of the HAZOP workshop will be mutually agreed upon by the parties, but should occur between the Schematic Design and Design Development deliverables.

A5.1.5 Design Development (65% Design Document). The Contractor shall submit a set of Design Development Documents to the Project Officer for review and approval. The Design Development documents shall be a logical development of the Schematic Design, accepted VE recommendations and HAZOP workshop, and incorporate all previous County comments. The Design Development shall be an iterative and collaborative process, involving the Contractor and County.

P&IDs and functional descriptions shall be at 100% design completion and the design shall be advanced to a level to fully convey the operational and maintenance requirements for the County. The overall level of percent completion for each discipline drawings and specification shall be agreed upon at the completion of the Schematic Design and be based on evaluation of the risk register. The purpose of this approach is to identify critical design development by engineering discipline that is necessary to develop a reasonable GMP. The Design Development documents shall serve as the basis for the GMP.

A5.1.5.1 Design Development Package Minimum Requirements. The Design Development package shall include the following drawings, specifications, documents, and BIM model.

1. Drawings
    a. Cover Sheets
    b. General Drawings
        i. List of Drawings

ii. Overall site plan
iii. Drawing symbols, numbering and tagging conventions, symbols, and abbreviations
iv. Solids process flow diagram
v. Solids mass balance diagram
vi. Design criteria

c. Civil Drawings:
   i. General Notes
   ii. Details
   iii. Overall site plans for existing site plan, grading plans, erosion and sediment control plans, and yard piping plans
   iv. Erosion and sediment control and phasing drawings
   v. Yard piping, paving, grading, and stormwater drawings
d. Structural Drawings:
   i. General notes
   ii. Plans and sections
   iii. Details
e. Architectural Drawings:
   i. General notes
   ii. Schedules
   iii. Code classification
   iv. Floor plans
   v. Roof Plans
   vi. Elevations
   vii. Sections and details
f. Process Mechanical Drawings
   i. Plans, sections, and details
   ii. Schedules (heat trace and insulation, etc.)
g. Plumbing, Heating, Ventilation and Air Conditioning (HVAC) and Fire Protection Drawings:
   i. Schedules
   ii. Plumbing isometric drawings
   iii. Plans, sections and details
h. Electrical Drawings
   i. General notes, symbols, abbreviations
   ii. Main switchgear single line diagram
   iii. Load schedules
   iv. Single line diagrams
   v. Electrical distribution site plan
   vi. Project Facility electrical plans
   vii. Lighting and receptacle plans
   viii. Lightning protection and grounding plans
i. Instrumentation Drawings
   i. Legends and symbols

  ii. Control system block diagrams/network architecture
  iii. P&IDs
  iv. Instrumentation control diagrams
2. Specifications
   a. Table of contents
   b. Contractor’s standard specifications for procurements
   c. Major Equipment Specifications
   d. Concrete Specifications
   e. Electrical Specifications
   f. Instrumentation Specifications
   g. Piping and valve specifications
   h. Functional descriptions
   i. Balance of specifications
3. Three-dimensional BIM model

A5.1.5.2 County Review of and Response to Design Development Package. The County will submit review comments within twenty-eight (28) calendar days to the Contractor. Review comments will be consolidated in Microsoft Excel file and uploaded to e-Builder for the Contractor’s review and response. The Contractor shall respond to the comments and record responses and/or actions required to resolve items within seven (7) calendar days of receiving comments. The Contractor’s responses requiring further discussion shall be brought to the attention of the County within the same seven (7) calendar days.

A5.1.5.3 Main Project Guaranteed Maximum Price. After resolving County comments on the Design Development submittal, the Contractor shall submit a GMP Proposal to the Project Officer for review. The basis for the Main Project GMP shall be the Design Development Documents with County comments addressed, resulting in the Contractor development of a set of Main Project GMP Drawings and Specifications. Adjustments to the GMP Proposal can only be made in accordance with the terms of this Agreement. Refer to Section A5.3 for additional information.

A5.1.5.4 Meetings and Workshops. The following are the anticipated meetings and workshops during development of the Design Development deliverables. The Contractor shall prepare all materials and meeting notes for the presentation. Meeting presentations shall be distributed to attendees 48 hours prior to each meeting.

1. Process Controls Narrative Workshop
2. Discipline Specific Coordination Meetings
3. Utility Coordination Meetings
4. Asset Management Workshop
5. Commissioning and Testing Workshop
6. Miscellaneous Workshop(s)
7. Design Development Handoff Workshop

8. Design Development Review Workshop

A5.1.6 Design Completion. With written approval of the County, the Contractor shall complete the design per the requirements of this section.

A5.1.6.1 Construction Documents (95% Design Document). The Contractor shall submit Construction Documents to the Project Officer for review and approval. The Construction documents shall be consistent with and a logical development of the Main Project GMP Drawings and Specifications and represent 95% design completion. The Construction Documents shall include all adjustments and decisions made by the parties during negotiation of the GMP.

A5.1.6.2 Construction Documents County Review and Response. The County will submit consolidated review comments within twenty-eight (28) calendar days to the Contractor. Review of Construction Documents by the County shall be for compliance with the Main Project GMP Drawings and Specifications and not subject to design concept changes without formal change authorization from the County.

A5.1.6.3 Issued for Construction (IFC) Set (100% Design Document). The Contractor shall submit an IFC Set to the Project Officer for review and approval. The IFC Set shall be consistent with and a logical development of the Construction Documents, the Permit Set, and the County's comments from the Construction Documents. The IFC Set shall represent 100% design, inclusive of all design necessary for receipt of all permits, and be prepared, signed and sealed by a professional engineer registered in the Commonwealth of Virginia. The County will review the IFC Set for compliance with the GMP Drawings and Specifications and not subject the design to concept changes without formal change authorization from the County. Within fourteen (14) days after the IFC Set submission, the Project Officer will meet with the Contractor and provide any comments on the IFC Set. The Contractor shall make such revisions as necessary to incorporate comments, feedback and other direction provided by the Project Officer. The Project Officer shall have the right to disapprove the IFC Set for any reason. Notwithstanding the design-build nature of this Contract, the Contractor shall be required to fully and faithfully implement the IFC Set unless the Contract is amended and such amendment to the IFC Set is approved by the Project Officer.

A5.1.6.4 Design Changes. If unforeseen circumstances beyond the control of the Contractor or changes required by the County make it necessary to amend any of the approved IFC Set, the Contractor shall prepare an amendment to the IFC Set and submit such amendment to the County for review and approval. In this submittal, the Contractor shall highlight (or bubble) any aspect of the design in the IFC Set that represent a material deviation and shall address in a narrative format the impact, if any, such departure shall have on the Project's aesthetics, functionality, or performance. Refer to Exhibit B: General Requirements Section 01 33 00 – Submittal Procedures for additional information.

A5.2 PRE-CONSTRUCTION SERVICES

A5.2.1 General Understandings. The Pre-construction Services shall be integrated with and completed in conjunction with the Early Work and Design Implementation Stages.

A5.2.2 Subcontracting and Procurement Plan. The Contractor shall develop a subcontracting and procurement plan and submit to the County for review and approval. The Contractor shall provide a separate draft plan for the Early Work at least 28 days prior to submittal of Early Work Design Development, and a final plan no later than the submittal of the Early Work GMP. For the Main Project, the Contractor shall provide a draft no later than the submittal of Schematic Design and a final no later than the submittal of Design Development.

The Contractor shall conduct any Subcontractor or Supplier proposal process on an "open book" basis and shall allow the County to observe the receipt and analysis of all proposals. The Contractor shall use commercially reasonable best efforts to obtain at least three (3) qualified and bona fide bids for each trade package. The Contractor shall carefully document its procedures for making bid packages available to potential bidders, the contents of each bid package, discussions with bidders at any pre-bid meetings, bidders' compliance with bid requirements, all bids received, the Contractor's evaluations of all bids, and the basis for the Contractor's recommendation as to which bidders should be chosen. The County shall be afforded access to all such records at all reasonable times so that, among other things, it may independently confirm the Contractor's adherence to all Contract requirements.

The Contractor shall develop a plan that describes how the Contractor will conduct procurement activities to bid work packages and develop the GMP. The following shall be included in the subcontracting and procurement management plan:

1. Discussion of how management of procurement processes from developing procurement documents through contract closure will occur
2. Identification of work packages and potential subcontractors, including subcontractor outreach required to meet the objectives of receiving a minimum of three (3) qualified and bona fide bids
3. Detailed scopes of work for each work package
4. Identification of work packages for which the Contractor may wish to self-perform, including procedures for establishing a fair market price for the self-performance packages. No self-performance work will be allowed without Project Officer approval of the procedures and specific work packages. Final approval of self-performance work will come with approval of the GMP.
5. Identification of "open book" processes to solicit County input in selection of equipment and materials, including evaluated proposals to obtain best value for the County
6. Guidance for the types of contracts to be used and comparison to County developed independent estimates and standardized documents
7. Handling of long-lead items
8. Procedures for preparation and negotiation of the GMP
9. Anticipated continuation of procurement activities after agreement on the GMP but prior to issuance of a Notice to Proceed for construction

A5.2.3 Project Schedule and Updates. The Contractor shall prepare an overall Project Schedule that includes all phases of the Work. The Contractor shall submit a finalized baseline schedule within 30 days of Notice to Proceed for construction. At a minimum, the schedule shall include:

1. Start date for each activity
2. Finish date for each activity
3. Major milestones dates
4. Key design milestones and bid packages
5. Release dates for long lead items
6. Release dates for key subcontractors
7. Meeting and workshop dates
8. Submittal dates including draft submission dates and County review periods
9. Substantial and final submission dates
10. Identification of critical path
11. Float

Schedules shall be submitted as electronic files in native and Adobe Acrobat PDF format. Refer to Exhibit B: General Requirements Section 01 32 16 for additional details.

A5.2.4 Maintenance of Plant Operations Plan. During design, the Contractor shall develop a draft Maintenance of Plant Operations Plan (MOPO) that ensures continuous, dependable operation of the Arlington WPCP, including meeting its regulatory requirements. The Contractor shall submit separate plans for the Early Work and Main Project. For Early Work, the Contractor shall submit a draft no later than submittal of Design Development and a final no later than submittal of the Early Work GMP. For the Main Project, the Contractor shall submit a draft no later than submittal of Schematic Design and a final no later than submittal of Design Development. Topics to address include, but are not limited to: maintaining the ability at all times to haul dewatered solids from the plant for permitted uses; protection of existing structures that are to remain in service during and after construction; construction phasing; major shutdowns; tie-ins; and temporary operations. Any temporary treatment facilities required will be the responsibility of the Contractor. The Contractor shall describe its processes and procedures to adhere to Exhibit B: General Requirements Section 01 14 16.

A5.2.5 Constructability Reviews. Within 28 days of each design submittal milestone, the Contractor shall provide constructability reviews of the design at each submittal milestones (including Early Work). The constructability reviews shall be structured reviews of the design package deliverables to confirm the documents are coordinated, biddable, and constructable. The Contractor shall provide recommendations and improvements to the construction without impacting the functionality of the Project. The Contractor shall submit Constructability Review comments to the County and Design Professional for review.

A5.2.6 Project Cost Estimates. The Contractor shall provide a construction cost estimate within 28 days of submission of each design milestone. Each cost estimate submittal shall represent an “open-book” cost estimate detailing both the direct and indirect cost components.

The Contractor shall submit cost estimates with the following organization:

1. Cost estimate summary memorandum
2. Attachment 1 - Detailed cost model information to include line item cost breakdown of all costs (i.e., all labor, materials, subcontractor, and supplier cost elements consistent

with Association for the Advancement of Cost Engineering (AACE) International practices). The cost model shall be organized as follows:

a. Direct costs by each designated facility/area as agreed to prior to the first cost estimate submission.

b. For self-performance work by the Contractor, direct costs should be distinguished as such and should be presented in conformance with Construction Specifications Institute (CSI) MasterFormat 2020 Edition.

c. General Conditions Fee, as agreed to in the cost proposal form, adjusted based on agreed to scope of work changes.

d. Design-Build Fee, as agreed to in the cost proposal form, adjusted based on agreed to scope of work changes.

3. Attachment 2 - Assumptions and Exclusions to include a list of all assumptions, clarifications, and exclusions used to determine the Project costs

4. Attachment 3 - Subcontractor and Supplier Estimates and/or Bids including a copy of all subcontractor and supplier quotes or bids received by Contractor

5. Attachment 4 - Engineering Services During Construction including the proposed engineering services scope and fee for all remaining professional services to be performed during construction. Percentage estimates may be used for the Schematic Design construction cost estimate. It is required that a detailed scope and fee be provided at the Design Development construction cost estimate. Professional services shall include but not be limited to: submittal review; problem resolution and design revisions (requests for information); site visits and witness tests; Process Operations Manuals and Standard Operating Procedures; facilities start-up assistance; process training, record drawings, and field-based resident engineering services.

6. Attachment 5 – Contingency outside of GMP. This contingency is a sum of money unassociated with any specific work to allow the Contractor to accommodate market changes and/or unforeseen conditions in order to complete the Project. The Contractor shall include proposed procedures for quantifying the amount of potential market changes, including what equipment, components, or commodities should be considered for adjustments. The Contractor shall include justification for value of contingency.

7. Attachment 6 – Allowance Items. Allowance shall be for the sole use of the County for scope changes and adjustments or agreed to risks that the County controls.

8. Attachment 7 – Contractor's Financial Risk Analysis. The Contractor shall provide a financial and probability-of-occurrence risk analysis and other supporting information used to determine the cumulative value of the risks incorporated into the cost estimate.

9. Attachment 8 - General Conditions Fee and information to support the General Conditions Fee provided in the cost model, including revisions from the General Conditions Fee submitted with the cost proposal. The information shall also include updates to level of staffing and field office costs, including supporting cost data.

10. Attachment 9 - Startup, Commissioning, Training, and Acceptance Testing information to include information to support the start-up, commissioning, training, and acceptance testing costs provided in the cost model. The Contractor shall provide: an organizational chart of its start-up, commissioning, training, and acceptance testing staff; a conceptual plan for performing these activities; and person-hour and cost analysis for the associated activities. Cost information shall also be included for development of the Operations and Maintenance Manuals and Training sessions by the Contractor. The Contractor shall also provide the costs elements for warranty periods following substantial completion.

11. Attachment 10 - Updated Letter from Surety (or sureties) verifying that Contractor has

sufficient performance and payment bonding capacity available for the Project based on the current cost estimate.

A5.2.7 **Health and Safety Plan.** The Contractor shall be responsible for preparing and submitting a Health and Safety Plan for the Project that is in conformance with County standards, including the WPCB Contractor Safety Standard, and applicable OSHA standards. The Contractor shall submit the Health and Safety Plan no later than the submittal of the Early Work GMP.

A5.2.8 **Quality Control Plan.** The Contractor shall prepare a Construction Quality Control Plan in accordance with Exhibit B: General Requirements Section 01 45 16. The Contractor shall submit the draft Quality Control Plan no later than the submittal of the Early Work Design Development. The final Quality Control Plan submittal shall be submitted no later than the submittal of the Early Work GMP.

A5.2.9 **Security Plan.** The Contractor shall prepare and submit a Site Security Plan. The security plan shall address how Site security will be maintained during construction activities. The Contractor shall submit the Security Plan no later than the submittal of Early Work GMP.

A5.2.10 **Site Logistics Plan.** The Contractor shall prepare and submit a Site Logistics Plan that addresses laydown area of stored material, location of construction trailers, ingress/egress of construction traffic at the plant, off-street parking and storage of equipment and material, and maintenance of traffic. The Contractor shall demonstrate how the Site logistics will change throughout the sequencing of construction. The Contractor shall use schematics to demonstrate location of temporary facilities, staging areas, and parking areas during the various phases of construction. The Contractor shall submit the Site Logistics Plan for each phase no later than the submittal of Design Development.

A5.2.11 **Sustainability and Envision.** The County will provide a Sustainability Lead to develop a Sustainability Management Plan and lead the Envision documentation and verification requirements. At a minimum, the project must meet Envision Silver verification, with a goal of Envision Gold. The Contractor shall appoint a Sustainability Lead to work with the County, incorporate the Envision framework into project workshops and decisions, and work with the County's Envision Lead to identify Innovation Credits and confirm expected credits. The Contractor's Sustainability Lead shall be an Envision Sustainability Professional as defined by the Institute for Sustainable Infrastructure. The Contractor shall cooperate with the County for development of documentation as necessary to achieve the targeted credits. Additional details on Envision Verification requirements are included with Exhibit B: General Requirements Section 01 81 13.

A5.2.12 **THP/AD Pilot Testing Research Coordination.** The County is coordinating various THP, digestibility, and dewatering research with Virginia Tech as part of a pilot program. This work is on-going and real-time information will be shared with the Contractor. The Contractor shall review data and participate in discussions of the pilot program to confirm design criteria for the new facilities. No deliverables are required by the Contractor.

A5.2.13 **Start-up and Commissioning Plan.** The Contractor shall provide a conceptual Start-up and Commissioning Plan. The Plan should be developed collaboratively with the County and shall be a living document throughout all Stages. At a minimum, during the Design Implementation Stage, the Plan shall include:

1. Proposed Commissioning Team
2. Preliminary Commissioning Schedule, including constraints
3. Definition of Commissioning Terms and description of each testing stage, including prerequisites to move into that stage of testing
4. Internal and external communication protocols
5. Coordination with outside utilities
6. Coordination with system integration, including responsibilities for development of graphics, programming, loop drawings, and loop testing and checkout
7. Description of Commissioning Responsibilities, including timing for the County taking over responsibility of operations and maintenance activities. Operations support from the Contractor may be considered.
8. Definition of Performance Guarantees for inclusion in the GMP Amendment, including: analytical tests required; information collection requirements; and calculations and analyses required for verification
9. Definition of Acceptance Tests for inclusion in the GMP amendment
10. Description of training requirements and training procedures, including both vendor-led training and Design Professional-led training
11. Description of Operations and Maintenance documentation requirements, including vendor Operations and Maintenance Manuals, Plant Operations and Maintenance Manuals, and Standard Operating Procedures
12. Definition of equipment or process failure as it relates to testing
13. Discussion of warranty applicability, including review of any extended warranties

The Contractor shall submit the draft Start-up and Commissioning Plan no later than the submittal of Design Development Documents.

A5.2.14 Vendor Procurement, Design Assist, and Shop Drawings. As part of the Design Development, the Contractor shall provide early procurement activities for the following long-lead time items: centrifuges, screens, digester mixing system, gas treatment systems, boilers, heat exchangers, THP equipment, and select electrical gear. All services for initial procurements, including soliciting and evaluating proposals, are included under preconstruction services. Should the County and Contractor agree, receipt and review of vendor shop drawings for the selected equipment will be authorized through the use of County allowance.

A5.3 Guaranteed Maximum Price. This Agreement is a guaranteed maximum price (GMP) Contract. After resolving County comments on each Design Development submittal (Early Work and Main Project) and submittal of the respective GMP Drawings and Specifications, the Contractor shall submit a GMP Proposal for the Construction Implementation Stage to the Project Officer for review. Adjustments to the GMP Proposals can only be made in accordance with the terms of this Agreement.

A5.3.1 Formation of GMP. The Contractor shall submit each GMP Proposal pursuant to this Section and include: (1) a list of proposed subcontractors and major suppliers, and the bid packages submitted by each sub-contractor, as requested by the County; and (2) procedures used for selecting each sub-contractor and major supplier to ensure that the selection process was fair and competitive. The GMP proposed therein is intended to represent the Contractor's offer to fully complete the Project. As part of any GMP Amendment, the Contractor shall certify that the GMP established thereby contains sufficient amounts to provide and complete the respective portion of the Project (i.e., Early Work and Main Project). The Contractor will further covenant and agree in the Main Project GMP Amendment that it will perform all construction work necessary to fully complete the Project including, without limitation, aspects of the Work that are not shown on the GMP Drawings and Specifications but which are a logical development of the design intent reflected in the GMP Drawings and Specifications, for an amount not to exceed the GMP.

A5.3.2 Review of GMP Drawings and Specifications. Before submitting its GMP, the Contractor shall review the respective GMP Drawings and Specifications for accuracy, constructability, and completeness and shall bring deficiencies to the attention of the County. To the extent that any such deficiencies in the GMP Drawings and Specifications could have been identified by such review by a competent Contractor, such deficiencies shall not be the basis for a change in the GMP or delaying the Project Schedule.

A5.3.3 Basis of Guaranteed Maximum Price. The Contractor shall include a written statement of its basis with each GMP Proposal. The written statement of its basis shall include updates to all information provided with the previous project cost models and the additional information noted below:

1. Attachment A: List of the Drawings and Specifications, addenda, and General, Supplementary, and other Conditions of the Contract on which the GMP is based.
2. Exhibit B: List of Unit Prices as well as a statement of their basis.
3. Attachment C: Assumptions and Clarifications made by the Contractor in the preparation of the GMP Proposal to supplement the information contained in the Drawings & Specifications.
4. Attachment D: The proposed GMP, including a statement of the detailed cost estimate for the Cost of Work organized by trade categories, General Condition Fee, and Design-Build Fee that comprise the GMP. Include the following information:
    a. Detailed cost model information
    b. Subcontractor and supplier bids
    c. Evaluation of subcontractor bids, including adjustments to the bids and/or self-performance cost models to arrive at the trade category cost estimates. Justify adjustments with appropriate detailed cost model information and additional backup as required by the County.
    d. Engineering Services During Construction including the proposed engineering services scope and fee for all remaining professional services to be performed during construction. A detailed scope and fee estimate must also be included. Professional services shall include, but not be limited to: submittal review, problem resolution and design revisions (requests for information); site visits and witness tests; Process Operations Manuals and Standard Operating Procedures; facilities start-up assistance; process training; record drawings; and field-based resident engineering services.
    e. General Conditions Fee. Provide backup to include a detailed staffing plan (with hours and rates by position) and details of all general conditions costs outlined in the scope of work.
    f. Details of costs for Startup, Commissioning, Training, and Acceptance Testing
    g. If the GMP is greater than the previous control budget, a cost memorandum shall be submitted to reconcile the difference. The memorandum shall compare the previous control budget to the GMP. Detailed justification shall be provided by construction

division with a summary of costs totaling the difference between the target estimate and GMP.

5. Attachment E: An agreed upon schedule that the Contractor has negotiated with the Design Professional, and all Subcontractors. The schedule shall include, but not be limited to the Substantial and Final Completion Dates, upon which the proposed GMP is based. All other project schedule requirements shall be followed as defined in the County issued RFP and Agreement.

Separate and outside of the GMP Proposal, the Contractor shall provide a recommendation and basis for the Contingency. This Contingency is a sum of money unassociated with any specific work to allow the Contractor to accommodate market changes and/or unforeseen conditions in order to complete the Project and is not included in the GMP calculations. For example, market changes and/or unforeseen conditions include:

- Market changes – extraordinary changes in pricing of certain equipment, components, or commodities that cause an increase in pricing. The parties agree that procedures for defining market changes and procedures for quantifying the amount of the potential increase will be defined in the GMP Amendment, including what equipment, components, or commodities will be considered for adjustments based on market changes.

- Unforeseen conditions – certain conditions and events identified in the County General Conditions that could not be foreseen at the time of GMP

The Contractor shall include a justification for the value of the Contingency based on market risks and potential unforeseen conditions. The County must approve all uses of Contingency. Any County authorized use of Contingency will result in a modification to the GMP per the terms of the Contract via the Change Order process. Any unused Contingency will be returned to the County with no shared savings.

In addition, separate from the GMP Proposal, the Contractor shall provide a list of allowance items for consideration by the County. Allowance shall be for the sole use of the County for scope changes and adjustments or agreed to scope items that the County controls. The Contractor shall include a list of any unit prices with the allowance items. The budget will be outside of the GMP. Any County authorized use of allowance will result in a modification to the GMP per the terms of the Contract via the Change Order process. The Contractor is not guaranteed any work as related to the allowance items, and any unused allowance will be returned to the County with no shared savings.

A5.3.4 County Review of GMP Proposal. Seven (7) days after submittal of each GMP Proposal, the Contractor shall meet with the County to review the GMP Proposal and the written statement of its basis. In the event of any inconsistencies or inaccuracies in the information presented, the Contractor shall make appropriate adjustments to the GMP Proposal. The County will submit comments on the GMP Proposal to the Contractor within twenty-one (21) calendar days of the GMP Proposal meeting. The Contractor shall respond to the comments and record responses and/or actions required to resolve items within seven (7) days of receiving comments. Multiple negotiating sessions and sequences consistent with the time frames listed above are anticipated.

A5.3.5 **GMP Amendment.** Upon acceptance by the County of each GMP Proposal, the GMP and its basis shall be set forth in a GMP Amendment. In the event that the Contractor and the County are unable to agree upon a GMP and a project schedule for any reason, the Contract will be terminated per the requirements of the Contract. In the event the Contract is terminated, the County shall be free to use any of the information developed during the Design Confirmation Stage and Design Implementation Stage to obtain a new contractor to complete the Project.

A5.3.6 **Certification.** As part of each GMP Proposal, the Contractor agrees to specifically acknowledge and declare that the Contract Documents are sufficiently complete to have enabled the Contractor to determine the Cost of the Work therein in order to enter into each GMP Amendment and to enable the Contractor to agree to construct the Work outlined therein in accordance with applicable leases, statutes, building codes, and regulations without any increase to the GMP or extension of Contract Time, except if and to the extent otherwise expressly provided in the Contract. The Contractor shall further acknowledge that: i) it has visited the Site, ii) it has examined all conditions affecting the Work, iii) it has performed and agrees with all studies the Contractor was required to perform under this agreement, iv) it is fully familiar with all of the conditions thereon and affecting the same, and v) it has carefully examined all drawings and specifications.

A5.4 PERMITTING

A5.4.1 **Permitting and Regulatory Approvals Plan.** The Contractor shall produce a Permitting and Regulatory Approvals Plan that identifies all necessary information, applications, permits, documents, and forms required to secure the permits necessary to perform the Work. The Plan shall identify all required approvals, a system to track the requirements of all approvals, and the roles and responsibilities for obtaining all approvals. The Plan shall include a strategy for meeting air permit and stormwater permit requirements. A preliminary list of anticipated permit requirements is provided in the Exhibit B: Facilities Plan. This list shall be further developed by the Contractor during the Design Implementation Stage.

A5.4.2 **Permit Set Submission to Code Officials and Regulatory Agencies.** The Contractor shall submit the necessary documents to the Code Officials in order to obtain the necessary permits to construct the Project (“Permit Set”) as determined by the Code Officials and all appliable laws and regulations. The Contractor shall monitor the permit process and shall incorporate any changes or adjustments required by the Code Officials, with no change to the GMP.

A5.4.3 **Permit Fees.** Except for trade permits, Permit Fees will be the responsibility of the County.

A5.5 CONSTRUCTION IMPLEMENTATION STAGE

A5.5.1 **General Understandings.**

The Project will have two defined Construction Implementation Stages: 1) Early Work Construction Implementation Stage; and 2) Main Project Construction Implementation Stage. The Construction Implementation Stage of the Project for each stage shall commence upon execution by the County of a GMP Amendment, a County issued Notice to Proceed, and a revised Purchase Order for any increased amount for the Construction Implementation stage.

A5.5.2 Drawings & Specifications. All of the Work shall be constructed in strict accordance with the final IFC Set and all Contract Documents.

A5.5.3 General Requirements. The General Requirements provided with the Exhibit B: RFP Plans provide specific requirements for the Construction Implementation Stage, including Early Work. The Contractor must adhere to the conditions described in the Exhibit B: General Requirements. Additional requirements are detailed in sections A5.5.4 through A5.5.9.

A5.5.4 Sustainability and Envision. The County will update the Sustainability Management Plan after issuance of the IFC Set. The Contractor shall cooperate with the County for development of documentation as necessary to achieve the targeted credits during the Construction Phase. Additional details on Envision Verification requirements are included with Exhibit B: General Requirements Section 01 81 13.

A5.5.5 Process Operations Manual and Standard Operating Procedures. The parties will work collaboratively during the Design Implementation Stage to define requirements for a Design Professional developed Process Operations Manual and Standard Operating Procedures (SOPs). The final scope for these materials will be defined in the GMP Amendment. It is anticipated that electronic Process Operations Manual and SOPs will be developed to include a variety of information including facility and equipment descriptions, design criteria, process control narratives, design drawings, standard operating procedures, and vendor supplied equipment Operations and Maintenance Manuals. The Process Operations Manual will include all systems and processes associated with the Biosolids Upgrades. The Process Manual will be subdivided by process area, and SOPs will be developed for each unit process. Together, the Process Operations Manual and SOPs shall include the following, at a minimum:

1. Scope and purpose
2. Health and safety information, including specific hazards, emergency relief, and hazardous gas monitoring
3. Process overview with system description, listing of major equipment, and process design criteria supported with appropriate data and graphics
4. Start-up procedures including pre-start-up checklists
5. Normal operations, including description of operation, equipment monitoring and control, process flow diagrams, typical set points, different modes of operation, and process limitations
6. Alarms and interlocks and process troubleshooting
7. Shutdown procedures for both normal and emergency shutdowns
8. Any special procedures
9. Description of any alternate operation scenarios, including when such alternate scenarios should be used and how they will be implemented.

Vendor supplied Operations and Maintenance Manuals are specified in Exhibit B: General Requirements Section 01 78 23.

A5.5.6 Contractor Provided Training. The Contractor shall provide training as indicated in this section.

A5.5.6.1 Training Plan. Prior to completion of the Pre-Demonstration Period, which is defined in Exhibit B: General Requirements Section 01 75 00, the Contractor shall develop a Training Plan for Project Officer review and acceptance. The training plan shall include the following requirements:

1. Description of classroom and field/maintenance shop training as provided by both the Design Professional and equipment suppliers.
2. Description of general content of training sessions, including theory, sequence of operations, hazard analysis, safety features, emergency procedures, assembly, disassembly, preventive, corrective and predictive maintenance, wiring, control loops, schematics, and diagrams.
   a. Process training from the Design Professional shall include process overview for each system, process principles, how the systems are integrated, safety features of the integrated systems, and review of functional descriptions and alternative operations. The training shall use the various sections of the Process Operations Manual and SOPs to guide the training. The final scope of work for the process training will be defined in the GMP Amendment.
   b. Supplier training shall include equipment specific training and shall utilize the supplier supplied Operations and Maintenance Manuals to guide the training.
3. List all equipment and systems in the Project to receive training. The list shall include a description of each system, instructor qualifications, availability of continuing education units (CEUs), identification of target audience, and duration of training sessions (classroom and hands on).
4. Hours of training that will be provided, including accommodating four operational shifts: two day shifts (6 AM – 6 PM) and two night shifts (6 PM – 6 AM) with non-overlapping personnel.
5. Each training session shall be professionally recorded (video/audio), including both classroom and hands-on portions of the training. Video/audio techniques and firms shall be submitted and accepted by the Project Officer.

A5.5.6.2 Lesson Plans and Training. The Contractor shall develop and submit lesson plans 14 days prior to all training. Training shall be completed for operations and maintenance staff at a time agreed upon between the Contractor and County. Training must accommodate all operating and maintenance shifts.

Process training by the Design Professional shall be initiated a minimum of 90 days prior to commencement of the Demonstration Period as agreed upon by the Contractor and Project Officer.

Supplier prepared training shall be coordinated by the Contractor and shall be initiated prior to commencement of the Demonstration Period as agreed upon by the Contractor and Project Officer. Training sessions by equipment suppliers shall comply with the requirements of the Design Professional's specifications.

A5.5.7 **Start-up and Commissioning.** The scope of work for Start-up and Commissioning during Construction Implementation will be defined during the Design Implementation Stage and must be included with the GMP Amendment, including delineation of roles and responsibilities of the parties.

A5.5.8 **On-Site Management.** The Contractor shall provide on-site management and superintendence during all working hours.

A5.5.9 **Supervision.** Throughout the Project, the construction office shall be manned by personnel competent to oversee the Work at all times while construction is underway. Such personnel shall maintain full-time on-site construction supervision and provide daily inspections, quality control, monitoring, coordination of various trades, record drawings, and daily work log.

A6. COMPENSATION

A6.1 **Sole Compensation.** The Contractor's sole compensation for the Work shall be the Design-Build Fee, the General Conditions Fee, and reimbursement for the Cost of the Work.

A6.1.1 **Cost of the Work.** The Cost of the Work shall include the following costs, which shall be reimbursable at cost and without mark-up of any kind:

1. Payments made by the Contractor to subcontractors and suppliers, but only in accordance with the subcontracts and supply agreements, including costs of rental equipment and handling, removal and disposal of existing hazardous materials on the Site and remediating existing regulated Site conditions;

2. Cost of materials and equipment suitably stored per the requirements of the General Conditions;

3. Design Fee;

4. Engineering Services During Construction, including all necessary assistance for start-up and training;

5. All amounts due to the Contractor for self-performed Work. If the Contractor self-performs work, the Contractor must submit three quotes by potential subcontractors validating price competitiveness of Contractor's decision to self-perform. The Project Officer may, in their sole discretion, approve self-performed work without competitive pricing submission. In such situation, the Contractor must submit the following documentation with applications for payment. **Note:** Self-performed work is not to be considered subcontractor work. Self-performed work includes work completed by the Contractor and the subcontractors included with Offeror Proposal.

   A. **Labor.** Properly documented wages actually paid to Project foremen, construction workers, and other personnel in the direct employ of the Contractor while engaged in approved self-performed work, together with contributions, assessments, payroll taxes, or fringe benefits required by the laws or applicable collective bargaining agreements.

B. **Incorporated Materials.** The cost, net of trade discounts, of all materials, products, supplies and equipment incorporated into the self-performed work, including, without limitation, costs of transportation and handling.

C. **Unincorporated Materials.** The cost of materials, products, supplies, and equipment not actually installed or incorporated into the self-performed work, but required to provide a reasonable allowance for waste or spoilage. Such amount shall be subject to the Contractor's agreement to turn unused excess materials over to the County at the completion of the Project or, at the County's option, to sell the material and pay the proceeds to the County or give the County a credit in the amount of the proceeds against the Cost of the Work.

D. **Equipment.** The cost of equipment and machinery owned by the Contractor used in the performance of the Work, inclusive of maintenance and operational costs subject to prior approval from the County with supporting documentation regarding cost. Rates and quantities of equipment shall be subject to the Project Officer's written approval;

6. The cost of temporary operations;

7. Royalty and license fees paid for use of a design, process or product, if its use is required by this Agreement or has been approved in advance by the County;

8. Fees for obtaining all required approvals or permits associated with trade permits;

9. All fees and other costs necessarily incurred to conduct testing and inspections required by the Agreement or applicable laws, or otherwise to maintain proper quality control, including those associated with start-up and commissioning. The costs the Contractor incurs to schedule and coordinate any additional testing and inspections that the County may decide to conduct itself shall be reimbursable unless the additional testing establishes that the Work tested was defective or otherwise failed to satisfy contract requirements, in which case the Contractor shall pay the costs, without reimbursement;

10. All bonds to jurisdictional agencies (utilities, stormwater management, land disturbance, and grading);

11. All performance and payment bonds and insurance attributable to the Project; and

12. Sales or use taxes where the Contractor establishes that applicable law required payment of such taxes. **Note:** Material incorporated into the Work may be exempt from Virginia sales tax per Code of Virginia 58.1-3660 and Code of Virginia 58.1-609.3. The Contractor is required to work with the Virginia Department of Environmental Quality to confirm applicability of this exemption. Any benefit of tax exemption related to the project shall be passed on to the County. *Reference* https://www.deq.virginia.gov/land-waste/recycling/tax-incentive-programs.

13. Storage costs under Section C.12 of the General Conditions of the Agreement.

A6.1.2 General Condition Fee. The General Conditions costs, which are reimbursable, shall include, but not be limited to, the following:

1. The cost of Construction Staff. The term Construction Staff shall mean the i) Project Executive, ii) Project Managers, iii) Project Engineers, iv) Commissioning Staff, v) Quality Control Staff, vi) superintendents and other personnel assigned to the Project that the County has agreed in writing can be included, vii) administrative staff assigned on a full-time basis to the Site, and viii) professional staff performing scheduling, cost estimating, and accounting services;

2. Fringe Benefits associated with Construction Staff;

3. Payroll taxes and payroll insurance associated with Construction Staff;

4. Staff costs associated with obtaining permits and approvals;

5. Out-of-house consultants;

6. The field office for the County's Program Manager and Contractor including, but not limited to: (i) trailer purchase and/or rent; (ii) field office installation, relocation and removal; (iii) utility connections and charges during the Construction Implementation Stage; (iv) furniture; and (v) office supplies;

7. Office equipment including, but not limited to: (i) computer hardware and software; (ii) fax machines; (iii) copying machines; (iv) telephone installation, system and use charges; (v) job radios; and (vii) any other supply or consumable required for a fully functioning office space subject to prior approval by the County;

8. Printing costs for County deliverables;

9. Off-site travel for all non-local witness testing and manufacturing visits in accordance with the Contract requirements;

10. Local delivery and overnight delivery costs;

11. The cost of temporary power and water necessary for construction operations to provide heating, cooling and ventilation for the building during construction. Such costs include the cost of any temporary construction necessary to provide such power and water during the Construction Implementation Stage;

12. First aid facility;

13. Other temporary amenities, including:
    a. Temporary toilets for use of all trade labor
    b. Temporary fire protection
    c. Project site security, including employee badging

d. Traffic control
e. Fencing, barricades, partitions, and protected walkways
f. Temporary and emergency lighting
g. Temporary facilities for equipment and spare part storage, including climate control, whether on-site or off-site
h. Temporary construction facilities and services, including parking and laydown areas whether on-site or off-site
i. Temporary heat and ventilation
j. Tools and tool sheds
k. Project signs;

14. Routine Site cleanup, including labor and equipment associated with daily Site cleanup and dumpsters, cleanup at substantial completion, and cleanup at final completion;

15. Health and safety program, including all necessary health and safety supplies and health and safety reward programs;

16. Project information and documentation, including drone and webcam photographs and videos and monthly progress photos;

17. Project groundbreaking and ribbon cutting ceremonies; and

18. Start-up and Commissioning Planning

A6.1.3 Non-Reimbursable Costs. The following costs are not reimbursable:

1. Fees for any permits or licenses the Contractor requires to conduct its general business operations;

2. Capital expenses and interest on capital employed for the Work;

3. The cost of home or regional offices, it being understood that compensation for such costs is included in the Design-Build Fee;

4. Local travel, including mileage and meals for local personnel. Local is defined as travel within the greater Baltimore-Washington Metropolitan Area, as defined by the United States Office of Management and Budget;

5. Costs due to the errors or omissions of the Contractor or its subcontractors or suppliers at all tiers that are a) negligent, b) caused by willful misconduct, or c) recoverable by proceeds of insurance policies under the Contract.

6. Costs dues to breach of Contract by the Contractor or its subcontractors or material suppliers at all tiers, including, without limitation: costs arising from defective or damaged Work or its correction; disposal of materials or equipment erroneously supplied; and

repairs to property damaged by the Contractor or its subcontractors or material suppliers at all tiers;

7. Legal costs incurred for any reason;

8. Fines or penalties assessed or imposed by third parties as a result of Contractor Fault;

9. Any costs associated with establishment of a joint venture (or other legal entity), including registration and accounting costs;

10. Any cost that would cause the GMP to be exceeded; and

11. Any costs incurred in performing work of any kind before the Notice to Proceed is issued, unless specifically authorized by the County in writing.

A6.1.4 Design-Build Fee. The Contractor's Design-Build Fee shall be as set forth in Attachment E (Guaranteed Maximum Price). The Design-Build Fee together with the General Conditions Fee is intended to compensate the Contractor for all costs not properly reimbursable as a Cost of the Work, including, but not limited to, the Contractor's home office overhead, profit, and staffing costs.

A6.1.4.1 At-Risk Portion of Design-Build Fee. Ten percent (10%) of the Design-Build Fee is at risk (the "At-Risk Portion"), and the Contractor shall only be entitled to the At-Risk Portion as set forth below. The Contractor shall be eligible to earn the At-Risk Portion of the Design-Build Fee based on its performance pursuant to the factors outlined below.

A6.1.4.1.1 Evaluation Factors

Factor 1: Design Management

- Adherence to Schedule
- Quality Performance: Effectiveness of Contractor and subcontractor Quality Control programs, responsiveness to County concerns regarding quality issues
- Technical Expertise and Experience: Commitment to energy-sustainable design, early identification and resolution of design and/or construction problems

Factor 2: Construction Management

- Adherence to Schedule and regular schedule updates
- Quality Performance: Effectiveness of Contractor and subcontractor Quality Control programs, responsiveness to County concerns regarding quality issues
- Technical Expertise and Experience: Early identification and resolution of design and/or construction problems
- Cooperation and effective working relationships with other contractors and County personnel

Factor 3: Safety Performance

- Jobsite Cleanliness

- Demonstrated efforts to achieve accident rates below target goals for Recordable and Lost Time injuries.
- Adherence to Safety Plan: Safety performance and management commitment to safety requirements

Factor 4: Plant Operations and Coordination

- Support of advanced planning and coordination needed to anticipate operational impacts
- Attentiveness to needs expressed by County operations staff
- Support and provide Site maintenance, including cleanup, erosion control, security, access and parking
- Responsiveness to issues that may jeopardize plant operations or water quality.
- Response to emergencies and other unexpected situations

Factor 5 : Project Management, Teamwork and Communication

- Contribution to effective, focused meetings
- Responsive, respectful and professional working relationship between Contractor and all team members, including support of the collaborative design-build process
- Proactive coordination with the County on responding to information requests and Requests for Interpretations
- Assist the County in responding to community requests and managing the high-profile project
- Minimization and timely submission and resolution of claims or requests for equitable adjustment including efforts in mitigating costs for changed conditions
- Planning, organizing and managing all program elements; management actions to achieve and sustain a high level of productivity
- Effectiveness in management of the Request for Interpretations process including adequacy of contract document review prior to submission of clarification requests and quality of recommended solutions

Factor 6: Start-up and Commissioning

- Effectiveness in coordination, execution of, and adherence to, commissioning plan through all phases of the Project
- Timeliness, quality, and thoroughness of operation and maintenance manuals and training
- Timeliness and quality (includes accuracy and format) of monthly as-built drawings updates and other submittals required by the commissioning process

Factor 7 : Project Closeout and Post Construction

- Effective scheduling and management of turnover actions
- Minimization and timely resolution of punch list items
- Timely response to warranty calls
- Quality of repairs

A6.1.4.1.2 Performance Monitoring

1. Project Officer will plan and carry out on-site assessment visits, as necessary.

2. Project Officer will conduct all assessments in an open, objective and cooperative spirit so that a fair and accurate evaluation is obtained. This will ensure that the Contractor receives accurate and complete information from which to plan improvements in performance. Positive performance accomplishments will be emphasized as readily as negative ones.

3. Project Officer will discuss the assessment with Contractor personnel as appropriate, noting any observed accomplishments and/or deficiencies. This affords the Contractor an opportunity to clarify possible misunderstandings regarding areas of poor performance and to correct or resolve deficiencies.

A6.1.4.1.3 Evaluation/Assessment Reports

1. Project Officer will submit the At-Risk Fee Evaluation Report to the Procurement Officer quarterly. The Contractor shall be furnished a copy of the At-Risk Fee Evaluation Report.

A6.1.4.1.4 Evaluation Periods

1. At-Risk Fee Award meetings will be held quarterly to discuss Contractor's performance and will include the Contractor and the Project Officer. The Contractor will be provided an opportunity to submit information on its behalf, including an assessment of its performance during the evaluation period. After the meeting, the Project Officer will consider matters presented by the Contractor and finalize its findings.

2. The Project Officer will determine the At-Risk Fee Award percentage earned by the Contractor, determine whether any unearned Fee may be earned back in the following evaluation period if Contractor addresses the issues, and generate a decision letter to the Contractor. The Contractor will submit an invoice for the earned At-Risk Fee upon receipt of the decision letter.

3. If the Project Officer and the Contractor disagree on an item of contention, the Procurement Officer at their sole discretion, will determine the appropriate At-Risk Fee Award percentage that will be earned by the Contractor.

4. The County may elect to distribute any unearned Fee to the subsequent period, or to apply any unearned Fee to specific future evaluation period(s) if the County determines that certain period(s) require increased performance incentive(s).

5. The amount available to earn in each evaluation period will be a proportionate percentage of the Cost of Work earned in that period, but the cumulative amount of the At-Risk Portion of the Design-Build Fee paid shall at no time constitute more than 10% of the Design-Build Fee paid to date.

A6.1.4.2 Not At-Risk Portion of the Design-Build Fee. The Not At-Risk portion of the Design-Build Fee is the 90% of the Design-Build Fee remaining after deduction of the

At-Risk portion of the Design-Build Fee. The Not At-Risk portion of Design-Build Fee will be paid proportionately to the percentage of Cost of Work earned in that period.

A6.1.4.3 Changes to the Design-Build Fee. The Design-Build Fee shall not be increased or decreased as a result of Change Orders unless such changes (i) extend the Period of Performance for Substantial Completion from that contemplated herein by more than 60 days; or (ii) the County makes additions to the scope of work that either individually or in the aggregate cause the GMP to increase. Change Orders related to differing site conditions, hazardous material, or Project delays shall not be considered an increase in the scope of work for this calculation.

A6.1.5 Savings. Upon completion of the Work, the Contractor shall provide to the Project Officer a detailed and complete accounting of the Cost of the Work and the General Conditions Fee for the Project. Should the actual final Cost of Work and General Conditions Fee be less than those amounts listed in Exhibit E as adjusted pursuant to the Agreement, the savings shall accrue seventy-five percent (75%) to the County and twenty-five percent (25%) to the Contractor. Should, however, the actual final Cost of Work and the General Conditions Fee exceed the Cost of Work and the General Conditions Fee listed in Exhibit E as adjusted pursuant to the Agreement, then the excess amount shall be borne solely by the Contractor.

A6.1.6 Progress Payments. The Contractor shall be paid its compensation in a series of progress payments and a final payment for Work completed in accordance with the Contract Documents and for which proper applications for payment have been submitted and approved. Prior to execution of GMP amendment, the Contractor shall be compensated for the completed design work and the proportionate Design-Build Fee percentage for the completed work pursuant to A6.1.4.

A7. DIVERSION OF KEY PERSONNEL AND SUBCONTRACTORS

A7.1 Identification of Key Personnel and Subcontractors. The following individuals and organizations shall be considered Key Personnel (whether employed by the Contractor or one of its subcontractors) and Subcontractors:

A. Design Build Project Manager – Dan Stromberg
B. Quality Control Manager – Vernon New
C. Design Manager – Joe Uglevich
D. Pre-Construction Manager – Alex Hango
E. Construction Manager – JC Lucas
F. Commissioning and Start-up Manager – Amanda Harris
G. Lead Solids Handling Design Engineer – Bryce Swillum
H. Lead Thermal Hydrolysis Engineer – David Socha
I. Lead Biogas Handling and Treatment System Engineer – Dru Whitlock

The Contractor will not be permitted to reassign any of the Key Personnel or Subcontractors unless the Project Officer approves the proposed reassignment and the proposed replacement.

If any of the Key Personnel must be absent for an extended period, the Contractor must provide an interim Key Personnel, subject to the County's written approval.

Arlington WPCP Phase 10C/D Comprehensive Biosolids Upgrade Project

Design and Preconstruction Rate Tables*

December 18, 2023

Stantec Rate Table**	
Title	Rate
Design Manager/Vice President	$ 334.58
Sr. Technical & DB Expert	$ 334.58
Senior Technical Specialist	$ 334.58
Technical Specialist	$ 309.81
Specialist	$ 265.00
Discipline Lead Engineer or QC Engineer	$ 223.06
Supervising Engineer, Scientist,CAD)	$ 189.59
Professional (e.g. permitting, engineer, scientist, CAD)	$ 165.57
Project Engineer	$ 132.80
Discipline Project Engineer	$ 132.80
Admin/ Tech Writer /EIT	$ 106.95
Punne CADD Manager	$ 106.95
CADD Technician	$ 106.95

PC Construction Rate Table Phase 1 Services***	
Title	Rate
Construction Executive	$ 218
Project Director	$ 208
Director of Preconstruction	$ 194
Preconstruction Coordinator	$ 116
MBE Coordinator	$ 75
Senior Project Manager	$ 171
Senior Superintendent	$ 177
Senior Project Engineer	$ 116
Commissioning Manager	$ 157
Chief Estimator	$ 135
Senior Estimator	$ 119
Project Estimator	$ 108
Staff Estimator	$ 82
Senior Safety Engineer	$ 125
Corp Safety Director	$ 155
Senior Field Office Manager	$ 89
Purchasing Manager	$ 145
Purchasing Coordinator	$ 66
Corp Chief Field Engineer	$ 171
Virtual Construction Engineer	$ 91
Project Controls Engineer (Aegis)	$ 145
Project Director (Aegis)	$ 190

PSI Rate Table****	
Title	Rate
Project Manager	$ 185.50
Chief Engineer	$ 265.00
Senior Engineer	$ 233.20
Project Engineer	$ 185.50
Geotechnical Engineer / Staff Engineer	$ 100.70
Geologist	$ 174.90
CAD Operator	$ 132.50
Administrative Support	$ 58.30

*Arlington general conditions have details of allowable overhead for work but it is understood that rates on these tables and rates that will be negotiated based on these rates for Phase 2 services will supercede standard notes in the General Conditions given the order of precedence of the documents in the Contract.

**Stantec's hourly rates have been escalated to be suitable for use throughout Phase 1 services. Stantec assumes that Phase 2 services will be at rates which are further escalated.

***Rates are based on the current 2023 rates escalated to be suitable for use throughout Phase 1 Services. Phases 2 services will be at rates which are further escalated.

****PSI's hourly rates have been escalated to be suitable for use throughout Phase 1 services. PSI assumes that Phase 2 services will be at rates which are further escalated.

<u>EXHIBIT B</u>

RFP PLANS

22-DES-RFPPW-672

Exhibit B – RFP Plans Contents

1. Facilities Plan
   - Volume 1 – Plan
   - Volume 2 – Drawings
   - Volume 3 – Appendices

2. Early Work Documents
   - Early Work Drawings
   - Early Work Specifications
   - Geotechnical Report
   - Survey Files in *.dwg, *.xml, and *.pdf format

3. General Requirements

4. VPDES Permits
   - VA0025143
   - VAR051421

5. WPCB Contractor Safety Standard

ARLINGTON
RE-GEN

FACILITIES PLAN

Volume 1

HDR

December 16, 2022

CONTENTS

VOLUME 2: DRAWINGS

VOLUME 3: APPENDICES

FIGURES

TABLES

ARLINGTON RE-GEN

ABBREVIATIONS

°C	degree(s) Celsius
°F	degrees Fahrenheit
3D	three-dimensional
A	ampere(s)
AA	Aluminum Association
AACE	Association for the Advancement of Cost Engineering International
AC	alternating current
ACH	air change(s) per hour
ACI	American Concrete Institute
ACM	asbestos-containing materials
ACT	acoustical ceiling tile
AD	anaerobic digestion
ADA	Americans with Disabilities Act
ADM	Aluminum Design Manual
AISC	American Institute for Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
AOB	ammonia-oxidizing bacteria
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society of Testing and Materials
AWG	American Wire Gauge
AWWA	American Water Works Association
BFP	belt filter press
BMP	best management practice
BPVC	Boiler and Pressure Vessel Code
Btu	British thermal unit(s)
$CaCO_3$	calcium carbonate
cc	cubic centimeter(s)
CFD	computational fluid dynamics
cfm	cubic foot/feet per minute
CFR	Code of Federal Regulations
CH_4	methane
CHP	combined heat and power
CIP	Capital Improvement Program

CL	cement-lined
CMU	concrete masonry unit
CO_2	carbon dioxide
COD	chemical oxygen demand
County	Arlington County
COW	County water
cP	centipoise
CRAC	computer room air conditioning
CTC	Certificate to Construct
CTO	Certificate to Operate
CY	cubic yard(s)
d	day(s)
DAFT	dissolved air flotation thickener
DB	design-build
DC	distribution center
DC Water	District of Columbia Water and Sewer Authority
DCU	distributed control unit
DE	Dominion Energy
DES	(Arlington County) Department of Environmental Services
DLR	device level ring
DMZ	demilitarized zone
DO	dissolved oxygen
DOE	U.S. Department of Energy
DS	digested solids
DSST	digested solids storage tank
DT	dry ton(s)
dtpd	dry ton(s) per day
DWB	Dewatering Building
DX	direct expansion
EBPR	enhanced biological phosphorus removal
EL	elevation
EMC	electromagnetic compatibility
Envision	Envision® V3 Sustainable Infrastructure Framework
EPA	Environmental Protection Agency
EQ	Exceptional Quality
ETAP	Ethernet Tap
ETL	Electrical Testing Laboratories
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
$FeCl_3$	ferric chloride

FEMA	Federal Emergency Management Agency
FER	Final Engineering Report
FIRM	Flood Insurance Rate Map
FLA	full load amp
FM	Factory Mutual Research Corporation
FOG	fats, oils, and grease
FRP	fiberglass-reinforced plastic
ft	foot/feet
ft^2	square foot/feet
ft^3	cubic foot/feet
ft/s	foot/feet per second
gal	gallon(s)
GBT	gravity-belt thickener
GHG	greenhouse gas
GMP	guaranteed maximum price
gpd	gallon(s) per day
gph	gallon(s) per hour
gpm	gallon(s) per minute
GT	gravity thickener
GTO	gravity thickener overflow
H_2O	water
H_2S	hydrogen sulfide
HDR	HDR Engineering, Inc.
HEX	heat exchanger
HHM	household hazardous materials
HMI	human-machine interface
HOA	Hand/Off/Auto
hp	horsepower
HPHMI	High-Performance Human-Machine Interface
HPIC	high-performance industrial coating
hr	hour(s)
HRSD	Hampton Roads Sanitation District
HRSG	heat recovery steam generator
HVAC	heating, ventilation, and air conditioning
IBC	International Building Code
ICEA	Insulated Cable Engineers Association
ICS	Industrial Control and Systems
IEC	Independent Electrical Contractors
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IESNA	Illuminating Engineering Society of North America

IFAS	integrated fixed-film activated solids
ILFI	International Living Futures Institute
I/O	input/output
IP	Internet Protocol
ISA	International Society of Automation
kg	kilogram(s)
kV	kilovolt(s)
kVA	kilovolt-ampere(s)
kW	kilowatt(s)
kWh	kilowatt-hour(s)
L	liter(s)
lb	pound(s)
lbm	pound(s) mass
LCP	local control panel
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design
LEL	lower explosive limit
LTE	Long-Term Evolution
m^3	cubic meter(s)
mA	milliampere(s)
Master Plan	2018 *Arlington County WPCP Solids Master Plan*
MBH	1,000 British thermal units per hour
MCC	motor control center
mg	milligram(s)
MG	million gallons
mgd	million gallons per day
MIC	microbial-induced corrosion
mm	millimeter(s)
MMBtu	million British thermal units
MOPO	maintenance of plant operations
MP01	Master Plan 2001
mph	mile(s) per hour
N	nitrogen
N/A	not applicable
NACE	National Association of Corrosion Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NG	natural gas
NH_3	ammonia

NH_4-N	ammonium-nitrogen
NMB	New Maintenance Building
NOC	network operations center
NO_x	nitrogen oxides
NSR	new source review
O_2	oxygen
OE3A	Obstruction Evaluation/Airport Airspace Analysis
OEM	original equipment manufacturer
OIT	operator interface terminal
O&M	operations and maintenance
OPCC	opinion of probable construction costs
OPPTS	Office of Prevention, Pesticides and Toxic Substances
orgS	organic reduced sulfur compounds
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PC	primary clarifier
PCS	process control system
pcf	pound(s) per cubic foot
PEW	plant effluent water
PF	peaking factor
PFAS	per- and polyfluoroalkyl substances
PFRP	process to further reduce pathogens
PG	Performance Guarantee
P&ID	process and instrumentation diagram
Plan	Facilities Plan
PLC	programmable logic controller
plf	pound(s) per linear foot
ppm	part(s) per million
ppmv	part(s) per million by volume
PPU	positive pressurization unit
Program	Arlington Re-Gen Biosolids Upgrade Program
PS	primary solids
P-S	Public Service District *(zoning designation)*
PSA	pressure swing adsorption
psf	pound(s) per square foot
psi	pound(s) per square inch
psig	pound(s) per square inch gauge
PTB	Preliminary Treatment Building
PTB Upgrades	Preliminary Treatment Upgrades (WPB2) Phase 9B
PVC	polyvinyl chloride

PVDF	polyvinylidene fluoride
PVRV	pressure and vacuum relief valve
PYPS	Potomac Yard Pump Station
QA	quality assurance
RAS	return activated solids
rDON	refractory dissolved organic nitrogen
RDT	rotary-drum thickener
RFP	Request for Proposals
RGS	rigid galvanized steel
RH	relative humidity
RIN	Renewable Identification Number
RIO	remote input/output
RIPS	Recycle Interceptor Pump Station
RNG	renewable natural gas
rpm	revolution(s) per minute
RTO	regenerative thermal oxidizer
SBS	styrene-butadiene-styrene
SCADA	supervisory control and data acquisition
SCAT	Sewage Collection and Treatment
scf	standard cubic foot/feet
scfd	standard cubic foot/feet per day
scfm	standard cubic foot/feet per minute
SCM	supplementary cementing materials
SCWD	scrubber waste drain
SDC	services during construction
SGF	Standby Generation Facility
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SMP	Sustainability Management Plan
SOP	standard operating procedure
SPB	Solids Processing Building
SRT	solids retention time
SSPC	Steel Structures Painting Council
SST	solids storage tank
sTKN	soluble total Kjeldahl nitrogen
SWD	side water depth
TBD	to be determined
TCP	Transmission Control Protocol
TDH	total dynamic head
THD	total harmonic distortion
TH	thermal hydrolysis

THHN-2	thermoplastic high-heat-resistant nylon-2
THP	thermal hydrolysis process
THS	thermally hydrolyzed solids
TKN	total Kjeldahl nitrogen
TM	technical memorandum
TMS	The Masonry Society
TN	total nitrogen
TPS	thickened primary solids
TS	total solids
TSS	total suspended solids
TWAS	thickened waste activated solids
UL	Underwriters Laboratories, Inc.
UPS	uninterruptible power supply
V	volt(s)
VAC	volt(s) alternating current
VCC	Virginia Construction Code
VDC	volt(s) direct current
VDEQ	Virginia Department of Environmental Quality
VECC	Virginia Energy Conservation Code
VFD	variable-frequency drive
VFGC	Virginia Fuel Gas Code
VMC	Virginia Mechanical Code
VOC	volatile organic compound
VPA	Virginia Pollution Abatement
VPC	Virginia Plumbing Code
VPDES	Virginia Pollutant Discharge Elimination System
VPN	virtual private network
VRRM	Virginia Runoff Reduction Management
VS	volatile solids
VSFPC	Virginia Statewide Fire Prevention Code
VSMP	Virginia Stormwater Management Program
VSr	volatile solids reduction
VUSBC	Virginia Uniform Statewide Building Code
WAS	waste activated solids
w.c.	water column
WIMS	Water Information Management Software
WMO	World Meteorological Organization
WPCB	(Arlington County) Water Pollution Control Bureau
WPCP	water pollution control plant
WSSC	Washington Suburban Sanitary Commission

wtpd	wet ton(s) per day
WWTP	wastewater treatment plant
XHHW-2	cross-linked polyethylene high heat-resistant water-resistant-2
yd	yard(s)
yr	year(s)

1 INTRODUCTION

1.1 Background and Purpose

Arlington County (County) has initiated the implementation of the Arlington Biosolids Upgrade Program (Program), referred to as Re-Gen, for the next generation of biosolids management facilities at the Arlington County Water Pollution Control Plant (WPCP). This comprehensive Program will include engineering, design, construction, and startup and commissioning services to add sustainable equipment and systems to effectively recover the County's renewable resources, produce a Class A biosolids product, and most efficiently utilize the biogas. The new solids handling processes (Facilities) will entail upgrades or replacement of nearly all existing solids handling processes. A thermal hydrolysis process (THP) followed by anaerobic digestion (AD) form the backbone of the new treatment train. The THP process uses temperature and pressure to break down the solids and remove pathogens, while the AD process stabilizes the solids and generates a methane (CH_4)-rich biogas. A marketable Class A biosolids product and biogas utilization system to clean and make use of recovered biogas either on or off site are also envisioned. The completed Program will enhance operating conditions and reliability of the Facilities while continuing to meet all permit requirements and ensure a persistent commitment to environmental stewardship.

1.2 Description of Existing Facility

The WPCP is located on an approximately 32-acre campus at 3402 S Glebe Road in Arlington, Virginia. The WPCP has a permitted design capacity of 40 million gallons per day (mgd) and provides enhanced nutrient removal wastewater treatment through physical, chemical, and biological processes. The WPCP currently treats an average of 23 mgd each day from Arlington County and portions of the neighboring localities of Alexandria, Fairfax, and Falls Church. The location of the WPCP is shown on Figure 1-1.

Wastewater reaches the WPCP via three interceptors and then passes through bar screens and grit cyclones before flowing to the primary clarifiers (PCs). Primary effluent is sent to aeration basins for biological nutrient removal followed by secondary clarifiers. At times of high flow, primary effluent is diverted to equalization tanks for flow attenuation before being discharged in a controlled manner to the secondary treatment processes. Iron salts (ferric chloride) are added at multiple locations for chemical phosphorus removal. Secondary effluent is pumped to deep-bed denitrification filters, followed by chlorination and dechlorination. Treated effluent is discharged into the Four Mile Run, part of the Potomac River Subbasin in the Chesapeake Bay Watershed.

Primary solids (PS) are thickened in gravity thickeners (GTs) and waste activated solids (WAS) are thickened in dissolved air flotation thickeners (DAFTs). Thickened solids are dewatered by centrifuges and combined with lime to stabilize them to a Class B biosolids product that are beneficially used by land application throughout central and southern Virginia.

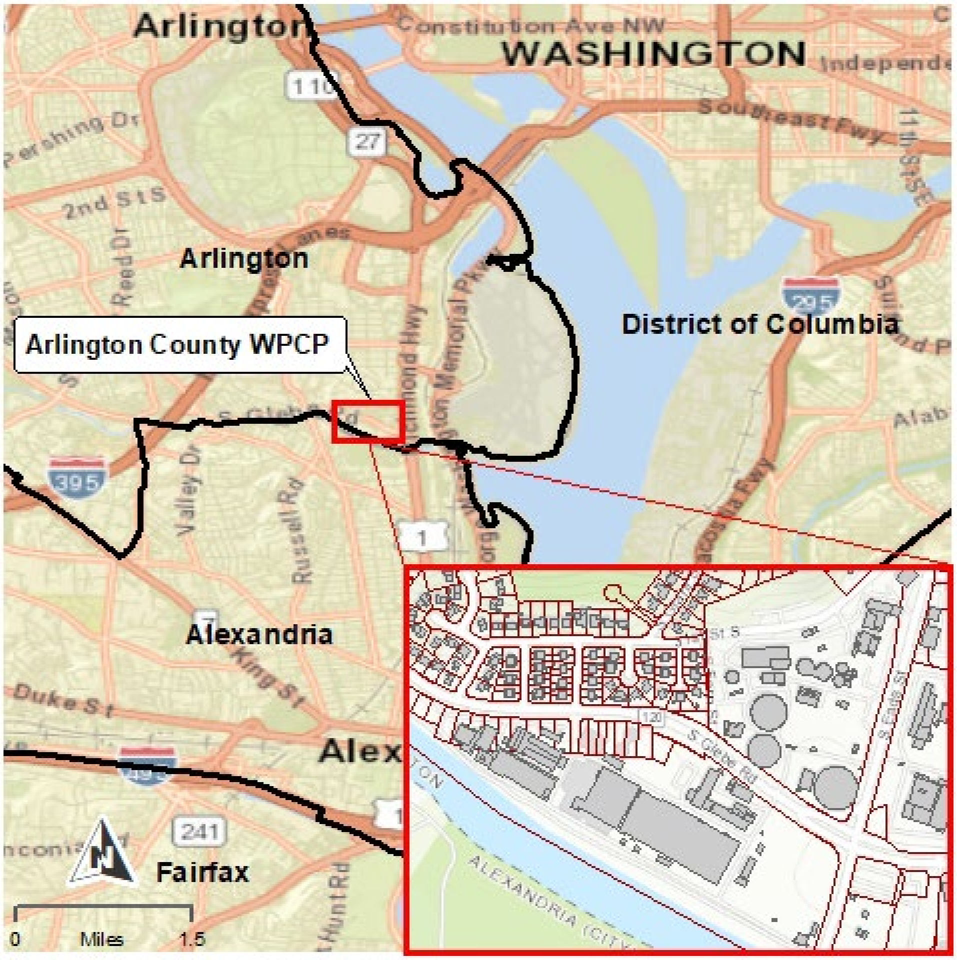


Figure 1-1. Location of the Arlington County WPCP

1.3 Solids Master Plan

The Program is largely the implementation of the plans developed during the master planning efforts completed in March 2018 and described in the *Arlington County WPCP Solids Master Plan* (Master Plan) authored by CDM Smith. The Master Plan effort evaluated several solids handling alternatives and developed a recommendation that addressed the many needs of the WPCP. The overall goals of the Master Plan work were as follows:

- Replace failing and end-of-life equipment

- Mitigate the risk of potential future regulatory changes to the current practice of recycling Class B biosolids through application to agricultural land
- Provide a solution that reduces the energy and greenhouse gas (GHG) footprint of the WPCP
- Achieve additional County-wide sustainability goals
- Develop a solids management strategy that offers long-term reliability
- Establish an implementation plan compatible with County Capital Improvement Program (CIP) funding

The alternatives evaluated in the Master Plan to achieve these goals included continuing lime stabilization, mesophilic anaerobic digestion (AD), THP followed by AD, and AD followed by heat drying. The evaluation took into consideration 19 criteria, including the energy balance of each alternative. The recommended alternative from the Master Plan was THP followed by AD.

1.4 Arlington Re-Gen Program

The Program seeks to implement the recommendations made in the Master Plan. The Program will enhance operating performance and reliability while continuing to meet all permit requirements and ensuring continued commitment to environmental stewardship at the WPCP.

1.4.1 Mission Statement

A mission statement can be a valuable tool to help set the tone for a program during internal meetings and workshops. The Program's mission statement is to:

Upgrade resource recovery facilities to produce Class A biosolids and renewable energy, maximizing sustainability and community acceptance. Collaborate with team members to select and implement processes that are safe, reliable, and financially responsible throughout planning, design, construction, operations and maintenance.

1.4.2 Program Goals

Building on the mission statement and related drivers for the Program, below are the Program goals developed by the County:

- **Produce a Class A Exceptional Quality (EQ) end product:** high-quality, low-odor product suitable for beneficial use and reduced risk of regulatory impact for land application
- **Recover biogas for beneficial use:** recovering and beneficially using renewable resources to help achieve County-wide sustainability goals

- **Provide ease of maintenance and repairs:** easy to work with equipment, updated technology with high efficiency and long-term ability to find replacement parts
- **Keep safety in mind:** throughout process, design, construction, and ongoing operations
- **Apply proper process selection and configuration:** appropriate choice of processes, well-designed and coordinated across the entire system, reliable with adequate redundancy
- **Implement an open, transparent, and collaborative process between all team members**
- **Achieve and maintain community acceptance:** maintain “good neighbor” status, including construction, and produce an outcome that is an asset to the community
- **Implement cost-effective solutions:** make the most out of the investment
- **Develop operator-friendly solutions:** comprehensive training on reliable and accessible equipment with clear operations and maintenance (O&M) and troubleshooting guidance
- **Design for long-term reliability:** eliminate nuisance-causing, aging equipment and processes
- **Actively engage staff throughout process:** during design, construction, startup, and training
- **Ensure that staff are well prepared to operate and maintain the new processes:** via comprehensive training, ample transition time, and appropriate staffing levels for new systems

1.5 Program Management

Arlington County has contracted with HDR Engineering, Inc. (HDR) to be the Program Manager for the County on this Program. Various delivery teams will contract with the County for design and construction services (refer to Section 22 for additional information). The delivery teams will interface with the Program Manager during all phases of the Program.

The Program Manager reports to the County and is responsible for assisting the County with the following activities:

- Preparation of this Facilities Plan (Plan) that describes the scope elements

- Preparation of 30 percent bridging documents for the early utility relocation and demolition activities
- Advice and assistance to the County on procurement (in a non-voting role)
- Administrative monitoring and contract management during design and construction in a quality assurance (QA) role
- Review of delivery team deliverables, including design documents, pre-construction submittals, and construction submittals
- Assistance with negotiations with delivery teams
- Outreach activities
- Commissioning assistance
- Arlington County O&M training coordination—the delivery teams will be responsible for vendor and County staff training
- Monitoring closeout
- Coordinating with all Re-Gen projects
- Leading Envision verification
- Other activities as may be deemed appropriate by the County

1.6 Organization of the Facilities Plan

This Plan is organized into three volumes. Volume 1 contains the body of the Plan, including all referenced tables and figures. Drawings referenced in Volume 1 are provided in 11-by-17-inch format separately in Volume 2. Volume 3 consists of all appendices, including technical memoranda (TMs) and other reports referenced in Volume 1 that were generated during the facilities planning process.

The remaining sections of Volume 1 describe the recommended process alternatives, design criteria, and configuration options for the recommended Program improvements, as well as key permitting, construction, and project implementation considerations. A summary of design solids production rates and other key design criteria is followed by process-by-process descriptions of the recommended improvements. Construction sequencing and maintenance of plant operations (MOPO) considerations are also discussed. The preliminary opinion of probable Program costs and a preliminary Program timeline are also presented.

2 DESIGN BASIS

2.1 Design Basis Summary

The design basis and approach for the Program were refined through multiple collaborative workshops with Arlington County and the Program Manager, as described in this Plan and appendices. All facilities shall be designed for projected solids load at 30.8 mgd, with space allocated for buildout loads at 40.0 mgd. Summaries of the overall and unit processes are provided below, followed by an introduction of the site plans and overall Program design preferences.

2.2 Overall Process Description

Several new processes and facilities will be added to the WPCP as part of the Program and there will also be modifications to some existing solids handling processes and equipment. The overall solids process flow diagram for the Program is shown on Drawings G-005 and G-006. Each unit process is described in detail in subsequent sections of this Plan; a brief summary of each is provided in this section.

2.2.1 Primary Solids Thickening

The existing GTs will be refurbished and used to thicken PS. This will maximize the capacity in the new solids storage tanks (SSTs) while reinvesting in an existing process. Thickened primary solids (TPS) will be combined with the stored WAS upstream of the solids screens. The combined screened solids will be stored in the new SSTs.

2.2.2 WAS Thickening

No thickening for WAS will be installed as part of this Program. WAS will be pumped by the existing WAS pumps to a new dedicated SST, and from there pumped to new solids screens where the WAS will combine with TPS prior to screening. Provisions for future WAS thickening are recommended using either gravity belt thickeners (GBTs) or rotary-drum thickeners (RDTs). When WAS thickening is included in the future, WAS will be pumped from the SST to the GBT or RDT, and new thickened waste activated solids (TWAS) pumps will pump the thickened WAS to the screens.

2.2.3 Solids Screening

Screening at the WPCP is performed on the influent flow at the Preliminary Treatment Building (PTB). New multi-rake bar screens with ½-inch openings between bars are currently being installed as part of the Preliminary Treatment Upgrades: Phase 9B project. Even with the improved influent screening, the PS and WAS generated at the WPCP contain debris that enters the downstream solids handling process. The implementation of THP requires solids to be screened to 5 millimeters (mm) to prevent adverse impacts on the THP equipment and to reduce excess debris in the final Class A biosolids product. Solids screens upstream of THP equipment will be used to mitigate these impacts and to ensure proper operation of the THP equipment.

2.2.4 Pre-Dewatering

The THP requires that undigested PS and WAS are pre-dewatered to a solids concentration of approximately 15 to 18 percent dry solids. New centrifuges will be provided to pre-dewater the solids to the recommended solids concentration.

At least two pre-dewatered cake storage bins will be provided to store the pre-dewatered cake, provide redundancy, and provide equalization to attenuate fluctuations in the upstream solids handling processes. The THP feed pumps will pump cake from the pre-dewatered cake storage bins to the THP preheating/reactor feed tank. The bins will also provide short-term storage for both planned and unplanned THP shutdowns.

2.2.5 Thermal Hydrolysis Process

THP uses medium-pressure steam to create high temperature and pressure conditions to lyse cells and to promote the release and solubilization of particulate organic material. THP further hydrolyzes large biological macromolecules, carbohydrates, and long-chain fatty acids to lower molecular weight intermediates, significantly improving the rate of digestion. Therefore, ADs can be operated at shorter retention times with equivalent process stability as conventional mesophilic ADs. In addition, the THP increases volatile solids (VS) destruction and biogas generation by approximately 10 to 20 percent relative to conventional digestion.

Another characteristic of THP is a decrease in viscosity of the digester feed solids, allowing higher feed solids concentrations in the ADs, in the range of 9 to 12 percent compared to 4 to 6 percent total solids (TS) for a conventional digestion process. As a result, the volume requirement of the ADs can be greatly reduced compared to the required capacity of conventional mesophilic ADs. Finally, the digested solids (DS) from a THP system provide less odorous cake and typically provide increased dewaterability compared to conventional AD, as well as Class A biosolids.

In general, the THP will be a batch process with redundancy provided for each component of the key unit processes, excluding process gas treatment. While the pressure vessels of the THP require annual shutdowns and inspection, the redundancy provided will eliminate the need for emergency storage.

THP systems from different manufacturers vary widely in their process configurations, equipment arrangement, and operational strategies. Additionally, the solids handling facility interfaces upstream and downstream of the THP are different with each technology. Therefore, the THP equipment manufacturer and equipment details will be pre-selected by the County via competitive negotiation so that the designer has adequate information about the technology to design the interfaces properly.

2.2.6 Hydrolyzed Solids Cooling

Following THP, the thermally hydrolyzed solids (THS) must be cooled to mesophilic digestion temperatures prior to digestion. The cooling will be accomplished by cooling heat exchangers (HEXs) using plant effluent water (PEW) as the cooling medium. Careful design of this system is required, including blending the THS with recycled DS prior to the HEXs in order to reduce viscosity of the cooled THS and ensure that the material remains easily pumpable.

2.2.7 Anaerobic Digestion

The WPCP currently stabilizes thickened PS and WAS using lime stabilization. This Program will construct new digesters, with two primary digesters and one secondary digester, to stabilize the THP preconditioned solids, reduce the mass of solids to be hauled, produce biogas to be beneficially used, and produce Class A biosolids. Space will be reserved for a future third primary digester.

2.2.8 Final Dewatering

DS will be dewatered using new centrifuges to produce a high-quality dewatered Class A biosolids cake suitable for beneficial reuse. The dewatered cake will be stored in final dewatered cake storage bins. The cake will be loaded into trucks in a new fully enclosed, drive-through truck loading bay and then hauled to beneficial reuse.

2.2.9 Biogas Management and Upgrading

Biogas generated during the AD process will be upgraded and beneficially used as renewable natural gas (RNG). The biogas will be treated to remove contaminants and carbon dioxide (CO_2) and then used off site. A biogas flare will be provided to safely combust biogas during startup and maintenance.

2.2.10 Other Systems

The Program requires new support systems and modifications to existing support systems; these are also described in the subsequent sections of this Plan. These systems include:

- New process steam system
- New odor control system
- Modifications to the PEW system
- Modifications to the electrical distribution system
- Modifications to the distributed control system

2.3 Facility and Site Plan

This section presents a facility and site plan, including site and process constraints and facility layout concept overview.

2.3.1 Site and Process Constraints

The WPCP site has limited available space, with the solids handling facilities situated on the triangular northernmost part of the WPCP. Refer to the Drawings in Volume 2 for the existing site and utilities plans. The location for the new facilities is bordered on all sides by critical buried infrastructure including major electrical ductbank, the Potomac Interceptor influent to the WPCP, and the common influent channel, which carries all influent wastewater flow to the PTB. Multiple facilities, including foundations from previously demolished facilities, will require demolition to construct the new Facilities for this Program. Careful planning with Arlington County and the Program Manager will be necessary to ensure continuous reliable operation of the existing solids handling processes during Program implementation, including major utility relocation. For preliminary MOPO considerations, refer to Section 22.

The WPCP is bordered by residential neighborhoods, and as stated in Section 1, the vision of this Program is to be a good neighbor within the community and maximize community acceptance. Therefore, the new Facilities will be designed to fit in with the existing WPCP aesthetics. Where feasible, process equipment will be located inside buildings, and where not feasible, screening walls will be installed to provide visual screening from large, exposed process equipment and pipe racks. Noise and vibration excursions from the WPCP also can adversely impact the neighbors, so the new Facilities will also be designed to minimize noise and vibrations leaving the WPCP.

2.3.2 Facility Layout Alternatives Overview

Two options for laying out the facilities to house the new unit processes are presented in this Plan, based on either renovating or decommissioning the existing Dewatering Building (DWB) (Options 1 and 2, respectively). Both options are feasible and will be further considered for the facility design by the delivery team. If the existing DWB is renovated, then it will be modified to house the screening and pre-dewatering processes as well as the process steam system. If the DWB is decommissioned, then a Solids Processing Building (SPB) will be constructed to incorporate both pre-dewatering and final dewatering. Refer to the Drawings for site plans for the two options (e.g., C-004 and C-007) and building concepts for the new facilities. The site plans and site considerations are described in greater detail in Section 17.

2.4 Program Design Preferences

During the development of the Plan's technical design criteria, a set of design preferences were developed by Arlington County. These criteria, listed in Table 2-1, identify criteria into the following three categories:

- **Requirement:** Based on evaluations during the planning period Arlington County has determined these criteria are a requirement to be implemented by the delivery team.
- **Preference:** Based on evaluations during the planning period Arlington County prefers these criteria, but the delivery team may propose alternatives for the County's consideration.
- **Further Evaluation:** The delivery team will perform additional evaluation and work with the County and Program Manager to reach an agreed solution.

Table 2-1. Program Design Preferences

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
Site Plan	Site plan design	Site plan shall be designed to accommodate future facilities (digester, etc.) required for 40 mgd.		
	Renovate DWB			Renovate or decommission DWB
	Decommission DWB			Renovate or decommission DWB
	Stormwater	Meet stormwater regulations		
	Stormwater	Drains in solids processing and hauling areas will go to process		Determine which areas can go to the head of the WPCP and how to route overflows
	Facilities siting	Avoid impacts to existing 480-volt (V) buried infrastructure and utility corridors as identified on site plan		
	Fats, oils, and grease (FOG)		Future but reserve space	Location
	Post-processing		Future but reserve space	Location, technology
	Sidestream treatment	Future but reserve space		Location
Thickening	Primary thickening	Existing GTs and underflow pumps	Use existing underflow pumps	GT drain pump approach
	WAS thickening	Plan for future and reserve space		Location, technology
Solids storage	Thickened solids storage		24 hours (hr) at peak 3-day solids	
	Unthickened WAS storage		8 hr at peak 3-day solids	
	Unthickened primary storage	None		
	Solids storage	Combined PS/WAS storage must be post-screening	Combined PS/WAS storage	
	Solids storage	Maintain ability to store screened PS/WAS separately or combined		
	SST mixing			Mixing technology (shown as large bubble mixing for SSTs)

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
Solids screening	Solids screening process design criteria		As defined in Sections 3 and 6 of the Plan	Separate screening of TPS and WAS
	Solids screening equipment type	Inline solids screens (5 mm)		
	Solids screening redundancy	N+1		
	Solids screening equipment manufacturer	Huber Strainpress Hydro-Sludge screen		Equipment manufacturer evaluation
	Solids screens materials of construction	Stainless steel		
	Solids screenings storage	Provide means of controlling odors from screenings		Enclosure or endless bagging system
Pre-dewatering	Pre-dewatering process design criteria		As defined in Sections 3 and 8 of the Plan	
	Pre-dewatering equipment	Centrifuges		
	Pre-dewatering equipment		Centrifuge manufacturers: Alfa Laval, Centrisys, GEA	Equipment manufacturer evaluation
	Pre-dewatered cake conveyance		As defined in Section 8	
	Pre-dewatering centrifuge redundancy	N+1		
	Pre-dewatered cake storage	No fewer than 2 bins		
	Pre-dewatered cake storage	24 hr at 40 mgd (350 cubic yards [CY])		
	Pre-dewatered cake loadout	Provide means of loading out pre-dewatered cake to trucks for hauling	For renovated DWB, maintain one existing truck scale and loading	

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
			bay for pre-dewatered cake emergency operations	
Renovated DWB /SPB	Operation spaces	Plant-wide redundant control room		
	Operation spaces	Separate break room from control room		
	Operation spaces	Bathroom and lab space (1,000 square feet [ft^2])		
	Operations storage	Dedicated storage for operations (1,000 ft^2)		
Renovated DWB /SPB	Maintenance space	Dedicated space must be provided for maintenance (600 ft^2 for maintenance and 600 ft^2 for electrical)		
THP	THP equipment	To be pre-selected by Arlington County		
	THP feed	Progressive cavity with dilution and lubrication		
	Dilution water (including THP downstream)	PEW with County water (COW) backup		
Steam	Steam boiler design criteria	As defined in Section 10 of the Plan, 10,000 pounds (lb)/hr, 350 horsepower (hp)		
	Steam boiler equipment	Conventional boilers, dual-fuel both natural gas (NG) and biogas		
	Steam boiler equipment	N+1		
Cooling	Cooling process design criteria	As defined in Section 11 of the Plan		
	Cooling method		Once-through cooling using PEW with COW backup	Once through vs. cooling tower with plume abatement (as described in Section 11)
	HEX type	Tube-in-tube		
	HEX redundancy	50% of the installed HEX can cool 100% of the solids in winter conditions	Two bifurcated HEX: provides redundancy	
Digestion	Digester process design criteria	12-day minimum solids retention time (SRT) 0.4 lb VS/cubic foot (ft^3) max 3,000 milligrams per liter (mg/L) ammonia (NH_3) max		
	Digester configuration	2 primary, 1 secondary sized for 30.8 mgd		

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
	Digester configuration	Secondary digester designed to function as redundant primary digester		
	Digester configuration	3 digesters now		Digester location
	Digester configuration	1 digester future		Planning for future digester (location/foundation)
	Digester feed approach		Direct feed to each digester	
	Digester mixing	Draft tubes and/or pumped mixing ONLY		Draft tubes or pumped mixing
Digestion	Digester mixing	Secondary digester fully mixed at 20% full		
	Digester construction method	Digester concrete material of construction		Digester construction method
	Digester geometry		1:1 diameter:height	
	Primary digester covers	Concrete covers for primaries without columns		
	Secondary digester covers		Membrane cover for secondary digester	
Final dewatering	Final dewatering design criteria		As defined in Sections 3 and 13 of the Plan	
	Final dewatering equipment	Centrifuges		
	Final dewatering equipment	Match pre-dewatering centrifuge (size, make, model)		
	Final dewatering equipment		Centrifuge manufacturers: Alfa Laval, Centrisys, GEA	
	Final-dewatering centrifuge redundancy	N+1		
	Final dewatering cake storage	Minimum 200 CY		

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
	Final dewatering cake storage	Minimum of two bins		
	Final dewatering truck loadout operations	Drive-through enclosed loadout area		
	Final dewatering truck loadout operations	Fully load truck without moving trailer		
	Final dewatering truck loadout operations		Fully load trailer within 45 minutes	
	Operation spaces in Final DWB (Renovate DWB option)	Viewing platform, bathroom, lab space, centrifuge control room in Final DWB		
	Centrate handling	Plan for future deammonification	Centrate equalization prior to installing deammonification	
Biogas	Biogas process design criteria		As defined in Section 14 of the Plan	
	Biogas storage	Provide low pressure biogas storage as defined in Section 12	Membrane cover to secondary digester	Means/location of storage
	Biogas utilization	Renewable natural gas		
	Biogas utilization	Provide pipe for on-site biogas use		
Biogas	Biogas upgrading technology		Membrane separation	Equipment manufacturer evaluation
	Tail gas combustion	Tail gas treatment/combustion		Method/technology for tail gas treatment/combustion
	Biogas flare	Enclosed flare technology, minimum 10:1 turndown, dual fuel pilots		
	Biogas flare	Redundancy required		Mode of redundancy

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
	Biogas upgrading technology	Redundancy required		Mode of redundancy
Chemicals	Polymer	Liquid emulsion	Final dewatering aging tank	
Odor control	Odor control	Performance requirements throughout construction		
	Odor control		Central scrubbers as defined in Section 15 of the Plan	
	Odor control		Consider future expansion capabilities when designing odor control system	
Utilities	Drains		Eliminate Recycle Interceptor Pump Station (RIPS)	
	Recycle management	Provide flow monitoring and efficient means to sample for each individual recycle stream		
	PEW	Use existing PEW system; provide COW as a backup to PEW in critical locations		Confirm PEW network is adequate
	COW	Provide looped COW system on north side of WPCP to improve COW resilience		Confirm loop arrangement and adequate fire flows
Electrical	Electrical equipment	Located in a building		
	DC-7 standby power	Provide a generator tap box to facilitate connection of a mobile generator		
	Potomac Yard Pump Station (PYPS) power reliability	Provide dual electrical services to PYPS at all times throughout project	Provide temporary generators to provide dual service to PYPS	
	Lighting	Light-emitting diode (LED)	Manufacturers: Holophane, Crouse Hinds, Appleton	
	Wire	Wire for process feeders or branch circuits: cross-linked polyethylene high heat-resistant water-resistant-2 (XHHW-2) Lighting and receptacle circuits and #14 American Wire Gauge (AWG) Class 1 control circuits: thermoplastic high-heat-resistant nylon-2 (THHN-2)		
Electrical	Conduit	Hazardous/corrosive spaces: polyvinyl chloride-coated rigid galvanized steel (PVC-RGS) Dry/wet spaces: RGS		

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
		Buried: PVC-RGS or Schedule 40 PVC when encased in a concrete ductbank.		
	Variable-frequency drive (VFD)	Allen-Bradley PowerFlex VFDs		
	Switchgear	Eaton or Schneider Electric (Square D)	Schneider Electric (Square D)	
	Motor control centers (MCCs)	Eaton or Schneider Electric (Square D)	Schneider Electric (Square D)	
	34.5-kilovolt (kV) switches		Prefer gas-filled instead of oil-filled	
Instrumentation	Distributed control unit (DCU) panels	ControlLogix 5580 controllers (or latest version)		
	Remote input/output (RIO) panels	ControlLogix platform, FLEX 5000™ input/output (I/O) distributed I/O platform (or latest version)		
	Local control panels (LCPs)	CompactLogix 5380 controllers (or latest version), Micro850 and Micro870 controllers (or latest version)		
	Electrical switchgear	Modicon programmable logic controllers (PLCs) (Schneider Electric)		
	Operator interface terminals (OITs)	Allen-Bradley PanelView Terminals	Thin Clients with touchscreen panels are preferred instead of industrial personal computers	
	Panel power supplies	Allen-Bradley Bulletin 1606 (or latest version), Pepperl+Fuchs, Phoenix Contact		
	Terminal blocks band breakers	Allen-Bradley, Phoenix Contact	Circuit breakers are preferred to fuses whenever possible	
	Relays	Allen-Bradley, Phoenix Contact		
	DCU panels	Allen-Bradley Stratix 5700 industrial access switch (or latest version)		
	RIO panels	Allen-Bradley Stratix 5700 industrial access switch (or latest version)		
	LCPs	Allen-Bradley Stratix 2500 switch (or latest version), Ethernet Tap (ETAP)		
Instrumentation	Network operations center (NOC)	Cisco Catalyst distribution switch, latest version		

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
	Distribution switch rack enclosure	Cisco Catalyst distribution switch, latest version		
	Zone enclosure	Allen-Bradley Stratix 5400 industrial access switch (or latest version)		
	Device-level networks: Ethernet-based protocols	Flow meter, analyzers, power monitors, and APL transmitters	Ethernet is preferred where possible	
	Device-level networks: HART/4–20 milliamperes (mA)	Pressure, temperature and level transmitters, actuators	HART/4–20 mA	
	Device-level networks: Foundation Fieldbus	Actuators, pH/ oxidation-reduction potential (ORP), mass flow. Foundation Fieldbus devices will be used only when existing Fieldbus infrastructure is present.		
	Device-level networks: wireless protocols	WirelessHART, WiFi, cellular/ Long-Term Evolution (LTE)		
	Device-level networks: BACnet	Heating, ventilation, and air conditioning (HVAC) controls		
	Pressure transmitters	Rosemount		
	Temperature transmitters	Rosemount		
	Level transmitters	Differential pressure: Rosemount		
	Level transmitters	Radar preferred to ultrasonic: Rosemount		
	Flow meters: mag meter	Endress+Hauser		
	Flow meters: differential type	Rosemount		
	pH/ORP	Yokogawa		
	Fixed-point gas detection	Sierra monitoring		

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
	Dissolved oxygen (DO)/total suspended solids (TSS)	Insite		
	Online TSS		Valmet	
	Weight (load cells)	Mettler-Toledo		
	Electric actuators		Rotork	
Instrumentation	Uninterruptible power supplies (UPSs): 120 volts alternating current (VAC) output	Vertiv/Leibert GXT series		
	UPSs: 24 volts direct current (VDC) output	Allen-Bradley 1606-XLS240-UPS, 1606-XLS480-UPS		
Architectural	Facility external appearance		Consistent with existing facilities	
	Facility and equipment external appearance		Provide screening walls to limit visual impact	
	External vibration and noise mitigation		Design facilities to limit noise and vibration excursions beyond WPCP fence line	
	Elevators	Freight elevator required if the building is 3 or more stories high		
	Facility sustainability		As described in Sections 2 and 18 of the Plan	
HVAC	HVAC	Conditioned space for all electrical rooms, control rooms, and break rooms	Design criteria as specified in Section 19	
	HVAC		Temperature design set points as identified in other sections	
	HVAC	National Fire Protection Association (NFPA) 820 compliance		

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
	HVAC equipment		Trane: one manufacturer for all systems Liebert for computer room air conditioning (CRAC) systems	
	HVAC controls	Siemens		
	Heating method			Overall approach to heating and cooling, including use of boilers, NG, and/or electricity for heating
Temporary facilities	Electrical	Limit temporary electrical		
	Solids stabilization			Temporary operations (pending site plan selection)
	Solids stabilization	Provide odor control for all temporary solids stabilization		
General	Overall design	Facilities and equipment shall be designed for 30.8 MGD design condition. New buildings shall be designed with space for future equipment required for 40 mgd.		
	Facility sustainability	Minimum Envision Silver verification	Envision Gold verification	
	Pump redundancy	N+1 for all process pumps		
	Positive-displacement pump		Progressive cavity or rotary lobe	
	Progressive-cavity pump manufacturers		Seepex or Moyno. Split-casing is preferred where possible.	
	Valve		Valve preferences to be provided	
	Grinders		Prefer Franklin Miller Super shredder instead of JMC Muffin Monster	
	Centrifugal pumps		Hayward Gordon	
	Screw pumps		Goulds or Hayward Gordon	
	Valves	DeZurik: full port preferred where applicable		

Unit Process/ Area	Item	Requirement	Preference	Further Evaluation
	Valves		Provide electric actuator with remote pushbuttons for all valves out of reach	
	Process piping	Cleanouts and flushing provisions on all solids and chemical lines, with hot water		
	Process piping		Provide standard (per American Water Works Association [AWWA] C110) piping sizes only, for all piping materials and systems	
	Process piping	4" and larger: ductile-iron. Glass lining for solids piping. Concrete lining for PEW.	Flange or Victaulic couplings acceptable	
	Process piping		3" and smaller: PEW—stainless steel or galvanized steel. Unions or flanges preferred to welding.	
	Process piping insulation	Insulation will have PVC jacketing. Insulation will be removable (via removable blankets) at access points, including fittings, valves, and instruments.		Consider/evaluate Dragon jacket manufacturer
	Process piping and instruments	Outside piping at risk for freezing will be heat traced and insulated.		
	Process piping		Maximize accessibility of all valves and instruments	

2.5 Program Sustainability

The completed Program will not only enhance operating conditions and reliability of the Facilities while continuing to meet all permit requirements; it will also ensure a persistent commitment to environmental stewardship by the County. Sustainability goals have been developed to support the Arlington County Facility Sustainability Policy for New Construction and Major Renovation (Green Building Policy, April 30, 2019). Table 2-2 below presents the Program sustainability goals and their aligned purpose from the Facility Sustainability Policy.

Table 2-2. Program Sustainability Goals

Re-Gen Sustainability Goals	Arlington County Facility Sustainability Policy Purpose
Demonstrate Arlington's commitment to environmental, economic, and social stewardship	Demonstrate Arlington's commitment to environmental, economic, and social stewardship
Produce a high-performing, durable, adaptable, and efficient project that is easy to operate and maintain	Achieve high-performing, durable, and efficient buildings that are easy to operate and maintain
Support staff and community health and well-being through the implementation of safe facilities	Invest in healthy indoor environments for staff and visitors
Support the County's goal of becoming carbon neutral by 2050	Reduce operating costs through energy and water efficiency
Facilitate an open, transparent, and collaborative process	Set a community standard of sustainable building practices
Convert wastewater to Class A biosolids and biogas for renewable energy	

2.6 Envision Rating System

The Green Building Policy requires that "all County buildings and public facilities will strive to incorporate the highest environmental performance standards using the Leadership in Energy and Environmental Design (LEED), International Living Futures Institute (ILFI), or Viridiant's EarthCraft Virginia green building rating system." Further, the policy notes that all eligible new construction must achieve at least LEED Silver certification "to demonstrate and communicate comprehensive sustainability to the public, including management of energy, water, materials, indoor environment, and sustainable sites."

Because of the industrial, process-oriented nature of the Program, it would be difficult for the Facilities to meet several of the LEED prerequisites. The Envision® V3 Sustainable Infrastructure Framework (Envision) was developed to foster "the dramatic and necessary improvement in the sustainable performance and resiliency of physical infrastructure” (*Purpose of Envision®,* Institute of Sustainable Infrastructure). Whereas LEED is intended to evaluate interior spaces with the primary purpose of human occupancy, Envision covers projects in broad civil infrastructure. As the nature of the Arlington Re-Gen Biosolids Upgrade Program is a broad and complex civil infrastructure project, the Program will proceed with the Envision verification system as a means to achieve a more sustainable Program while fulfilling the intent of the Arlington County Green Building Policy. The WPCP will use the Envision framework to improve sustainable performance, as a component of the forthcoming Program Sustainability Management Plan (SMP), and to pursue Envision verification. The SMP will be provided to the delivery teams as a separate document.

Based on the initial evaluations completed during the planning phase, the Program is well-suited to pursue credits that could result in an Envision verification, provided that the required supporting documentation is compiled. The Program currently demonstrates that it can achieve a Silver verification goal, which aligns with the Green Building Policy’s requirement for LEED Silver certification. There may be sufficient points to target a Gold verification when submitted.

Envision is similar in structure to the LEED rating system. While LEED is intended to be used for buildings, Envision provides industry-wide sustainability metrics for all infrastructure types, including industrial facilities such as the WPCP. Envision provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects, giving recognition to those projects that use transformational, collaborative approaches to assess the sustainability indicators over the course of a project’s life cycle. The majority of credits included in LEED correlate to Envision credits, refer to TM No. 15: *Envision Rating System Recommendations*. Additionally, to ensure that the intent of Arlington’s Green Building Policy is met, is it recommended that all Envision credits that correlate to LEED prerequisites be included, other than those intended for indoor occupied spaces.

3 SOLIDS PRODUCTION AND DESIGN CRITERIA

3.1 Background and Purpose

The purpose of this section is to establish the projected solids production and design criteria for the Arlington Re-Gen Project. Based on an evaluation of historical operating data and projected wastewater flows, design criteria were established for current, design, and ultimate WPCP buildout conditions. TM No. 1: *Solids Production and Design Criteria* (Appendix A) provides additional background of the plant data evaluation. This section presents the current solids production at the Arlington WPCP, the approach for developing solids loading design criteria, and the resulting design criteria. Additionally, the design condition is listed for each process along with the justification behind the design condition selection.

3.2 Current Solids Production

Three years of WPCP operation data from December 2017 through November 2020 were analyzed to evaluate current solids production and to serve as a basis for projecting future solids loads. This section summarizes the current solids production along with the methods for calculating these loads.

The overall goals of the current solids production analysis were to determine the following:

- WPCP solids production in terms of dewatered cake hauled (dry tons [DT] per million gallons [MG] of flow treated)
- PS and TPS production
- Primary scum production
- WAS and TWAS production
- Capture rates for existing thickening and dewatering processes
- 30-day, 14-day, 7-day, and 3-day load peaking factors (PFs) for PS, WAS, and cake

Figure 3-1 illustrates the current simplified overall plant process flow schematic. The approaches used for calculating key solids loads are also shown. The dewatered cake load prior to lime addition was calculated using two methods to provide additional confidence. These methods used liquid solids data (centrifuge feed minus centrate loads, “Method 1”) and hauled solids data (hauled cake minus lime, “Method 2”). Over the 2017–2020 period, the average WPCP effluent flow was 23 mgd, and overall solids production from the dewatering centrifuges was 1.30 DT/MG. WAS load was calculated using the total WAS flow and average TS concentration to the DAFT.

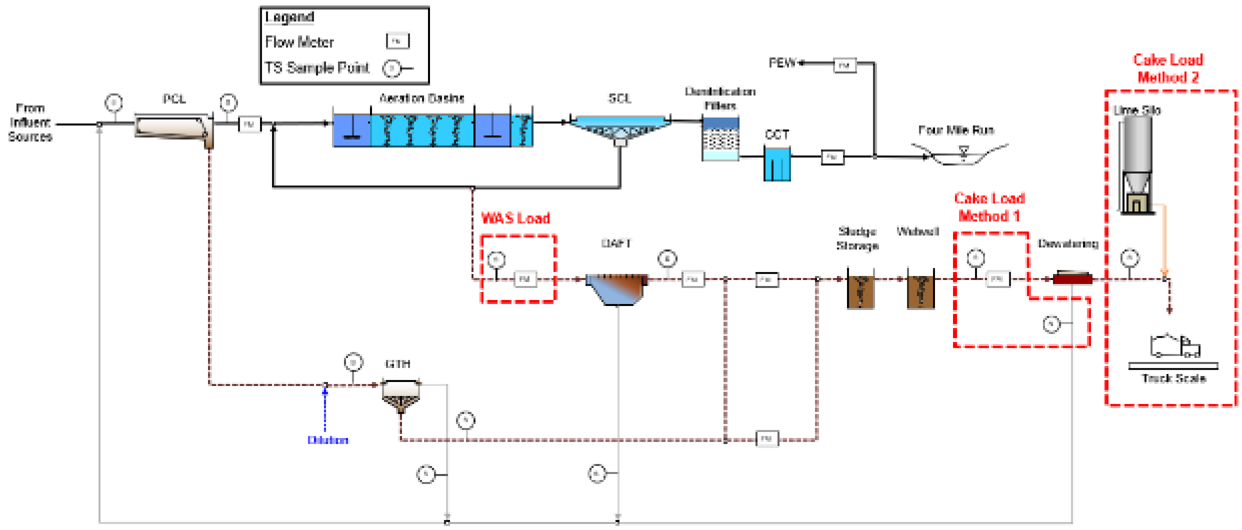


Figure 3-1. Current Simplified Process Schematic

PS production is influenced by the use of enhanced primary clarification. TPS and primary scum loads were calculated based on an overall mass balance using the cake load, WAS load, and capture rates for thickening and dewatering processes. Historically, primary scum has been added to the DAFT influent. Given the calculation approach used for this analysis, primary scum and TPS loads were initially quantified together, calculated as centrifuge feed minus TWAS.

Primary scum quantity was estimated based on total solids (TS) analysis of primary scum samples on 22 days in 2021, daily data for scum pump runtime, and the scum pumping rate as measured with a strap-on flow meter. The current primary scum production is estimated at 4,800 pounds per day (lb/d) based on an average primary scum pump runtime of 16 hours per day, flow of 120 gallons per minute (gpm) when running, and 0.50 percent TS. Peaking factors for scum were assumed to be the same as those for PS. Currently, primary scum is sent to the DAFT and ultimately to dewatering. As part of the Phase 9B project, scum will be concentrated separately and added to screenings sent to landfill. It is recommended that primary scum be added to the WAS storage tanks for processing through screening, THP and AD to recover biogas from the scum. This approach for primary scum is discussed in Section 7. The primary scum concentrator should be maintained as a backup.

Current solids production factors are summarized in Table 3-1, along with the method used for developing each factor. These parameters were used to generate a solids mass balance for current conditions, which then served as the basis for developing future loading conditions. These solids production factors are considered valid for the existing treatment process and are based on existing data. Solids production factors would need to be reevaluated if the liquid treatment process were changed (e.g., for biological phosphorus removal).

Table 3-1. Current Solids Production Factors (2017–2020)

Parameter	Value				Notes
Dewatered cake production	1.3 DT/MG treated				Based on analysis of centrifuge operating data and hauling records
Capture rates	Centrifuge: 95.0%, GT: 95.0%, DAFT: 99.5%				Based on analysis of operating data
TWAS load fraction [TWAS/(TWAS+TPS)]	34.5% of dry solids to dewatering				Based on average WAS load along with overall solids production and capture rates
Parameter	**30-day PF**	**14-day PF**	**7-day PF**	**3-day PF**	**Notes**
PS peaking factor	1.35	1.46	1.53	1.72	Based on blended solids load minus WAS load
WAS peaking factor	1.23	1.36	1.46	1.55	Based on WAS load to DAFT
Centrifuge feed peaking factor	1.31	1.41	1.51	1.66	Based on simultaneous TWAS and TPS peak

Current solids loads are summarized in Table 3-2 below.

Table 3-2. Current Solids Production Summary (2017–2020, 23 mgd)

Parameter	Average	30-day	14-day	7-day	3-day
Primary solids (lb/d)	38,400	51,800	56,000	59,100	66,000
Primary scum (lb/d)	4,800	6,500	7,000	7,400	8,200
WAS (lb/d)	21,800	26,800	29,700	31,600	33,800
Combined thickened solids (lb/d)	62,900	82,400	89,800	95,000	104,600
Centrifuge cake (lb/d)	59,800	78,300	85,200	90,200	99,300

The VS fraction of the solids is an important factor for evaluating future AD and digester gas utilization strategies. Based on the average WPCP data, the TPS was 84.2 percent volatile and the TWAS with primary scum added was 72.4 percent volatile. The primary scum alone is approximately 90 percent volatile. The TWAS without scum is approximately 68.5 percent volatile. Using these average values along with the solids production factors in Table 3-1, the mixed solids or cake is expected to be 80.6 percent volatile by mass balance. WPCP data indicate that blended solids were 78.0 percent volatile and dewatered cake was 81.4 percent volatile, so this calculated value is reasonable.

3.3 Design Solids Production Methodology

This section provides details regarding the methodology used to develop projections for future solids production.

3.3.1 Solids Characteristics

The design solids production values assume that operation of liquid treatment processes is similar in the future, including use of ferric chloride for enhanced primary clarification. This section discusses the solids concentrations at various points in the solids handling processes. VS fractions and relative WAS and PS loadings were presented in the previous section.

Typical TS concentrations through the processes include the following:

- **Primary solids:** PS was approximately 1.0 percent TS based on available data.
- **Thickened primary solids:** TPS from the GT averaged 5.0 percent TS. TPS concentrations can vary widely, so 4.0 percent TS was used for design criteria purposes.
- **Dilute primary scum:** Grab samples of dilute primary scum have been taken and percent TS varied widely, with average values typically between 0.5 and 1.0 percent TS. Dilute primary scum was assumed to be 0.5 percent TS on average.
- **Waste activated solids:** WAS has averaged 1.08 percent TS, and 1.0 percent TS was used for design criteria purposes.
- **Thickened waste activated solids:** TWAS samples from the existing DAFTs showed highly variable solids concentrations. It is expected that the TWAS from the DAFTs averages about 3.2 percent TS. With future mechanical thickening (GBT or RDT), it is expected that the TWAS would be 5 percent TS.
- **Dewatered cake:** The existing dewatered cake averages 31.5 percent TS prior to lime addition. The future pre-dewatering process does not require such a dry cake, but in practice, it may not be feasible to produce a cake with much lower TS.

3.3.2 Design Mass Balance

Solids load projections were evaluated for future WPCP flows of 30.8 mgd and 40.0 mgd. The 30.8 mgd WPCP flow condition represents approximately 40 dry tons per day (dtpd) from the centrifuges with the existing process configuration and was selected as the design condition for this project. Based on Arlington County growth projections (Arlington County Forecast Round 9.1) and assuming linear growth, the 30.8 mgd condition is expected to be met around year 2052. The 40.0 mgd WPCP flow condition represents the WPCP buildout capacity and the design capacity of the liquid side of the WPCP.

A solids process mass balance spreadsheet was developed to generate flows and loads for the future solids process configuration at 23.0 mgd (current), 30.8 mgd (design), and 40.0 mgd (buildout) WPCP conditions. The mass balance includes all major unit processes for the proposed solids handling configuration, as presented in the overall process flow diagram in Figure 3-2. Solids quantities and peaking factors used as inputs to the mass balance are based on the analysis of WPCP data presented in the previous section. This includes overall dewatered solids production of 1.30 DT/MG treated, stated peaking factors and VS fractions, and assumption of similar liquid treatment process operation in the future. It should be noted that if the liquid treatment process is changed to an enhanced biological phosphorus removal (EBPR) process in the future, the mass balance and design criteria would be affected. A change from enhanced primary clarification to EBPR may result in less PS production, more WAS production, lower dewatered cake solids concentrations, and higher hydrogen sulfide (H_2S) concentrations in digester gas and odorous air. Additionally, with EBPR it is recommended to include provisions to chemically remove soluble phosphorus from the digested sludge and/or centrate to help mitigate nuisance struvite scaling and high-phosphorus recycle loads.

Future changes in solids recycle loads relative to current thickening and dewatering operations are reflected in the model as additional PS. Capture rates for pre-dewatering and final dewatering should be evaluated by the design engineer.

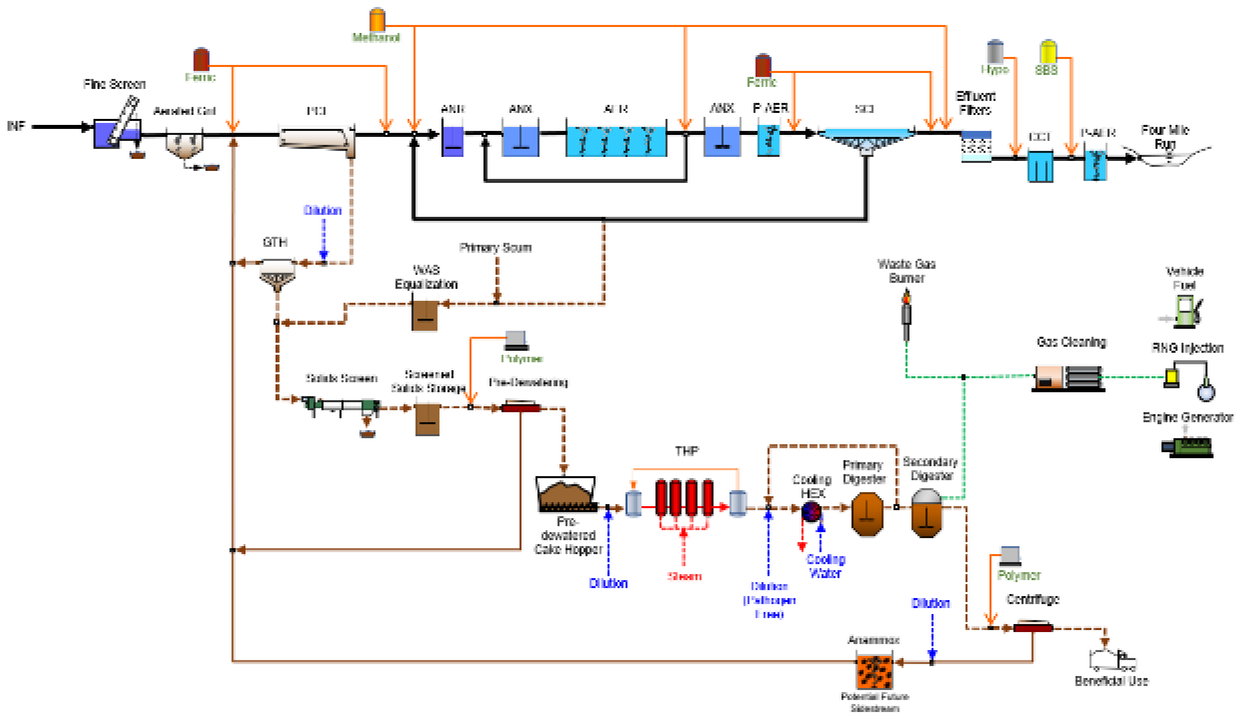


Figure 3-2. Proposed Overall Process Flow Diagram

Inputs to the mass balance include operating assumptions for each unit process, which are based on WPCP data, typical industry values, vendor information, and results from the THP/AD pilot testing with Virginia Tech. Initial pilot results for final dewatered cake percent TS were lower than expected, and the model assumption for this parameter has not yet been revised as investigation remains ongoing. Assumptions for process operation are listed in Table 3-3.

Table 3-3. Design Mass Balance Assumptions

Parameter	Value	Source
Primary Solids and Thickened Primary Solids		
PS solids concentration	1.0%	Based on analysis of special sampling 3/9/2021 and 4/15/2021
TPS solids concentration	4.0%	Based on analysis of WPCP data, average was 5%
Solids capture: PS thickening	95%	Based on analysis of WPCP data for GT influent and overflow
Primary Scum		
Dilute primary scum concentration	0.5%	Ranged from 0.5% to 1.0% during 2021 special sampling. Scum flow capped at 120 gpm in model and concentration increased accordingly.
WAS and TWAS		
WAS solids concentration	1.0%	Based on analysis of WPCP data, average was 1.08%
Future TWAS solids concentration	5.0%	Typical industry value
Solids capture: future WAS thickening	98%	Based on historical DAFT capture of >99%
WAS thickening polymer dose (lb active polymer/DT)	5	Typical industry value
Pre-dewatering		
Pre-dewatered solids concentration	25%	High solids not required for pre-dewatering; feasibility to be evaluated further
Pre-dewatering solids capture	95%	Based on current centrifuge dewatering
Dewatering polymer dose (lb active polymer/DT)	10	Based on historical operation at 8 lb/DT
THP/AD		
THP steam demand (ton steam per ton dry solids)	1.0	Typical value for Cambi
DS recycle ratio to HEX feed	3.5–5.0	Typically set to 3.5:1 recycle ratio at peak 3-day condition
Digester feed solids concentration	9.0%	Typical value for THP
VS reduction	60%	Typical industry value, supported by pilot results
Solids nitrogen content (lb-N/lb-VS)	0.045	Based on replicating THP/AD pilot digester NH_4-N
Biogas yield (ft^3-biogas/lb-VSr)	15	Based on THP/AD pilot results
Biogas higher heating value (Btu/ft^3-biogas)	650	Typical industry value
Biogas lower heating value (Btu/ft^3-biogas)	580	Typical industry value
Post-dewatering		
Post-dewatering solids capture	95%	Typical industry value for centrifuge dewatering
Post-dewatered solids concentration	33%	Estimate; evaluations ongoing
Dewatering polymer dose (lb active polymer/DT)	30	Estimate

Btu = British thermal units; DS = digested solids; ft^3 = cubic feet; NH_4-N = ammonium-nitrogen; VSr = volatile solids reduction.

The spreadsheet output is a mass balance at each step in the solids processes. Parameters specific to each unit process are also included, such as steam demand for THP, solids cooling requirements, nitrogen (N) released in the AD process, digester gas production, and estimated polymer use. These outputs are presented in Section 3.4 below.

3.4 Solids Loading Design Criteria

The solids loading design criteria for each unit process were established using biosolids projections at 30.8 mgd WPCP flow. The 40 mgd WPCP condition was used to establish facility footprint requirements for potential future equipment. All facilities must function properly at startup conditions. Flows and loads at 23 mgd WPCP flow are included in this section as a reference for startup conditions. Additional details are provided in this section and in the respective section for each unit process. Note that process loadings presented in this section are based on 24/7 operation, which may not be the design operating schedule for certain facilities (e.g., final dewatering). Design criteria in this section include primary scum but do not include future fats, oils, and grease (FOG) receiving, which is covered in Section 23. Design values used in TMs may vary from the values presented herein because of changes in design assumptions and process configurations during development of the Plan. Mass balance values provided in this section have been updated based on the most recent parameters and assumptions presented herein, and values may differ slightly from those listed in the remainder of the Facilities Plan. However, the slight variations in the parameters do not impact the findings of the unit process analyses included in subsequent sections. Design values would also need to be reevaluated if the liquid treatment process were changed (e.g., for biological phosphorus removal).

3.4.1 Design Peaking Factors by Solids Unit Process

Through collaborative workshops with Arlington County, individual facility design basis peaking factors were established for each unit process and are presented in Table 3-4. In general, processes upstream of THP are sized based on peak 3-day conditions. AD and downstream processes are sized based on peak 14-day conditions because of the equalization capacity provided by the secondary anaerobic digester as well as upstream cake and thickened solids storage. Loading rates for each unit process are provided in Section 3.4.2 with additional information included in the Plan section for each unit process.

Table 3-4. Peaking Factor by Solids Unit Process

Unit Process	Peaking Factor	Notes
PS thickening	Peak 3-day	Minimal upstream storage in PCs
WAS thickening (future)	Peak 3-day	Minimal upstream storage in secondary treatment process and SST
Solids storage	Peak 3-day	Minimal upstream storage in PCs, secondary treatment process, and GTs
Pre-dewatering and pre-dewatered cake storage	Peak 3-day	24 hours of screened solids storage upstream
THP	Peak 7-day	Attenuated by pre-dewatered cake storage and screened solids storage
Anaerobic Digestion	Peak 14-day	Attenuated by digester retention time and secondary digester
Final dewatering and final dewatered cake storage	Peak 14-day	Attenuated by all upstream processes

3.4.2 Design Solids Loading Rates by Solids Unit Process

Table 3-5, Table 3-6, and Table 3-7 summarize the solids loading criteria for the major unit processes at 23.0 mgd, the 30.8 mgd design condition, and the 40.0 mgd WPCP buildout condition, respectively. These tables include process flows at annual average, peak 30-day, 14-day, 7-day, and 3-day conditions. Model input parameters listed in the first column of these tables are italicized. Values shown in bold text represent the design basis loadings for the respective unit process. The 30.8 mgd design condition is used for equipment sizing and the 40.0 mgd buildout condition is used for sizing facility footprints, space for future equipment, and process piping. The key process design criteria for each unit process are described in greater detail in the corresponding sections of the Plan. The 30.8 mgd design condition is also shown on Drawing G-008.

Table 3-5. Process Design Criteria Summary, 23 mgd Condition

Parameter	Average	30-day	14-day	7-day	3-day
Primary Solids					
Total solids load (lb-TS/d)	39,924	53,831	58,234	61,434	68,576
Volatile solids load (lb-VS/d)	33,254	44,853	48,518	51,181	57,140
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	478,709	645,460	698,251	736,614	822,251
Flow (gpm)	332	448	485	512	571
Thickened Primary Solids					
Total solids load (lb-TS/d)	37,928	51,140	55,322	58,362	65,147
Volatile solids load (lb-VS/d)	31,592	42,610	46,092	48,622	54,283
Total solids concentration	4.0%	4.0%	4.0%	4.0%	4.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	113,693	153,297	165,835	174,946	195,285
Flow (gpm)	79	106	115	121	136
Waste Activated Solids					
Total solids load (lb-TS/d)	21,826	26,846	29,683	31,648	33,830
Volatile solids load (lb-VS/d)	14,951	18,389	20,333	21,679	23,174
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	68.5%	68.5%	68.5%	68.5%	68.5%
Flow (gpd)	261,702	321,894	355,915	379,468	405,639
Flow (gpm)	182	224	247	264	282
Primary Scum (to Solids Storage Tank with WAS)					
Total solids load (lb-TS/d)	4,784	6,458	6,985	7,367	8,228
Volatile solids load (lb-VS/d)	4,306	5,813	6,286	6,631	7,406
Total solids concentration (lb-TS/lb-solids)	0.50%	0.50%	0.50%	0.51%	0.57%
Volatile fraction (lb-VS/lb-TS)	90.0%	90.0%	90.0%	90.0%	90.0%

Parameter	Average	30-day	14-day	7-day	3-day
Flow (gpd)	114,724	154,878	167,497	172,800	172,800
Flow (gpm)	80	108	116	120	120
Combined Thickened Solids/Pre-dewatering Feed					
Total solids load (lb-TS/d)	64,538	84,444	91,990	97,377	107,206
Volatile solids load (lb-VS/d)	50,848	66,812	72,711	76,932	84,863
Total solids concentration	1.6%	1.6%	1.6%	1.6%	1.6%
Volatile fraction (lb-VS/lb-TS)	78.8%	79.1%	79.0%	79.0%	79.2%
Flow (gpd)	490,120	630,068	689,247	727,214	773,723
Flow (gpm)	340	438	479	505	537
Pre-dewatered Solids					
Total solids load (dtpd)	30.7	40.1	43.7	46.3	50.9
Total solids load (lb-TS/d)	61,311	80,222	87,391	92,508	101,845
Volatile solids load (lb-VS/d)	48,306	63,472	69,076	73,085	80,619
Total solids concentration (lb-TS/lb-solids)	25.0%	25.0%	25.0%	25.0%	25.0%
Flow (gpd)	29,406	38,476	41,914	44,368	48,847
Flow (gpm)	20	27	29	31	34
Cake mass (wtpd)	123	160	175	185	204
Cake volume (CY/d at 45 lb/ft^3)	202	264	288	305	335
Thermal Hydrolysis Feed Solids with Dilution Water					
Total solids load (lb-TS/d)	61,311	80,222	87,391	92,508	101,845
Volatile solids load (lb-VS/d)	48,306	63,472	69,076	73,085	80,619
Total solids concentration (lb-TS/lb-solids)	16.5%	16.5%	16.5%	16.5%	16.5%
Flow (gpd)	44,554	58,297	63,506	67,225	74,010
Flow (gpm)	31	40	44	47	51
Thermal Hydrolysis Depressurization Tank Solids with Steam Condensate					
Total solids load (lb-TS/d)	61,311	80,222	87,391	92,508	101,845
Volatile solids load (lb-VS/d)	48,306	63,472	69,076	73,085	80,619

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Parameter	Average	30-day	14-day	7-day	3-day
Total solids concentration (lb-TS/lb-solids)	14.2%	14.2%	14.2%	14.2%	14.2%
Flow (gpd)	51,906	67,916	73,985	78,317	86,222
Flow (gpm)	36	47	51	54	60
Temperature (°F)	221	221	221	221	221
Diluted THP Solids: Depressurization Tank Output and Pathogen-Free Dilution Water					
Total solids load (lb-TS/d)	61,311	80,222	87,391	92,508	101,845
Volatile solids load (lb-VS/d)	48,306	63,472	69,076	73,085	80,619
Total solids concentration (lb-TS/lb-solids)	9.0%	9.0%	9.0%	9.0%	9.0%
Flow (gpd)	81,683	106,877	116,428	123,246	135,685
Flow (gpm)	57	74	81	86	94
Temperature (°F)	168	168	168	168	168
Digested Solids Recycle: to Cooling Heat Exchanger					
Total solids concentration (lb-TS/lb-solids)	4.5%	4.5%	4.5%	4.5%	4.5%
Flow (gpd)	408,414	408,395	408,399	474,909	474,899
Flow (gpm)	284	284	284	330	330
Temperature (°F)	98	98	98	98	98
Digester Feed Solids: Diluted THP Solids with Recycled Digested Solids					
Total solids concentration (lb-TS/lb-solids)	5.1%	5.2%	5.2%	5.2%	5.2%
Flow (gpd)	490,097	515,272	524,827	598,155	610,584
Flow (gpm)	340	358	364	415	424
Temperature before HEX (°F)	110	113	114	112	114
Temperature after HEX (°F)	98	98	98	98	98
Digested Solids (to Final Dewatering)					
Total solids load (lb-TS/d)	30,692	39,930	43,557	46,137	50,660
Volatile solids load (lb-VS/d)	17,686	23,180	25,241	26,714	29,434
Total solids concentration (lb-TS/lb-solids)	4.5%	4.5%	4.5%	4.5%	4.5%
Volatile fraction (lb-VS/lb-TS)	57.6%	58.1%	58.0%	57.9%	58.1%

Parameter	Average	30-day	14-day	7-day	3-day
Flow (gpd)	81,683	106,877	116,428	123,246	135,685
Flow (gpm)	57	74	81	86	94
Ammonia-N concentration (mg/L)	1,996	2,006	2,004	2,003	2,007
Final Dewatered Cake Product					
Total solids load (dtpd)	15	19	21	22	24
Total solids load (lb-TS/d)	29,157	37,934	41,379	43,831	48,127
Volatile solids load (lb-VS/d)	16,802	22,021	23,979	25,379	27,962
Total solids concentration (lb-TS/lb-solids)	33.0%	33.0%	33.0%	33.0%	33.0%
Cake mass to end use (wtpd)	44	57	63	66	73
Cake volume (CY/d at 45 lb/ft^3)	73	95	103	109	120
Combined Recycles (Thickening, Pre-dewatering, and Final Dewatering)					
Total solids load (lb-TS/d)	6,758	8,910	9,689	10,247	11,322
Flow (mgd)	1.95	2.24	2.35	2.42	2.54
Post-dewatering recycle ammonia load (lb-N/d)	1,274	1,676	1,823	1,929	2,129

°F = degrees Fahrenheit; CY = cubic yards; gpd = gallons per day; wtpd = wet ton(s) per day.

Table 3-6. Process Design Criteria Summary, 30.8 mgd Design Condition

Parameter	Average	30-day	14-day	7-day	3-day
Primary Solids					
Total solids load (lb-TS/d)	53,464	72,087	77,983	82,268	**91,832**
Volatile solids load (lb-VS/d)	44,532	60,064	64,972	68,539	**76,518**
Total solids concentration	1.0%	1.0%	1.0%	1.0%	**1.0%**
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	**83.3%**
Flow (gpd)	641,053	864,356	935,049	986,422	**1,101,101**
Flow (gpm)	445	600	649	685	**765**
Thickened Primary Solids					
Total solids load (lb-TS/d)	50,791	68,483	74,084	78,154	**87,240**
Volatile solids load (lb-VS/d)	42,305	57,061	61,723	65,112	**72,692**
Total solids concentration	4.0%	4.0%	4.0%	4.0%	**4.0%**
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	**83.3%**
Flow (gpd)	152,250	205,285	222,074	234,275	**261,512**
Flow (gpm)	106	143	154	163	**182**
WAS					
Total solids load (lb-TS/d)	29,228	35,950	39,750	42,380	**45,303**
Volatile solids load (lb-VS/d)	20,021	24,626	27,229	29,031	**31,033**
Total solids concentration	1.0%	1.0%	1.0%	1.0%	**1.0%**
Volatile fraction (lb-VS/lb-TS)	68.5%	68.5%	68.5%	68.5%	**68.5%**
Flow (gpd)	350,454	431,058	476,617	508,158	**543,203**
Flow (gpm)	243	299	331	353	**377**

Parameter	Average	30-day	14-day	7-day	3-day
Primary Scum (to Solids Storage Tank with WAS)					
Total solids load (lb-TS/d)	6,406	8,649	9,353	9,866	**11,019**
Volatile solids load (lb-VS/d)	5,766	7,784	8,418	8,879	**9,917**
Total solids concentration (lb-TS/lb-solids)	0.50%	0.60%	0.65%	0.68%	**0.76%**
Volatile fraction (lb-VS/lb-TS)	90%	90%	90%	90%	**90%**
Flow (gpd)	153,631	172,800	172,800	172,800	**172,800**
Flow (gpm)	107	120	120	120	**120**
Combined Thickened Solids/Pre-dewatering Feed					
Total solids load (lb-TS/d)	86,425	113,082	123,187	130,400	**143,562**
Volatile solids load (lb-VS/d)	68,092	89,470	97,370	103,022	**113,642**
Total solids concentration	1.6%	1.7%	1.7%	1.7%	**1.8%**
Volatile fraction (lb-VS/lb-TS)	78.8%	79.1%	79.0%	79.0%	**79.2%**
Flow (gpd)	656,334	809,142	871,491	915,233	**977,515**
Flow (gpm)	456	562	605	636	**679**
Pre-dewatered Solids					
Total solids load (dtpd)	41.1	53.7	58.5	61.9	**68.2**
Total solids load (lb-TS/d)	82,104	107,428	117,028	123,880	**136,384**
Volatile solids load (lb-VS/d)	64,688	84,997	92,501	97,870	**107,960**
Total solids concentration (lb-TS/lb-solids)	25.0%	25.0%	25.0%	25.0%	**25.0%**
Flow (gpd)	39,378	51,524	56,128	59,415	**65,412**
Flow (gpm)	27	36	39	41	**45**
Cake mass (wtpd)	164	215	234	248	**273**
Cake volume (CY/d at 45 lb/ft^3)	270	354	385	408	**449**

Parameter	Average	30-day	14-day	7-day	3-day
Thermal Hydrolysis Feed Solids with Dilution Water					
Total solids load (lb-TS/d)	82,104	107,428	117,028	**123,880**	136,384
Volatile solids load (lb-VS/d)	64,688	84,997	92,501	**97,870**	107,960
Total solids concentration (lb-TS/lb-solids)	16.5%	16.5%	16.5%	**16.5%**	16.5%
Flow (gpd)	59,664	78,067	85,043	**90,023**	99,109
Flow (gpm)	41	54	59	**63**	69
Thermal Hydrolysis Depressurization Tank Solids with Steam Condensate					
Total solids load (lb-TS/d)	82,104	107,428	117,028	**123,880**	136,384
Volatile solids load (lb-VS/d)	64,688	84,997	92,501	**97,870**	107,960
Total solids concentration (lb-TS/lb-solids)	14.2%	14.2%	14.2%	**14.2%**	14.2%
Flow (gpd)	69,509	90,948	99,075	**104,877**	115,462
Flow (gpm)	48	63	69	**73**	80
Temperature (°F)	221	221	221	**221**	221
Diluted THP Solids: Depressurization Tank Output and Pathogen-Free Dilution Water					
Total solids load (lb-TS/d)	82,104	107,428	117,028	**123,880**	136,384
Volatile solids load (lb-VS/d)	64,688	84,997	92,501	**97,870**	107,960
Total solids concentration (lb-TS/lb-solids)	9.0%	9.0%	9.0%	**9.0%**	9.0%
Flow (gpd)	109,384	143,122	155,912	**165,042**	181,700
Flow (gpm)	76	99	108	**115**	126
Temperature (°F)	168	168	168	**168**	168
Digested Solids Recycle: to Cooling Heat Exchanger					
Total solids concentration (lb-TS/lb-solids)	4.5%	4.5%	4.5%	**4.5%**	4.5%
Flow (gpd)	546,920	546,894	546,900	**635,965**	635,951
Flow (gpm)	380	380	380	**442**	442
Temperature (°F)	98	98	98	**98**	98

Parameter	Average	30-day	14-day	7-day	3-day
Digester Feed Solids: Diluted THP Solids with Recycled Digested Solids					
Total solids concentration (lb-TS/lb-solids)	5.1%	5.2%	5.2%	**5.2%**	5.2%
Flow (gpd)	656,304	690,016	702,812	**801,007**	817,652
Flow (gpm)	456	479	488	**556**	568
Temperature before HEX (°F)	110	113	114	**112**	114
Temperature after HEX (°F)	98	98	98	**98**	98
Digested Solids (to Final Dewatering)					
Total solids load (lb-TS/d)	41,100	53,472	**58,328**	61,784	67,840
Volatile solids load (lb-VS/d)	23,684	31,041	**33,802**	35,774	39,416
Total solids concentration (lb-TS/lb-solids)	4.5%	4.5%	**4.5%**	4.5%	4.5%
Volatile fraction (lb-VS/lb-TS)	57.6%	58.1%	**58.0%**	57.9%	58.1%
Flow (gpd)	109,384	143,122	**155,912**	165,042	181,700
Flow (gpm)	76	99	**108**	115	126
Ammonia-N concentration (mg/L)	1,996	2,006	**2,004**	2,003	2,007
Final Dewatered Cake Product					
Total solids load (dtpd)	20	25	**28**	29	32
Total solids load (lb-TS/d)	39,045	50,798	**55,412**	58,695	64,448
Volatile solids load (lb-VS/d)	22,500	29,489	**32,112**	33,985	37,445
Total solids concentration (lb-TS/lb-solids)	33.0%	33.0%	**33.0%**	33.0%	33.0%
Cake mass to end use (wtpd)	59	77	**84**	89	98
Cake volume (CY/d at 45 lb/ft^3)	97	127	**138**	146	161
Combined Recycles (Thickening, Pre-dewatering, and Final Dewatering)					
Total solids load (lb-TS/d)	9,049	11,932	12,975	13,723	15,162
Flow (mgd)	2.26	2.62	2.75	2.84	3.01
Post-dewatering recycle ammonia Load (lb-N/d)	1,706	2,244	2,441	2,583	2,850

Table 3-7. Process Design Criteria Summary, 40 mgd Buildout Condition

Parameter	Average	30-day	14-day	7-day	3-day
Primary Solids					
Total solids load (lb-TS/d)	69,434	93,620	101,277	106,841	119,262
Volatile solids load (lb-VS/d)	57,834	78,005	84,379	89,011	99,374
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	832,537	1,122,540	1,214,350	1,281,068	1,430,002
Flow (gpm)	578	780	843	890	993
Thickened Primary Solids					
Total solids load (lb-TS/d)	65,962	88,939	94,572	94,572	94,572
Volatile solids load (lb-VS/d)	54,942	74,105	78,792	78,789	78,801
Total solids concentration	4.0%	4.0%	4.0%	4.0%	4.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	197,727	266,603	283,488	283,488	283,488
Flow (gpm)	137	185	197	197	197
Primary Solids Bypassed to WAS Storage Tank (with max. GT loading set to 30 lb/ft^2/d with one GT in service)					
Total solids load (lb-TS/d)	0	0	1,728	7,292	19,713
Volatile solids load (lb-VS/d)	0	0	1,439	6,075	16,426
Total solids concentration	-	-	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	-	-	83.3%	83.3%	83.3%
Flow (gpd)	0	0	20,714	87,432	236,366
Flow (gpm)	0	0	14	61	164
WAS					
Total solids load (lb-TS/d)	37,958	46,689	51,623	55,039	58,835
Volatile solids load (lb-VS/d)	26,001	31,982	35,362	37,702	40,302
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	68.5%	68.5%	68.5%	68.5%	68.5%

Parameter	Average	30-day	14-day	7-day	3-day
Flow (gpd)	455,134	559,815	618,983	659,945	705,458
Flow (gpm)	316	389	430	458	490
Primary Scum (to Solids Storage Tank with WAS)					
Total solids load (lb-TS/d)	8,320	11,232	12,147	12,813	14,310
Volatile solids load (lb-VS/d)	7,488	10,109	10,932	11,532	12,879
Total solids concentration (lb-TS/lb-solids)	0.58%	0.78%	0.84%	0.89%	0.99%
Volatile fraction (lb-VS/lb-TS)	90%	90%	90%	90%	90%
Flow (gpd)	172,800	172,800	172,800	172,800	172,800
Flow (gpm)	120	120	120	120	120
Combined Thickened Solids/Pre-dewatering Feed					
Total solids load (lb-TS/d)	112,240	146,859	160,070	169,716	187,430
Volatile solids load (lb-VS/d)	88,432	116,195	126,526	134,098	148,408
Total solids concentration	1.6%	1.8%	1.8%	1.7%	1.6%
Volatile fraction (lb-VS/lb-TS)	78.8%	79.1%	79.0%	79.0%	79.2%
Flow (gpd)	825,662	999,219	1,095,985	1,203,666	1,398,113
Flow (gpm)	573	694	761	836	971
Pre-dewatered Solids					
Total solids load (dtpd)	53.3	69.8	76.0	80.6	89.0
Total solids load (lb-TS/d)	106,628	139,516	152,066	161,230	178,059
Volatile solids load (lb-VS/d)	84,010	110,386	120,200	127,393	140,988
Total solids concentration (lb-TS/lb-solids)	25.0%	25.0%	25.0%	25.0%	25.0%
Flow (gpd)	51,141	66,914	72,933	77,329	85,400
Flow (gpm)	36	46	51	54	59
Cake mass (wtpd)	213	279	304	322	356
Cake volume (CY/d at 55 lb/ft^3)	351	459	501	531	586
Thermal Hydrolysis Feed Solids with Dilution Water					
Total solids load (lb-TS/d)	106,628	139,516	152,066	161,230	178,059

Parameter	Average	30-day	14-day	7-day	3-day
Volatile solids load (lb-VS/d)	84,010	110,386	120,200	127,393	140,988
Total solids concentration (lb-TS/lb-solids)	16.5%	16.5%	16.5%	16.5%	16.5%
Flow (gpd)	77,486	101,385	110,505	117,164	129,394
Flow (gpm)	54	70	77	81	90
Thermal Hydrolysis Depressurization Tank Solids with Steam Condensate					
Total solids load (lb-TS/d)	106,628	139,516	152,066	161,230	178,059
Volatile solids load (lb-VS/d)	84,010	110,386	120,200	127,393	140,988
Total solids concentration (lb-TS/lb-solids)	14.2%	14.2%	14.2%	14.2%	14.2%
Flow (gpd)	90,271	118,114	128,739	136,497	150,744
Flow (gpm)	63	82	89	95	105
Temperature (°F)	221	221	221	221	221
Diluted THP Solids: Depressurization Tank Output and Pathogen-Free Dilution Water					
Total solids load (lb-TS/d)	106,628	139,516	152,066	161,230	178,059
Volatile solids load (lb-VS/d)	84,010	110,386	120,200	127,393	140,988
Total solids concentration (lb-TS/lb-solids)	9.0%	9.0%	9.0%	9.0%	9.0%
Flow (gpd)	142,057	185,873	202,593	214,802	237,222
Flow (gpm)	99	129	141	149	165
Temperature (°F)	168	168	168	168	168
Digested Solids Recycle: to Cooling Heat Exchanger					
Total solids concentration (lb-TS/lb-solids)	4.5%	4.5%	4.5%	4.5%	4.5%
Flow (gpd)	710,286	710,252	710,643	827,707	830,277
Flow (gpm)	493	493	494	575	577
Temperature (°F)	98	98	98	98	98
Digester Feed Solids: Diluted THP Solids with Recycled Digested Solids					
Total solids concentration (lb-TS/lb-solids)	5.1%	5.2%	5.2%	5.2%	5.2%
Flow (gpd)	852,343	896,125	913,236	1,042,508	1,067,499
Flow (gpm)	592	622	634	724	741

Parameter	Average	30-day	14-day	7-day	3-day
Temperature before HEX (°F)	110	113	114	112	114
Temperature after HEX (°F)	98	98	98	98	98
Digested Solids (to Final Dewatering)					
Total solids load (lb-TS/d)	53,377	69,444	75,792	80,412	88,572
Volatile solids load (lb-VS/d)	30,759	40,313	43,926	46,575	51,501
Total solids concentration (lb-TS/lb-solids)	4.5%	4.5%	4.5%	4.5%	4.5%
Volatile fraction (lb-VS/lb-TS)	57.6%	58.1%	58.0%	57.9%	58.1%
Flow (gpd)	142,057	185,873	202,593	214,802	237,222
Flow (gpm)	99	129	141	149	165
Ammonia-N concentration (mg/L)	1,996	2,006	2,004	2,003	2,008
Final Dewatered Cake Product					
Total solids load (dtpd)	25	33	36	38	42
Total solids load (lb-TS/d)	50,708	65,972	72,002	76,392	84,143
Volatile solids load (lb-VS/d)	29,221	38,297	41,729	44,246	48,926
Total solids concentration (lb-TS/lb-solids)	33.0%	33.0%	33.0%	33.0%	33.0%
Cake mass to end use (wtpd)	77	100	109	116	127
Cake volume (CY/d at 55 lb/ft^3)	126	165	180	191	210
Combined Recycles (Thickening, Pre-dewatering, and Final Dewatering)					
Total solids load (lb-TS/d)	11,753	15,496	16,771	17,484	18,778
Flow (mgd)	2.61	3.05	3.22	3.34	3.55
Post-dewatering recycle ammonia load (lb-N/d)	2,215	2,914	3,172	3,362	3,722

Table 3-8 through Table 3-10 show the energy calculations for the current, design, and buildout conditions.

Table 3-8. Energy Calculations, 23 mgd Condition

Parameter	Average	30-day	14-day	7-day	3-day
THP Steam Demands					
Steam to THP (ton-steam/d)	31	40	44	46	51
Steam as condensate to solids (gpd)	7,351	9,619	10,479	11,092	12,212
Solids Cooling Demands					
Cooling demand (MMBtu/d)	48	63	68	72	79
Cooling demand (MMBtu/hr)	2.0	2.6	2.8	3.0	3.3
Digester Gas Production					
Biogas generated (scfd)	453,158	596,095	648,553	686,112	757,234
Biogas generated (scfm)	315	414	450	476	526
Biogas generated from scum only (scfm)	38	52	56	59	66
Lower heating value (MMBtu/hr)	11.0	14.4	15.7	16.6	18.3

hr = hours; MMBtu = million British thermal units; scfd = standard cubic feet per day; scfm = standard cubic feet per minute.

Table 3-9. Energy Calculations, 30.8 mgd Design Condition

Parameter	Average	30-day	14-day	7-day	3-day
THP Steam Demands					
Steam to THP (ton-steam/d)	41	54	59	62	68
Steam as condensate to solids (gpd)	9,845	12,881	14,032	14,854	16,353
Solids Cooling Demands					
Cooling demand (MMBtu/d)	64	84	91	97	106
Cooling demand (MMBtu/hr)	2.7	3.5	3.8	4.0	4.4
Digester Gas Production					
Biogas generated (scfd)	606,837	798,248	868,498	918,793	1,014,036
Biogas generated (scfm)	421	554	603	638	704
Biogas generated from scum only (scfm)	51	69	75	79	88
Lower heating value (MMBtu/hr)	14.7	19.3	21.0	22.2	24.5

Table 3-10. Energy Calculations, 40 mgd Buildout Condition

Parameter	Average	30-day	14-day	7-day	3-day
THP Steam Demands					
Steam to THP (ton-steam/d)	53	70	76	81	89
Steam as condensate to solids (gpd)	12,785	16,729	18,233	19,332	21,350
Solids Cooling Demands					
Cooling demand (MMBtu/d)	83	109	119	126	139
Cooling demand (MMBtu/hr)	3.5	4.5	4.9	5.2	5.8
Digester Gas Production					
Biogas generated (scfd)	788,101	1,036,686	1,128,534	1,195,835	1,323,951
Biogas generated (scfm)	547	720	784	830	919
Biogas generated from scum only (scfm)	67	90	97	103	115
Lower heating value (MMBtu/hr)	19.0	25.1	27.3	28.9	32.0

4 PRIMARY SOLIDS THICKENING

4.1 Background and Purpose

Multiple options for thickening PS and WAS were presented in TM No. 6: *Thickening Evaluation* (Appendix A). The purpose of thickening PS or WAS is to reduce the hydraulic loading to downstream processes including screening, solids storage, and pre-dewatering. WAS and PS thickening were evaluated together in TM No. 6 to allow consideration of co-thickening options and downstream impacts to solids storage, screening, and pre-dewatering. Thickening technologies that were evaluated included GTs (which are currently used for PS thickening), DAFTs (which are currently used for WAS thickening), and alternative processes including GBTs and RDTs. Evaluations were based on 30.8 mgd design conditions with considerations for future 40.0 mgd buildout. Conceptual process sizing, configurations, site layouts, and conceptual costs for thickening facilities as well as downstream solids storage, screening, and pre-dewatering were prepared for each alternative. These alternatives were further compared based on capital and O&M costs, site and process impacts, odors generated, energy requirements, and operability.

The selected thickening approach is to use the GTs for PS thickening and no thickening for WAS. Provisions for future WAS thickening using GBTs or RDTs were recommended, as discussed in Section 5. The selected alternative of gravity thickening for PS and no thickening for WAS was selected based on the overall best value to Arlington County. Rehabilitation of the existing GTs will be handled as an early project (Phase 10A) from the rest of the Program; refer to Section 22. The overall process flow diagram with gravity thickening is illustrated on Drawing G-005, with additional detail on Drawings I-100 and I-101.

This section presents the existing facilities for PS thickening, basis of design, and description of system improvements.

4.2 Existing Facility

Currently PS is thickened using GTs. PS is pumped from the PCs to the GTs at approximately 1.0 percent solids, prior to the addition of elutriation water. One of two GTs is typically in operation. PEW is added to the PS for dilution, increasing the hydraulic loading rate to the thickener. PS is thickened to approximately 4 to 5 percent solids in the GT. TPS is pumped to the existing SSTs where it is blended with TWAS prior to dewatering. The existing GT characteristics and TPS pump details are included in Table 4-1.

Table 4-1. Existing Gravity Thickener Characteristics

Characteristic	Value	Unit
Gravity thickeners		
Number of units	2 (1 operating, 1 standby)	
GT diameter	65	ft
Surface area, ea.	3,300	ft^2
Side water depth (SWD)	10	ft
Tank material	Concrete	
Drive	Two 1½ hp gear motors per GT	
TPS pump		
Number of pumps	4 (1 operating, 1 standby per GT)	
Pump type	Progressive cavity (Seepex)	
Motor and drive	25 hp, variable speed	
Flow rate	350	gpm
Pressure	32.5	psi
Speed	219	rpm
Grinders		
Number of units	4 (1 per pump)	
Type	Franklin Miller, Super Shredder Model SS8000	
Motor and drive	5 hp, constant speed	

ft = feet; ft^2 = square feet; hp = horsepower; psi = pounds per square inch; rpm = revolutions per minute.

A condition assessment of the existing GT facility was conducted and is summarized in TM No. 2: *Condition of Existing Facilities*. The GTs were originally constructed in 1967. The GT mechanisms were replaced in 1994. The TPS pumps and grinders were installed in 2013. Recommended improvements to the GTs include the following:

- GT interior concrete repairs, including:
  - Thorough hydro-cleaning of the wall and launder surfaces
  - Preparing exposed reinforcing and applying corrosion inhibitor
  - Protecting such reinforcing with a repair mortar to add cover
  - Spray-applying a mortar (fiber reinforced, with silica fume) to replace lost cement paste (approximately ⅜ to ½ inch) over full wall and launder areas
- GT exterior repairs, including mortar repointing and masonry crack repair
- Replacement of GT tank dome covers
- GT equipment replacement and modifications, including:
  - Replacement of mechanical equipment internal to the tanks

    - Potentially replacing the flat weirs with V-notch weirs to allow for reduced hydraulic loading

- GT Building repairs and upgrades, including:

    - Upgrading electrical and ventilation to National Fire Protection Association (NFPA) 820 standards
    - Miscellaneous corrosion protection and improvements to pipe supports

4.3 Basis of Design

Process equipment selections and facility concepts were based on a 30.8 mgd design condition for equipment sizing and a 40.0 mgd buildout condition for overall facility sizing. Peak 3-day solids loadings were used for sizing thickening processes because there is limited ability to store solids upstream and therefore any thickening processes will be subjected to such peak loadings. PS design loading criteria are summarized in Table 4-2.

Table 4-2. Primary Solids Design Loading

Design Condition	PS Flow (gpm)	Solids Concentration	Solids Loading (lb-DS/hr)
30.8 mgd, average	450	1.0%	2,300
30.8 mgd, peak 3-day	770	1.0%	3,900
40.0 mgd, peak 3-day	1,000	1.0%	5,000

4.4 Primary Solids Thickening Description and Design Criteria

This section presents a description and design criteria for PS thickening, including GTs, thickened solids pumps, and odor control.

4.4.1 Gravity Thickeners

The existing GTs will continue to be used to thicken PS. Existing PS pumps will convey the PS from the PCs to the GTs. Thickened PS will be pumped to the new solids screening process using the existing thickened solids pumps. The grinder associated with each thickened solids pump will also remain in service.

GT design criteria are summarized in Table 4-3. This table shows operation at peak 3-day loading conditions, which are the design basis for thickening processes. At the 40 mgd buildout condition, solids loading with one GT in service exceeds the recommended maximum loading of 30 pounds per day per square foot (lb/d/ft^2). To address this future loading without operating both GTs, it is assumed that a portion of the PS will bypass the GT and go to the WAS storage tank. Flows and loads for this condition are shown in the right column. While the second GT could be put in service for this condition if available, this operating condition with a future GT bypass was carried forward for sizing facilities downstream, including solids storage, screening, and pre-dewatering.

Table 4-3. Gravity Thickener Design Criteria

Parameter	Unit	Typical Range	30.8 mgd Peak 3-day	40.0 mgd Peak 3-day	40.0 mgd Peak 3-day with PS Bypass[a]
Number of GTs operating	No.	N/A	1 of 2	1 of 2	1 of 2
PS flow to GT at 1% solids	gpm	N/A	770	1,000	835
PS flow bypassing GT at 1% solids	gpm	N/A	0	0	165
Solids loading rate	lb/d/ft^2	20–30	28	36	30[a]
Hydraulic loading rate without dilution water	gal/d/ft^2	370–760	330	430	360[a]
TPS flow at 4% TS	gpm	N/A	182	236	197[a]

a. Primary solids bypass flow around GT is 165 gpm, 10 dtpd to limit loading to 30 lb/d/ft^2 at 40 mgd peak condition.
gal = gallons.

Currently PEW is added to the PS upstream of the GTs for dilution. In the future, there will be a source of PEW from the cooling HEXs after THP that could be reused for GT dilution water. The cooling water cannot be easily conveyed to the WPCP effluent, so it would be returned to the WPCP influent if it is not reused for GT dilution. Using the cooling water for GT dilution would offset much of GT dilution water demand, reducing the overall PEW demand by about 320 gpm at average conditions. However, one concern with this configuration is that cooling water will increase the temperature in the GT, which could impact thickening. The current WPCP effluent temperature ranges from about 61 to 82 degrees Fahrenheit (°F) throughout the year. Based on the cooling demand after THP, the use of cooling water for GT dilution could raise the temperature in the GT by up to 6°F at design average THP loading and up to a maximum of 10°F at peak THP loading. It is recommended to provide the ability to send cooling water to either the drain or to the GT for dilution, allowing operational flexibility in cases of high temperatures or thickener upsets.

4.4.2 Thickened Solids Pumps

The existing thickened solids pumps will be used for pumping thickened solids from the GT to the solids screens. Pump discharge pressure is expected to increase with the new configuration pumping to the screens, and this pressure may exceed the original design point. Based on the pump data sheet, at a 60-pound per square inch (psi) operating condition the pump would deliver about 320 gpm at 22 break horsepower (hp). The discharge pressure should be evaluated along with the existing pumps and instrumentation to confirm suitability.

4.4.3 Odor Control

The existing GTs have dome covers with ducting for odor control. The dome covers will be replaced, and new ducting will be provided to a new combined sodium hypochlorite scrubber system. Odorous air from the GTs will be treated in the new sodium hypochlorite scrubbers along with the odorous air collected from other solids processing facilities. The odor control system is discussed further in Section 15.

4.5 Equipment Operation and Control

The GT mechanism will have a center drive with a local on/off control station and torque overload protection. Status will be monitored by the WPCP's process control system (PCS). The thickened solids pumps are operated by variable-frequency drives (VFDs) which have a Hand/Off/Auto (HOA) selector switch. In Hand mode, the thickened solids pump on/off control and speed adjustments will be controlled manually from the VFD panel. In Auto mode, the thickened solids pump on/off and speed control will be controlled remotely by the WPCP's PCS based on operator input and manual solids blanket depth measurements. The thickened solids pumps include a stator temperature sensor to provide run-dry protection. A high-pressure switch on the discharge of each pump will shut down the associated pump at high pressure. The PCS will monitor a common flow meter on the discharge piping.

The WPCP PCS will monitor the status of all equipment. Monitoring by the operators will include the following:

- Measuring and tracking solids depths via Sludge Judges or other means
- Observing weir overflows and sampling for total suspended solids (TSS)
- Sampling and monitoring TS percentage in the underflow

5 WASTE ACTIVATED SOLIDS THICKENING

5.1 Background and Purpose

This section presents the existing facilities for WAS thickening, basis of design, location for future WAS thickening, and a description of the future system.

The purpose of thickening is to reduce the hydraulic loading to downstream processes including screening, solids storage, and pre-dewatering. TM No. 6: *Thickening Evaluation* considered multiple options for thickening PS and WAS. Thickening technologies that were evaluated included GTs (which are currently used for PS thickening), DAFTs (which are currently used for WAS thickening), and alternative processes including GBTs and RDTs. As discussed in the previous section, PS and WAS thickening were evaluated together to allow consideration of co-thickening options and impacts to downstream processes.

The selected thickening approach is to use the GTs for PS thickening and no thickening for WAS. Provisions for future WAS thickening are recommended using GBTs or RDTs. The overall process flow diagram with future WAS thickening is illustrated on Drawing G-005. In the configuration without WAS thickening, WAS will be pumped by the existing WAS pumps to a new SST, and from there pumped to new solids screens where the WAS will combine with TPS. WAS piping will be provided to at least two of the storage tanks to allow tank cleaning during operation. With future WAS thickening, WAS will be pumped from the SST to the GBT or RDT, and new TWAS pumps will pump the thicken solids to the screens.

5.2 Existing Facility

WAS is currently thickened using DAFTs. WAS is pumped at approximately 1 percent solids from the RAS discharge header to the DAFTs. The three WAS pumps are 4-inch, 15 hp Fairbanks Morse end-suction pumps, each with a rated design capacity of 400 gpm at 68 feet total dynamic head (TDH). The WAS pumps are approximately 15 years old and are expected to continue operating in the near term with regular maintenance. These pumps may be replaced with the future secondary clarifier upgrades, and any pump replacement should be coordinated with this Program. In the future, WAS will be pumped to a new SST instead of the DAFT. The capacity and discharge head of these pumps must be evaluated with the proposed SSTs location and piping configuration. Any replacement of these pumps must be coordinated with the design of the new solids facilities.

The existing DAFT characteristics are summarized in Table 5-1. Additional information is provided in TM No. 2. Complete details of the system components are not provided here as the DAFTs will not be used in the future process configuration. The DAFT mechanical equipment is nearing the end of its useful life, and the bottom chain and flights do not work. The DAFT uses a dry polymer system that is manually batched. One DAFT unit is typically in operation at a time. WAS is thickened to approximately 3 to 4 percent solids. TWAS pumps operate based on hopper level. The TWAS is pumped to the SSTs where it is blended with TPS prior to dewatering.

Table 5-1. Existing DAFT Characteristics

Characteristic	Value	Unit
DAFT		
Number of units	2 (1 operating, 1 standby)	
Length	50	ft
Width	12	ft
Height	10.75	ft
Surface area, ea.	600	ft^2
TWAS pumps		
Number of pumps	3	
Type	Progressive cavity (Moyno)	
Motor and drive	7.5 hp, variable speed	

psig = pounds per square inch gauge.

5.3 Basis of Design for Future WAS Thickening

Process equipment selections and facility concepts were based on a 30.8 mgd design condition for equipment sizing and a 40.0 mgd buildout condition for overall facility sizing. Peak 3-day solids loadings were used for sizing thickening processes because there is limited ability to store solids upstream and therefore any thickening processes will be subjected to such peak loadings. WAS is generated continuously, and it is assumed that any future WAS thickening process will operate 24 hours per day, 7 days per week. The WAS design loading criteria are summarized in Table 5-2. This table includes scum flows and loads from the PCs. The primary scum may be sent to one of the new SSTs with WAS, and the combined flow pumped to screening or future WAS thickening. Alternatively, primary scum may be concentrated and send to landfill if there are operational issues with processing the scum with WAS.

Table 5-2. Waste Activated Solids Thickening Design Loading

Design Condition	WAS Flow (gpm at 1% solids)	WAS Solids Loading (lb-DS/hr)	Primary Scum Flow (gpm at 0.5% solids)	Primary Scum Solids Loading (lb-DS/hr)	Combined Flow (gpm)	Combined Solids Loading (lb-DS/hr)
30.8 mgd, average	243	1,200	107	270	350	1,470
30.8 mgd, peak 3-day	377	1,900	184	460	561	2,360
40.0 mgd, peak 3-day	490	2,450	238	600	728	3,050
40.0 mgd, peak 3-day with PS bypass	490	2,450	238	600	892[a]	3,870[a]

a. Includes PS bypassed around GT to limit GT loading to 30 lb/ft^2/d with one GT in service.

It is expected that the existing WAS pumps will be used to pump WAS to the new SSTs. As such, they must be evaluated to confirm that they will be acceptable for pumping to the new SSTs. These pumps may be replaced with the future secondary clarifier upgrades, and any pump replacement should be coordinated with this Program. Any upgrades to the WAS pumps must consider the future discharge point to the SSTs. The existing primary scum pumps should also be evaluated as part of the new processes.

Initially, WAS will not be thickened. Space will be reserved for future WAS thickening using GBTs or RDTs. WAS would be pumped from an SST to the future thickeners by the proposed screen feed pumps as described in Section 6. The WAS thickening process would include polymer blend units, GBTs/RDTs, and TWAS pumps. WAS thickening may be implemented to increase the available storage time for screened solids and reduce the hydraulic loading to the screens and pre-dewatering centrifuges. Table 5-3 lists the future TWAS flows from GBTs/RDTs at 5 percent TS concentration.

Table 5-3. Thickened Waste Activated Solids Design Flows (at 5% TS)

Design Condition	TWAS Flow without Primary Scum (gpm)	TWAS Flow with Primary Scum (gpm)
30.8 mgd, average	48	58
30.8 mgd, peak 3-day	74	92
40.0 mgd, peak 3-day	96	119
40.0 mgd, peak 3-day with PS bypass	128[a]	152[a]

a. Includes PS bypassed around GT to limit GT loading to 30 lb/ft^2/d with one GT in service.

5.4 System Location

The new facilities will be designed to accommodate future WAS thickening using either GBTs or RDTs. Two building options are discussed in Section 17. If the existing DWB is renovated, structural modifications will be implemented to allow thickening equipment to be installed on the first floor. If the existing DWB is decommissioned, then space on the site will be allocated for future thickening. The pre-dewatering polymer system will also be designed to allow for expansion to accommodate the additional polymer blend units required for WAS thickening.

5.5 WAS Thickening Description and Design Criteria

Future WAS thickening alternatives include GBT and RDT. These technologies and the design criteria for implementation are described below.

5.5.1 Rotary-Drum Thickeners

RDT is a proven mechanical thickening technology and offers similar performance to GBTs. Polymer is added and mixed with the solids feed in a flocculation tank upstream of the RDT. An image of an RDT with floc tank is shown in Figure 5-1. Solids are fed into a rotating cylindrical screen fitted with a screw and flights to furrow and convey solids forward. Water is drained through the screen into a filtrate drain. Solids are discharged into a hopper at the downstream end of the RDT. A spray water system with booster pump is used to constantly clean the screen. The system is completely enclosed and odor control takeoffs will be provided.

Figure 5-1. RDT and Floc Tank

RDT design criteria are summarized in Table 5-4. A total of three units will be installed. An inline polymer blend unit with polymer feed pump will be included for each RDT (three total). A progressive-cavity pump will be paired with each thickener unit (three total) to convey TWAS to screening, prior to pre-dewatering.

Table 5-4. RDT Design Criteria

Parameter	Value	Unit
Number of units at 30.8 mgd (duty/standby)	2/1	-
Number of units at 40.0 mgd (duty/standby)	2/1[a]	-
Hydraulic loading per unit	350	gpm
Solids loading per unit	1,800	lb-DS/hr
Typical polymer dosages	5–15	lb/DT
Typical RDT thickened solids concentration	5.0	Percent
Typical motors per unit	Drum: 3 hp, VFD Floc tank mixer: 0.5 hp, VFD Booster pump: 5 hp TWAS pump: 10 hp	

a. Primary scum is assumed to be concentrated and sent to landfill at peak 3-day 40.0 mgd condition to maintain one RDT as standby.
DS = digested solids.

5.5.2 Gravity Belt Thickeners

GBTs are a proven technology for mechanical thickening and provide a competitive balance of thickening performance per footprint, operational cost, and power usage. GBTs typically require a slightly larger building footprint than RDTs. Typically, polymer is injected into the solids stream and mixed upstream of the GBT. The solids/polymer slurry is fed into a feedbox for a consistent distribution across the belt. The belt conveys the solids through stationary plows that furrow the slurry to promote water/solids separation. The belt discharges the thickened solids into a hopper, which is connected to a pump. Filtrate is collected in a drain pan and flows by gravity to the process drain system. A spray water system, including a booster pump and spray header, is used to clean the belt on the bottom side of the GBT as it returns to the feedbox. GBTs can be open to allow for easy observation of the thickening process; however, this can lead to local odor issues as the solids are exposed to the atmosphere, especially for co-thickened solids. GBTs can be covered to contain odors but covers can hinder the ability to easily observe the thickening process. GBTs are typically located indoors and off-site odors can be managed through ventilation and odor treatment. An image of an enclosed GBT is shown in Figure 5-2.

Figure 5-2. Enclosed GBT

GBT design criteria are summarized in Table 5-5. Two GBTs would be required to meet 30.8 mgd and 40.0 mgd design conditions. Similar to the RDT, each GBT will be paired with a polymer feed system and progressive-cavity pump for TWAS.

Table 5-5. GBT Design Criteria

Parameter	Value	Unit
Number of units at 30.8 mgd (duty/standby)	2/1	-
Number of units at 40.0 mgd (duty/standby)	2/1[a]	-
Belt width	2.0	Meters
Hydraulic loading per unit	400	gpm
Solids loading per unit	2,000	lb-DS/hr
Typical polymer dosages	6–10	lb/DT
Typical GBT thickened solids concentration	5.0	Percent
Typical motors per unit	Belt drive: 2 hp, VFD Booster pump: 5 hp TWAS pump: 10 hp, VFD	

a. Primary scum is assumed to be concentrated and sent to landfill at peak 3-day 40.0 mgd condition to maintain one GBT as standby.

5.6 Equipment Operation and Control

The overall system operation and control is similar for GBT or RDT. Each thickener will be provided with a local control panel (LCP) located near the equipment. Status will be monitored by the WPCP's PCS. VFDs will be provided for the thickener feed pumps, polymer feed pumps, TWAS pumps, and thickener motors (belt drive for GBT and floc tank mixer and drum for RDT). The VFDs will normally be operated with the HOA selector switch in Auto mode, with speed controlled through the WPCP PCS. The thickener LCP may have primary control over some components such as the TWAS pumps, depending upon the ultimate system configuration.

The operator will align the valves to pump from the thickener feed pump (pulling suction from the SST) to the thickeners that will be in operation, and from the thickeners to the screens. A flow meter and motorized flow control valve will be provided to each thickener to split flow to each unit and allowing two thickeners to be fed from one thickener feed pump. The operator will select the thickener feed pump, polymer blend unit(s), and thickener unit(s) to begin operation. With the system in Auto mode, the selected thickeners will begin operation (spray water, GBT belt, or RDT flocculation mixer and drum). When operation is confirmed by the thickener LCP, the system will start the thickener feed pump and polymer feed pump(s). The polymer will be flow-paced to the thickener feed based on a dosing set point. The TWAS pump will begin operation when a level is reached in the TWAS hopper.

For each progressive-cavity pump, a high-pressure switch on the discharge of the pump will shut down the system at high pressure, and a stator temperature sensor will provide run dry protection and shut down the system at high temperature. A failure or critical alarm for a polymer blend unit, thickener unit, or TWAS pump will shut down the paired equipment. The PCS will monitor a common flow meter on the TWAS discharge piping.

The WPCP PCS will monitor the status of all equipment. Monitoring by the operators will include the following activities:

- Checking flocculation
- Observing the filtrate and sampling for TSS
- Sampling and monitoring TS percentage from the thickener
- Adjusting the polymer dose and/or rotational speeds to maintain acceptable capture and thickened solids concentration

6 SOLIDS SCREENING

6.1 Background and Purpose

Screening at the WPCP is performed on the influent flow at the PTB. New multi-rake bar screens with ½-inch openings between bars are currently being installed as part of the Preliminary Treatment Upgrades: Phase 9B project. Even with the improved influent screening, the PS and WAS generated at the WPCP contain debris that enters the downstream solids handling process. Screens are required upstream of THP equipment to remove all debris greater than 5 mm. This is necessary to protect the nozzles within THP depressurization tanks from clogging. Screening also improves the quality of the final cake and helps prevent issues with ragging in downstream processes.

The screening design criteria were presented in TM No. 6: *Thickening Evaluation* (Appendix B). Screening and thickening were evaluated together because solids thickening directly impacts the number of solids screens that are required. Screening will be fed with WAS from the SSTs and TPS from the GTs. The overall process flow diagram with solids screening is shown on Drawing G-005, with additional detail on Drawings I-201 and I-202. Potential plan views of the screening system are shown on Drawings M-307 and M-351, for site Options 1 and 2, respectively. The purpose of this section is to present the basis of design, location, and description of the new solids screening.

6.2 Basis of Design

Process equipment selections and facility concepts were based on a 30.8 mgd design condition for equipment sizing and a 40.0 mgd buildout condition for overall facility sizing. Peak 3-day solids loadings were used for sizing the screening process because there is limited ability to store solids upstream during peak solids loading conditions. Screening will be operated 24 hours per day, 7 days per week.

The solids screening design loading criteria are summarized in Table 6-1. These flows and loads include TPS, WAS, and primary scum. Flows for each of these sources were presented in Section 3, as well as in Section 4 (TPS) and Section 5 (WAS). TPS will be pumped from the GT to the screens and WAS and primary scum will be pumped from an SST to the screens using positive displacement pumps. The peak future flow scenario is at 40 mgd buildout condition with one GT in service, with a portion of the PS bypassing the GT to the SST containing WAS. This scenario was discussed in Section 4. If WAS thickening is implemented in the future, the solids concentration to the screens will increase and flow to the screens will decrease.

Table 6-1. Solids Screening Design Loading

Design Condition	Without Primary Scum			With Primary Scum		
	Flow (gpm)	Solids Concentration	Solids Loading (lb-DS/hr)	Flow (gpm)	Solids Concentration	Solids Loading (lb-DS/hr)
30.8 mgd, average	349	1.9%	3,300	456	1.6%	3,600
30.8 mgd, peak 3-day	559	2.0%	5,520	742	1.6%	5,980
40.0 mgd, peak 3-day	726	2.0%	7,170	964	1.6%	7,760
40.0 mgd, peak 3-day with primary solids GT bypass	851	1.7%	7,210	1,089	1.4%	7,810

6.3 System Location

Two building options are discussed in Section 17 and the location of the screens will depend on which option is selected. The screens will be on an upper level so that the screenings can fall to the dumpster at grade level. Elevating the screens provides an added benefit of avoiding excessive back pressure on the screen itself. The screens are best operated without significant pressure in the discharge pipe from the screen. If the existing DWB is renovated, the solids screens will be located in that building with two screw conveyors to transfer the screens to a dumpster. This layout is shown on Drawing M-307. If a new SPB is constructed, it is expected that the screenings will drop directly into a dumpster through a chute, without using conveyors as shown on Drawing M-351.

6.4 Solids Screening Description and Design Criteria

This section presents a description and design criteria for solids screening, including screen feed pumps, solids screens, screenings handling, and odor control.

6.4.1 Screen Feed Pumps

Screen feed pumps will transfer WAS and primary scum from an SST to the solids screens, where the WAS will be screened with TPS. The combined screen solids will return to the adjacent SSTs. Screen feed pump design criteria are listed in Table 6-2. The screen feed pumps will operate in a duty/standby configuration. The design capacity is based on peak 3-day WAS and primary scum flow at 30.8 mgd conditions, with a 20 percent safety factor on the flow. These pumps would be replaced with larger pumps to reach the 40 mgd buildout conditions.

Table 6-2. Screen Feed Pumps Design Criteria

Parameter	Value
Number of pumps	2 (1 duty, 1 standby)
Pump type	Progressive cavity, rotary lobe, or screw centrifugal
Design capacity	670 gpm at 1% TS
Drive type	VFD

Pump type will be evaluated by the delivery team. Considerations will need to be given to capacity requirements, combined with operation of the TPS pumps and systems to the same screens. Consideration should also be given to maintaining operational flexibility to separately screen WAS and TPS, if desired by the County.

6.4.2 Solids Screens

The most common solids screening technology is enclosed, inline solids screens. This type of screen has a successful history in THP applications and is used in the District of Columbia Water and Sewer Authority (DC Water) Blue Plains Advanced Wastewater Treatment Plant (WWTP) THP system, Hampton Roads Sanitation District (HRSD) Atlantic Treatment Plant THP system, Washington Suburban Sanitary Commission (WSSC) Piscataway WWTP THP system, and various other THP installations in Europe. The basis of design for the screens is the Huber model SP290. The maximum hydraulic loading to the screen depends on the total suspended solids concentration. Inline solids screens can be fed at up to 6 percent solids and cannot be used on dewatered product.

Design criteria for the solids screens are listed in Table 6-3. This includes the maximum hydraulic loading to each screen as a function of solids concentration. Without primary scum, three screens are required for the 30.8 mgd design condition, with two screens operating and one on standby. A fourth screen will be installed to meet the 40 mgd design condition with one unit as standby. At design conditions with primary scum the standby screen can be operated or scum can be sent to the scum concentrator and landfill. The design will provide for an acceptable flow split to each screen, which may be achieved through hydraulic symmetry, derating the screen capacity, assigning separate screens to PS and WAS, or active flow control. Flow meters will be provided for the TPS and WAS flows to the screen and the combined flow leaving the screens.

Table 6-3. Solids Screens Design Criteria

Parameter	Value
Number of screens	3 + 1 future
Configuration/type	Inline
Size	5 mm (perforations)
Manufacturer/model	Huber/SP290, Hydro International/Hydro-Sludge
Body, screw, and screen material	304L stainless steel
Maximum hydraulic loading (values are 80% of Huber SP290 listed maximum)	352 gpm at 1.0% TS 288 gpm at 2.0% TS 260 gpm at 3.0% TS 228 gpm at 4.0% TS 208 gpm at 5.0% TS 192 gpm at 6.0% TS
Screen motor	5 hp

The operation of the screen is illustrated in Figure 6-1. The thickened solids from the GTs, WAS, and primary scum flow into the solids screen from the bottom and enter the tapered screening area. Here, the screenings are captured and screened solids flow out of the bottom. The stationary, tapered screening area contains 5 mm perforations, and the screen removes even smaller debris as a mat builds up. The screenings accumulate on the perforated screening section and are conveyed by rotation of the screw into the cylindrical dewatering section with smaller perforations. The cone forms a plug to hold the screenings back as they are pressed and extruded. The material is squeezed to approximately 45 percent dry solids by the screw and the pressure-actuated restriction cone. The screenings are extruded past the restriction cone and are discharged to a dumpster below. An air compressor is provided for each screen to supply the air pressure required at the cone.

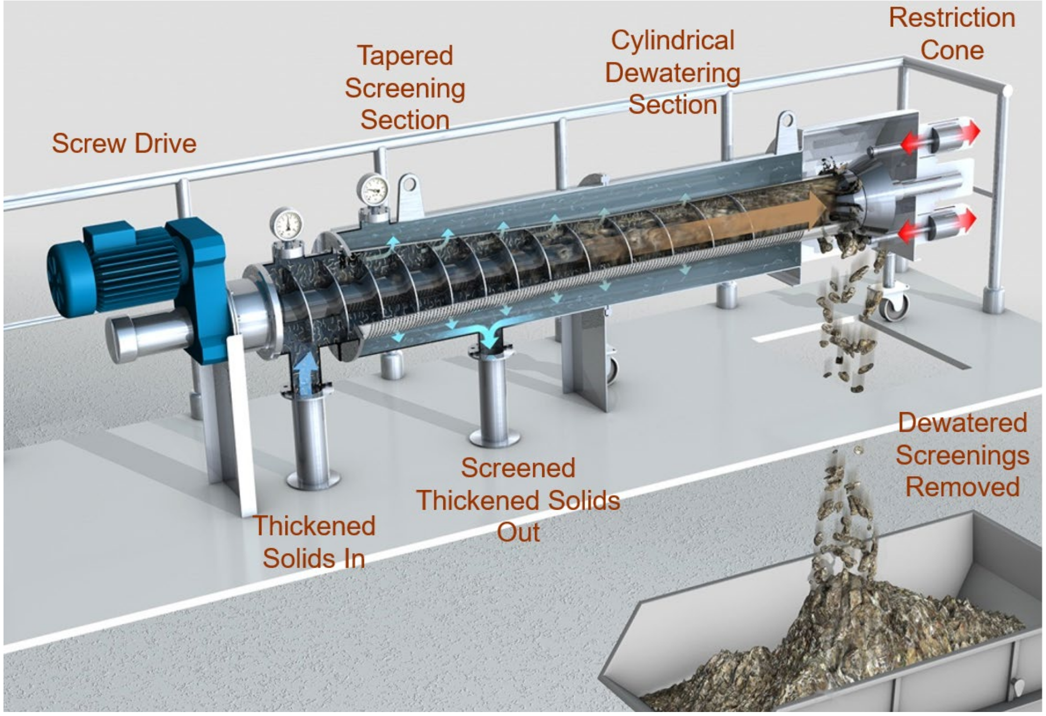

Figure 6-1. Solids Screen Diagram

The screens will be provided with flushing connections upstream and downstream of each unit to allow flushing prior to taking a screen out of service. A hose bibb will be provided nearby for flushing and washdown as well as a floor drain.

6.4.3 Screenings Handling

Screenings production was estimated based on 0.15 cubic yard (CY) per MG treated, based on experience at other facilities in the region. Based on this factor, average screening production at 30.8 mgd would be about 4.6 CY per day. Actual screenings production will not be known until they are in operation, and production could be higher than estimated from other facilities. The influent screens are being replaced as part of the Preliminary Treatment Upgrades project with ½-inch multi-rake bar screens. Screen opening size for these new screens is limited by hydraulics. Because the solids screens will be ¼ inch (5 mm), they may capture a significant amount of material that passes through the influent screens. Screening production can also vary widely from day to day depending on changes in the WPCP influent.

Screenings production and estimated storage times are listed in Table 6-4. The facility should be designed for a 20 CY dumpster with ability to accommodate up to a 40 CY dumpster to allow flexibility in operation. Leveling systems or baggers should be considered during design to maximize capacity and odor control. The layouts and odor control system presented in the Plan assume a continuous bagger system. Screening conveyors may also be required depending on the final building layout. The concept for the renovated DWB includes two conveyors for screenings because the screens are not located directly above the dumpster.

Table 6-4. Screenings Production and Storage

Parameter	Value
Average screening quantity estimate	4.6 CY/d at 30.8 mgd
Screenings dumpster quantity	1 + 1 standby
Storage capacity, ea.	20 CY
Dimensions	22.0 ft long × 7.5 ft wide × 4.5 ft high
Approximate storage time, ea.	~3 days at 75% fill

The screenings area will be provided a curb around the dumpster location, bollards, and 316 stainless steel skid plates for the dumpster. A trench drain will be provided with a hose bibb for washdown.

6.4.4 Odor Control

A bagging system is assumed to contain the screenings and control odor from the stored screenings. Alternatively, if screenings are stored in a room without a bagging system, a dumpster hood will be vented to the odor control system (and the sizing of the odor control system will need to accommodate this ventilation), where all solids treatment odor sources (except final dewatering) will be combined and treated with a common scrubber system. The odor control system is discussed in detail in Section 15.

6.5 Equipment Operation and Control

The solids screens are controlled by an LCP with programmable logic controller (PLC) and human-machine interface (HMI). The solids screens will provide a “ready” status signal and operate automatically as screenings build up and are discharged to the dumpster below. Motorized valves upstream and downstream of each screen will be opened when the screen is in operation and closed when out of service. The plant control system will have the ability to automatically bring screens from “standby” to “in service” when the total flow to the screens exceeds operator-entered setpoints for maximum flow with one, two, or three screens operating. A screen is brought in service by opening the motorized valves upstream and downstream of the screen.

It is important to interlock the pumps feeding the screens with a pressure switch or sensors to reduce the risk of a plug blowout. A failure of the pneumatic cone pressurization system can also result in a plug blowout. If excessive moisture is detected in the screenings by the moisture sensor at the screenings outlet, this should also generate a screen failure alarm and shut down the screen. These measures help to avoid a scenario where excessive liquid is discharged to the dumpster. In the case of a screen failure, the motorized valves upstream and downstream of the screen will be automatically closed and an alarm will be generated. The plant control system will have the ability to automatically bring another screen in service. If flow to the screens exceeds the capacity of the available screens, then the pumps feeding the screens will be shut down.

The screw will wear slowly and must be adjusted periodically, shifting it into the screen, so it can properly remove the screenings and keep the perforations clear. The screw should be replaced when adjustments are no longer possible. The perforated screen element will eventually need replacement but less frequently if proper maintenance is performed.

When taking a screen out of service for maintenance, operators should open and close valves to send flow to the other screen and then isolate the unit to be serviced. It is critical to keep debris out of the THP system and therefore the screens should not be bypassed.

7 SOLIDS STORAGE

7.1 Background and Purpose

Solids storage volumes upstream of pre-dewatering were considered as part of TM No. 6: *Thickening Evaluation*. SSTs are required for WAS upstream of screening, and for screened solids (WAS plus TPS) upstream of pre-dewatering. The overall process flow diagram with solids storage is shown on Drawing G-005, with additional detail on Drawing I-200. Plan views are shown on Drawings M-200 and M-202. The main purpose for solids storage is to provide a “wide spot” to decouple operation of two processes in series. WAS storage will allow continuous operation of wasting from the activated solids process during any unexpected shutdowns of solids screening. WAS storage will provide similar benefits for a future WAS thickening process and allow for steady loading to thickeners. TPS and WAS are combined, screened, and then stored upstream of pre-dewatering to allow the pre-dewatering centrifuges and polymer feed to be controlled independently from TPS pumping and solids screening. The purpose of this section is to present the basis of design, location, and description of the new SSTs.

7.2 Existing Facility

The WPCP has two SSTs. The SSTs provides adequate capacity to hold solids over the weekends to reduce dewatering operations. Each SST has two mixers. TM No. 2: *Condition of Existing Facilities* includes the condition assessment of these SSTs. Both SSTs are approximately 53 feet in diameter, with a side wall depth of 25.5 feet, not including the sloped bottom. The SSTs receive solids from the GTs and DAFTs. The current normal operation is to fill and draw from one SST.

The existing SSTs will be demolished and will not be reused as part of the new facilities. New SSTs will be constructed.

7.3 Basis of Design

The sizing for new solids storage is based on providing 8 hours of WAS storage and 24 hours of screened solids storage (TPS + WAS) at 30.8 mgd, peak 3-day conditions. Piping connections will be provided to deliver dilute primary scum to an SST with WAS or to the scum concentrator. Primary scum is not included in the design criteria for SST sizing because primary scum can be sent to the scum concentrator and landfill if needed. The amount of thickening impacts the required size of the SSTs. Table 7-1 shows the WAS and screened solids flows at a range of conditions including the design condition.

Table 7-1. Solids Storage Design Flows

Parameter	30.8 mgd, Annual Average	30.8 mgd, Peak 3-day (design condition)	40.0 mgd, Peak 3-day	40.0 mgd, Peak 3-day with PS Bypass
WAS (mgd)	0.350	0.543	0.705	0.942[a]
Screened solids (mgd)	0.505	0.809	0.105	0.123
Target WAS storage volume (MG)	-	0.18	-	-
Target screened solids storage volume (MG)	-	0.81	-	-
Hours WAS storage	12.4	8.0	6.2	4.6
Hours screened solids storage	38.4	24.0	18.5	15.8

a. Includes PS bypass around GT to avoid overloading one thickener in operation.

The County is open to considering reduced volumes for solids storage with further evaluation, considering wide spots in other areas of the facility and equipment redundancy.

7.4 System Location

The SSTs will receive flow from the WAS pumps and from the solids screens (WAS and TPS). The design will include WAS and screened solids piping to the SSTs, and piping from the SSTs to the screen feed pumps and pre-dewatering feed pumps

Two building options are discussed in Section 17. With either configuration, the SSTs will be located adjacent to the screen feed pumps and the pre-dewatering feed pumps to minimize the length of suction piping. If the existing DWB is renovated, then the SSTs will be located north of the DWB where the pumps will be located (refer to Drawing C-004). If the existing DWB is decommissioned and a new SPB is constructed, then the SSTs will be located on the south side of the new SPB (refer to Drawing C-007).

7.5 Solids Storage Tanks Description and Design Criteria

This section presents a description and design criteria for the SSTs, including SSTs, mixing system, and odor control.

7.5.1 Solids Storage Tanks

The SSTs will be rectangular concrete tanks with aluminum covers. The SSTs will be configured with one SST for WAS and three SSTs for screened solids. The SSTs for screened solids should be able to store screened WAS and PS separately or combined. Approximately 1 MG of storage is required to meet the design conditions presented in Table 7-2. The SST volume and configuration may vary depending on the site layout.

Table 7-2 lists the SST parameters for the design basis and the two site layouts. The SST for WAS is shorter to comply with the roadway setback in Option 1 and to accommodate the digesters in Option 2. The three SSTs for screened solids are slightly smaller for Option 2, and further modifications to the site layout should be evaluated to achieve the design basis storage volume. WAS will be piped to at least two of the SSTs to allow cleaning of a tank during operation.

Table 7-2. Solids Storage Tank Parameters

Parameter	Design Basis	Renovate DWB	Decommission DWB
WAS Storage			
Number of SSTs	1	1	1
Dimensions each	25 ft × 50 ft × 20 ft SWD	25 ft × 50 ft × 20 ft SWD	25 ft × 50 ft × 20 ft SWD
Total volume (MG)	0.18	0.18	0.18
Hours storage at design condition	8	8	8
Screened Solids Storage			
Number of SSTs	3	3	3
Dimensions each	30 ft × 60 ft × 20 ft SWD	30 ft × 60 ft × 20 ft SWD	25 ft × 60 ft × 20 ft SWD
Total volume (MG)	0.81	0.81	0.67
Hours storage at design condition	24	24	20
Total storage volume (MG)	0.99	0.99	0.85

Provisions for tank access for cleaning will be evaluated by the delivery team and will take into account factors such as top versus side access, vertical distance from access point to tank floor, ventilation provisions, and site location restrictions on access options. It is preferred that tank access for cleaning be provided from both the top and the side.

7.5.2 Mixing System

A large-bubble mixing system is proposed for the SSTs, although other mixing systems should be considered during design, particularly for mixing a blend of primary scum and WAS. The large-bubble mixing system is effective for tanks that operate with variable level and it consumes less energy than mechanical mixing equipment. The large-bubble mixing system uses compressors and stores compressed air in air receiver tanks. The compressors and air receiver tanks will be located in the building adjacent to the storage tanks. The compressed air is piped to a valve control panel at each SST. The valve control panel contains poppet valves, which are controlled by the panel to open for less than 1 second at a programmed time interval. The air from each valve is piped separately to a bubble-forming plate near the bottom of the SST. The pulse of air creates a large, flat bubble that rises to create mixing. The layout of the bubble-forming plates is provided by the manufacturer based on computational fluid dynamics (CFD) modeling, and the bubble sequence and timing are programmed in the control panel. Adjustments to the bubble sequence and timing can be made to change the level of mixing. The system is typically designed to create a rolling mixing pattern in the SST, with the bubbles pushing the mixture up and outward toward the wall, and flow returning down the wall and back to the bubble source.

The conceptual design for the mixing system is included in Table 7-3 below. The complete system is provided as a package from the system supplier (e.g., EnviroMix, Pulsed Hydraulics, Inc.). The mixing system design parameters are preliminary and should be provided by the system supplier based on the selected mixing tank dimensions and operational strategy.

Table 7-3. Solids Storage Tank Mixing System Design Parameters

Parameter	Value
Number of compressors and air accumulator tanks	2 (duty/standby)
Compressor type	Rotary screw
Discharge pressure	125 psig
Number of valve control panels	4 (one per SST)

7.5.3 Odor Control

To control odors from the SSTs, the SSTs will be covered and ventilated to an odor control system. All odor sources except final dewatering will be combined and sent to a common scrubber system. Details of the odor control system can be found in Section 15.

7.6 Equipment Operation and Control

The SST levels will be monitored by PCS as well as the status of the mixing system. Operators will check the level in the SSTs and verify that the mixing system is operating as intended. WAS and TPS flow rates to the SSTs will generally be consistent except for manual changes in solids flows. The WAS flow from the SSTs to the screens may be set manually or adjusted automatically. For automatic operation, screen feed pump speed will adjust based on SST level, with pump speed increasing if level exceeds the desired level range and decreasing if level drops below this range. Pumped flow to pre-dewatering will typically be operated manually. Alarms will be generated at high and low SST levels. High-high levels will be interlocked to shut down the pumps feeding the SST, and low-low levels will be interlocked to shut down the pumps drawing suction from the SST.

8 PRE-DEWATERING SYSTEM

8.1 Background and Purpose

Pre-dewatering is required because THP operates with a feed solids concentration of approximately 16 percent (the solids concentration of the combined screened and thickened solids is anticipated to be approximately 1.6 percent).

The new pre-dewatering system will rely on centrifuges, based on the findings of an alternatives analysis, which included a review of equipment sizing, footprint requirements, capital costs, and O&M costs. Dewatering alternatives evaluated included belt filter presses (BFPs), screw presses, centrifuges, rotary fan presses, and Bucher presses. Options were presented and reviewed at two workshops with the County, on April 26 and May 10, 2021. At the second workshop, the team shortlisted centrifuges and BFPs for further consideration. After further evaluation, the team selected centrifuges as the preferred technology for pre-dewatering, based on the compact footprint requirements, lower life-cycle costs, County familiarity, and other factors. For more information regarding this analysis, refer to TM No. 7: *Dewatering Equipment Evaluation*.

The new pre-dewatering system consists of the following equipment, which is described in further detail in this section:

- Pre-dewatering feed pumps (centrifuge feed pumps)
- Liquid emulsion polymer storage, blending, and feed systems
- Centrifuges
- Cake conveyance equipment: diverter gates and screw conveyors
- Pre-dewatered cake storage bins

The THP feed pumps are also included in this section but will be provided in the THP manufacturer's scope of supply.

An overall schematic of the pre-dewatering process is shown on Drawing G-005 with detail provided on Drawings I-300 through I-303.

8.2 Process Objectives

The purpose of pre-dewatering is to remove water from the thickened solids, to meet the process requirements of the THP. As noted in Section 9 of this Plan, THP operates with a feed solids concentration of approximately 16.5 percent. It is anticipated that the pre-dewatering process will dewater the thickened solids to approximately 20 to 25 percent. Dilution water is added upstream of the THP feed pumps to reach the target 16.5 percent solids, the typical feed solids concentration for THP, as noted in Section 9.

8.3 Basis of Design

Process equipment selections and facility concepts were based on a 30.8 mgd design condition for equipment sizing and a 40.0 mgd buildout condition for overall facility sizing. The solids loadings from Section 3 are summarized in Table 8-1.

Table 8-1. Anticipated Combined Thickened Solids Production

Design Condition	Total Solids Load (lb-DS/d)			
	Average	Peak 30-day	Peak 14-day	Peak 3-day
23.0 mgd	64,538	84,444	91,990	107,206
30.8 mgd	86,425	113,082	123,187	143,562
40.0 mgd	112,240	146,859	160,070	187,430

Total solids load includes TPS, unthickened WAS, and primary scum.

Peak 3-day solids loadings were used for sizing the pre-dewatering process. The pre-dewatering process will operate 24 hours per day, 7 days per week, to provide a continuous flow of solids to THP.

The flow to pre-dewatering will vary depending on the solids concentration of the feed; therefore, the system must be designed for a range of conditions. Three scenarios were considered:

- Typical conditions present anticipated values during normal operation. The flows are calculated assuming that PS are thickened to 4 percent solids, WAS is unthickened (1 percent solids), and primary scum is unconcentrated (0.5 percent solids). The total combined solids concentration is estimated to be approximately 1.6 percent.
- "Upper bound" presents a more conservative range of flows, assuming a TPS concentration of 2 percent, which results in a total combined pre-dewatering feed solids concentration of approximately 1.3 percent.
- "Lower bound" presents a lower range of flows, thickening of WAS to 5 percent solids, which results in a total combined pre-dewatering feed solids concentration of approximately 4 percent.

The anticipated flows and loads to pre-dewatering are summarized in Table 8-2. The projected peak 3-day flows at 1.3 percent solids are used to establish the 500 gpm minimum capacity for the pre-dewatering centrifuge feed pumps and centrifuges (849 gpm ÷ 2 units * 120 percent safety factor = approximately 500 gpm).

Table 8-2. Anticipated Flows and Loads to Pre-Dewatering

Design Condition	Solids Loading (lb-DS/hr)	Anticipated Values [a] (Typical Conditions)		Upper Bound [b] (TPS 2% solids)		Lower Bound [c] (WAS 5% solids)	
		Solids Conc.	Flow (gpm)	Solids Conc.	Flow (gpm)	Solids Conc.	Flow (gpm)
23.0 mgd, average	2,689	1.6%	340	1.3%	413	4.3%	125
23.0 mgd, peak 3-day	4,467	1.6%	554	1.3%	687	4.4%	203
30.8 mgd, average	3,601	1.6%	456	1.3%	513	4.3%	167
30.8 mgd, peak 3-day	5,982	1.6%	742	1.3%	849	4.4%	272
40.0 mgd, average	4,677	1.6%	592	1.3%	719	4.3%	217
40.0 mgd, peak 3-day	7,810	1.4%	1,089	1.3%	1,201	4.4%	355

a. All values in table above assume continuous (24/7) operation of the pre-dewatering system.
b. “Anticipated values” are based on the following feed flows to the pre-dewatering centrifuges:
- TPS solids concentration of 4.0%
- Unthickened WAS solids concentration of 1.0%
- Unconcentrated primary scum (solids concentration 0.5%)

a. “Upper bound” values are based on TPS solids concentration of 2% (half of anticipated value).
b. “Lower bound” values are based on thickened WAS solids concentration of 5%.

8.4 System Location

The location of the pre-dewatering system depends on which of the two shortlisted site layout options is selected. Further information on the site layout options is presented in Section 17. Below is a summary of the two shortlisted options:

- **Option 1: renovate existing Dewatering Building.** If the existing DWB is renovated, the existing dewatering area would be repurposed for the pre-dewatering system. The existing concrete cake bins would be reused, and a new polymer system would be installed in one of the existing truck bays. The other existing truck bay would remain, to be used for emergency pre-dewatered cake loadout, in the event that solids must be removed from the WPCP while the THP is out of service.
- **Option 2: decommission existing Dewatering Building.** If the existing DWB is decommissioned, then a new SPB would be constructed, containing both pre-dewatering and final dewatering equipment.

The THP feed pumps would be located on level 2 for Option 1, and on the ground level for Option 2. For both options, the remainder of the pre-dewatering equipment in the building would be laid out as follows:

- **Level 4 (elevation [EL] 70±):** pre-dewatering centrifuge, bridge crane, and control room
- **Level 3 (EL 60±):** centrifuge solids discharge chute, and cake screw conveyor
- **Level 2 (EL 40±):** dewatered cake bin
- **Ground level (EL 24±):** pre-dewatered cake bin screw conveyors, centrifuge feed pumps, polymer storage, blend, and feed system

Drawings M-309 and M-310 provide section views of the DWB showing the equipment listed above for Option 1, renovate DWB; M-361 and M-362 provide section views for Option 2, decommission DWB.

8.5 Pre-Dewatering Description and Design Criteria

The following sections provide a description and design criteria for the individual components of the pre-dewatering system.

8.5.1 Pre-Dewatering Centrifuge Feed Pumps

The centrifuges will be fed using pre-dewatering centrifuge feed pumps, which will withdraw solids from the SSTs. The pumps are located on the ground floor of the building. Three pumps will be provided (one for each centrifuge); floor space and pipe stubs will be provided to add a fourth pump to provide capacity for 40 mgd design conditions.

The pre-dewatering centrifuge feed pumps will have a common suction and discharge header, such that an alternate pump can be operated to serve each SST and centrifuge if the normally used pump is out of service. A magnetic flow meter will be provided on the discharge line to each centrifuge.

A schematic of the pumping system is provided in Drawing I-300: Pre-Dewatering Centrifuge Feed Pumps. Design criteria for the centrifuge feed pumps are shown in Table 8-3.

Table 8-3. Centrifuge Feed Pump Design Criteria

Parameter	Value
Number of units	3 (one per centrifuge), space for 1 future
Type	Progressive cavity
Manufacturers	Moyno, Netzsch, or Seepex
Design flow	500 gpm or greater
Drive type	VFD, direct-coupled motor
Maximum pump speed at design point	260 rpm
Rotor-shaft connection	Pin joint or gear joint
Maximum pressure per pump stage	50 psi

8.5.2 Pre-Dewatering Polymer System

A new polymer feed system will be installed to provide polymer to the pre-dewatering centrifuges. The system will be designed for deliveries of emulsion polymer (as opposed to dry polymer) and consist of the following equipment:

- One fill station
- Two bulk polymer storage tanks
- One polymer recirculation pump
- Three skid-mounted polymer blending and feed systems
- Eyewash station, with tempered water and flow switch

The polymer fill stations will have a level readout for the storage tank, and alarm indicators for high level.

The discharge piping of the polymer feed pumps will be interconnected so that the polymer feed systems are not dedicated to a specific centrifuge. However, not all combinations of polymer feed pump/centrifuge would be possible when more than one centrifuge is operating. Space and capped piping connections will be provided for a future fourth pre-dewatering polymer skid. The system will be located on the ground level.

A separate polymer storage, blend, and feed system will be provided for the pre-dewatering centrifuges (this applies to both site layout options). The final dewatering and pre-dewatering polymer systems will not be interconnected, because it is anticipated that each system may require different types of polymer to optimize dewatering performance. However, for ease of maintenance and interchangeability of parts, the same model of polymer blend system may be used for pre-dewatering and final dewatering.

One skid-mounted polymer blending and feed systems will be provided for each centrifuge. The blending and feed systems will have a common discharge header, such that an alternate skid can be operated to serve each centrifuge if the normally used skid is out of service. Floor space and pipe stubs will be provided to add four additional polymer blending units: a fourth skid for a future fourth pre-dewatering centrifuge, and three skids for future WAS thickening.

A schematic of the pre-dewatering polymer system is provided in Drawing I-303: Pre-Dewatering Polymer. Design criteria for the polymer storage tanks and recirculation pump are provided in Table 8-4. Design criteria for the polymer skids are provided in Table 8-5. Note that the design criteria are based on an assumed polymer dose of 10 pounds of active polymer per ton dry solids. Because the polymer dose may be affected by the centrifuge selection, the delivery team will verify the polymer dose and system sizing during detailed design.

Table 8-4. Polymer Storage Design Criteria

Parameter	Value			
Total final dewatering polymer consumption, gallons neat polymer per day	Average	Peak 30-day	Peak 14-day	Peak 3-day
23.0 mgd	90	117	127	135
30.8 mgd	120	157	171	181
40.0 mgd	156	203	222	235
Storage volume basis of design	Total storage volume provided ≥ 30-day consumption at 40 mgd peak 30-day			
Total storage volume required (30-day consumption at 40 mgd peak 30-day)	~6,000 gallons			
Number of tanks	2			
Volume per tank	3,000 gallons			
Total storage volume provided	6,000 gallons			
Tank dimensions	8 ft diameter, 10.5 ft tall			
Tank material of construction	FRP			
Tank accessories and instrumentation	One ultrasonic level sensor per tank One ladder and cage per tank			
Storage tank mixing system				
Quantity	One recirculation pump serving both tanks			
Pump type	Progressive cavity			

Total neat polymer consumption is based on the solids production values in Section 3, an assumed neat polymer dose rate of 10 lb per ton of dry solids, and an as-delivered concentration of 40% active polymer by weight.

Table 8-5. Polymer Blending and Feed System Design Criteria

Parameter	Value
Basis of design	
Number of polymer skids	3 (one per centrifuge), plus space for 4 future skids: 1 for pre-dewatering, 3 for thickening
Neat polymer feed rate, per skid	1.5–15 gallons per hour (gph)
Dilution water feed rate, per skid	6–60 gpm
Manufacturers	Fluid Dynamics or Velodyne
Polymer mixing chamber	
Type	Either non-mechanical without motor or hydro-mechanical with motor
Accessories/instrumentation	Differential pressure switch, inlet/outlet pressure gauges
Neat polymer metering pump	
Quantity	1 per skid
Type	Progressive cavity
Skid dilution water inlet assembly	
On/off valve	Solenoid valve, normally closed
Flow control valve	Motor operated needle/orifice valve
Instrumentation	One dilution water magnetic flow meter, one rotameter
Other skid accessories	calibration column, flush/drain valve, pressure relief valve
Dilution water main (not provided in skid)	One pressure-reducing valve (to serve all skids). Two stainless duplex basket strainers: one 40-mesh, one 80-mesh. Pressure gauges before and after each strainer and PRV.

The dilution water feed is based on an assumed polymer make down solution concentration range of 0.25 to 0.5 percent (i.e., 0.25 [0.5] pounds of neat polymer per 99.75 [99.5] pounds of dilution water).

8.5.3 Pre-Dewatering Centrifuges

Design criteria for the centrifuges are listed in Table 8-6. Three centrifuges (two duty plus one standby) will be provided for the 30.8 mgd design condition. Additional space will be provided to install a fourth centrifuge in the future to provide additional capacity and redundancy for the 40 mgd design conditions. A schematic of the pre-dewatering centrifuges is provided in Drawing I-301: Pre-Dewatering Centrifuge. The centrifuges will be located on the upper level of the building. A bridge crane sized to lift the rotating assembly and floor opening large enough to fit the rotating assembly will be provided in the centrifuge room to lift and lower the centrifuges for maintenance and repairs.

For ease of maintenance and interchangeability of parts, the same model of centrifuge will be used for pre-dewatering and final dewatering. The delivery team will be responsible for evaluating sizing and selection of the centrifuge manufacturer and model. The selected system must be sized to reliably meet the full range of flows and loads at the 23.0 and 30.8 mgd design conditions, with space to expand to meet the 40 mgd design conditions. For reference, the evaluations and layouts presented in this

Plan were based on a 29-inch diameter bowl and assumed capacity of 4,200 lb/hr (equal to 6,000 lb/hr nameplate capacity, de-rated by 30 percent as a safety factor).

Table 8-6. Centrifuge Design Criteria

Parameter	Value
Number of units	3 (2 duty and 1 standby), (plus space for 1 future)
Manufacturer	Alfa Laval, Centrisys, or GEA
Hydraulic capacity per unit	500 gpm or greater at 1.3% feed solids
Target solids capture	95%
Target cake dryness	20-25% solids
Motor size	To be determined by delivery team
Drive type	VFD

Centrate will be sent to the WPCP drain. The centrate drain piping for each centrifuge will be a minimum size of 10 inches, sloped at 1/4-inch per foot or greater, with flushing connections throughout. The delivery team will be responsible for sizing the main centrate header piping and centrate drain vent to provide adequate capacity and reduce the risk of foaming issues. More information about the centrate drain piping is provided in Section 16.

8.5.3.1 Cake Conveyance

Solids from each centrifuge will fall through a chute into a “slop” diverter slide gate below the machine. During centrifuge startup, before the cake reaches a target dryness, the diverter gate will close to send “slop” to the WPCP drain via the centrate piping. Once the centrifuge is producing cake, the diverter gate will open, allowing solids to fall into a “pant-leg” diverter gate.

When the “pant-leg” diverter gate is an “open” position, cake will fall directly into the pre-dewatered cake bin. When the gate is “closed,” cake will fall into a “bin distributing” horizontal screw conveyor. The purpose of the screw conveyor will be to transport cake to a different bin, to allow even distribution of cake. The conveyor will be able to operate in forward or reverse. Design criteria for the cake conveyance equipment are provided in Table 8-7.

Table 8-7. Cake Conveyance Design Criteria

Parameter	Value
Materials of construction, frame	Type 304L stainless steel
Materials of construction, wetted parts	Type 316 stainless steel
“Slop” diverter slide gates	
Quantity	3 (one per centrifuge), plus space for 1 future
“Pant leg” diverter gates	
Quantity	3 (one per centrifuge), plus space for 1 future
“Bin distributing” screw conveyor	
Quantity	1
Maximum screw speed	20 rpm
Materials of construction	Stainless steel shaft Flights with abrasion-resistant wear shoes
Safety features	Zero speed switch and emergency stop pull cord
Screw conveyor slide gates	
Quantity	To be determined in detailed design

8.5.3.2 PEW Connections

The dewatering system will be provided with the following PEW connections:

- Centrifuge automatic rotating assembly/bowl flush, with one motorized valve and one check valve per centrifuge, or as required by the centrifuge manufacturer
- Centrifuge manual casing flush, with manually operated ball valves
- Flushing water for cake conveyance and storage equipment:
    - “Slop” diverter slide gates
    - “Pant leg” diverter gates
    - Screw conveyor
    - Cake bin live-bottom screws
- THP feed dilution water (see Section 8.5.6)

8.5.4 Pre-Dewatered Cake Storage Bins

A minimum 24 hours of usable storage at 40 mgd average conditions is recommended between the pre-dewatering centrifuges and THP preheating/reactor feed tank. The storage hopper will serve multiple purposes:

- Attenuate fluctuations in the solids flow upstream of the hopper.
- Provide storage during temporary shutdowns of THP equipment (planned and unplanned) to keep upstream process equipment operational.
- Provide additional storage capacity during an emergency storage situation.

The layout and design of the pre-dewatered cake bin will depend on which of the two shortlisted site layout options is selected. Further information on the site layout options is presented in Section 17 of the Plan. Below is a summary of the two shortlisted options:

- **Option 1: renovate existing Dewatering Building.** If the existing DWB is renovated, the existing four concrete cake bins would be reused. The total capacity of the existing cake bins is approximately 430 CY. The cake conveyance equipment (screw conveyors and slide gates) would be replaced. Each cake bin has a horizontal screw conveyor on the bottom that, depending on the rotation of the screw, unloads cake from the bin into one of two cake “collector screws” (one dedicated for each THP feed pump). This configuration allows any centrifuge to be paired with any cake bin and THP feed pump. Refer to Section C, Drawing M-309 and Section B, Drawing M-310).
- **Option 2: decommission existing Dewatering Building.** In this option, two new pre-dewatering cake storage bins would be provided below the pre-dewatering centrifuges. Each bin would have a capacity of 175 CY, which would provide more than one day’s worth of storage at 40 mgd design average conditions. Each cake bin would have horizontal screw conveyors on the bottom that would unload cake from the bin towards either end of the conveyor, feeding one of the two THP feed pumps.

The requirements for the pre-dewatered cake storage bins are as follows:

- Two radar level sensors for each bin
- Type 304L stainless steel for the bin
- Type 316 stainless steel for moving parts
- Adequate clearance for removal of live-bottom screws
- Abrasion-resistant wear shoes for the screw flights
- Rectangular knife gate valves for cake discharge
- Minimum sidewall slope of 70 degrees
- Outlets sized to avoid bridging/clogging of cake at anticipated solids concentrations

A schematic of the cake bins is provided in Drawing I-302: Cake Bin and THP Feed Pumps.

8.5.5 THP Feed Pumps

THP feed pumps located below the pre-dewatered cake bins will convey solids from the cake bins to the THP preheating/reactor feed tank or to the emergency pre-dewatered cake loadout.

Progressive-cavity pumps are recommended for the THP Feed Pumps. This type of pump has been successfully applied at similar facilities such as DC Water, HRSD, and many others in North America, Europe, and other places around the world. More powerful piston type pumps were not considered because of the success and relatively modest expected operating pressures of the PC pumps (i.e., less than 350 psi). Pump inlets will be an open throat or hopper-type with anti-bridging auger incorporated into the pump shaft as depicted in Figure 8-1. Figure 8-1 also depicts an additional anti-bridging device incorporated into the pump feed hopper; this additional anti-bridging device at the pump inlet is recommended. Several pump manufacturers offer various configurations that serve the same purpose.

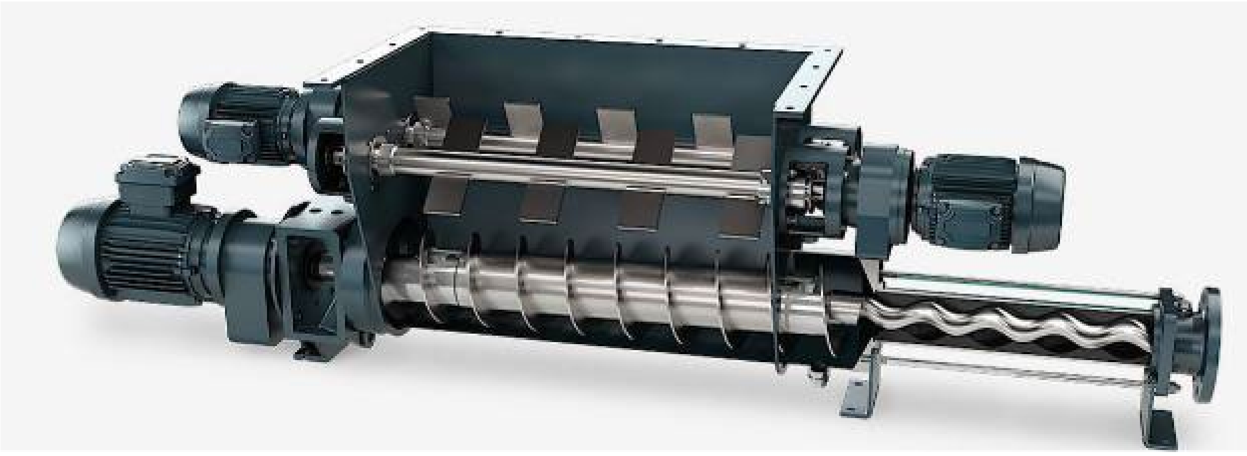

Figure 8-1. Progressive-Cavity Pump with Anti-Bridging Devices (source: Netzsch)

The pump speed will be limited to about 50 revolution per minute (rpm) at maximum design flow. Higher speeds lead to excessive maintenance. Progressive-cavity pump manufacturers generally recommend this speed when pumping cake at 20 percent solids or greater.

The THP feed pumps will be designed for conservative pressure requirements. Solids pumping can be unpredictable and prone to clogging, which warrants a conservative approach.

The THP preheating/reactor feed pump flow is based on the THP system design. As noted in Section 9, the THP system will be sized to handle the peak 7-day solids production at 40 mgd or greater.

Pipeline velocities need to be minimized in order to reduce pressure loss. Design of Municipal Wastewater Treatment Plants (Water Environment Federation, Manual of Practice No. 8, 5th Edition, 2010) suggests a 0.25 ft/s preferred maximum velocity for dewatered solids. A typical pipeline diameter used at other THP facilities is 12 inch or smaller. DC Water was designed for 0.31 ft/s and experienced pressure losses of 0.98 psi per linear foot when pumping 16 percent solids. The delivery team will further evaluate the pipeline sizing to reduce pressure loss. Additional cake pumping data are being collected from other installations in the United States, as well as from Thames Water in the United Kingdom. Thames Water operates seven THP/AD plants and has a broad experience with different types of cake pumping situations at different distances. This data will be evaluated along with other information to refine the system pumping needs and system design attributes.

Check valves are not recommended downstream of the THP feed pumps. Instead, motor operated three-piece trunnion ball valves are recommended.

A schematic of the pumping system is provided in Drawing I-302: Cake Bin and THP Feed Pumps. Design criteria for the THP feed pumps are shown in Table 8-8.

Table 8-8. THP Pump Design Criteria

Parameter	Value
Number of units Renovate existing DWB Decommission DWB	 2 pumps (one duty, one standby) 4 pumps (2 per cake bin)
Type	Progressive cavity
Manufacturers	Moyno, Netzsch, or Seepex
Design flow	80 gpm or greater [a]
Design pressure	To be determined by delivery team
Drive type	VFD, direct-coupled motor
Maximum pump speed at maximum flow	50 rpm
Minimum number of pump stages	4
Rotor-shaft connection	Pin joint or gear joint

a. THP feed pump will be sized to match the maximum throughput of the THP system.

8.5.5.1 Requirements for Cake Feed Piping

Defining pressure loss in solids pipelines with cakes in the 16 to 30 percent solids range requires cautious evaluation. A conservative approach is recommended, based on the experience at several domestic cake pumping facilities (including DC Water's THP/AD facility) and other THP/AD facilities in the United Kingdom.

Seven facilities with cake solids of 25 to 30 percent had a median pressure loss of 2.0 psig/ft-length. Note that the piping layout of the reference facilities is unknown and the impact of fitting losses in the system is also unknown. The cake piping must be designed to limit the number of fittings and reduce friction losses by use of long (minimum three times diameter) radius elbows and wyes. The cake pipe lengths for the

THP feed pumps may up to 100 feet based on the current layout. Also, each system is expected to experience about 15 psig of static head. A design discharge pressure of 350 psig has been used in several United Kingdom installations.

Pumping of dewatered cake will not be at greater than 20 percent solids under normal operating conditions. Dilution water is added directly at the pump inlet for process purposes and to maintain consistency in the downstream solids content (see Section 8.5.6). The application of boundary layer water injection ring technology in the solids pipelines is an additional design feature that should be evaluated by the delivery team in an effort to minimize pumping pressures.

The evaluation of discharge pressure should also account for the possibility of pumping cake to a loadout area for hauling off site when the THP is out of service. The distance to the loadout area may be further than the preheating/reactor feed tank. During these conditions, the cake solids concentration may be higher (possibly 30 percent), to reduce the net volume of solids hauled off site.

The recommended material of construction for cake feed piping is Type 304 stainless steel.

The system should be designed to accommodate potential pressure buildup caused by off-gassing of the pre-dewatered solids. Recommendations include providing minimum 0.25-inch-thick stainless steel chutes with gusset reinforcement between the THP feed pumps and downstream valves, as well as vent lines with motorized valves that could be opened when the pipe is offline.

8.5.6 Cake Dilution System

As noted earlier, a cake dilution system will be provided to reduce pressure loss in the cake pumping systems and provide process control over the cake in the cake bin and the cake feed to THP. PEW is recommended for this purpose. Each cake pump will have a utility water injection point at, or just upstream from, the pump. The amount of dilution water added will be controlled by the pumping pressure. An algorithm will be created during startup for the pre-dewatered cake material. The algorithm will provide a relationship between percent solids and pumping pressure so that dilution water is added to achieve the correlated pumping pressure. This type of control system has been successfully used for several years by Thames Water and other agencies which have THP/AD systems. It is not perfect in its control of cake percent solids but is close enough to provide relatively consistent thickness in the cake bins, and to provide proper dilution when feeding to the THP system. The feed into the THP preheating/reactor vessel is anticipated to average 16.5 percent solids, with an acceptable range of 15to 18 percent solids. This may vary based on the THP vendor selected.

The dilution water system will include the following components:

- Strainers and pressure reducing valve(s) to reduce pressure for the flow control valve
- Magnetic flow meter (one per cake bin)
- Motor operated flow control valve (one per THP feed pump, either v-port ball valve or globe valve)

The dilution water demands will depend on the solids concentration of the pre-dewatered cake: drier cake will require more dilution water. Table 8-9 summarizes the anticipated dilution water flow requirements for various conditions to achieve the target 16.5 percent solids.

Table 8-9. Anticipated Dilution Water Flows

Design Condition	THP Feed Dilution Water Flows, gpm	
	Anticipated Values (25% cake solids)	Conservative Design Condition (30% solids)
23.0 mgd, average	11	14
23.0 mgd, peak 7-day	17	23
30.8 mgd, average	13	17
30.8 mgd, peak 7-day	22	29
40.0 mgd, average	18	24
40.0 mgd, peak 7-day	31	40

Values above are based on a target THP feed solids concentration of 16.5%.

8.5.6.1 Boundary Layer Injection Rings

Boundary layer injection rings may be considered to further reduce pumping pressure in the pipeline. Boundary layer injection rings usually consist of a short spool piece with three water injection points around the circumference of the pipe. Figure 8-2 depicts the boundary layer injection ring system. Typical flow rates are less than 1 gpm for each THP feed pump in service. Booster pumps may be required to provide adequate pressure to overcome the high pressures in the cake piping. The locations of the injection rings can be determined by the pump manufacturer and delivery team at a later time when the piping systems have been routed.

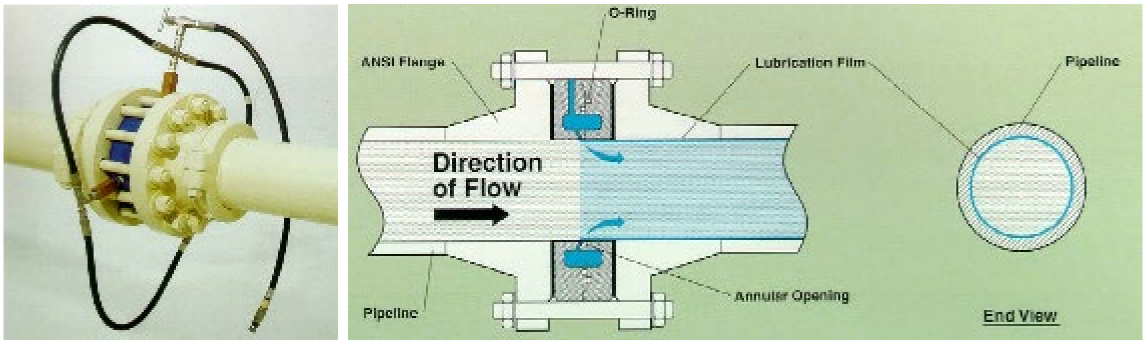

Figure 8-2. Boundary Layer Injection Ring System (Source: Schwing Bioset)

8.5.7 Odor Control

Foul air will be withdrawn from the following areas:

- Centrifuge centrate discharge chute
- Centrifuge solids discharge chute
- Cake conveyor
- Pre-dewatered cake bin

The odor control system is discussed further in Section 15.

8.6 Equipment Operation and Control

8.6.1 Centrifuge Feed

The centrifuge feed pumps will operate continuously while the pre-dewatering centrifuges are in service. A magnetic flow meter will be provided on the feed line to each centrifuge.

The centrifuge feed pumps will be provided with VFDs. The PCS will automatically adjust the pump speed so that the recorded flow matches the operator-adjustable flow set point.

8.6.2 Polymer System

The polymer feed to each centrifuge will be automatically adjusted to maintain an operator-adjustable dose rate, based on the following parameters:

- Solids feed flow, as measured by flow meter on the pre-dewatering centrifuge feed pump discharge
- Solids concentration of STS, entered in the PCS by the operator on a regular interval based on sampling and testing results
- Polymer dose rate (pounds of active polymer per dry ton of solids), entered in the PCS

The polymer blending unit will receive a polymer demand from the PCS, in units of pounds per hour (lb/hr). A PLC on the polymer blending unit will automatically adjust the speed of the neat polymer metering pump to deliver the polymer demand. The dilution water flow into the polymer blending unit will be adjusted manually via needle/orifice valve to achieve a target polymer solution concentration.

The polymer recirculation pump will be operated on a timer cycle. The suction and discharge tanks of the pump will be adjusted using manual valves.

8.6.3 Centrifuges and Cake Conveyance

The centrifuges will be controlled by the manufacturer’s PLC. During commissioning, the polymer dosage, mixing, washwater, and centrifuge control will be adjusted to optimize the system to achieve the highest cake dryness while minimizing the total polymer usage. Every installed centrifuge should be operated periodically to distribute wear and ensure that each is functional when needed.

The “slop” diverter slide gate will be automatically opened and closed by the centrifuge PLC but could also be manually controlled from the centrifuge control panel or local control station.

The cake conveyance system will be controlled from the PCS. The system will be interlocked with the centrifuge and will send a stop command to the centrifuge PLC if a critical fault is detected. Before starting a centrifuge, the operator will select the discharge location of the cake by adjusting the following settings:

- Position of the pant leg diverter gate
- Cake screw conveyor direction of rotation, and
- Position of the slide gates below the screw conveyor

If the cake bin level exceeds a high-level set point, a warning alarm will be triggered, to notify the operator that the cake discharge location should be adjusted to prevent cake from overflowing the bin. If the level exceeds a high-high level, the PCS will send a stop signal to the centrifuge feed pumps.

8.6.4 Cake Storage, THP Feed, and Cake Dilution

The Cake Storage Bins will be equipped with load cells and contain sensors to monitor the actual cake levels within the bins. Level switches will be included to detect high level conditions. Inventory will be monitored to avoid over-filling as the cake receiving pumps transfer material to the Cake Storage Bins.

As noted in Section 9, the THP PLC will automatically control the THP feed pumps. The anti-bridging mechanism of the bin will be initiated when the THP feed pumps are called to run.

Pipeline lubrication with the boundary layer injection ring will be initiated when a cake pump is called to start and turn off when the pump is stopped.

Cake pipeline valves that have the capability to contain cake within the pipeline when closed, should be left open during inactive conditions. Off-gases from the cake with a blocked pipeline can drive up the pressure to unsafe levels.

Various levels of automation are possible and will be further discussed with the Delivery team.

9

THERMAL HYDOLYSIS PROCESS

9.1 Background and Purpose

Thermal hydrolysis (TH) has been selected as the process best able to achieve the Re-Gen Program's goals and objectives. It produces a Class A EQ biosolids product while minimizing the total quantity of final product produced and maximizing energy recovery from the solids in the form of biogas generated in the anaerobic digesters.

Multiple technologies were evaluated for TH. These alternatives are discussed in TM No. 4: *Thermal Hydrolysis Process Evaluation*.

All TH technologies use steam and pressure to hydrolyze solids. However, these systems vary widely in their process configurations, equipment arrangement, and operational strategies. Additionally, the solids handling facility interfaces upstream and downstream of the THP are different with each technology.

Because of the differences in technologies and the desire to select the THP configuration before proceeding into detailed design, the County is proceeding with a competitive negotiation process to pre-select the THP equipment manufacturer.

An overall schematic of THP is shown on Drawing G-006 with additional detail provided on Drawings M-400 and I-400.

9.2 Process Objectives

THP consists of a high-temperature, high-pressure steam pretreatment of solids to create THS, prior to treatment, in a MAD process. THP requires upstream screening and pre-dewatering of the solids and is classified as a pasteurization "process to further reduce pathogens" (PFRP), as listed in Appendix B of the U.S. Environmental Protection Agency (EPA) Part 503 federal regulations. THP involves heating sewage solids and maintaining its temperature above 70 degrees Celsius (°C) (158°F) for 30 minutes or longer. As one example, the Cambi THP maintains temperatures above 70°C (158°F) through the preheating/reactor feed tank and reactors and provides a total detention time greater than 30 minutes. The THP/AD system satisfies time and temperature requirements necessary to produce Class A biosolids.

Medium-pressure steam (90 psig) is used to create high temperature and pressure conditions to lyse bacterial cells and to promote the release and solubilization of particulate organic material upon depressurization. THP further hydrolyzes large biological macromolecules, carbohydrates, and long-chain fatty acids to lower molecular weight intermediates. The process also significantly increases the rate of digestion and the destruction of feed solids as these constituents are much more easily digested. The digesters can operate at shorter retention times with equivalent process stability as conventional mesophilic digesters. In addition, THP can increase volatile solids reduction (VSr) and biogas generation by approximately 10 percent, compared to AD alone.

One characteristic of THS is a decrease in the viscosity of DS, allowing the operation of higher feed and mixed solids concentrations in digesters as it is both easier to pump and mix. THS digester feed solids are from 8 to 12 percent TS versus 4 to 6 percent TS for a conventional digestion process. As a result, the required volume of the digesters can be greatly reduced, requiring only half the volume relative to the required volume of conventional MAD systems. Additionally, the DS from THP provide increased dewaterability, less odorous cake, and Class A biosolids.

All TH technologies use steam and pressure to hydrolyze solids. However, these systems vary widely in their process configurations, equipment arrangement, and operational strategies. Additionally, the solids handling interfaces upstream and downstream of the THP are different with each technology. It is therefore necessary to select the specific THP configuration before proceeding to detailed design.

9.3 Basis of Design

The pre-dewatered solids will be pumped from the pre-dewatered cake storage bins to the THP by the THP feed pumps, located in the renovated DWB or the new SPB, depending on the selected site layout. The THP design loading criteria are summarized in Table 9-1.

Table 9-1. Thermal Hydrolysis Process Design Loading

Design Condition	Total Solids Load (lb-TS/d)	Volatile Solids Load (lb-VS/d)	Flow (gpd)[a]	Flow (gpm)[a]
30.8 mgd, average	82,104	65,771	56,664	41
30.8 mgd, peak 7-day	123,880	99,441	90,023	63
40.0 mgd, peak 7-day	161,230	129,432	117,164	81

a. At a pre-dewatered cake concentration of 16.5% TS.

The selected operating condition for the THP is the peak 7-day operating condition at 40 mgd, as the equipment will be a single train (with redundancy) and therefore it is recommended to size the THP for the 40 mgd design condition, rather than trying to expand the system at a later date. The batch-wise operation of the THP makes it very flexible to turn down to a lower throughput. This can be achieved by either lengthening the duration of the reactor “hold” time or increasing the time between batches.

9.4 System Location

The location of the THP equipment at the Arlington WPCP is shown on the site plans for the two configuration options, Drawings C-4 and C-6. The location of the THP is critical because of the material handling complexities of pumping pre-dewatered cake from the cake bins to the preheating/reactor feed tank. The location was selected because of its proximity to the pre-dewatered cake bins for the renovated DWB or the new SPB. It is also desirable to locate the THS cooling HEXs (see Section 10) near the THP to minimize the distance pumping the hot, undiluted THS. If outages or interruptions of service occur and the THS is allowed to cool before diluting with DS, the cooled THS will clog the pipe resulting in maintenance headaches. Therefore, the design should minimize the distance for pumping the undiluted THS to reduce the risk of this occurrence and reduce the impact should it happen.

9.5 THP Installation

The THP equipment will be installed outdoors on a concrete pad. The equipment package will arrive to the site from the manufacturer. The slab will be sized to accommodate the THP equipment and to provide access around the equipment. The pad will have a perimeter concrete curb and a trench drain to allow rainwater and washwater drainage from the THP train to the WPCP drain system. The concrete walkway around the system will be sloped to the perimeter curb to facilitate washdown and cleaning. A hose big and reel will be located on each end of the equipment train to accommodate cleaning operations. Floor drains will be provided at pumps for seal water drainage.

Outdoor lighting in this area will also be provided along with supplementary lights and convenience receptacles if not provided by THP manufacturer. The THP equipment will also be equipped with lightning protection. Site grading will provide positive drainage to prevent ponding or flooding around the slab.

The THP feed pumps will be located at the pre-dewatered cake bins. The THS flow control valves and flow meters will be located at the cooling system, adjacent to the cooling HEXs. The entire area surrounding the THP equipment flow control valves, and cooling heat exchanges will have a perimeter concrete curb, trench drains, and hose bib/reels for maintenance. Refer to Section 11 for additional information on the cooling system.

9.6 Thermal Hydrolysis Facility Description and Design Criteria

The THP will be a batch process system (rather than continuous), installed outdoors on a concrete slab, and will consist of one train with installed redundancy to ensure continuous operation. The THS flow meters and digester feed flow control valves will be located adjacent to the THP equipment near the cooling HEXs. The THP equipment details and configuration will be finalized following the competitive negotiation with the THP manufacturers and a manufacturer is selected.

The THP has multiple interfaces with the rest of the solids handling processes, which require careful coordination to ensure optimal and efficient operation of the THP and the downstream processes. The primary interfaces are:

- Pre-dewatering and cake storage bins
- Steam system
- Plant effluent water
- Anaerobic digestion

THP manufacturer will be responsible for designing and selecting the following equipment to provide a complete and functioning system:

- THP equipment skid, including redundant preheating/reactor feed tanks, reactors and depressurization tanks, all associated pumps, valves, instruments
- Process gas treatment system
- THP PLC and controls system
- THP feed pumps
- THS feed control valves and flow meters
- Spare parts package

9.6.1 Preheating/Reactor Feed Tank

The preheating/reactor feed tank represents the first vessel in the THP sequence. At least two preheating/reactor feed tanks will be provided to provide redundancy and continuous operations when a tank is removed from service during the required annual shutdown and inspection. Diluted pre-dewatered solids are continuously fed to the preheating/reactor feed tank from the upstream pre-dewatered cake storage bins. The quantity of dilution water needed will depend on the THP manufacturer, as the preferred feed rates to the THP vary. Variances in the pre-dewatered cake solids concentration will be offset by the addition of dilution water to the preheating/reactor feed tank, which further reduces the solids concentration to a steady, targeted feed to the THP. The solids are preheated to about 90°C to 105°C (194°F to 221°F) by injection of the recycled steam from the depressurization tank. The specific process temperature is dependent on the feed solids concentration and temperature, as well as operational parameters upstream of the THP. The increase in temperature decreases the viscosity of the solids, increasing the homogeneity of the solids and enabling them to remain in suspension. The preheating/reactor feed further provides the required storage capacity for recovery of energy in the form of recycled steam from the depressurization tank.

The solids in the preheating/reactor feed tank are circulated and homogenized by two variable-speed, progressive-cavity pumps. One pump operates in a continuous-duty mode. The second pump operates as standby and is started upon the failure of the operating pump. One circulation pump runs continuously at a constant speed, set by the THP control system, so long as the level transmitter in the preheating/reactor feed tank indicates that there is sufficient quantity of solids in the tank. The circulation pump serves as the reactor feed pump. It conveys preheated solids from the preheating/reactor feed tank into the reactors when the system reaches the solids-filling stage. In the case of one manufacturer, steam is added to the reactor feed line and mixed into the preheated solids using a dynamic mixer.

9.6.2 Reactors

TH occurs in the reactors, which function as a batch process consisting of the following steps (with general times for approximation use only):

1. **Solids fill (10 minutes):** At the start of the reactor cycle, the preheated solids are discharged from the reactor feed pump to the empty, non-pressurized reactor.
2. **Steam fill (10 minutes):** This step applies only to one manufacturer. If not added upstream of the reactor, steam is added to hydrolyze the solids by further increasing pressure and temperature. The steam control valve is opened gradually to minimize the effects of thermal shock. The steam control valve will close partially to a preset position, to decrease the rate of steam injection, when a set pressure in the reactor is reached.
3. **Retention (20 minutes):** Once the target pressure is reached, it is maintained in the reactor to provide batch treatment of the solids at the required temperature and pressure for Class A pathogen reduction.
4. **Depressurization (1 minute):** The main outlet valve at the bottom of the reactor is opened and the THS is depressurized to the depressurization tank because of the differential pressure between these vessels, when the hydrolysis process is complete. This is done at the maximum pressure differential to achieve the largest pressure drop.
5. **Blowdown (5 minutes):** Following the explosive depressurization, the remainder of the THS from the reactor completes the transfer to the depressurization tank.

During a typical cycle, each reactor of the THP train reaches a process temperature of 149°C to 182°C (300°F to 360°F). The process starts over when the cycle is completed. The total time for one reactor cycle is optimized during startup based on energy balance and actual steam consumption. Multiple reactors operate on a staggered basis, allowing continuous discharge from the pre-dewatering process through the THP to the AD system. At least two reactors will be provided to provide redundancy and continuous operations when a tank is removed from service during the required annual shutdown and inspection. The total reactor cycle time ranges from 40 to 50 minutes.

Most of the process gases are returned to the preheating/reactor feed tank from the depressurization tank during the depressurization. However, a small gas vent line from each reactor is also connected to the preheating/reactor feed tank, for the purpose of discharging an accumulation of insoluble gases (e.g., CO_2, nitrite, amines, alcohol, etc.) periodically during the batch cycle. A valve in the venting line is opened by the PLC to transfer these gases to the preheating/reactor feed tank. The gases are then conveyed for treatment.

9.6.3 Depressurization Tank

The main purpose of a depressurization tank is to release the steam contained in the THS and recycle it to the preheating tank. This is achieved by returning steam to the preheating/reactor feed tank to preheat the cake feed, using the pressure differential between the depressurization tank and the preheating tank. The depressurization tank inlet takes the pressure drop from the reactor (approximately 100 psi) to the depressurization tank pressure of approximately 10 psi. This generates a fast and powerful expansion of the steam referred to as steam “explosion,” leading to the biomass cell destruction. Following the initial “explosive” depressurization, the remaining THS from the reactor are transferred by differential pressure to the depressurization tank; no pumps are used. The depressurization tank further provides short-term storage equalization, so that the digesters can be fed continuously. At least two depressurization tanks will be provided to provide redundancy and continuous operations when a tank is removed from service during the required annual shutdown and inspection.

9.6.4 THS Dilution System

Prior to the digester feed pumps and after discharge from the depressurization tank, THS are reduced from 13–16 percent to 8–12 percent with dilution water. Filtered and disinfected utility water is used as dilution water to maintain Class A solids. Dilution water is required to achieve the following objectives:

- Decrease the temperature of the THS to protect the digester feed pump rotor, stators and seals

- Reduce the THS viscosity, avoiding larger digester feed pumps
- Control ammonia concentrations in the digesters to below 3,000 milligrams per liter (mg/L) by reducing the solids feed loading

Laboratory pilot testing, currently underway, shows that a 9 percent solids feed is maintaining ammonia concentrations in the digester below 3,000 mg/L. The THP digesters will operate at a higher ammonia concentration than conventional digestion and the management of ammonia concentration in the digesters is a critical operational point.

The dilution water system, using chlorinated PEW includes a modulating control valve and flow meter to control the flow of dilution water as directed by the THP control system. A discussion of the PEW system is provided in Section 16. Potable water (County Water [COW]) will be provided as a backup water supply to avoid contamination of the THS, in the case of an interruption or contamination of the PEW.

9.6.5 Digester Feed Pumps

Progressive-cavity digester feed pumps will continuously convey diluted THS from the depressurization tank to the THS feed system control valves. The diluted and cooled THS will be equally split to the cooling HEX/DS circulation system. One duty and one standby PC pump and associated discharge control valves will be mounted on the THP train.

The speed of the digester feed pumps is the primary control parameter of the THP. An increase of the feed rate of the digester feed pumps will result in a corresponding increase in the speed of the reactor feed pumps as they work to maintain a set level in the preheating/reactor feed tank. The overall effect will be more throughput to the THP. Operators will set the digester feed rate based upon the pre-dewatered solids cake production rate and the desired feed rate to the digesters.

9.6.6 Process Gas Treatment System

The gas/steam released from the preheating/reactor feed tank is highly odorous and is saturated with water. The description of the process gas treatment system is based around a single manufacturer, Cambi, Inc. Other manufacturers will be required to provide a system that is proved to condense, convey and treat the process gasses resulting from TH. The process gas system treating this stream consists of two elements:

- A process gas cooler, which is a tube-in-tube HEX and is located at the upper level of the THP train and shown on Figure 9-1.
- A process gas skid, located on the second level of the THP train, and shown on Figure 9-2.

Figure 9-1. Process Gas Cooler

Figure 9-2. Process Gas Skid

The treatment of odorous air has improved with the evolution of the Cambi THP. The Cambi THP B6-4 train includes several upgrades from Cambi's earlier foul-gas treatment skids, including an overall simplification of the system as well as modifications to the piping system and valving, in order to reduce the opportunities for leaks.

The process gas from the THP is treated as follows:

1. Process gas from depressurization tank and reactors is sent to the preheating/reactor feed tank along with the steam from the depressurization process.
2. The process gas is sent from the preheating/reactor feed tank to the process gas cooler. The process gas cooler is used to remove condensable gases from the stream, and to cool down gases from the preheating/reactor feed tank. The condensed liquid drains back to the preheating/reactor feed tank.
3. The cooled gas is conveyed to the process gas skid, where ejectors compress and convey it into the process gas tank using disinfected utility water. The compressing capacity of the ejectors is controlled by the water flow (i.e., speed of the water pumps). The process gas tank is operated at a fixed level and constant temperature.
4. Two process gas pumps circulate disinfected utility water through the system, which served as carrying fluid for the cooled gases, as well as to maintain constant level and temperature in the tank.
5. The resulting process gas condensate overflows from the process gas tank and is conveyed in a pressurized line to the digester feed piping. It is critical to avoid intermediate high or low points in the process gas condensate line between the process gas skid on the THP train and the point of injection into the digester feed lines.

The condensed process gas from the THP will be transported to the digesters in a process gas header pipe and will be injected into the operating digesters via the DS recirculation piping, downstream of the HEXs. The entire system is operated at a controlled pressure in order to overcome the pressure in the digester feed lines. The pressure in the system is controlled by a modulating valve on the process gas tank outlet.

Under normal operations, the process gas will be discharged to one or the other operating primary digesters. It is recommended to alternate the receiving digester as it has been shown that the process gas condensate can cause process issues in the digesters, such as digestion inhibition or a reduction in biogas generation. It is recommended to review the findings from recent operational experiences for other THP facilities for additional information.

9.7 Equipment Operations and Control

The THP PLC will control the THP equipment, as well as the speed of the digester feed pumps and the flow control valves. The speed of the digester feed pumps is the primary control parameter of the THP. Increased feed rate of the digester feed pumps at the PLC will cascade to upstream components and increase the overall solids throughput of the THP. Operators will set the digester feed rate, number of reactors in service and reactor cycle time, based upon the pre-dewatered solids cake production rate and the desired feed rate to the digesters.

Operator walk-throughs are required to look and listen for problems and make occasional adjustments to the digester feed rate. Dramatic changes in digester feed rate have shown to cause an increased risk of digester upsets or rapid volume expansion events. To maintain stable digester conditions and reduce the risk of rapid volume expansion, it is recommended to limit changes to the digester federate to less than 5 percent daily. The operators' main objective is to keep the pre-dewatered cake percentage of solids consistent. To this end, the primary operation efforts are sampling and analyzing the percentage of solids being fed to the preheating/reactor feed tank and correlate that to the THP feed pump discharge pressure. The THP feed pump controls the pumping to maintain constant pressure, thereby providing a consistent feed to the THP. It is also valuable to regularly confirm the percent solids feeding to the digesters. Sampling locations will be provided at the discharge of the THP feed pumps at the discharge of the digester feed pumps to facilitate these activities. During startup and commissioning, samples of the pre-dewatered cake will be analyzed multiple times each day to develop and adjust the dilution system controls. After steady-state operation is achieved, samples are typically taken once per operations shift to confirm the functionality and accuracy of the dilutions system feeding the pre-dewatered solids to the preheating/reactor feed tank.

Regular maintenance activities will include inspecting the duty pumps on the THP equipment, including the THP feed pumps, reactor feed pumps and digester feed pumps and performing preventative and corrective maintenance as required. Additionally, the packing on the knife gate valves will need to be tightened and greased periodically.

Most of the maintenance required will be performed during the annual shutdown of each pressure vessels, at which time the tank will be cleaned, welds inspected, and the valves and instruments associated with tank will be replaced with spares so that the valves can be rebuilt and instruments calibrated. The annual shutdown will require close planning with the THP equipment manufacturer to minimize downtime of each vessel and to ensure the proper materials are ordered and on hand.

10 PROCESS STEAM SYSTEM

10.1 Background and Purpose

The THP requires steam injected into the system's reactors in a batch process to heat the incoming solids mixture before depressurization. The process steam system consists primarily of the steam boilers and the feedwater system. Multiple steam production technologies were analyzed and discussed in the *Biogas Utilization Report.* The recommendation from this report was to produce RNG on site and to provide standalone boilers for steam generation.

The selected alternative is to install two firetube-type steam boilers (one duty/one standby) with two deaerators (one duty/one standby), two feedwater pumps, water treatment, chemical feed equipment and blowdown tanks in a new boiler room located near the new THP equipment. The boilers will be equipped with dual fuel capability to fire on either municipal-supplied natural gas or cleaned biogas.

An overall schematic of the process steam system is shown on Drawing G-007 with detail provided on Drawings I-600 through I-604.

10.2 Basis of Design

The basis of design is presented below for the steam boiler and the boiler feedwater system. The steam system process flow diagram is shown on Drawing G-7. Refer to Section 9 for details regarding the THP.

10.2.1 Steam Boiler

The average steam demand required by the THP is based on an assumed steam demand of 1 ton steam per ton of dry solids. The THP solids feed design loading criteria are detailed in Section 3. According to THP equipment providers, peak demand for the process is nearly 9,000 lb/hr. Accounting for a 10% margin and other preheating needs 10,000 lb/hr will be used as the design basis for the boiler. Each fill lasts for approximately 20 minutes and is then held at the design temperature and pressure for approximately 20 minutes. An additional amount of steam may be required throughout this "hold" process to maintain temperature and pressure. The minimum steam demand from the THP may conceivably go to zero, and the design should consider the full operating range.

The steam sent to the THP reactors will be consumed in the process, however, a small amount of condensate will be filtered from the steam traps. The design should consider sending this condensate back to the deaerator tank. Table 10-1 below presents the design loads for the various solids load projections as detailed in Section 3.

Table 10-1. THP Steam Design Criteria

Design Criteria	Solids Feed to THP, DTPD	Average Steam Demand, lb/hr[a]	Peak Instantaneous Steam Demand, lb/hr
23.0 mgd			
3-day	50.9	4,244	9,000
7-day	46.3	3,855	
14-day	43.7	3,642	
30-day	40.1	3,343	
Average	30.7	2,555	
30.8 mgd			
3-day	68.2	5,683	9,000
7-day	61.9	5,162	
14-day	58.5	4,877	
30-day	53.7	4,477	
Average	41.1	3,421	
40.0 mgd			
3-day	89.0	7,381	9,000
7-day	80.6	6,704	
14-day	76.0	6,333	
30-day	69.8	5,814	
Average	53.3	4,443	

a. Average steam demand based on assumption of 1 ton of steam for every 1 dry ton of solids processed. Actual steam demands will be updated with selected THP vendor.

The THP requires steam at a pressure of 160 to 170 pounds per square inch gauge (psig) and the recommended steam boiler pressure at the main steam outlet is 175 to 185 psig to account for system pressure drop between the boiler outlet and reactor inlet. Reference Section 9 for details on THP model assumptions and explanations.

A firetube boiler was selected over a water tube boiler because of the proportionately larger water volume in the firetube type, which allows it to handle greater process flow swings. However, cold startup time is generally longer with the firetube design. As such, both boilers should include a standby heating coil to be kept warm for quick startup in the event of a trip of the operating boiler. The firetube boiler will typically come pre-packaged with the burner and controls, allowing for lower installation costs from an installation contractor. The firetube type boiler will typically have larger service clearances than a water tube type, so space considerations between boilers and within the boiler room should be considered early in the detailed design process.

10.2.2 Feedwater System

The boiler feedwater system will consist of deaerating feedwater heater(s) and two feedwater pumps with one in constant operation and the second serving as standby with each rated for a minimum of 125 percent of peak boiler feedwater flow rating for process reliability. Table 10-2 below provides approximate feedwater flow rates accounting for steam demand and a 5 percent continuous surface blowdown based on the density of water at 227°F and 200 psig for the various solids load projections.

Table 10-2. Feedwater Design Criteria

Design Criteria	Steam Demand, lb/hr	Boiler Feedwater, gpm
23.0 mgd		
3-day	4,244	9.3
7-day	3,855	8.5
14-day	3,642	8.0
30-day	3,343	7.4
Average	2,555	5.6
30.8 mgd		
3-day	5,683	12.5
7-day	5,162	11.4
14-day	4,877	10.7
30-day	4,477	9.9
Average	3,421	7.5
40.0 mgd		
3-day	7,381	16.2
7-day	6,704	14.8
14-day	6,333	13.9
30-day	5,814	12.8
Average	4,443	9.8
Peak instantaneous	10,000	22.0

COW will be used as the source of makeup water for the boilers. PEW is not recommended as a backup to COW. Rather, the COW system should be looped to increase over reliability and protection from inadvertent pipe breaks (reference Section 16 for additional information). The COW will be chemically treated before entering a deaerator, which will remove the dissolved gases. Two water softeners (duty/standby) are recommended to provide soft water if one softener is out of service. A backflow preventer will be required in the COW supply line before entering the water softeners. Additional treatment of potable water including filtration and/or chemical treatment may be required to remove impurities based on detailed evaluation of makeup water analysis to support design. Additional treatment will be handled by a chemical feed system that will inject directly into the deaerator. Sample coolers will be included in the steam header line and the feedwater line that will use County water to cool the liquid to be able to analyze the quality.

The deaerator's makeup water design condition will be based on the amount of condensate returned from the steam traps and the full consumption of instantaneous steam demand in the THP. This Plan assumes that two deaerators will be supplied (one duty/one standby); however, further analysis should be completed during detailed design on the requirements for full redundancy on the deaerator tank, as these tanks do not have any moving parts and typically require a short service outage for an annual inspection and cleaning. Deaerator and feedwater pump models from similar projects should be investigated by the delivery team to ensure a reliable system.

Table 10-3 below provides the typical design criteria and treatment methods for the boiler feedwater system. Criteria limits should be confirmed during detailed design and chemical feed and filtration design should be designed to satisfy requirements.

Table 10-3. Boiler Water Quality Design Criteria

Feedwater Criteria	Typical Limits	Treatment Method
pH	8.5–9.2	Chemical
Hardness	<0.3 ppm	Softener
Silica	Dependent on blowdown frequency	Softener/blowdown
Total copper	<0.05 ppm	Chemical
Total dissolved solids	Dependent on blowdown frequency	Softener/blowdown
Dissolved oxygen	<0.007 ppm	Deaeration and oxygen scavenger
Suspended matter	0	Blowdown
Oil and grease	0	

ppm = parts per million.

A drinking water quality report obtained from Arlington County is summarized in Table 10-4, which describes the expected quality of source water for the feedwater treatment system.

Table 10-4. Arlington County 2022 Water Report

Parameter	Unit	Value
pH	N/A	7.7
Hardness	mg/L	125
Copper	ppm	0.06
Chlorides	mg/L	30

10.3 System Location

The steam boiler, blowdown tank, and feedwater equipment will be located together in a boiler room, whose location is dependent on the site plan option chosen. The two options proposed focus on renovating the existing DWB or decommissioning the existing DWB. Design and installation challenges can occur with items such as exhaust piping, drains, electrical, equipment clearances and equipment access in the renovated DWB option and should be considered when choosing between configurations. Refer to Section 17 for additional details on the DWB options.

For Option 1 in the renovated DWB, the boiler room will be located on the second floor on the southwest corner of the existing DWB as shown on Drawing M-306. Structural analysis of the DWB has not yet been completed. An evaluation during detailed design will be completed to confirm location of the equipment.

For Option 2, with the existing DWB being decommissioned, the boiler room would be located on the second floor of the northwest corner of the new SPB as shown on Drawing M-351. Note the second floor will exit at grade to the west.

10.4 Process Steam Description and Design Criteria

This section describes the design criteria, and operations for individual equipment or packaged systems that make up the process steam system, including the steam boiler, deaerator and feedwater pumps, water softener, chemical feed system, and blowdown separator.

10.4.1 Steam Boilers

Two packaged firetube-type steam boilers will be installed with each having a nominal boiler horsepower of 300 hp capable of supplying 10,000 lb/hr of saturated steam at 175 to 185 psig. The boiler will be a three- or four-pass wet back design outfitted with a forced draft low-nitrogen oxides (NO_x) burner that is capable of meeting standard 30 parts per million by volume (ppmv) NO_x emissions at 3 percent oxygen (O_2). This NO_x level is typical for meeting air permit regulations at industrial facilities but would need to be confirmed to be capable of meeting state and local emissions requirements. The burners will have a 10:1 turndown control that will allow the boilers to maintain the quick cycling that is required for the THP batch process. The boilers will be designed to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Section I and have all safety features as outlined per NFPA 85.

Natural gas piping will be installed per NFPA 54 fuel gas code as dictated by NFPA 85 and all state and local codes. Separate fuel trains will be required for the natural gas and biogas supplies for each boiler that will feed a burner that is capable of firing both fuels. Depending on the natural gas distribution line supply pressure, a pressure regulating and metering station would be required before the boiler fuel skid designed for the natural gas flow rates and pressures of a single boiler in operation.

The boiler will connect to a steam header where steam pressure is controlled and has a takeoff for the THP and the deaerator steam supply. Table 10-5 below provides the design parameters for the steam boilers.

Table 10-5. Boiler Design Criteria

Parameter	Unit	Value
Quantity	No.	2 (1 duty/1 backup)
Type		Firetube
Steam pressure	psig	175 - 185
Steam quality description	N/A	Saturated
Peak steam output	lb/hr steam at 175 - 185 psig	10,000
Nominal capacity	BHP	300
Fuel	N/A	Natural gas/clean digester gas
Burner turndown	N/A	10:1
NO_x emissions	ppmv at 3% O_2	30

Each boiler will be equipped with a forced draft fan for its burner and the flue gas will be vented through a dedicated stack to the atmosphere.

10.4.2 Deaerator and Feedwater Pumps

The deaerators reduce oxygen in the feedwater to less than 0.007 ppm (0.005 cubic centimeters per liter [cc/L]) using a small amount of steam from either the steam header or the blowdown separator to preheat the feedwater to the boiling temperature in the pressurized tank. The deaerators will typically operate at a pressure between 5 and 15 psig.

The one deaerator in operation will be selected locally by the plant operator. The deaerators will be installed as packaged systems with the feedwater pumps and makeup water control valves. The deaerators will each be sized for a minimum of 15 minutes of storage with one steam boiler operating at the boiler design capacity of 10,000 lb/hr and up to 5 percent continuous blowdown from the boiler. A spray/tray type of deaerator is recommended to achieve more dependable elimination of oxygen. Two packaged feedwater pumps will be installed directly below each deaerator. Pumps will be of the multistage centrifugal or vertical-turbine type and will have 316 stainless-steel housings and impellers to protect against corrosion. Feedwater flow to the boiler is continuous and is controlled with a modulating valve controlled by the boiler’s control system and recirculation line back to the deaerator that protects the feedwater pumps. Feedwater pumps are typically designed for capacities higher than the peak evaporation rate of the boiler to make up the water level and are capable of supplying water to the boiler at a pressure of 3 percent higher than the boiler's pressure relief valve. Additional feedwater pump head is required to account for losses in the feedwater piping. Table 10-6 below provides the design parameters for the deaerator and feedwater system.

Table 10-6. Feedwater System Design Criteria

Parameter	Unit	Value
Deaerator tank quantity	No.	2
Type	N/A	Spray/tray
Makeup water	Percent	100
Storage, minimum	gal	425
Deaerator operating pressure	psig	5–15
Oxygen removal, maximum	ppm	0.007
Feedwater pumps per deaerator	No.	2
Feedwater pump flow, each	gpm	30

H_2O = water.

10.4.3 Water Softener

Water softening is required to control the levels of equivalent calcium carbonate ($CaCO_3$), which at levels exceeding ASME guidelines, can lead to scaling and damage to the boiler. The duty/standby water softeners will be the dual-tower regenerative type with a brine tank. Total hardness will be reduced to below 0.3 ppm $CaCO_3$. The regeneration is controlled by the softener control panel that is mounted locally to the equipment. Periodic filling of salt into the brine tank is required. Table 10-7 below provides the design parameters for the water softener system.

Table 10-7. Water Softener Design Criteria

Parameter	Unit	Value
Quantity	No.	2 (duty/standby)
Type	N/A	Alternating system

10.4.4 Chemical Feed System

A pre-packaged chemical feed system is recommended for chemical dilution and metering to the deaerator to provide extra protection against scaling and corrosion. The chemical feed system will add chemicals to the deaerator based on the feedwater flow to ensure the proper ratio of chemical addition to fresh makeup water. The packaged system will consist of a minimum of one premixed chemical tank and two chemical feed pumps per tank (one duty/one standby). The chemical feed system is designed to accommodate feeding of multiple chemicals as determined during detailed design.

Table 10-8 below provides the relevant design parameters for the chemical feed system.

Table 10-8. Chemical Feed Design Criteria

Parameter	Unit	Value
Quantity	No.	1
Type	N/A	Preassembled packaged
Chemical feed pump, number	No.	2 per tank (one duty/one standby)
Mixing type	N/A	Pre-mixed

10.4.5 Boiler Blowdown Separator

The single blowdown separator will be an ASME Code Section VIII Division 1 tank capable of safely handling the continuous surface blowdown and intermittent bottom blowdowns from both boilers. Design criteria is provided in Table 10-9. The blowdown water will be cooled below 140°F (60°C) and mixed with non-potable water prior to being conveyed to a drain using a temperature control valve. For Option 1, design would need to consider the existing drains capacity to handle the additional blowdown drainage. The steam from the depressurization process will be vented to a safe location. Considerations for steam recovery from the separator vent line for injection into the process and blowdown drainage recovery into the process should be investigated during detailed design.

Table 10-9. Blowdown Separator Design Criteria

Parameter	Unit	Value
Quantity	No.	1
Capacity	gal	518
Blowdown capacity	lb/hr	500
Blowdown tank operating pressure	psig	5

10.4.6 Process Steam Safety Features

All steam, feedwater and natural gas piping will be designed and constructed per ASME B31.1 Power Piping Code. A detailed pipe stress analysis will need to be completed in accordance with the piping code for pipe support design. The boilers and deaerator will each be equipped with pressure relief valves connected to the equipment that comply with the applicable sections in the ASME BPVC. Vent piping will not have any intervening valves between the relief valve and point of discharge and will be piped to a safe location outdoors, typically above roof level away from any platforms or areas used by personnel. The vent piping diameter will not be less than the size of the discharge of the safety relief valve and is typically larger to limit velocity and noise when release occurs. All vent piping will require drains at low points to be sent to plant drains.

Discharge piping and supports for the pressure relief valves will consider deadweight, thermal expansion, earthquake, flow induced reaction forces, and any other mechanical loads that are applied to the system. The safety relief valve discharge piping may require installation of a silencer to reduce the noise level during discharge depending on facility requirements. The additional back pressure due to a silencer will be considered during detailed design. Drainage from condensation in the discharge line will be considered and piped to plant drains or deaerator tank to be determined during detailed design.

The boiler will be equipped with additional safety controls including high and low water level cutoff and burner safeties, including loss of flame and loss of fuel flow. The deaerators will also be equipped with water level cutoff and safety relief valves.

10.5 Equipment Operations and Control

The boiler is supplied as a packaged system with the burner, pressure and level controls, and the combustion controls/flame safety system. The boilers will have local PLC-based control panels that control the burners and water level with status, alarms, and start/stop controls and can be integrated into the plant master control system. The THP packaged control system will be PLC-based and will control the amount of steam injection to the reactors by opening and closing steam valves. As the steam header pressure drops, the boiler will ramp up in load by increasing the heat input to the burner to produce more steam to maintain the steam header pressure setpoint. The THP valves will then close, and the boiler will ramp down in load during the hold cycle.

The boiler duty/standby operation will be initiated locally. Consideration should be given during detailed design for corrosion within the boiler and piping while a boiler is in standby for extended periods of time. Wet storage is recommended where the boiler is filled to the top with chemically treated water and maintained at a pressure greater than atmospheric.

The boiler level controller will modulate the feedwater control valves to allow the feedwater to flow into the boiler. Refer to Section 9 for additional details on the THP control system.

The boiler draft will be controlled by a draft damper assembly that will provide the optimal excess air for the fuel air mixture and to provide the proper draft pressure in the boiler. Because of the low turndown expected for the boiler during certain operational conditions of the THP, a feed forward control may be required to improve the system response to load fluctuations. Additional analysis should be completed during detailed design to confirm the control methodology.

The continuous blowdown rate from the boilers to the blowdown separator tank will be set by plant operators based on water chemistry in the boilers. The drain water cooling flow will either be sent to the THP steam header as heat recovery or sent to drain with an automatic temperature control valve using County water to maintain a mixed drain flow of less than 140°F.

The water softener system will have an LCP and will measure water usage and regenerate the system as soon as the calculated system capacity is depleted. A manual regeneration can also be initiated locally. The operator will monitor the salt levels in the brine tank and add salt when necessary. The chemical feed system will have an LCP and be set to automatically inject the correct amount of chemicals into the deaerator.

11 HYDROLYZED SOLIDS COOLING SYSTEM

11.1 Background and Purpose

This section provides the process description and design conditions for the hydrolyzed solids cooling system that will cool the THS from the THP system to mesophilic digestion temperatures before entering the primary and secondary digesters.

Conceptual process conditions, configurations, cooling technology sizing, and conceptual operation costs were summarized and a comparative analysis of technologies is included in TM 12: *Cooling Technologies Evaluation*. The recommendation from TM 12 was to include the once-through cooling configuration using PEW in this Plan. However, alternative configurations could be considered in the future as design progresses.

An overall schematic of the cooling system is shown on Drawing G-006 with detail provided on Drawing I-450.

11.2 Process Objectives

After the hydrolyzed solids leave the THP depressurization tank at approximately 221°F, pathogen-free dilution water is added, allowing the solids concentration to be reduced to approximately 9 percent. DS recycle is subsequently added to the stream to reduce viscosity of stream and lower the solids temperature before entering the cooling HEXs. The target digester recycle to THP solids ratio is 3.5 to 5.0 (3.5 was used for the design criteria basis). The HEXs cool the solids further to the mesophilic digestion design temperature of 98°F. There will be two primary digesters and one secondary digester that could act as a primary during maintenance. Each primary digester will have a HEX available and both HEXs will be piped to the secondary digester to provide the required redundancy when the secondary digester is acting as a primary. Space is currently allocated for a third HEX for a future primary digester.

The cooling water for the HEXs will come from the PEW where it will pass through the HEX and be sent to the GTs as elutriation or to the plant drain. The system is expected to operate on a continuous basis, 24 hours per day, 7 days per week.

The cooling system is designed with a capacity for the 30.8 mgd design average peak 3-day loading to the WPCP. The third HEX would be installed to achieve the full 40,0 mgd design capacity. Table 11-1 below summarizes important design criteria for the cooling system including hydrolyzed solids properties and the energy balance for the THS cooling.

Table 11-1. Cooling System Design Criteria at 30.8 mgd Peak 3-day

Parameter	Unit	Value
Diluted THP output	gpm	126
Digester recycle (3.5 recycle ratio)	gpm	442
Total mixed solids flow to digesters	gpm	568
Mixed solids flow per digester	gpm	284
Mixed solids temperature post-dilution/recycle, maximum	°F	114
Mixed solids viscosity	cP	25.0
Mixed solids density	lbm/ft^3	61.3
Target digester feed temperature	°F	98.0
Total cooling demand	MMBtu/hr	4.43
Cooling demand per digester	MMBtu/hr	2.22

cP = centipoise; lbm = pound(s) mass.

11.3 Cooling System Description and Design Criteria

This section describes the design criteria and operations for the cooling system including the HEXs, cooling water supply, and control valves for temperature and flow.

11.3.1 Cooling System Configuration

The pre-digester cooling HEXs will be located downstream of the THP system before the primary and secondary digesters. The THS feed will be mixed with the digester recirculation solids before entering the HEX. For each of the two primary digesters, there will be one dedicated HEX with two stages, each of which can be isolated and bypassed. Each HEX will also be able to feed the secondary digester as a backup to the primary digesters. If a HEX is taken out of service, both the solids and water side of the HEX should be flushed and drained.

PEW taken from the existing distribution header will be used as the heat transfer fluid for the HEX where it will extract heat from the THS feed and digester recirculation mixture and subsequently be sent to the GTs as elutriation or to the plant drain. Refer to Section 4 for additional details on the design criteria of the GTs and elutriation water. Refer to Section 16 for details on the PEW system design. A new tie-in point to an existing underground PEW distribution header would be required for sending the PEW to the new HEXs.

Temperature control for the HEXs will be achieved with a motorized control valve that will control the flow of PEW to the inlet of the HEX to bring the solids temperature to the mesophilic digestion design temperature of 98°F. The cooling water recirculation line from the HEX will have a variable-speed centrifugal pump that will boost the cooling water return flow to cooling water supply pressure.

The cooling system is summarized in Figure 11-1 and additional detail can be found in Drawing I-450.

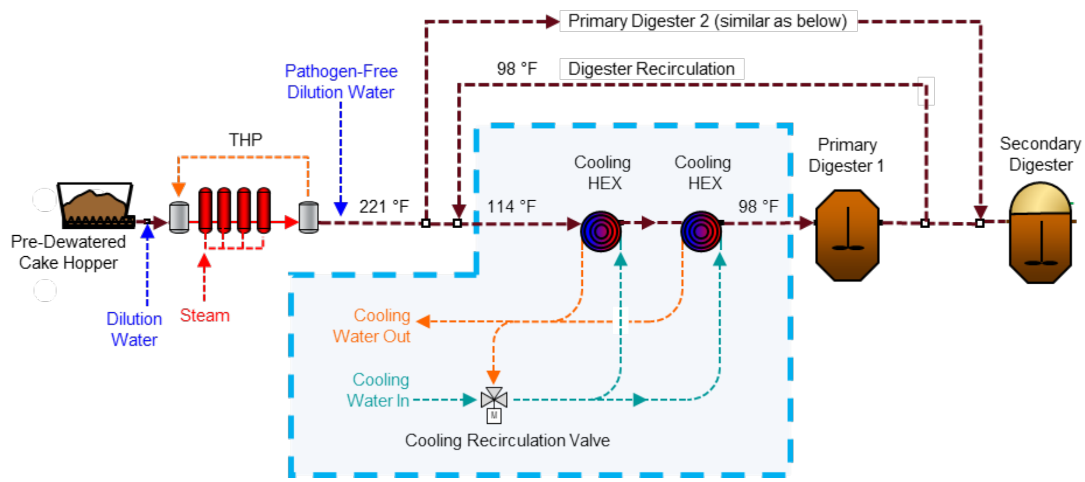

Figure 11-1. Hydrolyzed Solids Cooling System Configuration

11.3.2 Cooling Water Supply

For the once-through cooling method, PEW would provide the required cooling through the concentric-tube HEX and then be sent to the GTs to provide elutriation water with the option to send the water to the plant drain. Refer to Section 4 for more details on the usage of the PEW as elutriation for the GTs.

The PEW temperature varies throughout the year depending on outdoor ambient temperature conditions. Three years of temperature data were given and the monthly average, maximum, and minimum temperatures were extracted and are presented in Figure 11-2 and Table 11-2 below. The highest effluent temperature recorded (84°F) should be used as the design condition for sizing the HEX.

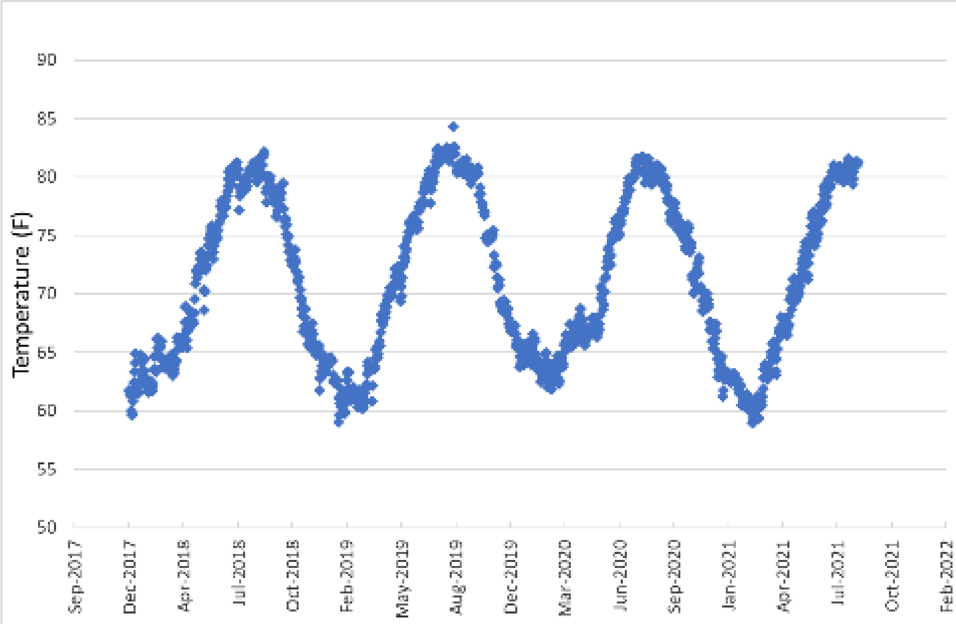

Figure 11-2. Plant Effluent Water Historical Temperatures, 2018–2021

Table 11-2. Plant Effluent Water Monthly Temperature Data, 2018–2021

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effluent average (°F)	62.9	62.1	63.8	67.2	71.4	76.3	80.2	80.8	79.4	75.8	69.7	65.0
Effluent maximum (°F)	66.6	66.2	67.4	70.6	76.2	79.5	82.5	84.3	82.2	80.8	73.8	67.6
Effluent minimum (°F)	59.1	58.9	59.4	63.1	66.3	73.4	77.2	78.9	76.1	71.2	65.4	61.2

The lower effluent temperatures in the winter reduce the required flow through the HEXs, allowing one pass of the HEX to be taken offline for maintenance. The average effluent winter temperature of 64°F should be used as a design case where the winter temperature effluent could handle the entire cooling duty with one pass. This eliminates the need to provide a redundant third HEX that would serve both primary digesters. Refer to Section 16.2 for additional system characteristics of the PEW.

11.3.2.1 Sodium Hypochlorite Dosing

Sodium hypochlorite dosing will be used in the PEW line to minimize bio-fouling of the HEXs to ensure that optimal heat transfer is maintained between cleaning operations. If optimal residual chlorine concentrations are maintained, hypochlorite dosing will be effective in reducing the frequency of invasive mechanical cleaning. The hypochlorite dosing system will ensure that a residual chlorine concentration between 1 and 2 mg/L is maintained and will be capable of momentarily shock-dosing the cooling water at a rate of up to 15 mg/L. Residual chlorine concentration will be measured upstream of the cooling HEXs inlet. For additional information on the sodium hypochlorite plant system, refer to Section 16, WPCP Support Systems.

11.3.3 Digester Cooling Solids Recirculation Pumps

DS from the two primary digesters will be recirculated and mixed with the THS upstream of the two new cooling HEX inlets. DS are recycled and blended with THS to reduce the acidity and viscosity of THS and improve the overall operation of the digester. The expected digester recycle flow ranges from 140 gpm per digester at 23 mgd average conditions to 220 gpm per digester at 30.8 mgd (2 digesters) gpm at 40 mgd peak 3-day loading conditions.

DS will be recycled with variable-speed, screw-centrifugal pumps to maintain a target recycle to feed ratio from 3.5 to 5.0 for every unit of THP solids.

Table 11-3 provides the digester recycle pump design criteria.

Table 11-3. Digester Recycle Pump Design Criteria

Parameter	Unit	Value
Quantity	No.	2 per digester (1 duty/1 standby)
Type		Screw-centrifugal, variable speed
Target recycle to feed ratio		3.5:1 to 5:1
Capacity, each	gpm	140-220

11.3.4 Cooling Heat Exchanger

One HEX will be required for each primary digester and will be a concentric steel tube-in-tube, counterflow design with two stages in series. The two-stage design allows flow to bypass one or both sections, allowing each stage to operate independently of the other during low-flow operating conditions or during maintenance operations. The HEX design will include the condition of one stage taken offline and the other stage able to handle the entire cooling duty (typically during winter months when the HEX cooling load can be met with less HEX area). The two-stage design will also allow a lower pressure drop for the solids and water sides, lowering pumping costs.

The HEXs will be designed for a flow rate that produces a minimum velocity of the solids at 6.5 feet per second (ft/s) to maintain turbulent flow, optimal temperature for microbe health, acidity for materials compatibility, and a favorable solids rheology for heat transfer and minimum long-term maintenance.

Elevated PEW temperatures have a potential risk of higher corrosion in piping due to microbial-induced corrosion (MIC) from manganese-consuming bacteria among other factors. Based on previous experience, and the uncertainty associated with long-term corrosion resistance of Type 316 stainless steel with solids cooling operations using PEW as the cooling liquid, Super Duplex 2507 alloy is recommended for the HEX tubes. This higher alloy material provides exceptional resistance to MIC.

Table 11-4 provides the 30.8 mgd design average, peak 3-day design criteria for the cooling HEXs.

Table 11-4. Cooling HEX Design Criteria

Parameter	Unit	Value
Type		Concentric tube counterflow
Quantity	No.	2 × 2 stage
Tube material		Seamless Super Duplex 2507
Solids flow per HEX	gpm	283
THS	gpm	63
Digested solids (3.5 recycle ratio)	gpm	220
Mixed solids density	lbm/ft^3	61.3
Solids temperature, in	°F	114
Solids temperature, out	°F	98
PEW maximum inlet temperature	°F	84
PEW maximum outlet temperature	°F	103
PEW winter average inlet temperature	°F	64
PEW winter average outlet temperature	°F	98
Total cooling demand	MMBtu/hr	4.4
Cooling demand per digester	MMBtu/hr	2.2
Maximum PEW demand per HEX	gpm	250

Table 11-5. Cooling HEX Startup and Future Buildout Conditions

Parameter	Unit	20.8 mgd – Average (startup conditions)	40.0 mgd – 3 day (future buildout conditions)
Solids flow	gpm	308	737
THS	gpm	51	164
Digested solids	gpm	257	574
Solids temperature, in	°F	110	114
Solids temperature, out	°F	98	98
Total cooling demand	MMBtu/hr	2.0	5.8
Number of primary digesters	No.	2	3
Cooling demand per digester	MMBtu/hr	1.0	1.9

11.3.5 Cooling Heat Exchanger Recirculation Booster Pump

A new pump will be required for each PEW recirculation line at the HEX inlet for additional temperature control. During the winter months when the PEW temperature is colder, there is a risk of FOG buildup in the solids tubes due to the colder PEW contacting the solids tubes. To mitigate this risk, recirculation of the warm PEW from the outlet of the HEX inlet is required to raise the temperature of the PEW entering the HEX. The PEW temperature downstream of the HEXs will be used to control the speed of the recirculation booster pump, which will be equipped with a VFD.

The booster pump will provide the additional pressure head to mix with the incoming PEW flow. Further analysis of the minimum PEW temperature to prevent FOG buildup will need to be included in detailed design to determine the amount of PEW recirculation required and the pump sizing.

Table 11-6. Cooling Water Recirculation Pump Design Criteria

Parameter	Unit	Value
Quantity	No.	2
Type		Centrifugal, variable speed

11.4 Equipment Operations and Control

The solids flow through the HEXs will be controlled by the plant PCS. The THS flow control valves based on the THP demand and the variable-speed digester recirculation pumps using the target digester to feed recycle ratio. The PEW cooling flow will be modulated using the flow control valve to maintain a solids temperature set point downstream of the HEX before entering the digester. The PEW flow control should be programmed to use the flows and inlet and outlet temperatures to calculate heat exchange rate and efficiency and warn of fouling. Additionally, inlet and outlet pressures can be compared against expected head loss to warn of potential clogging in the HEX.

Periodic cleaning of the HEX tubes will be required to maintain the necessary HEX efficiency. Space should be allocated to provide the necessary clearance to pull the HEX tubes.

12 ANAEROBIC DIGESTION

12.1 Background and Purpose

The purpose of this section is to present the selected digester configuration. The results of the evaluation detailed in TM No. 11: *Digestion Facilities Evaluation* informed the recommendations given in this Plan.

An overall schematic of the digestion process is shown on Drawing G-006 with detail provided on Drawings I-500 through I-503.

12.2 Process Objectives

This following process objectives for the digesters at the WPCP have been established through collaborative workshops:

- **Stabilize solids:** Achieve 60 percent VSr in the digesters. The primary process controls that control the VSr are solids retention time (SRT) and digester temperature. The SRT basis of design is discussed in this section. Mesophilic digester temperatures typically range between 95°F and 100°F. Control of digester temperature is discussed in depth in Section 11.
- **Digester redundancy:** Maintain target SRT in primary digesters with one digester out of service at peak 14-day loading.
- **Solids storage:** Minimum 4 days of DS at peak 14-day loading.
- **Biogas storage:** Provide storage to minimize the potential for flaring during interruption of RNG operations.
- **Safety:** Meet or exceed the current standard of practice for digester safety on both the biogas and solids sides of the process. Potential safety concerns and mitigation measures are discussed in Section 12.4.7.
- **Operations and maintenance considerations:** Mitigate foreseeable O&M issues. The foreseeable issues and mitigation measures are expounded upon in the following sections but generally cover topics such as access, resilience, contingent/alternate operation, process monitoring, and ability to mitigate potential process upsets.

12.3 Basis of Design

The following three design loading conditions were considered for digester equipment evaluation:

- **23.0 mgd)—current conditions:** annual average loading was considered for “minimum” operating conditions and as a baseline for annual O&M costs

- **30.8 mgd—2052 projected conditions:** used as the basis for equipment sizing and number of units required for this Plan
- **40.0 mgd—buildout conditions:** used to establish total footprint requirements and facility sizing, with space reserved for future digester tanks and equipment

The proposed process consists of MAD in a primary/secondary configuration. THS from the THP will be fed to primary digesters (in parallel), and the DS from the primary digesters will be fed to the secondary digester. The system will be designed to provide a minimum SRT in the primary digesters; the volume of the secondary digester is not included in the SRT calculations.

Typically, anaerobic digesters are sized for 15-day SRT to meet EPA requirements for Class B pathogen reduction. However, because THP meets the requirements for Class A pathogen reduction, the proposed digesters for this project can be sized for a lower SRT. THP pilot testing recently performed by Virginia Tech using solids generated at Arlington WPCP evaluated digester performance at 10.0-, 12.5-, and 15.0-day SRTs; digester performance was determined to be acceptable at the lower SRTs. A 12-day SRT target at peak 14-day loading will be used to size the primary digesters. The possibility of operating the digesters at a 10-day SRT can be evaluated in the future, but the project team selected 12 days as a more conservative basis of design. In addition, all configurations were checked to make sure peak VS loading rates were lower than 0.4 lb-VS/ft^3-d and that predicted ammonia concentrations in the digesters were below 3,000 mg/L. These parameters are important to maintain digester health.

The project team selected a minimum 4 days of storage downstream of the primary digesters. This value was based on the County’s preference to avoid operating the dewatering system during a 3-day weekend, plus 1 additional day for operational reliability. The DS storage can also help mitigate disruptions that prevent biosolids from being hauled from the WPCP, such as inclement weather or scheduling issues with the biosolids hauling contractor.

The option to provide digested solids storage tanks (DSSTs) was considered and eliminated in preliminary evaluations. Instead, the project team opted for a secondary digester downstream of the primary digesters, as the volume, equipment, and energy requirements were similar to DSSTs. In addition to providing DS storage, a secondary digester provides operational flexibility of being able to function as a primary if one of the other digesters is out of service. Furthermore, using a similar shape and dimensions for the secondary digester as the other digester tanks is anticipated to reduce the complexity and cost of construction.

12.4 Anaerobic Digester Description and Design Criteria

This section presents a description and design criteria for the anaerobic digesters.

12.4.1 Digester System Configuration

Given the preference to reduce construction costs and minimize impacts to the viewshed, a conventional cylindrical digester configuration with a 1:1 height-to-diameter ratio was selected. This ratio balances footprint and height and aligns with the recommendations of one THP supplier, based on multiple installations. To reduce the cost and complexity of construction, a gradual floor slope of 1:6 (2 inches per foot) was selected.

In the digester evaluation four configurations were considered each with a different number of digester tanks and tank volume. The recommended configuration is presented in Table 12-1.

Table 12-1. Digester Configuration

Feature Evaluated	Value
Number of digesters (primary + secondary)	2 + 1 with space for 1 future
Compatible with site plan options? Renovate DWB Decommission DWB	 ✓ ✓
Able to meet target SRT at peak 14-day flows and loads at 30.8 mgd condition?	✓
Excess digester volume to avoid 24/7 dewatering when one digester offline 30.8 mgd condition?	No
Total (primary + secondary) volume provided ÷ primary volume required for 30.8 mgd condition, MG	2.81 ÷ 1.87 150%
Sufficient capacity to accept FOG? Start-up (24.2 mgd) peak loads Average loading at 30.8 mgd condition Peak 14-day load at 30.8 mgd condition	 ✓ ✓ No
Storage provided in secondary digester at 14-day peak load loads at 30.8 mgd, days (percentage of target 4 days)	5.4 (134%)
Secondary digester membrane volume, ft^3	46,000
Hours of biogas storage at current average loading, assuming 10,000 gpd of FOG at 40 mgd condition	2.0
Mitigation options to accommodate rapid volume expansion, between now and design year of 2052	Use the 12% excess freeboard then use excess secondary digester volume or divert overflow to external containment
Able to meet target SRT at 40 mgd?	Only for average loads, a third primary digester is required for 14-day peak loads

12.4.2 Digester System Design Criteria

Digester sizing is determined by the design SRT and maximum allowable organic loading rate. Selected values for this project are presented in Table 12-2.

Table 12-2. Digester Sizing Design Criteria

Process Metric	Unit	Basis of Design at 14-day Peak Loads
Maximum organic loading rate	lb-VS/ft^3-digester-day	0.4
Minimum solids residence time (days)	Days	12
Maximum total ammonia-N concentration	mg-N/L	3,000

lb-VS/ft^3 = pounds volatile solids per cubic foot; mg-N/L = milligrams nitrogen per liter.

To provide redundancy and comply with Virginia Sewage Collection and Treatment (SCAT) regulations, the digesters will be sized for a target SRT of 12 days at peak 14-day flows and loads with one digester out of service. As noted in Section 12.3, one of these digesters will be a secondary digester that can provide solids storage or serve as a primary digester if another digester is out of service. Therefore, the dimensions are based on achieving a 12-day SRT with all primary digesters in service.

The metrics for the preferred configuration are listed in Table 12-3 below:

As noted previously, a 1:1 height-to-diameter ratio was selected. The normal liquid operating level, also referred to as the side water depth (SWD), is assumed to be 88 percent of the digester tank height, to provide 12 percent freeboard to accommodate fluctuations in liquid level.

Table 12-3. Digester Configuration: Sizing Metrics

Process Metric		Value
1.	Basis of design	30.8 mgd: 2052 projected conditions
2.	Number of primary digesters	2
3.	Number of secondary digesters	1
4.	Diameter and height, ft	56
5.	Side wall depth, ft	50
6.	Volume including freeboard, MG	1.05
7.	Liquid volume per digester, MG	0.94
8.	SRT provided by one tank at peak 14-day loading, days [a] 30.8 mgd condition 40.0 mgd condition	 6.0 4.6
9.	Storage provided by one tank at peak 14-day loading, days [b] 30.8 mgd condition 40.0 mgd condition	 5.4 4.1
10.	Total primary digester volume, MG	1.87
11.	SRT, all primary digesters, days Average loading at 30.8 mgd condition Peak 14-day load at 30.8 mgd condition	 17.1 (exceeds target) 12.0 (meets target)
12.	SRT, all primary digesters, days Average loading at 40.0 mgd condition Peak 14-day load at 40.0 mgd condition	 13.2 (exceeds target) 9.2 (below target)
13.	Total primary + secondary volume, MG	2.81
14.	SRT, primary + secondary, days Peak 14-day load at 30.8 mgd condition Peak 14-day load at 40.0 mgd condition	 18 14
15.	SWD in primary digesters for 12-day SRT at peak 14-day 30.8 mgd condition, ft (percentage of tank height)	50 (90%)
16.	Freeboard available when operating at SWD required for peak 14-day loads at 30.8 mgd, ft (percentage of tank height) MG of freeboard Volume expansion (ft freeboard ÷ SWD) Equiv. days of storage at 14-day peak	6 ft (10%) 0.22 12% 1.4
17.	SWD required to provide 4-day storage in one tank, ft (percentage of tank height) [b] Peak 14-day load at 30.8 mgd condition Peak 14-day load at 40.0 mgd condition	 34 (60%) 44 (80%)

a. The SRTs shown in row 8 were calculated based on the liquid volume per digester, which is 88% of the total tank volume, to account for 12% freeboard. Flow is peak 14-day flow.

b. The days of storage shown in row 9 were calculated based on 80% of the total digester tank volume because approximately 20% of the digester tank height must always remain full to ensure proper mixing. For this reason, the SWD shown in row 17 must be no more than 80% of the digester tank height to ensure that 4 days' worth of storage volume is available above the minimum operating level.

If one of the digesters is out of service, then the remaining digesters must operate as primary digesters at 88 percent of digester tank height to meet the 12-day SRT target at 14-day peak flows and loads (row 15). The remaining space available to accommodate volume expansion or solids storage would be the 12 percent freeboard. Therefore, if a digester outage occurred with the selected digester configuration, either the DS would be dewatered continuously (7 days per week) to reduce the risk of over-filling the digesters or the digesters would operate at a reduced level and use the freeboard for solids storage.

The selected configuration does not provide adequate primary digester volume to meet the 12-day SRT target at peak 14-day loads for the 40 mgd buildout conditions (row 12); however, there is adequate volume for the average loads at buildout (row 14). If operating at a lower SRT during peak loading is considered acceptable (as demonstrated in pilot testing), addition of the future digester could be deferred.

The County would like to consider accepting FOG in the future. The selected configuration does not provide adequate primary digester volume to accept FOG at peak 14-day loads at 30.8 mgd conditions, but it is able to accept FOG at current peak conditions and future average conditions. Refer to Section 23 for additional discussion of potential future FOG facilities, including sizing approaches.

A minimum 4 days of DS storage in the secondary digester is recommended for operational reliability, to accommodate the preferred dewatering schedule. The volume of each digester tank is able to provide approximately 6 days of storage at the 30.8 mgd condition. The liquid level required to provide 4 days of storage (row 17 of Table 12-3) must be no more than 80 percent of the digester tank height to ensure that 4 days' worth of storage volume is available above the minimum operating level to ensure mixing: approximately 20 percent of the digester tank height.

In addition to the 4 days of storage, additional volume is desired to accommodate a potential rapid volume expansion in the primary digesters caused by a process upset.

The layout and location of the digesters depends on the selected option for the existing DWB. Two options are under consideration for the DWB: Option 1—renovate existing DWB and Option 2—decommission existing DWB. Refer to Section 17 for additional discussion of the options. Refer to Drawings C-004 and C-007 for the site layouts of the different options.

12.4.3 Digester Tanks and Covers

As mentioned previously, the digester tanks for both primary and secondary digesters will have a conventional cylindrical configuration with a 1:1 height-to-diameter ratio. Cylindrical digesters can be constructed of concrete or steel. Concrete was chosen for its low maintenance requirements compared to steel. In addition to cast-in-place, the following two methods of American Water Works Association (AWWA) D110 concrete construction are considered:

- **Type III** tanks use precast concrete walls with an embedded steel diaphragm. The tank wall is placed in permanent compression with horizontal prestressing.
- **Type I** tanks use a cast-in-place concrete wall, horizontal strand prestressing, and vertical post-tensioning. The tank wall is placed in permanent compression with horizontal prestressing, like the Type III tanks.

No recommendation is being made at this time for the construction method. If an AWWA D110 construction method is selected there is value in an early pre-selection because of the need to keep manufacturers closely involved in the design process. The type of construction can be further evaluated by the delivery team.

Provisions for tank access for cleaning will be evaluated by the delivery team and will take into account factors such as top versus side access, vertical distance from access point to tank floor, cover type, ventilation provisions, and site location restrictions on access options. It is preferred that tank access for cleaning be located as low in the digester as possible.

12.4.3.1 Primary Digester Covers

Fixed concrete covers are recommended for the primary digesters, as they provide more advantages over all other options, except for the ability to store biogas.

Fixed covers are the most common type of covers used in THP applications. They are typically constructed of steel, but concrete fixed covers have become more common in the past few years and require less maintenance. Fixed covers (versus submerged or floating non-gasholder) provide a large headspace, large surface area for biogas release, the possibility of top-mounted mixers, and the ability to withdraw solids from the liquid surface. However, the underside is exposed to the corrosive atmosphere in the digester. Steel fixed covers are easier and less costly to install, but they require a side skirt and biogas seal, which can be exposed to the corrosive digester tank atmosphere if the digester is operated at a low liquid level. Steel fixed covers require repainting approximately every 10 years. Concrete fixed covers are sealed regardless of liquid level and do not require periodic painting, but they are more costly and difficult to install.

12.4.3.2 Secondary Digester

A dual membrane gas holder cover is recommended for the secondary digester to provide biogas storage. The headspace of all digesters would be connected to allow biogas to flow from the primary digesters to the biogas storage.

Membrane covers are inflatable hemispherical domes made of polyvinyl chloride (PVC)-impregnated fabric with the ability to store biogas. They typically consist of two membranes: the inner membrane contains the biogas headspace, and the outer membrane holds air kept at a constant pressure. The air pressure provides structural support for the cover and is designed to resist wind and snow loads. Air is introduced or vented between the two membranes to regulate biogas pressure. When more biogas is being consumed than generated, the chamber is filled with air and the inner membrane “deflates.” When more biogas is being generated than consumed, the chamber is vented and the inner membrane “inflates.”

The main benefit of membrane covers is the variable headspace volume, which provides flexibility for biogas management and utilization. The most common mixing systems used with membrane covers are pumping or outboard draft tube systems. Membrane covers typically cannot be used with most types of roof-mounted mixers, although some inboard mounted draft tube options are available. Membrane covers typically have a life span of 10 to 20 years.

12.4.4 Digested Solids Transfer and Withdrawal

Digester transfer pumps will be provided and are sized based on final dewatering centrifuge feed requirements. Those sizing criteria are summarized in Section 13.3 of this Plan. The digester transfer pumps are multi-purpose; they can feed the centrifuges, transfer solids from one digester to another, and be automated to convey settled solids in the primary digesters to the secondary digester. The automation of these pumps is discussed in section 12.5.4. Pump layouts and process flow diagrams are shown in Volume 2 of the Plan.

Digester recirculation pumps provide DS to dilute and cool solids leaving THP prior to the cooling heat exchangers. Sizing for these pumps is summarized in Section 11 of this Plan. Automation of these pumps is described in Section 12.5.3. Pump layouts and process flow diagrams are shown in Volume 2 of the Plan.

12.4.4.1 Digested Solids Pump Types

Building layouts currently assume that DS are pumped using progressive-cavity pumps. Progressive-cavity pumps have the largest footprint of the various typical solids pumping options so other suitable pumps are compatible with the current layouts (Figure 12-1). Typically, positive-displacement pumps are used for solids conveyance that involves high pressure, intermittent flow, or varying head loss across the pump. DS recycle back to THP does not typically meet that criterion and centrifugal or screw-centrifugal pumps (Figure 12-2) can be used for their higher efficiency.

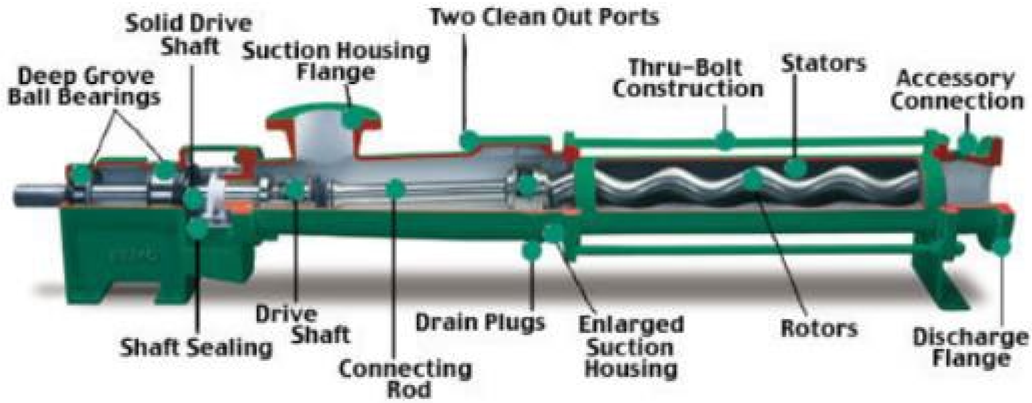

Figure 12-1. Cutaway of a Typical Progressive-cavity Pump

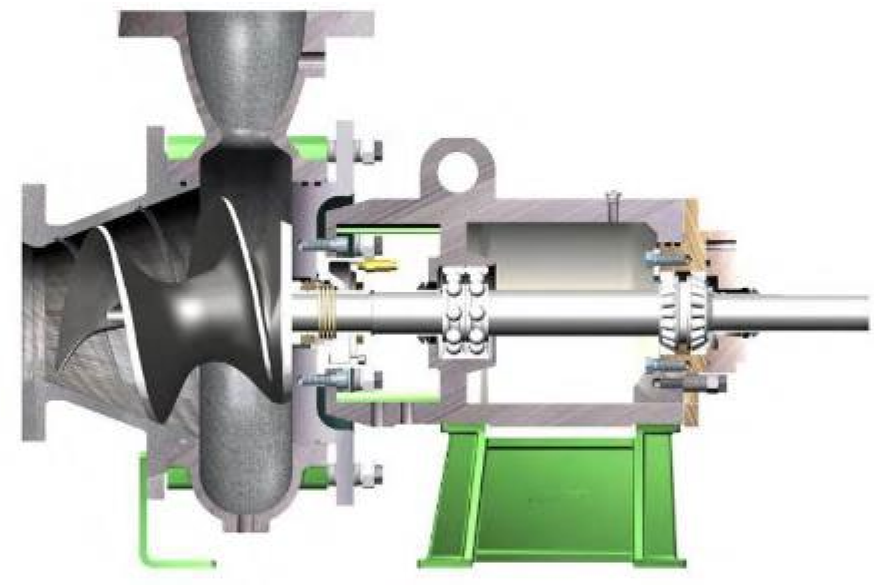

Figure 12-2. Cutaway of Typical Screw Pump

12.4.5 Digester Mixing System

Digester mixing is intended to homogenize the contents of the digester, prevent settling of solids, prevent stratification, reduce short circuiting, promote biogas release, and prevent foaming. Mixing should minimize dead volume and distribute feed throughout the digester tank. Inadequate mixing can negatively impact digester performance (reduced VSr and biogas production), increase the risk of rapid volume expansions, and increase the frequency of digester tank cleaning. The shortlisted alternatives are pump mixing and mechanical draft tube mixing.

12.4.5.1 Pump Mixing

Pump mixing systems withdraw solids from the digester and discharge the solids through nozzles located throughout the digester tank at a high velocity to maintain circulation and mixing in each digester. An example of a typical mixing pump and mixing nozzles is pictured in Figure 12-3.

Mixing pump

Mixing nozzle

Figure 12-3. Typical Pump Mixing System

The main advantages of pump mixing systems are that there is no mechanical equipment within the digesters, it is compatible with all types of digester tank covers, and it does not require a minimum liquid level to operate. Redundancy can be provided by installing spare mixing pumps. Multiple manufacturers exist, so the system can be competitively bid to vendors.

The main disadvantage of pump mixing systems is the higher energy requirements compared to other options because of the head loss associated with pumping solids through the mixing nozzles at high velocity. Additionally, biogas entrainment or plugging of the pumps, nozzles, and piping can reduce system efficiency, further raising energy requirements to ensure adequate mixing. Because the pump suction and the majority of the discharge nozzles are located in the lower portion of the digester tank, pump mixing has limited ability to fight stratification.

12.4.5.2 Draft Tube Mixing

Mechanical draft tube mixers continuously transfer high volumes of solids from the upper layer of the digester to the bottom using a propeller pump.

The main advantages of draft tube mixing systems are the lower energy requirements and better mixing performance compared to pump mixing. The propeller rotation can be reversed to change the direction of mixing. Redundancy can be provided by installing additional draft tubes.

Draft tube mixers can be located either inside or outside the digester (Figure 12-4, top). External draft tube mixers are easier to maintain but typically cost 10 percent more than internal draft tube mixers because of the additional piping and maintenance platform. The motor for internal draft tube mixers can be mounted directly on a fixed digester cover. For digesters with membrane covers, the motor can be mounted on a platform on the inside edge of the digester tank; in this application, the sides of the mixer platform can be provided with walls that follow the slope of the membrane cover (Figure 12-5).

Internal roof-mounted draft tube External draft tube

Figure 12-4. Typical Draft Tube Mixers

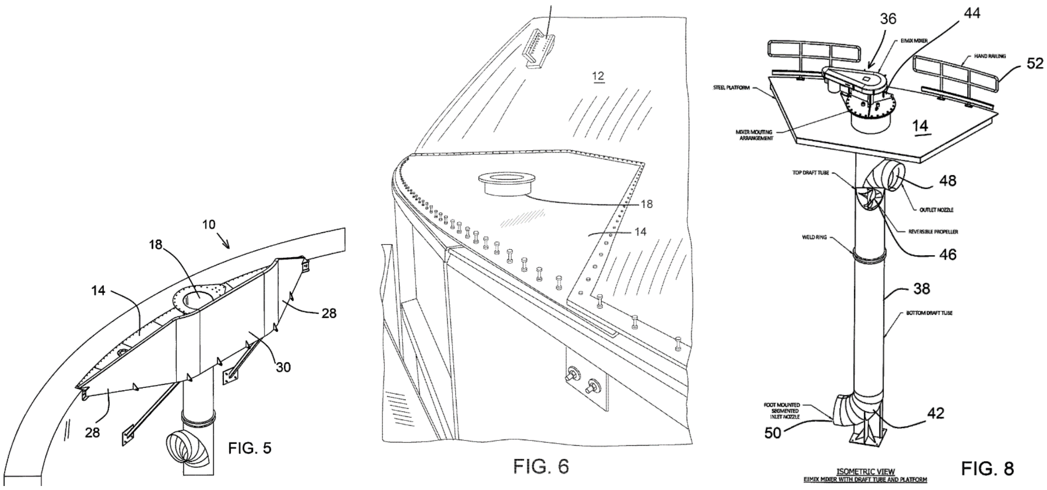

Figure 12-5. Draft Tube Mixer Design for Digesters with Membrane Covers

Draft tube mixing systems typically require a crane for removal and maintenance of the mixing propeller; however, maintenance of other components, such as the motor and gearbox, can generally be performed without a crane. Unlike pump mixing systems, draft tubes are sensitive to the liquid level and require a minimum level to operate effectively. Internal draft tubes are typically recommended for digester tanks with varying liquid levels.

Table 12-4 provides a side-by-side comparison of the relative advantages and disadvantages of pump versus draft tube mixing.

Table 12-4. Comparison of Digester Mixing Technologies

Evaluation Consideration	Pump Mixing	Draft Tube
Mechanical equipment located outside liquid	✓	No
Low energy requirements	No	✓
Ability to prevent stratification	Limited	✓
Can be designed for redundancy	✓	✓
Implemented with THP	✓	✓
Compatible with membrane covers	✓	✓
Applicable for tanks with varying liquid levels	✓	Medium
Common O&M challenges and other considerations	Air entrainment Nozzle plugging	Requires crane for mixer replacement

The energy requirements for pump mixing and draft tube mixing are compared for the recommended digester configuration in Table 12-5. Annual costs assume an electricity cost of $0.06 per kilowatt-hour (kWh).

Table 12-5. Yearly Mixing Costs

Mixing Option	Digester Configuration: 2+1 56 ft digesters	
	Total hp	Annual Electricity Cost
Pump mixing	283	$111,000
Draft tube mixing	77	$30,000

Pump mixing systems are generally easier to operate and maintain than draft tube mixing, especially for digester tanks with varying liquid levels, but they are not as effective at preventing stratification and require nearly four times as much energy as draft tube mixing systems. The decision between draft tube and pump mixing systems will be further evaluated by the delivery team.

12.4.6 Digester Emergency Overflow and Volume Expansion

The primary digesters will have overflows that normally convey DS to the secondary digester by gravity. A larger backup gravity overflow from the primary digesters to the secondary digester will be sized to convey a rapid volume expansion event. The backup overflow inlets will be higher than the regular overflows. The regular and backup digester overflows will have valves to allow isolating the digester tanks from one another. Digesters will have emergency overflows sized to convey a rapid volume expansion event to a designated area that can be drained or pumped back into the process. The emergency overflows will have liquid-filled pea traps to ensure that they cannot be shut yet maintain a barrier between the biogas and the outside atmosphere.

12.4.7 Biogas Management and Safety Systems

This section presents a description and design criteria for biogas management and safety systems, including flame arresters, pressure relief valves, and biogas storage.

12.4.7.1 Flame Arresters

Flame arresters (see Figure 12-6) will be placed in locations where there is the potential for biogas to come in contact with oxygen such as pressure relief valves, dual-membrane cover air supply, flares, and boiler fuel trains. Often on smaller biogas lines such as sensing lines for pressure regulators, flame checks are used in place of larger flame arresters. A flame arrester prevents flame propagation into the biogas piping by cooling a flame front temperature to below the ignition temperature. A flame check protects biogas piping by closing when an element inside the valve melts from flame temperature.

Figure 12-6. Flame Arrester

12.4.7.2 Pressure Relief Valves

Each digester will have two combination pressure and vacuum relief valves (PVRVs) to structurally protect the digester from high pressure or vacuum condition (see Figure 12-7). Each of these PVRVs will be mounted on a flame arrester and both assemblies will be mounted on a “safety selector valve” that ensures that one of the two pressure protection devices is always online. In addition to the PVRVs each digester will be equipped with at least one 48-inch-diameter pressure relief manhole cover. The pressure relief manhole cover is the last structural line of defense if a rapid volume expansion event exceeds the digester tank freeboard volume and the flow capacity of the overflows.

Figure 12-7. PVRVs and Pressure Relief Manhole Cover

12.4.7.3 Biogas Storage

The outer membrane of the dual-membrane biogas holder cover will be monitored for combustible gas to detect any inner membrane leaks. Any detected leak will both trigger an alarm and increase ventilation between the two membranes to keep the leak diluted to below the lower explosive limit (LEL).

12.5 Equipment Operations and Control

This section describes AD equipment operations and control.

12.5.1 Digester Feed

The digesters will be continuously fed by pumps located at the TH system. These pumps will be provided by and controlled by the THP PLC. Refer to Section 9.6.5.

12.5.2 Digester Mixing

Digester mixers will be controlled with VFDs through the PCS. The speed can either be set manually or it can be controlled automatically based on digester level. It is recommended that the percentage speed setting corresponds to the percentage of mixer full load amp (FLA) rating versus revolutions per minute (rpm) rating so that the mixing energy per unit volume remains constant regardless of solids density. This will help prevent rapid volume expansion, which is a lowering of solids density because of entrained biogas in the solids. Mixing is the primary tool to fight this biogas holdup, but if the solids density decreases, the mixing energy per unit volume decreases, which further compounds the issue. Controlling the pump speed to maintain a percentage of FLA will actively increase pump speed to prevent the holdup of biogas.

12.5.3 Digester Recirculation

Digester recirculation pump speed will be controlled by the PCS to maintain an operator-entered recirculation rate that is based on a percentage of solids forward flow.

12.5.4 Digester Transfer Pumps

The digester transfer pumps will each be able to act as either centrifuge feed pumps or transfer pumps that can transfer from one digester to another. The pumps that are valved to serve the acting secondary digester will serve as centrifuge feed pumps and their speed will be controlled from the centrifuge control system. The pumps not acting as centrifuge feed pumps are available to transfer solids from one digester to another. Normal configuration for pumps serving the active primary digesters will have them valved to send solids from their respective primary to the secondary digester and a timer control will occasionally have them pump solids to the secondary digester to remove grit accumulation. This timer will be operator configurable and is intended to convey settled solids to the secondary digester.

12.5.5 Dual-Membrane Gas Holder Cover

The dual-membrane gas holder covers will be controlled by a vendor-supplied PLC that will report status to the PCS. The biogas storage level will be used to inform biogas utilization decisions; low level would trigger a decision to decrease biogas utilization and high level would trigger a decision to increase biogas utilization. During final design options to automate these decisions will be considered. Alarms will alert operators when the inner membrane is near full or empty.

12.5.6 Biogas Pressure and Safety

Digester level will be monitored with both pressure and radar level instruments. A difference in level reading between these two instruments will trigger an alarm indicating a change in digester density. The digester pressure level indication will automatically subtract out biogas pressure. There will be different tiers of high- and low-level alarms each corresponding to the level approaching different danger such as level diverging from the level set point, dropping low enough to break a liquid biogas seal, high enough to emergency overflow, approaching top of sidewall elevation, and approaching pressure relief manhole elevation. High level indications will inform decisions to increase digester outflow/limit inflow and the opposite for low level indications. During final design options to automate these decisions will be considered.

Biogas pressure will be monitored at each digester and in select locations in the biogas distribution system. There will be different tiers of high- and low-pressure alarms each corresponding to the pressure diverging from the pressure set point, nearing zero, and approaching the set point of each type of safety device.

The outer membrane in the dual-membrane gas holder cover will monitor the LEL of the atmosphere to detect leaks in the inner membrane. Detection of LEL will generate an alarm. If the dual-membrane gas holder cover is a design that does not normally ventilate air through the outer cover, detection of LEL will initiate a ventilation sequence.

The biogas flare will be controlled by a vendor LCP. Operators will be able to remotely select the pilot fuel source between NG or biogas. Flare status will be viewable remotely at the plant control system.

13 FINAL DEWATERING SYSTEM

13.1 Background and Purpose

This section presents design criteria, location, and related improvements required for the final dewatering process. The current process primarily consists of three centrifuges on the upper floor of the existing DWB. Dewatered solids from the centrifuge fall into a pant-leg diverter gate located below each centrifuge, which directs cake into one of the two bin diverting screw conveyors. Slide gates on the bottom of the screw conveyor direct the cake into one of four cake bins. The total capacity of the four cake bins is 430 CY. Cake stored in the bins is conveyed to a lime mixer to meet Class B stabilization requirements. The lime-stabilized product is then loaded onto trucks. The existing centrifuges were installed in 1996 and will be replaced. The existing dewatering system equipment includes the following equipment:

- Dry and liquid polymer storage and feed
- Centrifuge feed well and centrifuge feed pumps
- Dewatering centrifuges
- Dewatered cake bins and conveyors
- Lime storage and feed, including storage silo, day bins, and lime metering system
- Solids/lime mixers
- Two truck loading bays

Additional details regarding the existing dewatering system and the justification for replacement are provided in TM No. 2: *Condition of Existing Facilities*.

The new final dewatering system will also rely on centrifuges, based on the findings of an alternatives analysis, which included a review of equipment sizing, footprint requirements, capital costs, and O&M costs. Dewatering alternatives evaluated included BFPs, screw presses, centrifuges, rotary fan presses, and Bucher presses. Options were presented and reviewed at two project workshops with the County, on April 26 and May 10, 2021. At the second workshop, the project team shortlisted centrifuges and BFPs for further consideration. After further evaluation, the project team selected centrifuges as the preferred technology for final dewatering, based on the compact footprint requirements, lower life-cycle costs, County familiarity, and other factors. For more information regarding this analysis, refer to TM No. 7: *Dewatering Equipment Evaluation*.

The new final dewatering system consists of the following equipment, which is described in further detail in this section:

- DS transfer pumps (centrifuge feed pumps)
- Liquid polymer storage, blending, and feed systems
- Inline polymer mixers
- Centrifuges
- Cake conveyance equipment: diverter gates and screw conveyors
- Final dewatered cake bin
- Truck loading bay, with weight scale

An overall schematic of the final dewatering process is shown on Drawing G-006 and further detailed on Drawings I-503 and I-700 through I-702.

13.2 Process Objectives

The purpose of final dewatering is to remove water from the DS, thereby reducing the volume of biosolids to be hauled off site and enhancing the handleability of the end product. As noted in TM No. 5: *Biosolids Product Market Analysis*, the moisture content can affect the end product desirability. Some end users, such as commercial soil blenders and construction contractors, may prefer a product that is at least 30 percent solids. Based on experience from other facilities with THP, the final dewatering system is anticipated to achieve 32 to 38 percent solids. This will be validated by dewatering tests from the THP and AD pilot study being completed by Virginia Tech.

13.3 Basis of Design

Process equipment selections and facility concepts were based on a 30.8 mgd design condition for equipment sizing and a 40.0 mgd buildout condition for overall facility sizing. The anticipated digested solids productions at various conditions are summarized in Table 13-1.

Table 13-1. Anticipated Digested Solids Production

Design Condition	Total Solids Load (lb-DS/d)		
	Average	Peak 30-day	Peak 14-day
23.0 mgd	30,206	39,333	42,897
30.8 mgd	40,450	52,672	57,445
40.0 mgd	52,533	68,406	74,644

Notes: Solids loads above represent average weekly solids production based on a 24/7 schedule; the actual loading to final dewatering will be higher because the system will not be operated 24/7.

Peak 14-day solids loadings were used for sizing final dewatering processes because of the equalization capacity provided by the secondary anaerobic digester as well as upstream cake and thickened solids storage. The final dewatering process is sized to operate 24 hours per day, 5.5 days per week at peak 14-day loading conditions. The anticipated flows and loads to final dewatering are summarized in Table 13-2.

The third column of the table represents anticipated typical flows, when the DS solids concentration is 4.4 percent; the final column presents more conservative values, assuming that the DS solids concentration is lower than normal. The projected peak 14-day flow at 30.8 mgd and 3 percent solids (~200 gpm) is used as the minimum capacity for the final dewatering centrifuge feed pumps and centrifuges.

Table 13-2. Anticipated Flows and Loads to Final Dewatering

Design Condition	Solids Loading (lb-DS/hr)	Flow at 4.4 percent Solids (gpm)	Flow at 3 percent Solids (gpm)
23.0 mgd, average	1,602	72	107
23.0 mgd, peak 14-day	2,275	103	152
30.8 mgd, average	2,145	97	143
30.8 mgd, peak 14-day	3,046	138	203
40.0 mgd, average	2,786	126	186
40.0 mgd, peak 14-day	3,956	179	n/a

Notes: Flows and loads were developed assuming a 132 hours (5.5 days) per week operating schedule. No value is presented for 40 mgd peak flow at 3% solids because it is assumed the centrifuges would be operated longer hours under those conditions.

13.4 System Location

The location of the final dewatering system depends on which of the two shortlisted site layout alternatives is selected. Further information on the site layout options is presented in Section 17 of this Plan.

- **Option 1: renovate existing Dewatering Building.** If the existing DWB is renovated, the existing dewatering area would be repurposed for the pre-dewatering system, and a new Final DWB would be constructed to house the final dewatering centrifuges, as well as ancillary equipment such as the polymer storage and feed equipment, cake storage, screw conveyors, and truck loadout.
- **Option 2: decommission existing Dewatering Building.** If the existing DWB is decommissioned, then a new SPB would be constructed, containing both pre-dewatering and final dewatering equipment.

For both options, the final dewatering equipment is laid out as follows:

- **Level 4 (EL 70±):** final dewatering centrifuge, bridge crane, and control room
- **Level 3 (EL 60±):** centrifuge solids discharge chute, and cake screw conveyor
- **Level 2 (EL 42±):** final dewatered cake bin
- **Ground level (EL 24±):** truck scale, polymer storage, blend, and feed system

13.5 Final Dewatering Description and Design Criteria

The following sections provide a description and design criteria for ancillary equipment systems related to final dewatering.

13.5.1 Final Dewatering Centrifuge Feed Pumps

The centrifuges will be fed using final dewatering centrifuge feed pumps, which withdraw solids from the bottom of the digesters. The pumps will be located in the digester pump room. Design criteria for the centrifuge feed pumps are listed in Table 13-3. Five pumps will be provided (one for each installed centrifuge, and two spares).

The primary purpose of the final dewatering centrifuge feed pumps is to pump solids from the primary digesters to the secondary digester, and from the secondary digester to final dewatering. It will also be possible to pump from the primary digesters directly to the centrifuges if the there is no secondary digester in operation. As noted in Section 12, there will be two means of solids transfer from the primary digesters to the secondary digesters: gravity overflow and pumped transfer.

The final dewatering centrifuge feed pumps will have a common suction and discharge header, such that an alternate pump can be operated to serve each digester and centrifuge if the normally used pump is out of service. A magnetic flow meter will be provided on the discharge line to each centrifuge. A single magnetic flow meter will be provided on the “pumped transfer” pipe (the pipe connecting the centrifuge feed pump discharge back into the digesters).

A schematic of the pumping system is provided in Drawing I-503: Digested Solids Transfer Pumps.

Table 13-3. Centrifuge Feed Pump Design Criteria

Parameter	Value
Number of units	3 duty, 2 standby
Type	Progressive cavity
Manufacturers	Moyno, Netzsch, or Seepex
Design flow	200 gpm or greater
Drive type	VFD, direct-coupled motor
Maximum pump speed at design point	260 rpm
Rotor-shaft connection	Pin joint or gear joint
Maximum pressure per stage	40 psi

13.5.2 Final Dewatering Polymer System

A new polymer feed system will be installed to provide polymer to the final dewatering centrifuges. The system will be designed for bulk deliveries of emulsion polymer (as opposed to dry polymer) and consist of the following equipment:

- Two fill stations (one per storage tank)
- Two bulk polymer storage tanks
- One polymer recirculation pump
- Two polymer blending and activation units
- One aging tank
- Two polymer solution metering pumps
- Two inline polymer solution mixers (to blend polymer and dilution water)
- Two motorized polymer injection mixers (to blend polymer and solids)
- Eyewash station, with tempered water and flow switch

The polymer fill stations will have a level readout for the storage tank, and alarm indicators for high level.

The discharge piping of the polymer feed pumps will be interconnected so that the polymer feed systems will not be dedicated to a specific centrifuge. However, not all combinations of polymer feed pump/centrifuge will be possible when more than one centrifuge is operating. Space and capped piping connections will be provided for a future third polymer skid. The system will be located on the ground level.

A separate polymer storage, blend, and feed system will be provided for the final dewatering centrifuges (this applies to both site layout options: renovate existing DWB and decommission existing DWB). The final dewatering and pre-dewatering polymer systems will not be interconnected, because it is anticipated that each system may require different types of polymer to optimize dewatering performance.

Unlike the pre-dewatering polymer system, the polymer solution from the final dewatering blend units will not be fed directly to the centrifuges. Instead, the polymer blending units will deliver polymer solution to an aging tank.

A schematic of the final dewatering polymer system is provided in Drawing I-702: Final Dewatering Polymer. Design criteria for the polymer storage tanks and recirculation pump are provided in Table 13-4. Design criteria for the polymer skids are provided in Table 13-5. Note that the design criteria are based on an assumed polymer dose of 30 pounds of active polymer per ton dry solids. The delivery team will further evaluate the polymer system sizing during detailed design, including evaluating information gleaned from the pilot studies.

Table 13-4. Polymer Storage Design Criteria

Parameter	Value		
Total final dewatering polymer consumption, gallons neat polymer per week	Average	Peak 30-day	Peak 14-day
23.0 mgd	951	1,238	1,350
30.8 mgd	1,273	1,658	1,808
40.0 mgd	1,653	2,153	2,349
Storage volume basis of design	Total storage volume provided ≥ 30-day consumption at 40 mgd peak 30-day		
Total storage volume required (30-day consumption at 40 mgd peak 30-day)	9,230 gallons		
Number of bulk storage tanks	2		
Volume per tank	5,000 gallons		
Tank material of construction	FRP		
Tank accessories and instrumentation	One ultrasonic level sensor per tank One ladder and cage per tank		
Storage tank mixing system			
Quantity	One recirculation pump serving both tanks		
Pump type	Progressive cavity		

Note: Total neat polymer consumption is based on the solids production values in Section 3, an assumed neat polymer dose rate of 30 lb per ton of dry solids, and an as-delivered concentration of 40% active polymer by weight.

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Table 13-5. Polymer Blending System Design Criteria

Parameter	Value
Basis of design	
Number of polymer blending units	2 (one duty, one standby)
Neat polymer feed rate, per skid	1.5–15 gallons per hour (gph)
Dilution water feed rate, per skid	6–60 gpm
Manufacturers	Fluid Dynamics or Velodyne
Polymer mixing chamber	
Type	Either non-mechanical without motor or hydro-mechanical with motor
Accessories/instrumentation	Differential pressure switch, inlet/outlet pressure gauges
Neat polymer metering pump	
Quantity	1 per skid
Type	Progressive cavity
Skid dilution water inlet assembly	
On/off valve	Solenoid valve, normally closed
Flow control valve	Manually operated needle/orifice valve
Instrumentation	One dilution water magnetic flow meter, one rotameter
Other skid accessories	Calibration column, flush/drain valve, pressure relief valve
Dilution water main (not provided in skid)	One pressure-reducing valve (to serve all skids). Two stainless duplex basket strainers: one 40-mesh, one 80-mesh. Pressure gauges before and after each strainer and PRV

Note: The dilution water feed is based on an assumed polymer make down solution concentration of 0.25% (i.e., 0.25 pounds of neat polymer per 99.75 pounds of dilution water).

Table 13-6. Polymer Aging Tank and Feed System Design Criteria

Parameter	Value
Polymer aging tank	
Number of units	1
Minimum volume	3,000 gallons
Tank material of construction	FRP
Tank accessories and instrumentation	Ultrasonic level sensor High level switch (stop blend units) Low level switch (start blend units) Low-low level switch (alarm) Ladder and cage
Polymer solution metering pumps	
Quantity	2 (one per centrifuge) 1 per skid
Type	Progressive cavity
Flow range	20–90 gpm
Pressure requirements	Account for head loss at injection quill of inline polymer mixer
Other accessories	One static mixer on the discharge of each polymer solution feed pump

13.5.2.1 Inline Polymer Mixer

Inline mixers will be provided upstream of each centrifuge, to rapidly mix polymer into the centrifuge feed solids and enhance dewatering performance. Polymer solution injection points will be provided both upstream and downstream of the mixer. Design criteria for the mixer are provided in Table 13-7.

Table 13-7. Inline Polymer Mixer Design Criteria

Parameter	Value
Number of units	2 (one per centrifuge)
Manufacturer	SNF
Materials of construction	Type 316 stainless steel
Approximate motor size	7.5 hp
Drive type	VFD

13.5.3 Final Dewatering Centrifuges

Design criteria for the centrifuges are listed in Table 13-8. Two centrifuges (one duty plus one standby) will be provided for the 30.8 mgd design condition. Additional space will be provided to install a third centrifuge in the future to provide additional capacity and redundancy for the 40 mgd design conditions. A schematic of the final dewatering centrifuges and cake conveyance equipment is provided in Drawing I-700: Final Dewatering Centrifuge. The centrifuges will be on the upper level of the building. A bridge crane sized to lift the rotating assembly and floor opening large enough to fit the rotating assembly will be provided in the centrifuge room to lift and lower the centrifuges for maintenance and repairs.

For ease of maintenance and interchangeability of parts, the same model of centrifuge will be used for pre-dewatering and final dewatering. The delivery team will be responsible for evaluating sizing and selection of the centrifuge manufacturer and model. The selected system must be sized to reliably meet the full range of flows and loads at the 23.0 and 30.8 mgd design conditions, with space to expand to meet the 40 mgd design conditions. For reference, the evaluations and layouts presented in this Plan were based on a 29-inch diameter bowl and assumed capacity of 4,200 lb/hr (equal to 6,000 lb/hr nameplate capacity, de-rated by 30 percent as a safety factor).

Table 13-8. Centrifuge Design Criteria

Parameter	Value
Number of units	1 duty and 1 standby (space for 1 future)
Manufacturer	To be determined
Hydraulic capacity per unit	200 gpm or greater at 3% feed solids
Target solids capture	95%
Target cake dryness	32%–38% solids
Motor size	To be determined by delivery team
Drive type	VFD

Centrate will be sent to the plant drain. The centrate drain piping will be a minimum size of 12 inches, sloped at 1/4-inch per foot or greater, and have flushing connections throughout. The delivery team will be responsible for sizing the centrate pipe piping and centrate drain vent. More information about the centrate drain piping is provided in Section 16.

Centrate equalization is desirable to limit impacts to the liquid treatment process prior to implementation of future sidestream treatment. The delivery team will need to evaluate potential sizing and location of centrate equalization and integration into the future sidestream treatment system, as described in Section 23.

13.5.3.1 Cake Conveyance

Solids from each centrifuge will fall through a chute into a “slop” diverter slide gate below the machine. During centrifuge startup, before the cake reaches a target dryness, the diverter gate will close to send “slop” to the plant drain via the centrate piping. Once the centrifuge is producing cake, the diverter gate will open, allowing solids to fall into a “pant-leg” diverter gate.

When the “pant-leg” diverter gate is in “open” position, cake will fall directly into the final dewatered cake bin. When the gate is “closed,” cake will fall into a “bin distributing” horizontal screw conveyor. The purpose of the screw conveyor will be to transport cake to a different compartment of the dewatered cake bin, to allow the cake to be evenly distributed throughout the cake bin. The conveyor will be able to operate in forward or reverse. An outlet at the end of the conveyor will allow direct discharge into a truck, in the event that the cake bin is out of service. Design criteria for the cake conveyance equipment are provided in Table 13-9.

Table 13-9. Cake Conveyance Design Criteria

Parameter	Value
Materials of construction, frame	Type 304L stainless steel
Materials of construction, wetted parts	Type 316 stainless steel
"Slop" diverter slide gates	
Quantity	2 (one per centrifuge), plus space for 1 future
"Pant leg" diverter gates	
Quantity	2 (one per centrifuge), plus space for 1 future
"Bin distributing" screw conveyor	
Quantity	1
Maximum speed	20 rpm
Safety features	Zero speed switch and emergency stop pull cord
Screw conveyor slide gates	
Quantity	3

13.5.3.2 PEW Connections

The dewatering system will be provided with the following PEW connections:

- Centrifuge automatic rotating assembly/bowl flush, with one motorized valve and one check valve per centrifuge
- Centrifuge manual casing flush, with manually operated ball valves
- Flushing water for cake conveyance equipment:
  - "Slop" diverter slide gates
  - "Pant leg" diverter gates
  - Screw conveyor
- Solids dilution water assembly, provided for the purpose of reducing the solids concentration of the centrifuge feed. The assembly includes the following components:
  - One pressure-reducing valve
  - One magnetic flow meter, with bypass
  - One motorized valve
  - Check valve
  - Isolation valves

13.5.4 Final Dewatered Cake Bin

A single bin will be provided for the short-term storage of final dewatered cake. The bin will be sized to provide 1.5 days of usable storage at 30.8 mgd peak 14-day conditions, with the assumption that dewatering and hauling operation schedule could be adjusted at peak 40 mgd design conditions. The bin will consist of three compartments, each with a live-bottom mixer, a motorized slide gate, and discharge chute. Each compartment could be isolated for maintenance or repair. Design criteria for the dewatered cake bin are provided in Table 13-10. A schematic is provided in Drawing I-701: Final Dewatering Cake Bin.

Table 13-10. Cake Bin Design Criteria

Parameter	Value
Number of units	1 (with three compartments)
Materials of construction	Type 304 stainless steel
Instrumentation	Radar level sensors (two per compartment)

13.5.5 Final Dewatered Cake Truck Loadout

The indoor truck loading area will be located below the final dewatered cake bin, on the ground floor of the DWB. A truck scale will record the weight as cake is loaded into the trailer. The truck loading area will have hose bibbs on each side of the truck and floor drains to convey washdown and spills to the plant process drain.

A roll-up garage door will be located on each side of the room, allowing trucks to pull in and continue through without having to back up. A truck viewing platform will provide access for the operator and truck driver to look inside the trailer. Bollards will be provided to protect equipment and building components.

The truck loading area is shown on the following drawings:

- Option 1: renovate existing Dewatering Building. Plan: M-700; Sections: M-703 and 704.
- Option 2: decommission existing Dewatering Building. Plan: M-350; Sections: M-361 and 362.

13.5.6 Odor Control

Foul air will be withdrawn from the following areas:

- Centrifuge centrate discharge chute
- Centrifuge solids discharge chute
- Cake conveyor
- Dewatered cake bin
- Truck bay

The odor control system is discussed further in Section 15.

13.6 Equipment Operation and Control

13.6.1 Centrifuge Feed

The final dewatering centrifuge feed pumps will operate in “Digester Transfer” or “Digester Waste” mode. In the former mode, solids will be transferred from one digester to another; in the latter mode, solids will be withdrawn from the digester and pumped to the final dewatering centrifuges. Pipe cross connections and manual valves on the discharge lines will provide flexibility to feed any centrifuge or digester with any pump.

A magnetic flow meter will be provided on the discharge line to each centrifuge. A single magnetic flow meter will also be provided on the “pumped transfer” pipe (the pipe connecting the DS transfer pumps discharge back into the digesters).

When adjusting the operational mode of a final dewatering centrifuge feed pumps, the operator will enter the withdrawal location and discharge location via the PCS. The PCS will use this information to record the flow meter reading to and from each process.

The final dewatering centrifuge feed pumps will be provided with VFDs. The PCS will automatically adjust the pump speed so that the recorded flow matches the operator-adjustable flow set point.

13.6.2 Polymer System

The polymer feed to each centrifuge will be automatically adjusted to maintain an operator-adjustable dose rate, based on the following parameters:

- Solids feed flow, as measured by flow meter on centrifuge feed pump discharge
- Solids concentration of DS, entered in the PCS by the operator on a regular interval based on sampling and testing results
- Polymer dose rate (pounds of active polymer per dry ton of solids), entered in the PCS

The polymer blending unit will receive a polymer demand from the PCS, in units of pounds per hour. A PLC on the polymer blending unit will automatically adjust the speed of the neat polymer metering pump to deliver the polymer demand. The dilution water flow into the polymer blending unit will be adjusted manually via needle/orifice valve to achieve a target polymer solution concentration.

The polymer recirculation pump will be operated on a timer cycle. The suction and discharge tanks of the pump will be adjusted using manual valves.

13.6.3 Centrifuges and Cake Conveyance

The centrifuges will be controlled by the manufacturer's PLC. During commissioning, the polymer dosage, mixing, washwater, and centrifuge control will be adjusted to optimize the system to achieve the highest cake dryness while minimizing the total polymer usage. Every installed centrifuge should be operated periodically to distribute wear and ensure that each is functional when needed.

The "slop" diverter slide gate will automatically be opened and closed by the centrifuge PLC, but it can also be manually controlled from the centrifuge control panel or local control station.

The cake conveyance system will be controlled from the PCS. The system will be interlocked with the centrifuge and will send a stop command to the centrifuge PLC if a critical fault is detected. Before starting a centrifuge, the operator will select the discharge location of the cake by adjusting the following settings:

- Position of the pant leg diverter gate
- Cake screw conveyor direction of rotation
- Position of the slide gates below the screw conveyor

If the cake bin level exceeds a high-level set point, a warning alarm will be triggered, to notify the operator that the cake discharge location should be adjusted to prevent cake from overflowing the bin. If the level exceeds a high-high level, the PCS will send a stop signal to the centrifuge feed pumps.

The live-bottom screws and slide gates in the cake storage bin will be manually operated from an LCP in the truck loading bay, for convenient operator access. A digital readout in the truck bay will report the truck weight. The operator will tare the weight when the empty truck pulls into the bay. The level reading for each compartment of the cake bins will be displayed on the LCP to assist the operator in deciding which of the bin discharge chutes to use.

14 BIOGAS MANAGEMENT AND UPGRADING

14.1 Background and Purpose

The Program will produce a marketable biosolids product and biogas that could be used on site to produce electricity and/or heat or further conditioned and used off site as RNG.

The objective of the previously developed Biogas Utilization Report (see Appendix A) was to look at all feasible alternatives for the beneficial use of the biogas to assist in meeting Arlington County's sustainability goals while also reliably meeting the WPCP's heating and electrical needs. Monetary, non-monetary, and sustainability evaluations were completed to determine the recommended alternative for the County.

The range of feasible alternatives includes using the biogas for one or a combination of the following:

- On-site use for process and building heating
- Production of electrical power and recovering waste heat (CHP)
- Production of RNG for off-site use as vehicle fuel or pipeline injection

Based on the results presented in the Biogas Utilization Report, the County recommended proceeding with RNG as the selected biogas utilization approach. The basis for this recommendation is as follows:

- The RNG sub-alternatives have the lowest net present value (i.e., lowest total cost to the County) for the baseline conditions.
- Sub-alternative 3A (RNG into Pipeline) scored the highest in the County's non-financial scoring. In particular, the County found that the RNG sub-alternatives would be less complex and would result in fewer localized impacts than the CHP alternatives.
- A sensitivity analysis concluded that when considering multiple variables, including Renewable Identification Number (RIN) volatility, Sub-alternative 3A (RNG into Pipeline) had a very high likelihood of being more financially advantageous than Sub-alternative 2A.
- The County has the ability to retain GHG credits if the biogas is used within Arlington County. With County operations projected to be 100 percent renewable by 2023, it is likely that the CHP sub-alternatives would not result in any GHG reduction.
- Benefits of on-site CHP are limited because the CHP size would not be sufficient to power the entire WPCP and the existing WPCP is already protected with backup generators.

The County's current preference is for converting biogas into RNG; however, the final decision to inject RNG into the natural gas (NG) utility pipeline or to use CNG will be made in the future as more discussions with the stakeholders are conducted.

An overall schematic of the biogas management process is shown on Drawing G-007 with detail provided on Drawings I-800 through I-803.

14.2 Process Objectives

Below is a summary of the major process objectives for the biogas utilization systems. Other non-financial criteria such as flexibility, aesthetics, noise, and local emissions were captured in the Biogas Utilization Report.

- **Minimize flaring:** Minimize the flaring of biogas produced within the digester system. This will be accomplished by providing adequate storage, utilization capacity for the primary end use, and flexibility to use the biogas on site as a secondary end use
- **Maximize Beneficial Use:** Several biogas end uses were explored and evaluated on a financial and non-financial basis along with a sensitivity analysis to select the end use with the highest benefit to the County.
- **Biogas Storage:** Provide storage to minimize the potential for flaring during interruption of RNG operations.
- **Safety:** Meet or exceed the current standard of practice for digester safety on both the biogas and solids sides of the process. Potential safety concerns and mitigation measures are discussed in Section 12.4.7.
- **Operations and Maintenance Considerations:** Mitigate foreseeable O&M issues. The foreseeable issues and mitigation measures are expounded upon in the following sections but generally cover topics such as access, resilience, contingent/alternate operation, process monitoring, and ability to mitigate potential process upsets.

14.3 Basis of Design

Future biogas production is based on the criteria presented in Section 3, which includes 95 percent solids capture in the pre-dewatering system, 60 percent VSr for primary and secondary biosolids, and 90 percent VSr of primary scum and FOG. The assumed biogas yield is 15 standard cubic feet (scf) of biogas produced per pound of VS reduced.

Table 14-1 below presents the biogas production values for the planning period.

Table 14-1. Biogas Production, scfm

Parameter	2027	2037	2047	Design 2052
Average	343	378	413	428
30-day max	451	497	543	563
14-day max	491	541	590	612
7-day max	520	572	625	648
3-day max	573	631	689	715

14.3.1 RNG Quality Requirements

The American Biogas Council has developed a recommended RNG-quality specification for pipeline injection, which is presented in Table 14-2 below. RNG-quality specifications will continue to be updated based on the ultimate end user.

Table 14-2. Anticipated RNG Pipeline Specification

Parameter Maximum (unless noted otherwise)	Unit	Acceptable Limit	Typical Raw Biogas
Minimum high heating value	Btu/scf	960	580–680
H_2S	ppm	0.0057	300–1,000
Total sulfur	ppm	0.458	300–1,200
CO_2	Percentage by volume	2.0%	32%–42%
O_2	Percentage by volume	0.4%	<1.0%
Total inerts	Percentage by volume	5.0%	33%–45%
Water	lb/MMscf	7.0	~2,000
Siloxanes	ppm	1.0	5–20
Dust, gum, bacteria, and pathogens	Filter microns	Commercially free	N/A
Minimum and maximum limits of acceptable temperature range	°F	50–120	90–110

14.4 Biogas System Description and Design Criteria

For the recommended biogas to RNG alternative, shown schematically in Figure 14-1, all the biogas produced will be conditioned to RNG quality for use off site. The production of RNG from biogas requires treatment of the biogas to remove contaminants such as H_2S, moisture, siloxanes, volatile organic compounds (VOCs), and CO_2. A discussion on the technologies available to accomplish this treatment is presented in Section 14.5. At this point it is assumed that all of the biogas would be conditioned and used off site and NG would be purchased and used in boilers to meet the process and building heating needs to maximize the amount of RINs. However, piping and valving should be provided as necessary to use biogas in the boilers in lieu of natural gas, should County operations decide that is the preferred method of operation.

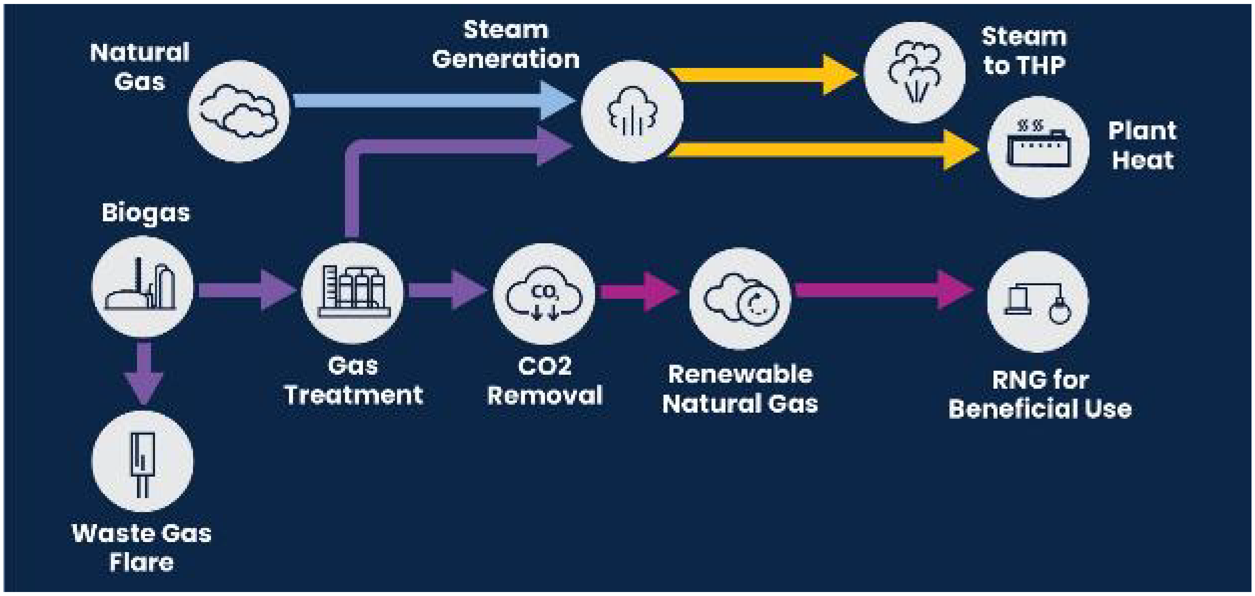

Figure 14-1. Biogas to RNG Schematic

The removal of contaminants from the raw biogas, regardless of the technology used, results in some loss of CH_4 in the waste biogas stream, or tail gas. The disposal of the tail gas is site-specific and dependent on air quality regulations and sustainability goals as it contains a small amount of CH_4 as well as some H_2S and other contaminants. It is assumed that the tail gas was combusted in a regenerative thermal oxidizer (RTO) designed to oxidize low-Btu gas streams, effectively converting CH_4 to CO_2 and other contaminants to oxidized states. The overall CH_4 capture is technology-dependent but is generally in the range of 95 to 98 percent.

The RNG conditioning equipment will have downtime for maintenance. During these periods it was assumed that the biogas would be diverted directly to the boilers to minimize flaring.

Figure 14-2 illustrates the energy balance for the RNG and boiler alternatives. This energy balance does not distinguish between injecting the RNG into the NG utility pipeline or piping the RNG directly to bus fleet fueling.

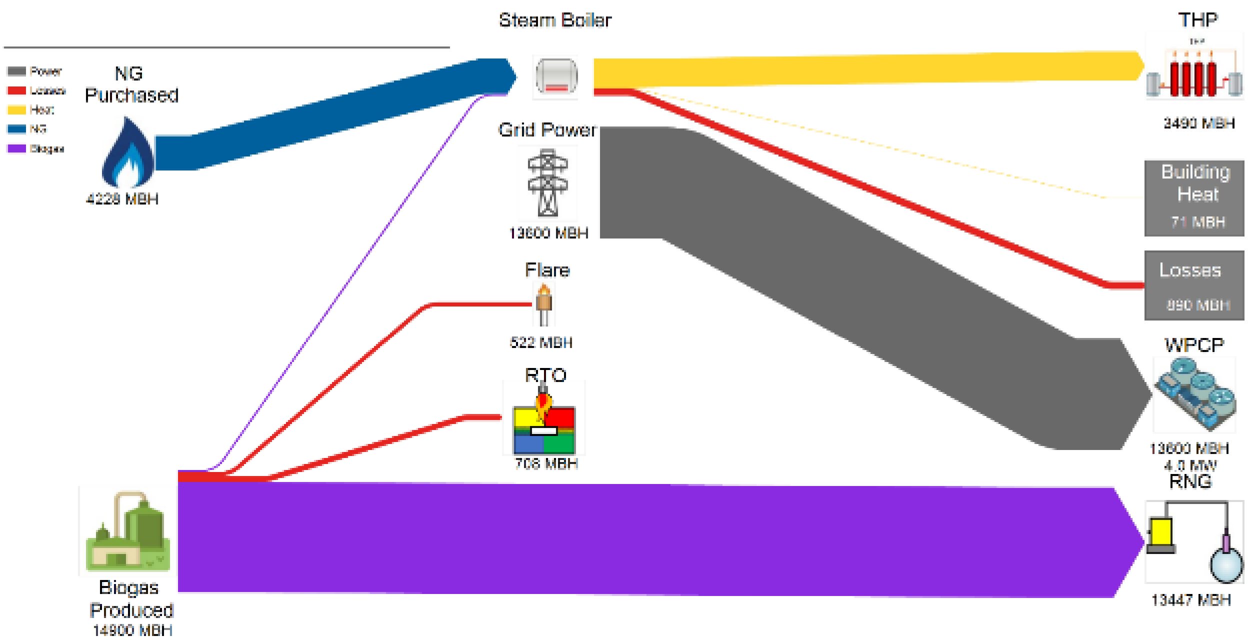

Figure 14-2. Biogas to RNG Energy Balance: Average Condition 2037

14.4.1 Equipment Capacity Summary

Based on the biogas production summary and the selected end use as RNG, a summary of the major equipment component capacities was developed and is summarized in Table 14-3.

Table 14-3. Equipment Capacity Summary

Component	Quantity	Unit	Basis
Waste gas flare capacity	1,200	scfm	Future peak biogas production
	50,000	MBH	Peak flow at 650 Btu/scf
Conditioning system inlet capacity	600	scfm	Future max month
	23,000	MBH	Design flow and 650 Btu/scf
Conditioning system performance			
Minimum CH_4 capture	95	Percent	Design target
Minimum uptime	95	Percent	Design target
Gas quality requirements	See Table 2	See Table 2	To be confirmed with NG utility
RNG injection system	400	scfm	
	23,000	MBH	Match conditioning system
RTO inlet capacity	300	scfm	
	2,500	MBH	
Raw biogas to boiler capacity	10,000	MBH	Boiler fuel requirement
	290	scfm	Fuel requirement at 580 Btu/scf
RNG to boiler capacity	170	scfm	Fuel requirement at 980 Btu/scf

14.4.2 Low-Pressure Biogas System

For details and requirements on the low-pressure biogas system, see Chapter 12.

14.5 Biogas Conditioning System Details

With the recommended alternative of conditioning the biogas to be used as RNG off site, an additional analysis was completed to select the most appropriate CO_2 removal conditioning technology along with the necessary pretreatment, compression, post-treatment, and tail gas management equipment for each type. There are three main types of biogas conditioning technologies available to produce RNG: membrane separation, pressure swing adsorption (PSA), and water wash scrubbing.

A suite of alternatives using various biogas conditioning technologies was developed. Conceptual process conditions, configurations, cooling technology sizing, and conceptual operation costs were prepared, documented in TM No. 16: *Gas Cleaning Evaluation*, and were presented at project workshops with the County. The technologies were evaluated and compared based on budgetary capital equipment costs, conceptual operating cost estimates, and non-cost considerations including space requirements and noise. A 20-year life-cycle cost analysis was also conducted.

Overall, the three biogas conditioning technologies are comparable in present value and performance; however, some differences should be considered before the final technology selection is made. Table 14-4 presents these differences graphically where the green indicates positive, red is negative and yellow is neutral.

Table 14-4. Technology Comparison

Criterion	Membranes	PSA	Water Wash
Capital cost	↑	↓	↑
O&M cost	↑	↓	↓
Methane capture	↑	↓	↑
Uptime	↔	↔	↔
Noise	↓	↑	↓
Aesthetics	↑	↑	↓
Flexibility for future CHP	↑	↓	↓
Tail gas management	↑	↑	↓

Arlington County participated in additional discussions with the equipment vendors and conducted site visits to existing installations to see the equipment in person and talk to O&M staff who have experience with the equipment options. Based on the analysis presented in TM No. 16 and the lessons learned from vendor discussions and site visits to existing installations, the preferred biogas treatment technology for implementation at the WPCP is membrane separation.

The Biogas Utilization Report includes costs for enclosing most of the biogas conditioning equipment in a building. Enclosing this equipment inside a building has several advantages for weather protection, access for O&M activities, and reduced noise production. The final layout of the Biogas Conditioning Building and equipment will occur after facility site visits and selection of a conditioning technology.

14.6 Equipment Operation and Controls

The biogas upgrading system is a complete system that will be packaged by a single vendor. During normal operation, the biogas upgrading system will operate in response to variable digester gas production as indicated by a pressure signal, and automatically increase or decrease compressor speed to feed biogas through the system.

The biogas upgrading system will include local control panels for the individual process, scrubbing, and compression skids with a PLC to provide operational and safety controls, including startup cycles, shutdown cycles, normal operation, capacity adjustment, and product gas quality control. The PLC will control and monitor the gas upgrading system in both Hand and Auto modes. The main scrubbing LCP will include an HMI touchscreen.

The biogas upgrading system will perform the following primary functions:

1. Compress and cool digester gas
2. Remove H_2S (if required), siloxanes, water, and other contaminants from the digester gas
3. Separate CO_2 and residual contaminants from the CH_4 in the digester gas to produce RNG and tail gas
4. Measure and control biomethane quality prior to pipeline injection

14.6.1 Alternative Modes of Operation

Piping, valves, and the necessary pressure-reducing equipment will be provided to send raw or conditioned biogas to fuel the steam boilers. Raw biogas will be sent to the boiler if biogas production exceeds the capacity of the biogas conditioning system and biogas storage capacity is exceeded or if the biogas conditioning system is out of operation for maintenance. Conditioned biogas will be sent to the boilers in the event that the RNG quality does not meet pipeline standards and the gate station valve is closed.

14.6.2 Safety Features

The biogas handling system will be designed to provide safe operations and proper disposal of the biogas throughout the entire range of anticipated and emergency conditions. Pressure relief valves will be provided to send the biogas to the waste gas flare in the event that biogas production exceeds the capacities of the biogas conditioning system and the on-site uses and biogas storage capacity are at maximum capacity. Emergency flaring will be controlled by pressure set points to prevent damage to the biogas storage system and associated equip

15 ODOR CONTROL

15.1 Background and Purpose

Planned improvements to replace the existing lime stabilization process with THP and AD will result in either the rehabilitation of the existing DWB or decommissioning of the DWB and construction of a new SPB. Both will involve replacement of all existing processes with new ones, requiring new odor control takeoffs and ductwork. The existing DWB is served by an odor control system; however, that system is approaching the end of its useful life and should be replaced.

TM No. 13: *Odor Control Evaluation* includes a comparison of four alternatives for establishing permanent odor control to replace the existing DWB odor control system. The four alternatives were developed for comparison based on preliminary design criteria established through:

- Estimated foul-air exhaust rates for the potential odor sources
- Estimated peak and average concentrations of odorants in combined foul-air exhaust flows
- Identified odor treatment system design parameters
- Identified odor collection and treatment system arrangement and redundancy requirements

Based on the results of the assessment and comparison, one alternative was recommended to serve as a basis for design: treatment of the combined exhaust from GTs, SSTs, and pre-dewatering with a two-stage packed-tower scrubber system targeting sulfur odor and treatment of the combined exhaust from final dewatering with a one-stage packed-tower scrubber targeting ammonia odor followed by a one-stage packed-tower scrubber and carbon polishing unit targeting sulfur odor.

The purpose of this section is to provide background on the existing odor control at the WPCP, describe the preliminary design criteria used to develop the contemplated alternatives, and review the recommended alternative, including its impacts on utility requirements and site planning.

Details of the odor control system are provided on Drawings I-900 through I-902.

15.2 Existing Facilities

There are three existing odor control systems at the WPCP: the south odor control system, north odor control system, and DWB odor control system.

The south odor control system currently serves the following:

- Four Mile Run Pump Station
- PTB
- DAFT
- GTs
- SSTs

The north odor control system primarily serves the equalization tanks and the PC effluent channel. The DWB odor control system serves the entire DWB including multiple process points within the DWB and the truck bays.

The locations of the three scrubber systems and facilities served are shown in Figure 15-1.

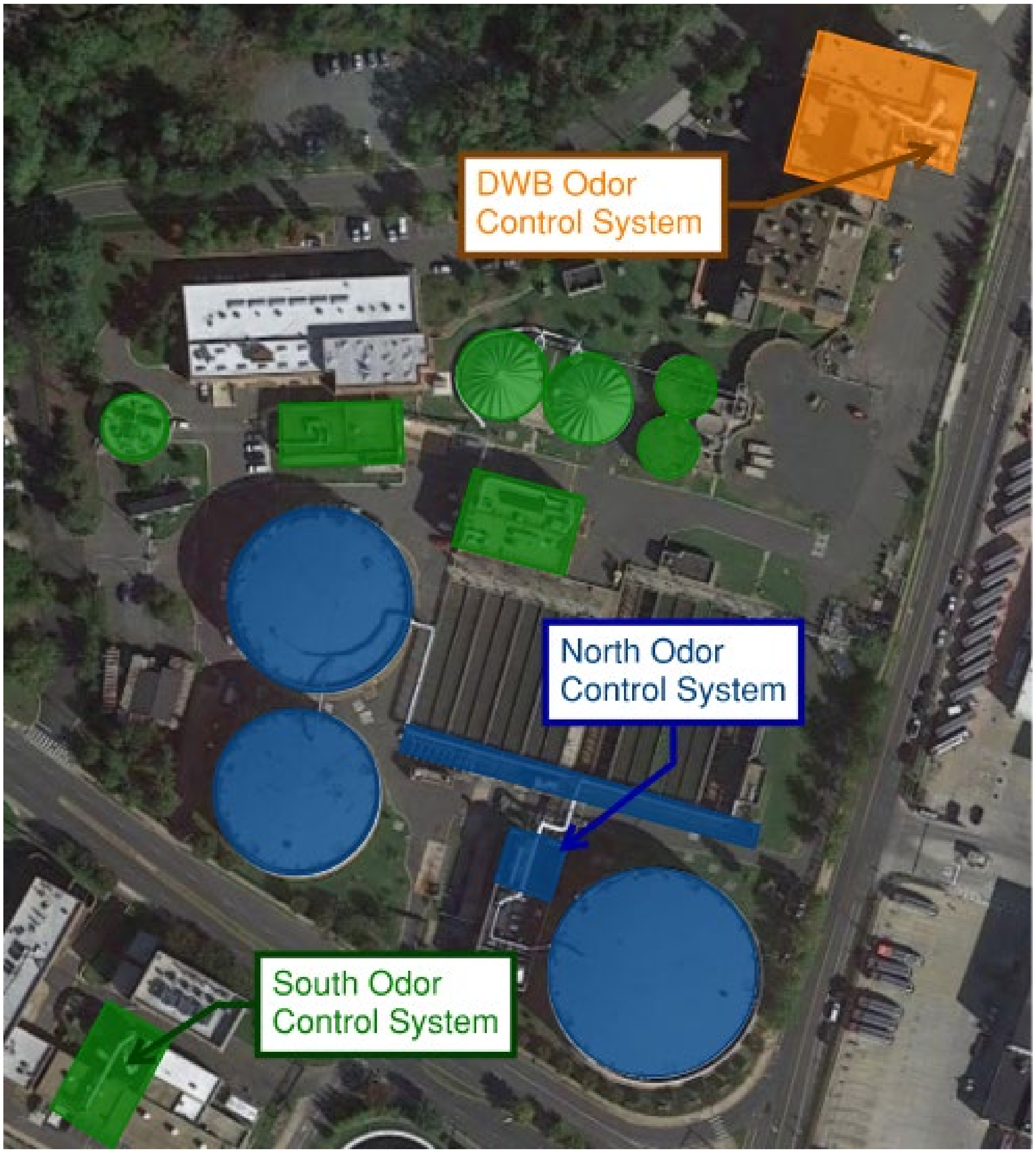

Figure 15-1. Locations of Existing Odor Control Facilities

15.2.1 South Odor Control

The south odor control system includes a two-stage packed-tower scrubber for removal of H_2S and low molecular weight organic sulfur compounds. This system has a capacity of approximately 31,000 cubic feet per minute (cfm). Many recent studies have been completed to review the design and capacity of the south odor control system and the DWB odor control system, including the *Foul Air Study for Preliminary Treatment Building and Dewatering Building* (CDM Smith 2017) and the *Preliminary Treatment Upgrades (WPB2) Phase 9B Odor Control Alternatives Ventilation System Evaluation and Recommendations* (CDM Smith 2019).

The design for the Preliminary Treatment Upgrades (WPB2) Phase 9B (PT Upgrades) includes new ventilation for the PTB. Odor control for this new ventilation will be provided by directing the PTB airflow through the GTs, and then on to the south odor control system. The expected odor control ventilation rates to the south odor control system subsequent to the PT Upgrades are listed in Table 15-1.

Table 15-1. Expected Ventilation

Source	Flow (cfm)	Notes
PTB	23,000	Directed through GTs
GTs	20,000	Captures PTB airflow
DAFTs	5,300	
Four Mile Run PS	4,800	
SSTs	700	
Minor sources	450	
Total to south odor control	**34,250**	Airflow from GTs not additive as it receives air from PTB

15.2.2 North Odor Control

The north odor control system treats odors from equalization and primary effluent in a two-stage packed-tower scrubber for removal of H_2S and low molecular weight organic sulfur compounds. No modifications to the north odor control system are expected as part of the Arlington Re-Gen Program.

15.2.3 Dewatering Building Odor Control

The DWB odor control system treats odors collected from the existing DWB in a multistage process: packed-tower scrubbers with acid to remove ammonia (NH_3) followed by two-stage packed-tower scrubbers with hypochlorite to remove H_2S and a wide range of organic sulfur compounds.

15.3 Process Objectives

The fundamental objective of any odor control system should be to prevent the occurrence of corrosive odors in spaces on site, unsafe odors in occupied spaces on site, and nuisance odors in occupied spaces on site and at sensitive locations off site.

The following facilities will generate odors that should be addressed as part of the Arlington Re-Gen Program:

- GTs
- WAS equalization storage tanks
- Solids screens
- Thickened solids storage tanks
- Screw conveyors

- Pre-dewatering centrifuges
- Pre-dewatered cake bins
- Final dewatering centrifuges
- Final dewatered cake bins
- Truck bay
- Future

It is assumed that screenings from the solids screens will be bagged prior to discharge into the screenings dumpsters and the screenings dumpsters will not generate odors. Future facilities may include future WAS thickening, future FOG receiving, or other facilities as described in Section 23.

15.4 Basis of Design

To guide development of the contemplated odor control alternatives, a common set of preliminary design criteria were established. The preliminary design criteria, constituting the basis of design, consist of the following:

- Estimated foul-air exhaust rates for the potential odor sources
- Estimated peak and average concentrations of odorants in combined foul-air exhaust flows
- Identified odor treatment system design parameters
- Identified odor collection and treatment system arrangement and redundancy requirements

15.4.1 Foul-Air Collection

Foul-air exhaust rates were estimated to either maintain a specific rate of air changes per hour (ACH) in an odorous space or to be consistent with manufacturer-recommended exhaust rates maintained for similar equipment at other sites. Table 15-2 presents the estimated exhaust rates for the processes and facilities to be served by the new odor control system.

The values listed in Table 15-2 are preliminary for initial sizing purposes and will change based on the final configuration designed by the delivery team. During design, it is recommended that the estimates be revisited and the design rates be coordinated with manufacturers, to ensure that exhaust rates will both maintain vacuum (i.e., a maximum of -0.1 inch water column [w.c.] pressure) in odor spaces and avoid wasting treatment capacity with over-generous ventilation.

Table 15-2. Basis of Design for Foul-air Collection

Source	Ventilation Criteria	Ventilation Basis	Number of Units	Ventilation Rate, Unit (cfm)	Ventilation Rate, Total (cfm)
GTs	12	ACH	2[b]	10,000	20,000[b]
Storage tank (WAS equalization)	2	ACH	1	1,050	1,050
Storage tanks (thickened and screened solids)	2	ACH	3	1,050	3,150
Solids screens	-	Mfr	3	200	600
Screw conveyors	-	Mfr	2	100	200
Pre-dewatering centrifuge cake discharges	-	Mfr	4	100	400
Pre-dewatering centrifuge centrate drains	-	Mfr	4	100	400
Pre-dewatered cake bins	12	ACH	2	950	1,900
Final dewatering centrifuge cake discharges	-	Mfr	3	100	300
Final dewatering centrifuge centrate drains	-	Mfr	3	100	300
Final dewatering cake bins	12	ACH	1	1,100	1,100
Truck bay	6	ACH	1	5,500	5,500
Future[a]	-	Mfr	2	600	1,200
Total					36,100

a. Reserve capacity for future facilities is captured via the inclusion of future GBTs for WAS thickening
b. The WPCP operates only a single GT at present; ventilation is continuously provided from both GTs.

Odorous air from the TH skid will be vented separately and directly to the digesters and is not considered in this evaluation. Staff will need to follow proper procedures for preventing odor release during maintenance of the TH system (including flushing vessels and piping before exposing to the atmosphere). These procedures will be documented separately.

15.4.2 Foul Air Loading

Peak and average concentrations of H_2S, organic reduced sulfur compounds (orgS), and NH_3 were estimated to provide a basis for evaluating potential treatment options and sizing treatment stages, chemical dosing pumps, and chemical storage required.

The design concentrations presented in Table 15-3 reflect the Program Manager's experience at other sites; however, the concentrations are subject to significant uncertainty. Actual concentrations will be a function of site-specific factors including liquid-phase wastewater chemistry and operating conditions.

Table 15-3. Basis of Design for Foul-air Loading

Exhaust	Airflow (cfm)	H_2S (ppmv)		orgS (ppmv)		NH_3 (ppmv)	
		Average	Peak	Average	Peak	Average	Peak
GTs	20,000	1.0	10.0	0.5	2.0	0.0	0.0
Solids storage and pre-dewatering	8,900	5.0	25.0	2.0	10.0	0.0	0.0
Final dewatering	7,200	1.0	10.0	1.0	5.0	10.0	50.0

15.4.3 Minimum Required Treatment

To evaluate potential treatment options, preliminary design criteria addressing minimum required treatment of each type of odorant were also established:

- 99 percent removal of H_2S
- 90 percent removal of orgS
- 99 percent removal of NH_3

15.4.4 System Configuration

TM No. 13 detailed additional design criteria to address the following potential causes of incidental odor emission:

- Deficient ductwork under positive pressure
- Equipment breakdown
- Variable (i.e., "shock") odorant loading

Ultimately, it was recommended that new odor control satisfy the following criteria:

- Minimize the length of collection ductwork (i.e., ductwork carrying untreated exhaust flow) under positive pressure by locating blowers near odor treatment, rather than odor sources
- Provide fully redundant (i.e., spare) equipment (i.e., blower, recirculation pump, chemical metering pump) capacity
- Provide redundant treatment capacity of sulfur odor via provision of multiple treatment stages in series

15.5 Odor Control Facility Description and Design Criteria

As detailed in TM No. 13, the preferred approach to new odor control is to treat the combined exhaust from GTs, SSTs, and pre-dewatering with a two-stage packed-tower scrubber system targeting sulfur odor and to treat the combined exhaust from final dewatering with a one-stage packed-tower scrubber targeting ammonia odor followed by a one-stage packed-tower scrubber and carbon polishing unit targeting sulfur odor.

15.5.1 Process Flow Diagram

The recommended approach includes the following:

- Treatment of the estimated 7,200 cfm exhaust from final dewatering and the truck bay with:
- One-stage chemical treatment of NH_3 odor with sulfuric acid
- One-stage chemical treatment of sulfur odor with sodium hydroxide and/or sodium hypochlorite
- One-stage carbon polishing of sulfur odor
- Treatment of the estimated 28,900 cfm exhaust from the GTs, SSTs, and pre-dewatering processes with:
- Two-stage chemical treatment of sulfur odor with sodium hydroxide and/or sodium hypochlorite

For clarity, the former is subsequently referred to as OCFA and the latter as OCFB.

A schematic representation of the alternative identifying the estimated gas loading, required liquid loading, makeup water demand, and chemical demand (at both peak and average odorant loading) is provided as Figure 15-2.

Both treatments, OCFA and OCFB, include two stages designed to remove sulfur odor. While H_2S can usually be reduced to satisfactory levels by one stage of chemical treatment, reduction of reduced organic sulfur compounds to satisfactory levels typically requires two stages of chemical treatment (or a single stage of carbon adsorption). OCFA also includes an additional stage to remove NH_3, which, if left untreated, could cause local odor issues and consume significant sodium hypochlorite dosed in the sulfur odor removal stage(s), potentially impairing sulfur odor removal or requiring higher dosing of sodium hypochlorite.

Redundant sulfur odor treatment capacity is provided via multiple stages of sulfur odor treatment. With OCFB, even if one packed tower was removed from service, adequate H_2S removal could be maintained by the other vessel, though that vessel would only be able to remove up to approximately 75 percent of reduced organic sulfur compounds. With OCFA, if the carbon scrubber was removed from service, adequate H_2S removal and up to 75 percent organic sulfur removal could be maintained by the packed-tower scrubber designed for sulfur odor.

Redundant (i.e., spare) blower, recirculation pump, and chemical metering pump capacity will be provided. The blowers and recirculation pumps shown on Figure 15-2 reflect pairs of blowers and recirculation pumps respectively, sized for duty/standby operation. Each NaOH and sodium hypochlorite input shown on Figure 15-2 is associated with a dedicated chemical metering pump.

The final criteria from Section 15.4, minimization of ductwork under positive pressure upstream of treatment, is satisfied via the location of the blowers within the two treatment schemes. The OCFA blowers are located downstream of the two packed towers, the latter designed for sulfur odor removal; the OCFB blowers are located downstream of the two packed towers, both designed for sulfur odor removal, as well. The location of the blowers should ensure that untreated (i.e., odorous) exhaust is never under positive pressure and thus at risk of uncontrolled release from deficient ductwork.

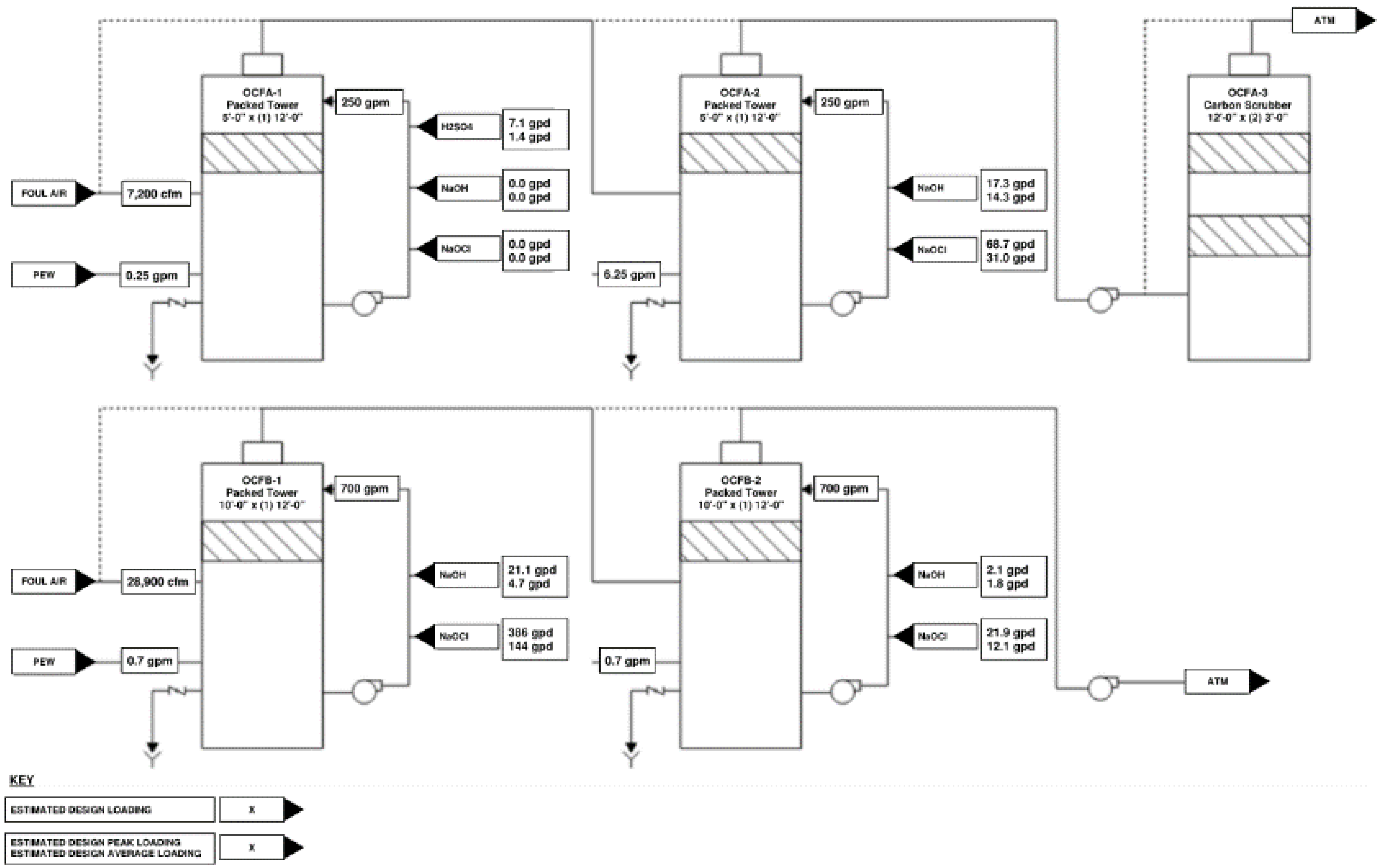

Figure 15-2. Schematic of Recommended Alternative for New Odor Control

15.5.2 Equipment

The recommended alternative requires the following equipment:

- Treatment vessels
- Blowers
- Recirculation pumps
- Chemical metering pumps
- Chemical storage

The quantity and size of the treatment vessels associated with the preferred alternative are listed in Table 15-4.

Table 15-4. Vessels Required

Qty.	Diameter		Packing Height	Equipment
2	5 ft	×	12 ft	Packed towers
2	10 ft	×	12 ft	Packed towers
1	12 ft	×	6 ft[a]	Dual-bed carbon scrubber

a. Each carbon bed has a depth of 3 feet.

All treatment vessels should be provided with integral demisters.

Two blowers will be provided for each exhaust flow, each sized to convey 100 percent of the flow. All blowers will be driven by VFDs. The preliminary quantity and size of the blowers are listed in Table 15-5.

Table 15-5. Blowers Required

Qty.	Size	Equipment
2	7,200 cfm	OCFA blowers
2	28,900 cfm	OCFB blowers

Two recirculation pumps should be provided for each packed-tower vessel, each sized to pump 100 percent of the design recirculation rate. All recirculation pumps should be provided with constant-speed motors. The quantity and size of the recirculation pumps required for the preferred alternative are listed in Table 15-6.

Table 15-6. Recirculation Pumps Required

Qty.	Size	Equipment
4	250 gpm	OCFA recirculation pumps
4	750 gpm	OCFB recirculation pumps

The chemical storage required to treat peak odorant loading over a 14-day period is estimated as follows:

- 105 gallons of sulfuric acid (97.0 percent active concentration by weight)
- 610 gallons of sodium hydroxide (25.0 percent active concentration by weight)
- 7,000 gallons of sodium hypochlorite (12.5 percent active concentration by weight)

Accordingly, the following chemical storage should be provided:

- One 300-gallon (i.e., 4-foot-long by 3.5-foot-wide by 3.5-foot-tall) tote for sulfuric acid
- One 6,000-gallon (i.e., 8-foot-diameter by 13.5-foot-tall) tank for sodium hydroxide
- One 7,000-gallon (i.e., 10-foot-diameter by 12-foot-tall) tank for sodium hypochlorite

As previously noted, one spare chemical metering pump should be provided for each of the three chemicals: sulfuric acid, sodium hydroxide, and sodium hypochlorite. Each set of chemical metering pumps, in order to provide maximum flexibility, should be sized to provide up to the maximum chemical dose estimated to treat peak odorant loading required by any of the four packed towers, with turndown to deliver the minimum estimated to treat average odorant loading. The quantity and size of the chemical metering pumps associated with the preferred alternative are listed in Table 15-7.

Table 15-7. Chemical Metering Pumps Required

Qty.	Design Flow Range (gpd)			Service
2	1	to	8	Sulfuric acid
4	1	to	25	Sodium hydroxide
4	10	to	400	Sodium hypochlorite

15.5.3 Facility Layout

The two treatment facilities under the preferred alternative, OCFA and OCFB, should be co-located on the same pad, both for convenience and in order to compact the overall odor control footprint. It is estimated that the pad would need to be a minimum of 50-feet-wide by 75-feet-long in order to fit all of the requisite vessels, equipment (i.e., blowers and recirculation pumps), and ductwork and have the ductwork configured in such a way that appropriate loading conditions are maintained at all vessels and blowers. Only the chemical storage and chemical metering pumps will be located elsewhere.

15.6 Equipment Operation and Controls

Maintaining continuous odor collection simply requires continuously running one blower associated with each treatment and maintaining a free flow path to and from it. The pairs of blowers will be operated as duty/standby. The duty blower will be alternated at intervals in order to preserve blower life.

The dampers located immediately upstream of the blowers will be used for isolation and motor actuated. The actuators will be configured to open and close according to the logic governing the duty/standby operation of the respective blowers. The dampers located immediately downstream of each fan will be backdraft dampers.

The dampers located at the inlet and discharge of each packed-tower scrubber will be manually adjusted dampers and used to isolate vessels. Those dampers will only be closed to remove a vessel from service; when a vessel is removed from service, the manually adjusted dampers on the respective bypass, which will normally be closed, will be opened. The open position of each bypass damper will be set such that roughly equal flow is maintained regardless of whether flow is through the bypass or the associated vessel.

The damper located at the inlet to the carbon scrubber and the damper located on the line to the OCFA bypass stack will also be manually adjusted and be used to isolate the carbon scrubber and block flow to the bypass stack respectively. The damper at the inlet to the carbon scrubber will be kept open unless the scrubber is removed from service (e.g., for carbon media replacement); the damper on the line to the bypass stack will normally be kept closed and only opened if the carbon scrubber is removed from service. Its open position will maintain flow close to the OCFA design rate.

The blower VFDs will adjust blower motor speed to maintain constant flow.

The pair of recirculation pumps associated with each packed-tower scrubber will also operate as duty/standby. The duty recirculation pump will run continuously as long as the respective scrubber is in service. The duty pump will be alternated manually, periodically to preserve pump life. When a standby pump is set to become the duty pump, the previous duty pump will be manually stopped and the isolation valves upstream and downstream of it manually closed. Then the isolation valves on either side of the new duty pump will be manually opened and the new duty pump manually started. Seal water to the recirculation pumps will be controlled by solenoid valve. The valve will open and close according to recirculation pump run status.

PEW will be used to supply make-up water to each of the packed-tower scrubbers. PEW flow to each vessel will be controlled by a solenoid valve, set to open and close to maintain a pre-set flow as set through a control valve and magnetic flow meter. A high level and low float switch will also be provided in each vessel and programmed to generate alarms.

PEW will also be used to supply water for spray nozzle cleaning and for demister cleaning. PEW flow to each spray nozzle and integral demister will be controlled by solenoid valve, normally closed but set to open in response to a PCS command to initiate cleaning.

Dedicated chemical metering pumps and spare metering pumps will operate as duty/standby. The dedicated chemical metering pumps will be used as the duty pumps unless removed from service. If a spare pump is to be used as a duty pump, the manual isolation valves upstream and downstream of the dedicated pump will be closed and the manual isolation valves upstream of the spare pump and downstream of the pump on the appropriate crossover line opened.

Duty metering pump operation will be automatic. Each duty pump for dosing sulfuric acid and sodium hydroxide will be set to run to maintain pH in the vessel being dosed within a target range. Each duty pump for dosing sodium hypochlorite will be set to run to maintain oxidation-reduction potential (ORP) in the vessel being dosed within a target ORP range.

Connections will be provided to allow for dosing sulfuric acid to OCFA-1, either into the recirculation line or directly into the vessel sump, dosing sodium hydroxide into the recirculation line of each of the four packed-tower scrubbers, and dosing sodium hypochlorite into each of the four packed-tower scrubbers, either into the respective recirculation lines or directly into the vessel sumps. All connections will be provided with manual isolation valves; chemical piping connecting to recirculation lines will be provided with a check valve immediately upstream of the connection. For safety, the piping supplying sodium hydroxide and sodium hypochlorite to OCFA-1 will be left disconnected. Prior to using OCFA-1 for sulfur odor treatment and connecting sodium hydroxide and sodium hypochlorite piping, the sulfuric acid piping to OCFA-1 will be purged with water and disconnected.

16 WPCP SUPPORT SYSTEMS

16.1 Background and Purpose

The solids handling process at the Arlington WPCP require support from several auxiliary, including non-potable water, chemicals added to the solids process, and process drains that recycle waste streams back into the liquid treatment process. The purpose of this section is to describe the existing support systems and the modifications anticipated. Modifications are described for both layout options: Option 1—renovate existing DWB, and Option 2—decommission the existing DWB. Modifications to existing support systems to support operations during construction are discussed in Section 22.

16.2 Plant Effluent Water System

This section describes the PEW system, including the existing PEW system and modifications to the PEW system.

16.2.1 Existing PEW System

Non-potable water at the Arlington WPCP is sourced from the plant effluent, so it is called PEW. The existing PEW pumps are located on the south side of the WPCP, west of the sodium hypochlorite facility, and are used to pump PEW throughout the facility for use in various processes. The PEW pumps draw previously disinfected water from the system. There are open-top tanks prior to the PEW pumps; consideration should be given to whether these tanks should be covered with netting or other materials to prevent debris (leaves) from entering the PEW system.

There are currently four vertical line shaft pumps configured in parallel, each rated for 3,650 gpm at 181 feet of head. Each is equipped with a 250 hp motor and a variable-speed drive. The basis for PEW system sizing, from MP01, is provided in Table 16-1 below.

Table 16-1. PEW Design Flows

Process Unit	Average (gpm)	Peak (gpm)	Notes
Elutriation water for GTs	1,200	2,400	Assumes two thickeners for peak
AT foam control spray	4,200	4,200	Assumes spray water to all tanks
AT hoods	50	200	Hypochlorite dose of 2 mg/L at 144 mgd
AT hoses	240	0	
AT effluent channel	910	910	
Chemical dilution	430	450	
Dewatering Building	60	550	Based on cleaning two centrifuges simultaneously
Secondary clarifiers	540	310	Foam spray nozzles
PTB	510	700	
Maintenance Building	500	500	Chillers (seasonal)
Miscellaneous	160	380	
Total	**8,800**	**10,600**	

Existing historical PEW usage is shown in Figure 16-1 below. As shown in this figure, average historical PEW usage is around 6 mgd (4,170 gpm). There was a sustained peak in excess of 9 mgd (6,250 gpm) in 2020. Operations reported this was a period of higher PEW use in the aeration tanks for foam control.

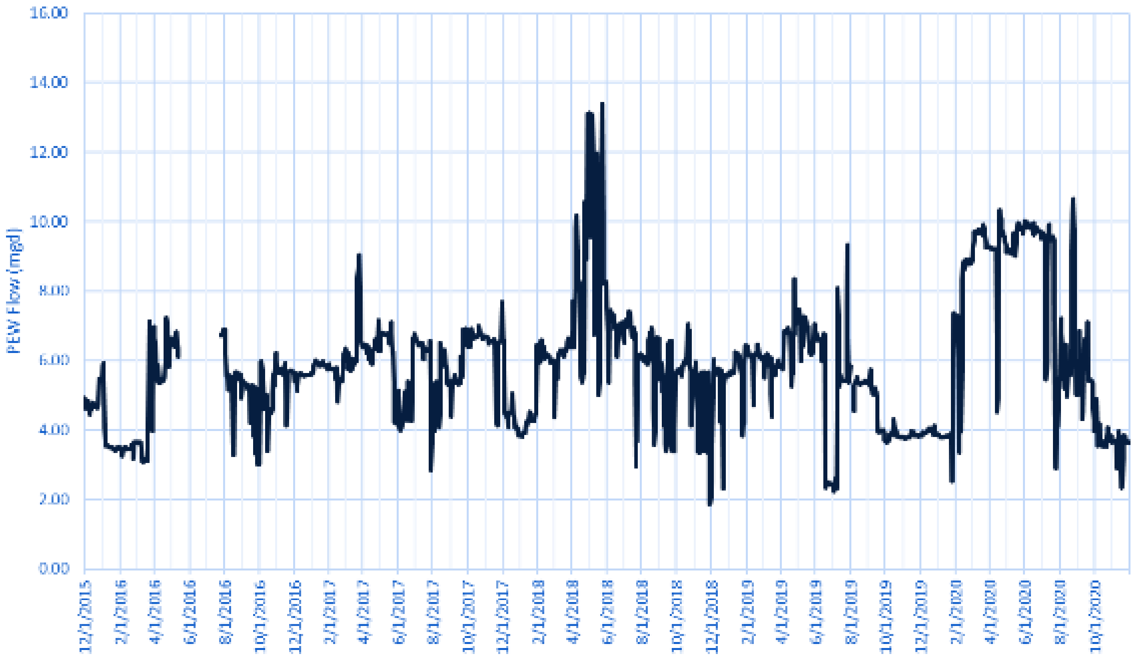

Figure 16-1. Average Historical PEW Usage

Based on discussion with operations, it was agreed that the existing design peak was very conservative. Suggested PEW design peaks for the liquid side treatment process are provided in Table 16-2 below.

Table 16-2. PEW Demand Revisions

Process Unit	Design Peak (gpm)	Revised Peak (gpm)	Notes
Elutriation water for GTs	2,400	700	One GT maximum (typically 600–700 gpm, less if HEX cooling water is recycled as elutriation)
AT foam control spray	4,200	2,400	Spray water to three tanks at a time
AT hoods	200	0	Not used
AT hoses	0	0	Used periodically, but not continuously
AT effluent channel	910	450	Used partially
Chemical dilution	450	450	
Dewatering Building	550	--	Analyzed below
Secondary clarifiers	310	310	
PTB	700	700	
Maintenance Building	500	500	Chillers (seasonal)
Miscellaneous	380	380	
Wet weather facility	--	2,080	Used when wet weather facility is off line, looking to eliminate—currently at 1,040 gpm
Total	**10,600**	**7,970**	

Flushing water from the preliminary treatment backup system is not included because of the short duration of the flow (30 to 60 minutes). The maximum liquid side usage of 7,970 gpm (11.5 mgd) aligns with recent historical usage and leaves 2,630 gpm (3.8 mgd) available capacity for solids handling process usage.

Sodium hypochlorite can be added to the discharge header from the pumping station to maintain a chlorine residual in the piping, although this is not current operating practice. PEW is supplied to the solids handling area of the WPCP through a 12-inch-diameter main located close to S Eads Street and a 14-inch-diameter main located between the existing GTs and SSTs. Both of these mains will remain in service for both layout options.

16.2.2 Modifications to the PEW System

The Program will retain the existing uses of PEW. In general, PEW will be used in similar ways as the existing solids handling processes – GT elutriation (accounted for above), polymer dilution, seal water, odor control, and centrifuge flushing and cleaning.

In addition, as discussed in Section 11, PEW will be used for cooling water at the HEX. PEW will be used for dilution of THS prior to digestion and could be added for dilution of centrate in the future if a deammonification system is added. Total peak PEW demands for the new solids handling processes are provided in Table 16-3 below.

Table 16-3. Solids Handling Processes PEW Demands

Process Unit	Design Peak (gpm)	Notes
Centrifuge clean in place	500	Two centrifuges simultaneously
Polymer	120	Pre-dewatering and final dewatering
Odor control	20	Refer to Section 15
HEX cooling	500	Refer to Section 11
Cake and THS dilution	80	Refer to Section 3
Future centrate dilution	100	To prevent inhibition
Miscellaneous	180	
Total	**1,500**	

The estimated pumping capacity available (2,630 gpm) is higher than the solids handling processes estimated PEW demand of 1,500 gpm. Some peak PEW loads could likely be reduced, if needed for capacity reasons, such as flows to the wet weather facility. In addition, the 14- and 12-inch-diameter PEW mains to the solids handling processes appear to be adequately sized to convey the maximum amount of water needed. The delivery team will complete a hydraulic model to confirm adequate water supply and pressure at all demand locations.

The dilution downstream of THP must be pathogen-free, so it would normally be supplied by the potable water (COW) system. Because the PEW can be chlorinated in the distribution system, it may be used as a backup supply for the post-THP dilution water.

Staff at the Arlington WPCP have considered operating the PEW system at a lower pressure on the south side of the WPCP and adding booster pumps for the north side where the solids handling process is located. If this occurs, a survey of all the PEW demands on the north campus should be competed to calculate the design parameters of the booster pumps. Isolation valves and pressure-reducing valves may be required to create a northern pressure zone in the PEW system.

16.3 County Water System

COW is provided to the north side of the WPCP through a 12-inch-diameter main off of S Eads Street. The New Maintenance Building (NMB) is fed COW from an 8-inch-diameter main off of 31st Street S. To improve resilience, the COW should be looped between S Eads Street and 31st Street S through existing connections or a new metered connection on 31st Street S. The delivery team will evaluate configuration and also confirm adequate COW for fire protection needs.

16.4 Recycle Management and Conveyance

This section describes recycle management and conveyance at the WPCP.

16.4.1 Recycle Flows

Table 16-4 provides the recycle flows at various design conditions. Drain piping will be designed for peak buildout flows. Major recycle flows include GT overflow, pre-dewatering centrate, final dewatering centrate, and HEX cooling water. Additional minor flows include washdown and seal water. The gravity thickener overflow (GTO) is based on a dilution water flow of 700 gpm, which could be reduced at peak flows. The pre-dewatering centrate is based on continuous operation at the specified loading condition except for peak day, which is based on all duty centrifuges operating at capacity (one centrifuge standby). The final dewatering centrate is based on operating 24 hours per day, 5.5 days per week at the specified loading condition without dilution of the feed to the centrifuges, with the exception of peak day, which is based on all duty centrifuges operating at capacity and diluting the centrifuge feed to 3.5 percent solids. HEX cooling water may be directed to the GT to offset a portion of the dilution water used there, but also may be directed to drain and contribute to the combined recycle flow.

Table 16-4. Recycle Flows Summary (all flows in mgd)

Source	30.8 mgd Average	30.8 mgd Peak 3-day	30.8 mgd Peak Day[a]	40 mgd Peak 3-day	40 mgd Peak Day[a]
GTO	1.50	1.85	1.85	1.92	1.92
Pre-dewatering centrate	0.63	1.02	1.09	1.50	1.63
Final dewatering centrate[b]	0.14	0.23	0.34	0.29	0.69
HEX cooling water	0.46	0.72	0.72	0.94	0.94
Combined recycles	**2.73**	**3.82**	**4.00**	**4.65**	**5.18**

a. Peak day is based on all duty centrifuges operating at full capacity of 400 gpm or 4,240 lb DS/hr and diluting the final dewatering feed to 3.5% solids.
b. Final dewatering centrate flows for average and peak 3-day conditions are based on 5.5 days per week operation.

16.4.2 Recycle Treatment

After startup of the new solids facilities, the final dewatering nitrogen recycle load will be returned to the WPCP and treated in the existing mainstream process. Design criteria for this recycle load are presented in Section 23 as part of the future sidestream treatment design criteria. The new facilities will be designed to accommodate a future sidestream deammonification process for the final dewatering centrate, as discussed in Section 23. This section addresses the treatment of the final dewatering recycle stream in the mainstream process.

The mainstream activated solids process uses conventional nitrification and denitrification for nitrogen removal. The major operating costs for mainstream treatment of the recycle load are methanol for denitrification, supplemental alkalinity, handling of solids generated from denitrification, and additional air for nitrification. Table 16-5 lists the estimated impacts to the mainstream process at 28 mgd plant flow (design midpoint). These values represent average or continuous operation, and it should be noted that the centrate will be returned approximately 24 hours per day, 5.5 days per week during final dewatering operation, prior to implementing future centrate equalization and sidestream deammonification. This final dewatering operating schedule will result in higher daily loads during operation. Consideration could be given during design to installing centrate equalization now instead of with future sidestream deammonification.

Table 16-5. Mainstream Treatment Impacts from Recycle Load (28.0 mgd, Design Midpoint)

Item	Unit	Value	Notes
Additional methanol	gpd	1,050	Assuming 100% of ammonia recycled to mainstream is denitrified with methanol at 3.5 lb methanol/lb-N ratio.
Additional caustic	gpd at 25wt%	740	Supplementing 35% of alkalinity deficiency for complete nitrification prior to denitrification
Additional electricity	kWh/d	2,400	From aeration for nitrification, based on a literature value of 1.2 kWh/lb-N
Additional solids to THP (from methanol)	DT/d	1.23	From use of additional methanol for denitrification

While Arlington WPCP does not currently feed supplemental alkalinity to the mainstream treatment process, supplemental alkalinity is recommended to reliably treat the new nitrogen recycle load. Additional capacity for storing and feeding supplemental alkalinity may be required. Preliminary estimates for supplemental alkalinity feed to the mainstream process include two new 12,500-gallon storage tanks for 25 percent caustic, providing an estimated 30 days of storage at 30.8 mgd plant flow, as well as feed pumps and accessories. Additional details regarding preliminary estimates for supplemental alkalinity are provided in TM No. 8: *Recycle Management and Sidestream Treatment*. Supplemental alkalinity demand and storage capacity should be evaluated further and expanded as required. This evaluation should include process modeling and evaluations of equipment and processes to confirm sufficient nitrogen removal capacity and to develop measures for improving nitrogen removal performance. The activated sludge process likely has excess aeration capacity because the blowers are sized for plant buildout flow, and aeration capacity for nitrification should be confirmed. It is expected that the liquid treatment process consultant will provide evaluation of the chemical requirements as well as optimization measures for mainstream treatment.

16.4.3 Existing Recycle Conveyance

This section describes the recycle loads from the existing solid processes and the facilities that convey them. Table 16-6 lists the design conditions for recycle flows.

Table 16-6. Existing Recycle Flows Summary (all flows in mgd)

Source	40 mgd Average	40 mgd Peak 7-day
GTO	1.40	1.60
DAFT subnatant	0.43	0.80
Centrate	0.55	0.65
Combined recycles	**2.38**	**3.05**

Source: Process Flow Diagram, Drawing G00-08, Upgrade and Expansion Phase 7B, Malcolm Pirnie, 2005.

16.4.3.1 Plant Drains

Each of the existing flows in Table 16-6 has a gravity drain into one of the influent channels. The centrate from the DWB is connected to 24-inch scrubber waste drain (SCWD) in the basement of the Biological SPB (Bio-building) where the abandoned incinerator is located. The SCWD goes between GT 2 and the SSTs into the Potomac Interceptor. The DAFT subnatant can flow from the west side of the DAFT Building through a 14-inch drain into the Four Mile Run Interceptor. A 20-inch GTO drain discharges to the influent channel into the PTB.

16.4.3.2 Recycle Interceptor Pump Station

Under normal circumstances, the existing recycle flows are not discharged into the influent sewers through the gravity drains. In the Arlington WPCP Upgrade and Expansion Phase 7B Project a Recycle Interceptor Pump Station (RIPS) was installed to pump these recycle flows around the preliminary treatment processes. The centrate and DAFT subnatant are directed through alternate gravity drains to the 20-inch GTO drain. A valve was inserted into the 20-inch GTO drain to direct all the recycle flows into the RIPS. The RIPS is an 8-foot-diameter concrete manhole with two submersible pumps. The RIPS discharge goes to the PC gallery where it can be directed to either the grit effluent channel or the primary effluent channel.

16.4.4 Modifications to Recycle Conveyance

The pumps in the RIPS are approximately 15 years old and approaching the end of their useful lives. They are not reliable and have significant maintenance costs. They also have significant operating power costs. Therefore, WPCP staff would like to replace the RIPS with gravity drains downstream of preliminary treatment and influent sampling. The centrate and DAFT subnatant could be diverted to the PCs 5–8 influent channel by installing a valve in the 24-inch SCWD just prior to the Potomac Interceptor and installing a gravity extension to the west end of the channel. The extension would have to avoid potential conflicts with the Potomac Interceptor under the access road, storm drains on the north side of the access road, and the RIPS discharge pipe.

Preliminary hydraulic calculations show that the GTO could be redirected to flow by gravity through the RIPS discharge pipe. Hydraulic calculations should be confirmed during detailed design after a pipe route is laid out. A schematic layout is shown in Figure 16-2 below.

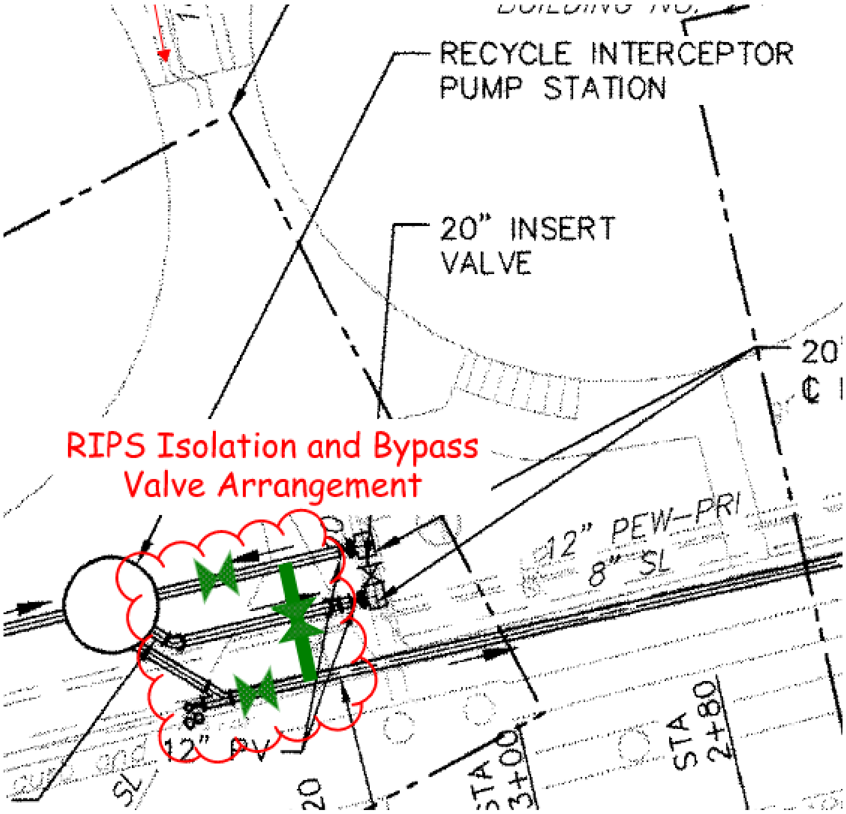

Figure 16-2. RIPS Isolation and Bypass Arrangement

The modifications to the recycle conveyance facilities also need to provide drains for the new recycle flows created by the Program—final dewatering centrate and HEX cooling water. In Option 1—renovate existing DWB, the final centrifuges would be installed on the east side of the solids process away from existing process drains. For this option, a new process drain to the PCs 5–8 influent channel would be installed. In Option 2—decommission existing DWB—the final dewatering centrate would be combined with the pre-dewatering centrate and recycled through the modified 24-inch SCWD described above.

The HEX cooling water could be used for elutriation water in the GTs. In this case, the cooling water would be recycled as GTO as described above. If cooling water is not used for elutriation, it could be recycled to the liquid treatment process through the same drain as the final dewatering centrate. All recycle streams shall be independently monitored for flow and shall be provided with an efficient means to be individually sampled.

16.5 Sodium Hypochlorite Storage and Feed Facility

This section is limited to the sodium hypochlorite system for the existing and proposed odor control facilities on the north side of the Arlington WPCP. It does not include details of the sodium hypochlorite system on the south side of the WPCP.

16.5.1 Existing Facility

The existing sodium hypochlorite system on the north side of the WPCP for the DWB (odor control) only consists of the following:

- A delivery station located off S Eads Street
- A storage tank with approximately 10,000 gallons of capacity located in the basement of the Bio-building
- Two transfer pumps located near the 10,000-gallon storage tank
- A storage tank with a working volume of 3,300 gallons located on the ground floor of the DWB
- Metering pumps located near the 3,300-gallon tank to feed sodium hypochlorite to the odor control system adjacent to the DWB

This existing facility will be demolished because the existing odor control system it serves will be demolished as discussed in Section 15. Refer to Section 22 for temporary facilities and MOPO during construction.

16.5.2 New Facility

A new sodium hypochlorite facility is required for the new odor control system and to supplement PEW chlorination for the HEX cooling water. The new odor control facility will be located in the area of the abandoned digesters north of PCs 5–8. The new sodium hypochlorite facility will be located in a new Chemical Building next to the odor control facility.

Because of the size and demand for sodium hypochlorite, a bulk storage tank with independent delivery from south side sodium hypochlorite is recommended. Peak demands for odor control are expected to be infrequent and approximately 10 times higher than average demands. Therefore, it is recommended to size the facilities for peak 14-day storage. One storage tank with a working volume of 7,000 gallons is required. The tanks will be situated in a containment area large enough to hold the contents of one full storage tank. The delivery station will include safety features such as an eyewash/shower and a drain line to direct spills into the containment area.

17 FACILITY AND SITE PLAN

17.1 Background and Purpose

This section presents preliminary site layout options and site design considerations.

17.2 Site Layout Options

This section describes the two site layout options for the Program.

17.2.1 Options Evaluated and Site Selection

This section presents two options for the site layout based on either renovating or decommissioning the existing DWB (Options 1 and 2, respectively). These two options were developed to confirm feasibility and may not represent the final site layout developed collaboratively with the delivery team, County, and Program Manager.

For both options, equipment sizing was based on a 30.8 mgd design flow and building space was sized for future equipment required at the 40.0 mgd plant buildout condition. Design flow conditions for each process were presented in Section 3. If the existing DWB is renovated, then it will be modified for the pre-dewatering process as well as screening and steam boilers. If the DWB is decommissioned, then a new SPB will be constructed that incorporates pre-dewatering, final dewatering, screening, and steam boilers.

Key considerations for the initial development of the site layouts included the following:

- Locating pre-dewatering close to THP to minimize cake pumping distance
- Locating SSTs close to screen feed pumps and pre-dewatering centrifuge feed pumps to minimize suction piping distance
- Minimizing piping distance between other facilities
- Locating flare at least 50 feet away from the anaerobic digesters
- Providing adequate truck access to final dewatering
- Providing adequate space for digester construction
- Maintaining WPCP operations during construction by avoiding critical electrical infrastructure, construction sequencing, and/or providing temporary systems
-
- These same considerations should be carried forward for all site layouts considered by the delivery team.

17.2.1.1 Option 1: Renovate Existing Dewatering Building

The proposed site plan for Option 1—renovate existing DWB—is shown on Drawing C-004. Modifications to the existing DWB are shown on the M-300 series drawings. For this option, the existing DWB would be repurposed for pre-dewatering, solids screening and future WAS thickening. The existing DWB is not being considered for final dewatering because the size and loadout configuration are better suited for pre-dewatering. A separate Digester Building and Final DWB would be required for this option. The new Final DWB will have a drive-through truck loadout.

The existing DWB was constructed in the 1990s. A condition assessment of the existing facilities including the DWB was conducted and is documented in TM No. 2: *Condition of Existing Facilities*. This condition assessment evaluated processes being considered for replacement as a part of the new solids handling processes and evaluated whether the existing facilities can be expected to operate for the next 5 years until the new process starts up. The evaluation determined that the existing DWB is structurally sound and could be used for future facilities. If the existing DWB is renovated it would be reconfigured as necessary to serve the new treatment processes.

The following building components would be repaired, replaced, or upgraded to renovate the DWB:

- Repair cracks in exterior brick, repointing, and sealant
- Replace all doors and windows
- Replace roof
- Replace all electrical systems
- Overhaul and replace all heating, ventilation, and air conditioning (HVAC) equipment as required for the new process configuration and to meet NFPA 820 requirements
- Complete an overall code compliance check to confirm upgrade requirements
- Structural modifications including a WAS thickening area (EL 25.00), boiler room (EL 43.00), and screening area (EL 66.00)

The following equipment would be upgraded or replaced as part of the DWB renovation:

- Replace solids feed pumps with new pre-dewatering centrifuge feed pumps
- Replace centrifuges
- Replace polymer systems
- Install new cake diverter gates and conveyors, and completely rehabilitate any conveyors and gates being reused
- Retain one existing truck bay for emergency loading of pre-dewatering cake and repurpose the other truck bay for polymer storage and feed system, screen feed pumps, and SST mixing system
- Install odor control ducting to new odor control system

The existing cake storage bins would be used to store pre-dewatered cake. These bins have a total capacity of 428 CY and would provide 29 hours of storage at 40 mgd average conditions. The pre-dewatered cake would be pumped to THP on the east side of the DWB.

17.2.1.2 Option 2: Decommission Existing Dewatering Building

The proposed site plan for Option 2—decommission existing DWB—is shown on Drawing C-007. For this option, the existing DWB would no longer be used, and a new SPB would be constructed. The concept for the new SPB is shown on the M-350 series drawings. The new SPB would include equipment serving the SSTs, screening, pre-dewatering, final dewatering, anaerobic digester pumps, polymer systems, and steam boilers and would include provisions for future expansion to add WAS thickening equipment.

The first level of the SPB (EL 24.00) would be accessible from grade from the east side where truck loading bays are located for final dewatered cake and screenings. The second level (EL 42.00) would be accessible from grade on the west side. The digester cooling HEXs are shown on top of the south side of the SPB at this level. The third level (EL 60.00) would provide access to the top of the cake bins, and the centrifuges would be located on the fourth level (EL 74.33).

17.2.2 Facilities to Be Demolished

The overall site demolition plan is shown on Drawings C-003 and C-006. The following existing facilities would be demolished:

- SSTs including solids pumping station
- Bio-building and existing retaining wall
- Odor control system located outside the existing DWB and DWB truck bay extension
- Lime silo and associated lime handling equipment
- Remaining walls and foundation of original digesters and digester control building
- Metal storage building at the north end of the site (Butler Building)

17.2.3 Major New Facilities

Major new facilities for both site layout options would include the following:

- SSTs
- THP and THS cooling systems
- Anaerobic digesters
- Odor Control and Chemical Building
- Biogas upgrading facilities and flare
- Electrical Building

Additionally, Option 1—renovate existing DWB—would include:

- Renovated DWB with pre-dewatering, screening, and steam boilers
- Digester Building
- Final DWB

Option 2—decommission existing DWB—would include a new SPB with digester pumps, pre-dewatering, final dewatering, screening, and steam boilers.

17.2.4 Future Facilities

Future facilities include WAS thickening, FOG receiving, sidestream deammonification, and solids post-processing. This section describes the site layout implications for these future facilities. Design information for the future facilities is provided in Section 5 (Waste Activated Solids Thickening) and Section 23 (FOG, Sidestream, and Post-processing). Space must be reserved for WAS thickening, FOG receiving, and sidestream deammonification. Solids post-processing facilities must be evaluated to determine if they can fit on the site.

Mechanical WAS thickening will not initially be included, and un-thickened WAS will be combined with thickened PS prior to pre-dewatering. For both site layout options, space will be allocated for future WAS thickening should process changes be implemented at the WPCP. For Option 1—renovate existing DWB—RDTs are assumed for future WAS thickening because they have a more compact footprint than GBTs. The future RDTs in the existing DWB are shown on Drawing M-305. For Option 2—decommission existing DWB—GBTs or RDTs could be implemented in a new facility. Drawing C-007 shows the future WAS thickening location for Option 2—decommission existing DWB.

Future FOG receiving should ideally be located close to THP. For Option 2—decommission existing DWB—future FOG receiving could be configured in the location of the existing DWB truck loading bays. For Option 1—renovate existing DWB—there is limited space for FOG receiving in the vicinity of THP. FOG receiving may be configured at the north end of the site but would require close coordination with the layout of solids storage and biogas upgrading. This location would also put a source of potential odors near the roadway. For both site layout options, FOG receiving could be configured in the location of the existing DAFT Building, but this location is a long distance from THP and therefore not ideal due the length of FOG piping required. The location for future FOG receiving must evaluated and coordinated with the overall site plan.

The proposed location for the future sidestream deammonification process is south of the anaerobic digesters. The location and orientation of the system may vary between Options 1 and 2 (refer to Drawings C-004 and C-007, respectively). The sidestream treatment location is near final dewatering to minimize the length of centrate piping between these two processes.

Post-processing could include drying and potentially an additional pyrolysis process after drying. Ideally, post-processing should be located close to final dewatering to minimize the distance for cake conveyance. For Option 2—decommission existing DWB—a dryer facility could be configured on the north side of final dewatering in the location of the existing DWB. For Option 1—renovate existing DWB—incorporating a dryer facility would require more significant changes to the conceptual site layout. Odors and dust near roadways would be key considerations for dryer facility locations.

17.2.5 Site Evaluation and Site Selection

The County will work collaboratively with the delivery team to finalize a site layout. The delivery team is not constrained to the two site layouts presented. Rather, the site considerations presented in Section 17.2.1 should be considered while evaluating whether the existing DWB should be renovated or decommissioned.

It is understood that Option 2—decommission existing DWB—presents site challenges associated with grading, utility locations, and existing structure locations. However, Option 2 also has the potential benefits of consolidated facilities, elimination of temporary operations, and greater space for future accommodations.

The site layout for Option 2 presented in the Facilities Plan drawings is shown schematically below in Figure 17-1.

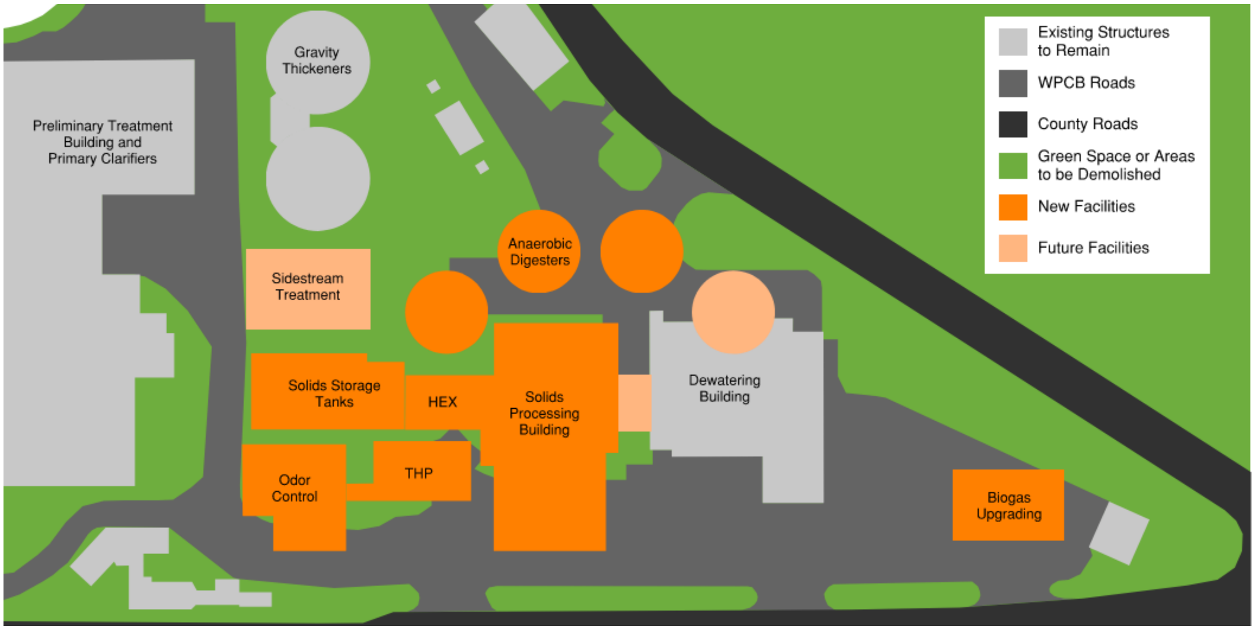

Figure 17-1. Option 2: Decommission Existing Dewatering Building as Presented in Facilities Plan

There are likely multiple permutations of this site layout that could be considered. Two alternative concepts are presented in Figure 17-2 and Figure 17-3 below.

Figure 17-2. Option 2: Decommission Existing Dewatering Building—Alternative Concept 1

Alternative Concept 1 relocates the digesters to the area of the existing Bio-building, while relocating the SPB to the south.

Figure 17-3. Option 2: Decommission Existing Dewatering Building—Alternative Concept 2

Alternative Concept 2 would relocate the digesters to the area of the old digesters and retain the SPB in the area of the existing Bio-building.

These are presented not to convey preferences but to show that alternatives will be considered should they offer benefits to the concept presented in the Facilities Plan.

17.3 Site Design Considerations

The site civil design will include drainage structures, grading, erosion control, landscaping, truck and vehicle access, utility relocations, and other appurtenances to support the proposed improvements. The civil design will be coordinated with all other deign disciplines. The Program Manager developed an existing-conditions base file using information provided by Arlington County to prepare the facilities' civil conceptual plans. A new topographic survey will be required for the design of this project to establish a site control or benchmark for construction of the improvements. No assessment of existing retaining walls on site was performed for this study as it is not anticipated that any existing retaining walls would remain.

17.3.1 Existing Conditions

The WPCP is bordered by 31st Street S on the north, S Eads Street on the east, S Glebe Road on the south, and S Fern Street on the west. The northwest portion of the site can currently be accessed from two entrances on S Eads Street and one entrance on 31st Street S. The site is zoned P-S (Public Service District).

The WPCP site is a very congested site, with the solids handling facilities situated on the triangular northernmost part of the WPCP. The location for the new facilities is bordered on all sides by critical buried infrastructure including major electrical ductbank, the Potomac Interceptor influent to the WPCP and the influent channel, which carries all influent wastewater flow to the PTB.

Drainage patterns on site are generally from north to south toward Four Mile Run stream. The site is in Flood Hazard Zone X according to Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel 51013C0081C effective August 19, 2013. Zone X is an area of minimal flood hazard.

17.3.2 Neighborhood

As the WPCP is surrounded by residential neighborhoods, and as stated in the Section 1, the vision of this Program is to be a good neighbor within the community and maximize community acceptance.

17.3.2.1 Visuals/Aesthetic

Design considerations will be taken for the new biosolids facilities to provide a pleasant visual aesthetic to the public as they travel along 31st Street S and S Eads Street bordering the north section of the WPCP. Where feasible, process equipment will be located inside buildings, and where not feasible, screening walls will be installed to provide visual screening from large, exposed process equipment and pipe racks. New buildings will be designed to blend in with the existing treatment plan aesthetics.

New facilities at the WPCP will be designed to coordinate with the existing structures on site. Refer to Section 17 for architectural details.

17.3.2.2 Noise

Design considerations will consider noise reduction for both equipment selection and facility location and design. Rooms where noise is a concern (such as centrifuge operating floors) will have sound attenuation panels, both to reduce noise impacts to operators and to reduce any noise leaving the building envelope. Where outdoor equipment noise is a concern, such as air compressors for the THP pneumatic valve actuators, enclosures will be considered for sound attenuation.

17.3.3 Site Civil Design and Landscaping

All site plan options will require demolition of pavement and buildings to install proposed improvements. Major grading will be necessary for both options. New retaining walls will need to be constructed around Digester 2 for Option 1—renovate existing DWB—and new retaining walls will need to be constructed between the solids storage tanks and Digester 1 and Digesters 1 and 2 for Option 2—decommission existing DWB—as shown on the drawings. Proposed water and sewer utilities will be designed to avoid conflicts with other utilities, storm drains, buildings, and walls. Depending on proximity of new structures to existing utilities, some existing utilities may need to be rerouted.

Tree replacement will be required where construction activities impact existing trees. Street trees will need to be replaced along 31st Street S according to the standards described in the Arlington County Zoning Ordinance, Article 14.2 Landscaping, where the existing entrance will be closed and landscaped.

There may be a slight increase in impervious area, but the increase is not anticipated to be at a degree that will require additional stormwater detention facilities. The proposed site design, for both options, will preserve existing drainage patterns. Stormwater management performance will meet the requirements of the Virginia Stormwater Management Act. More information about stormwater management is provided in Section 17.3.6 below.

Building setbacks from streets are required for buildings on this site. Setbacks for this P-S zoned site are 40 feet from the centerline of any street. No side or rear yard setbacks are required. The maximum height of structures according to the ordinance is 75 feet. Smokestacks and water towers may, by use permit, exceed 75 feet.

Specific parking requirements for wastewater treatment plants are not listed in the Arlington County Zoning Ordinance; however, Section 14.3.7.B of the ordinance states that by the interpretation of the zoning administrator, spaces will be provided on the same basis as required for the most similar listed use in the table provided in Section 14.3.7. This site seems to align closely with the listing for Warehouse and Freight Movement—uses consisting of manufacture, processing, assembly, storage, warehousing, wholesale. The required spaces for this use are one space per 1,000 ft^2 of floor area, or one space for each two employees, whichever is greater.

17.3.4 Traffic Management

This section presents traffic management considerations for the two site layout options considered for the project. Truck considerations were evaluated with a WB40 truck for solids loadout and a GU714 for solids screenings.

17.3.4.1 Option 1: Renovate Existing Dewatering Building

For Option 1—renovate existing DWB—there would be no change to vehicle access along 31st Street S. However, the southernmost entrance off S Eads Street (Gate 2) would be moved farther to the south to accommodate solids hauling trucking operations.

Solids hauling trucks would enter the site from the newly relocated Gate 2 entrance off S Eads Street and proceed to the drive-through Final DWB to be loaded with solids. Trucks would then exit the WPCP through the northern entrance (Gate 1) off S Eads Street entrance.

Access to the solids screenings dumpster would be from the existing 31st Street S entrance (Gate 3) to the plant. Trucks would back into the dumpster bay and load/unload the screenings dumpster then exit out of the WPCP through the 31st Street S entrance.

17.3.4.2 Option 2: Decommission Existing Dewatering Building

For Option 2—decommission existing DWB—there would be no change to vehicle access along S Eads Street. However, the Gate 3 entrance would be relocated to accommodate the construction of the new digesters. A new entrance would also be required to maintain access to the NMB.

Solids hauling trucks would enter the site from Gate 2 off S Eads Street and proceed to the easternmost drive-through SPB to be loaded with solids. Trucks would then exit the WPCP through Gate 1.

Access to the solids screenings dumpster would be from Gate 2 with the trucks driving past the SPB and backing into the dumpster bay, which is adjacent to the solids loading bay, and load/unload the screenings dumpster. The truck would then exit out of the WPCP through Gate 1.

17.3.5 Utility Relocations

The extensive demolition of existing structures and construction of new facilities will impact the utilities on the site. Utilities include different water systems, energy systems, and communications. Process-related site piping such as chemicals and process drains are discussed in Section 16. Construction sequencing and MOPO are discussed in Section 22.

The utilities on site include:

- COW
- WPCP PEW
- Storm drains
- Natural gas
- Electricity
- Communications

The two options have similar utility impacts because demolition and construction activity are concentrated in the area occupied by the existing Bio-building, SSTs, and abandoned digesters. However, there are significant differences as described below.

17.3.5.1 COW and PEW Piping

COW is supplied to the existing solids processing facilities from a 12-inch-diameter main in S Eads Street. Construction activities will not impact the street or the COW main. For both options there will be only limited modifications to the driveway in the WPCP along S Eads Street, so major piping relocations are not anticipated.

PEW is sourced from the WPCP effluent and the PEW pumps are located on the south side of the WPCP. PEW is supplied to the solids handling area of the WPCP through a 12-inch-diameter main located close to S Eads Street and a 14-inch-diameter main located between the existing GTs and SSTs. Both of these mains will remain in service for both layout options, so major piping relocations are not anticipated.

17.3.5.2 Natural Gas

NG service for the existing DWB and Biological Solids Building is provided through a 4-inch-diameter line that enters the site from 31st Street S. The existing NG meter is adjacent to the Bio-building. For Option 1—renovate existing DWB—the NG meter could be permanently relocated nearby where the NG line enters the DWB. For Option 2—decommission existing DWB—the existing DWB is designated for Digester 4 in the future. The NG meter could be permanently relocated close to 31st Street S or adjacent to the new SPB. A plan for maintaining NG service would have to be developed for this option.

Coordination with the NG utility is required to determine sufficient pressure and flow is available for the new solids process. The NG pressure and existing regulators need to be evaluated during design because the new boilers may use NG as a fuel source.

17.3.5.3 RNG

An RNG interconnect will be required with the local utility to supply RNG to the gas distribution system. This RNG interconnect will be designed and constructed by the gas utility and will contain all necessary infrastructure for injection and monitoring of RNG into the gas grid. It is anticipated that this interconnect will be located near the gas upgrading equipment at the northern tip of the site. This location is near the existing utility's existing distribution line.

17.3.5.4 Electrical and Communications

For electrical relocations, refer to Section 19, Electrical Distribution System.

17.3.6 Stormwater Management

The Arlington WPCP site generally slopes from north to south with runoff from the WPCP draining to Four Mile Run stream, which is a tributary to the Potomac River, which ultimately discharges into Chesapeake Bay. Because this project site is in the Chesapeake Bay Preservation Area, any land disturbance activities greater than or equal to 2,500 ft^2 must meet the requirements of Virginia Stormwater Management Act.

As required under this act, water quality and quantity requirements must be met for this project in compliance with Virginia Administrative Code Title 9 Agency 25 Chapter 870, Sections 65 and 66.

This site has been previously developed so this project would qualify as a redevelopment project. Based on our initial assessment of the two design options—Option 1, renovate existing DWB, and Option 2, decommission existing DWB—it was determined that the limit of disturbance (LOD) area associated with both options is approximately 3.5 acres. The LOD area for the Option 1—renovate existing DWB—is slightly greater than that for Option 2—decommission existing DWB.

In accordance with Virginia Stormwater Management Program (VSMP) Part IIB water quality criteria, preliminary evaluation using the Virginia Runoff Reduction Management (VRRM) spreadsheet was performed and it was concluded that the total phosphorus reduction requirement for this project for both options is less than 10 pounds per year (lb/yr). In accordance with Virginia Administrative Code Title 9 Agency 25 Chapter 870, Section 69, this project would be eligible for purchase of nutrient credits based on the facts that total limit of disturbance is less than 5 acres and the total required phosphorus reduction is less than 10 lb/yr, and on-site stormwater best management practices (BMPs) to meet the water quality requirements are not required and not anticipated.

In the proposed condition for both options, approximately 0.4 acre of site area will be collected and treated by the wastewater process. For both options the total area that contributes to stormwater runoff is less than the runoff in the existing condition. Therefore, on-site stormwater BMPs to manage channel protection and flood control flows are also not anticipated to comply with Virginia Administrative Code Title 9 Agency 25 Chapter 870, Section 66.

18 FACILITIES DESIGN CRITERIA

18.1 Background and Purpose

This section summarizes the general design criteria for the Program design specialties including structural, architectural, HVAC, plumbing, and fire protection. It also highlights some of the sustainable building design features that will be included in the Program to align new and renovated facilities with Arlington County’s Green Building Policy.

18.2 Structural Design Criteria

18.2.1 Codes and Standards

All buildings and structures will be designed to meet or exceed the minimum requirements as required by applicable codes and standards using commonly accepted engineering methods and practices. Structural design will be in accordance with the following codes and standards:

- 2018 Virginia Uniform Statewide Building Code (VUSBC) (referencing the International Building Code [IBC], 2018) with Virginia and local amendments (hereafter called “Building Code” or “Code”)
- American Society of Civil Engineers (ASCE) 7-16 “Minimum Design Loads and Associated Criteria for Buildings and Other Structures”
- American Concrete Institute (ACI) 318-14 “Building Code Requirements for Structural Concrete”
- ACI 350-20 “Code Requirements for Environmental Engineering Concrete Structures”
- ACI 350.3-06 “Seismic Design of Liquid Containing Concrete Structures”
- Aluminum Association (AA) ADM-2015, Aluminum Design Manual
- American National Standards Institute (ANSI)/American Institute for Steel Construction (AISC) 341, Seismic Provisions for Structural Steel Buildings
- ANSI/AISC 360, Specification for Structural Steel Buildings
- AISC Design Guide 27, Structural Stainless Steel
- AWWA, D110 Wire and Strand Wound Circular, Prestressed Concrete Tanks
- The Masonry Society (TMS) 402-2016, Building Code Requirements for Masonry Structures

18.2.2 Dead Load

Dead load includes the weight of all permanent or semi-permanent loads imposed on a structure. These loads include, but are not limited to, the weight of materials used for construction; walls; floors; ceilings; stairways; built-in partitions; finishes; cladding; equipment; and other architectural, mechanical, and structural components incorporated into the structure.

18.2.3 Live Loads

Live loads are forces imposed on a structure from its use or occupancy. Floor loads will be applied to buildings and structures as specified in the Building Code but typically will not be less than 100 pounds per square foot (psf). Floor and other service live loads used for design are given below:

Corridors and egress	100 psf reducible
Stairs	100 psf reducible/300 lb concentrated
Light storage	125 psf non-reducible
Heavy storage	250 psf non-reducible
Shop and maintenance	250 psf minimum
Mechanical rooms	150 psf minimum
Electrical rooms	300 psf minimum
Roof	20 psf reducible/300 lb concentrated
Guardrails/handrails	50 plf/200 lb concentrated
Bollards	6,000 lb concentrated, static
Roof load	20 psf minimum
Operating floors	250 psf minimum
Pump room floors	300 psf minimum
Stairs and grating	100 psf, unless otherwise required

Pipes less than 12 inches in diameter will be accounted for in a uniform piping load. The uniform load will be evaluated after preliminary piping layouts are known. A minimum load of 5 psf will be used. Where fire protection piping is present an additional minimum uniform load of 10 psf will be applied.

For piping 12 inches and greater in diameter, pipe racks, piping corridors, and valves produce heavier concentrated loads on pipe racks and structures supporting the pipes. Pipe racks will include an allowance for future piping as recommended by the process engineer and consideration given to any electrical equipment that may be supported therefrom. Pipe support reactions, including any thrust loads, will be calculated and structural members will be designed for the appropriate loads.

18.2.4 Process Loads

Lateral and vertical loads imposed on the structure due to static and dynamic content forces will be considered in the design of tanks, channels, and basins. The specific gravity of the content will be verified during the design phase, but typical densities for municipal sewage are as follows:

Water	62.4 pcf
Raw sewage	63 pcf
Digested solids	65–70 pcf
Dewatered solids (non-compacted)	45–50 pcf

18.2.5 Wind Loads

Wind forces will be determined in accordance with ASCE 7. Site specific parameters for wind design are as follows:

Basic wind speed, V	119 mph
Wind direction factor, Kd	0.85
Topographic factor, Kzt	1.0
Exposure	C
Gust effect factor, G	0.85
Internal pressure coefficient, GCpi	+/-0.18 enclosed, +/-0.0 open

18.2.6 Snow Loads

The code-prescribed ground snow load will be used for determination of snow loads for the roofs of buildings and other structures. Drifting snow will be considered in the design. Site-specific parameters are as follows:

Ground snow load	25 psf
Risk category	III
Importance factor	1.10

18.2.7 Seismic Loads

Seismic forces will be determined as prescribed by the VUSBC and ASCE 7. Site-specific parameters determined per the ASCE 7 Hazard Report are as follows:

Risk category	III
Soil classification	D (assumed—to be verified)
MCE 5% damped spec, acceleration, S_S	0.133 g
MCE 5% damped spec, acceleration, S_1	0.043 g
Design 5% damped spec, acceleration, S_{DS}	0.142 g
Design 5% damped spec, acceleration, S_{D1}	0.069 g
Importance factor	1.25
Seismic design category	B

18.2.8 Geotechnical

Lateral earth and groundwater pressures and coefficients will be obtained from the Program's geotechnical report. Geotechnical investigations will be coordinated and implemented during the early stages of the detailed design phase of the Program. Historical geotechnical information is available from past projects at the site. Geotechnical loads will not be used to offset other lateral loads.

Frost depth for construction will be as specified by the geotechnical report; designs will avoid damage due to soil heaving.

18.2.9 Specific Structure Considerations

Facility descriptions in this section are based on conceptual design and are subject to the delivery team's final recommendations.

18.2.9.1 Solids Processing Building (only for Option 2: Decommission Existing Dewatering Building)

The SPB is a four-story structure that will house pumps, centrifuges, truck scales, cake bins, polymer tanks, boilers, and other process mechanical and controls. Columns and floor framing located at and below the centrifuge level will be cast-in-place concrete. Columns and framing above the centrifuge core will be structural steel; lateral resistance for this uppermost area will be provided by steel bracing between columns or precast shear wall sections. The remainder of the SPB floor framing may be cast-in-place, load-bearing precast concrete or structural steel with concrete on metal deck. Walls will be precast concrete panels with thin-set brick veneer or concrete masonry unit (CMU) with brick veneer (to be coordinated with architect). All roof framing will be metal deck placed over steel beams or joists. Auger cast piles supporting cast concrete will be used for the foundation system.

An analysis will be performed to evaluate the impact of centrifuge operation on the SPB structure. Centrifuge operating frequencies will be compared to the fundamental natural frequency of the SPB structure. The SPB structure will be designed to ensure that the structural fundamental frequency is well above the centrifuge operating frequencies to keep resonance within acceptable limits.

18.2.9.2 Solids Storage

The SST will be an at-grade cast-in-place reinforced concrete structure and will be divided into four compartments. The walls will bear upon a base slab, which will be supported on auger cast piles. A cast-in-place reinforced concrete or precast concrete roof will be used to cover the tanks. Aluminum access hatches will be provided at each compartment. An aluminum stair system will be used to provide access to the top of the tanks. The perimeter of the structure deck will be protected with a guardrail system.

18.2.9.3 Digesters

Digester walls will be constructed of prestressed concrete. The digester base will be a cast-in-pace reinforced concrete slab supported on auger-cast piles. The digesters will have fixed roofs constructed of concrete. Design will meet or exceed the requirements of ACI 350, AWWA D110 Type II, and other applicable code requirements.

18.2.9.4 Digester Building (only for Option 1: Renovate Existing Dewatering Building)

The Digester Building will be constructed using load-bearing reinforced CMU with a brick exterior. Retaining walls will be cast-in-place concrete. Roof framing will use precast prestressed double tees or hollow-core planks. The building will be founded on a shallow foundation system. As an alternative to CMU, load-bearing precast concrete wall panels with a thin-set brick veneer may be used.

18.2.9.5 Odor Control

Odor control equipment, fans, piping, and ductwork will be placed on a slab-on-grade. A containment curb will be placed around the perimeter of the slab. The top of the slab will be sloped to provide drainage.

18.2.9.6 Final Dewatering Building (only for Option 1: Renovate Existing Dewatering Building)

The Final DWB will be a three-story structure. The lower floor is at grade and will house polymer tanks and a truck loading scale, and will provide support for the cake bins. The second floor will house mechanical and support systems. Centrifuges and the electrical and control rooms will be located on the third floor. A reinforced concrete frame will be used at and below the centrifuge level; the balance of the Final DWB may be cast concrete, precast or steel framed. Framing located above the third floor will be either cast-in-place concrete or braced structural steel. Roof framing will be structural steel with a metal roof deck over steel beams or bar joists. Auger cast piles will be used to support the complete foundation system.

18.2.9.7 Thermal Hydrolysis Process

THP equipment and piping will be placed on a reinforced concrete slab-on-grade. A containment curb will be placed around the perimeter of the slab. The top of the slab will be sloped to provide drainage.

18.2.9.8 Electrical Building

The Electrical Building will be constructed using load-bearing reinforced CMU with a brick exterior. Roof framing will use precast prestressed concrete hollow-core planks. The building will be founded on a slab-on-grade shallow foundation system. As an alternative to CMU, load-bearing precast concrete wall panels with a thin-set brick veneer may be used.

18.2.9.9 Chemical Building

The Chemical Building will be constructed using load-bearing reinforced CMU with a brick exterior. Roof framing will use precast prestressed concrete double tees or hollow-core planks. The building will be founded on a slab-on-grade shallow foundation system. As an alternative to CMU, load-bearing precast concrete wall panels with a thin-set brick veneer may be used.

18.2.10 Materials of Construction

Minimum design strength and specification requirements are as follows:

Cast-in-place concrete, f'c	4,000 psi
Cast-in-place concrete (water retaining), f'c	4,500 psi
Precast or prestressed concrete, f'c	5,000 psi
Reinforcing steel, Fy	60,000 psi
Structural steel, Fy	50,000 psi
Structural aluminum alloy	6061-T6
Bolts for aluminum structures	ASTM F593/594 (stainless Type 304)
Concrete masonry, f'm	2,000 psi
Stainless steel, Fy	30,000 psi
Concrete	
Aggregate	ASTM C33
Cement (blended)	Type I/II (or IL-10) Portland cement
Target content (including SCM)	517 lb/yd (4,000 psi) 564 lb/yd (4,500 psi)
Max. w.c.	0.40 typical for water-retaining concrete
Air content	4%–7% typical 1%–3% troweled indoor slabs
Concrete reinforcing	ASTM A615 deformed bar, 60,000 psi
Masonry	
Compressive strength of masonry (f'm)	2,000 psi
Masonry reinforcing	ASTM A615 deformed bar, 60,000 psi
Structural Steel	
Angle, plate, channel, bar	ASTM A36, 36,000 psi
Wide flange	ASTM A992, 50,000 psi
Rectangular and square HSS	ASTM A500, 46,000 psi
Round HSS	ASTM A500, 46,000 psi
Pipe	ASTM A53, 35,000 psi
Bolts	ASTM F3125, galvanized per ASTM A153

18.2.11 Material Usage
Materials used for the construction of specific items will be as stated below:

- Guardrails, handrails and hatches: aluminum
- Channel covers: aluminum
- Grating: serrated or “I” bar, aluminum
- Exterior pipe/utility supports and structures: aluminum or galvanized steel
- Interior pipe supports: galvanized steel
- Stairs, exterior: all aluminum, non-slip
- Stairs, interior: aluminum, galvanized steel or concrete, non-slip
- Stair Treads: same material as stringer
- Bollards: galvanized steel and painted
- Metal decking: galvanized and painted
- Anchor bolts: stainless steel Type 304 typical unless noted otherwise; stainless steel Type 316 for submerged conditions; galvanized steel for dry interior locations

18.2.12 Foundations
Before foundations are designed, a subsurface investigation will be made to confirm foundation requirements and establish the geotechnical design criteria.

18.2.13 Modifications to Existing Structures
Existing buildings or structures that require modifications or partial demolition will be analyzed to confirm that the structure is stable and safe to support the applied loads and forces. Analysis should include the stability of the structure, both as work progresses and for the completed structure.

18.3 Architectural Design Criteria

18.3.1 Design Options
The delivery team will evaluate options for the program facilities as listed below:

1. New SPB
2. Chemical Building
3. Electrical Building
4. Renovation of the existing DWB
5. New Final DWB
6. New Digester Building

The architectural considerations will include:

1. Safety
2. Life cycle and cost
3. Building design materials and finishes
4. Operator spaces

Sustainability is also a consideration and is discussed further in Section 18.7 below.

18.3.2 Safety

All building structures will be designed to meet or exceed the minimum construction and life-safety requirements as required by applicable codes and criteria. Appropriate access and egress provisions will be maintained, and emergency lighting, alarms, and signage will be provided in equipment rooms in compliance with all applicable fire and life-safety codes and per process design criteria.

Appropriate definition of all life-safety provisions will be provided on the Drawings in accordance with local jurisdictional authority. This definition will include preparation of a Life Safety Analysis Plan and code compliance summary for each building floor area. Table 18-1 includes various codes and standards to govern the design of the facility. (See Section 18.6 for additional in-depth, life-safety and fire protection requirements.)

Table 18-1. Building Codes and Standards

Criterion	Code
Building safety	2018 Virginia Construction Code (VUSBC)
Existing building safety	2018 Virginia Existing Building Code
Building fire safety	2018 Virginia Statewide Fire Prevention Code
Building energy compliance	2018 Virginia Energy Code or ASHRAE 90.1
Building fixture count compliance	2018 Virginia Plumbing Code
Equipment safety	OSHA 1910 General Industry
Standard for wastewater plants	NFPA 820
Accessibility standards	2010 ADA Standards (as applicable)
Sustainability goals	Envision Rating System
Sustainability goals	Arlington Facility Sustainability Policy
Local context requirements	Arlington Zoning Ordinance

ADA = Americans with Disabilities Act; ASHRAE = American Society of Heating, Refrigerating and Air Conditioning; NFPA = National Fire Protection Association; OSHA = Occupational Safety and Health Administration.

18.3.3 Life-Cycle

The design life of the building structures will be 50 years. Surfaces exposed to view will have an aesthetic service life of 20 years, covering color fade, crazing, and delamination of applied coatings. Roof coverings will be specified to provide a minimum 20-year weathertightness warranty.

18.3.4 Building Design Materials and Finishes

Design documents will be submitted that include material elevation studies and three-dimensional (3D) renderings for owner approval and fit the allotted construction budget. The 3D renderings will include model walk-through and context imagery to evaluate how the new buildings fit contextually with adjacent buildings. Schedules of doors, finishes, windows, and other criteria will also be submitted during design submissions for owner approval and evaluated based on cost. Table 18-2 and Table 18-3 include recommended building materials and finishes that are to be considered in the design.

Table 18-2. Building Exterior Envelope Systems

Criterion	Roof System	Wall System	Doors/Frames	Natural Light
Type	PVC	CMU or precast with brick veneer	Aluminum (hollow metal at rated walls)	Translucent wall panels
Finish/color	Membrane/white	Integral color	PVDF/TBD	Factory/white
Maintenance	Biannual inspection	Clean annually	Clean annually	Clean annually
Life span	20–30 years	30–50 years	20–40 years	20–40 years
Benefits	Common aesthetic	Durable/low cost	Corrosive resistant	Corrosive resistant
Notes	Requires insulation	Requires insulation	Requires insulation	Maximizes natural light

PVC = polyvinyl chloride; PVDF = polyvinylidene fluoride coating; SBS = styrene-butadiene-styrene; TBD = to be determined.

Table 18-3. Building Interior Finishes

Criterion	Floor	Wall	Doors/Frames	Ceiling
Type	Concrete Non-skid or non-skid coated	CMU or precast concrete	Aluminum	None/ACT/gypsum verify
Finish/color	Sealed/HPIC	Paint/TBD	Anodized/clear	Factory finish/ painted
Maintenance	None	None	None	Clean annually
Life span	50–100 years	30–50 years	20–40 years	20–40 years
Benefits	Durable/low cost	Durable/low cost	Corrosive resistant	Durable/low cost

ACT = acoustical ceiling tile; CMU = concrete masonry unit; HPIC = high-performance industrial coating; TBD = to be determined.

18.3.4.1 Exterior Wall System

Exterior wall systems are recommended to be CMU backup with brick veneer that is compatible with the existing façades within the WPCP campus. As an option, precast walls with thin-set brick may be considered. The walls are to be insulated to meet local Energy Code requirements and/or Envision sustainability goals.

18.3.4.2 Interior Walls and Partitions

Interior wall systems are recommended to be CMU with a durable finish that prolongs the life of the wall and has low maintenance requirements. Examples of acceptable finishes include coatings or tile finishes.

18.3.4.3 Doors and Hardware

Pedestrian doors will be a minimum 7 feet high and 3 feet wide, except for special-purpose doors where an increased size may be appropriate. Door openings and hardware in accessible areas will be configured and specified to satisfy Americans with Disabilities Act (ADA) standards (if applicable). Door sizes will be of adequate size to accommodate installation and removal of equipment and other items. Monorail doors will also be provided if required.

Door hardware will be compatible with the existing WPCP keying system. Door hardware security will be coordinated with the security system of the existing WPCP.

18.3.4.4 Windows

Exterior windows are recommended to be fiberglass translucent wall panels that have dual capacity to be used as removable openings to allow for the installation or removal of large process equipment. Standard windows will also be considered.

18.3.4.5 Roofing and Rainwater Conveyance

The minimum roof slope for nominally flat roofs will be ¼ inch per foot. Roof crickets will be a minimum of ½ inch per foot. Roofing is recommended to be a low-VOC PVC membrane system, but other systems such as styrene-butadiene-styrene (SBS) or modified bitumen will be considered. Insulation will be furnished to meet applicable Energy Code or Envision rating system guidelines. Roofing attachments will satisfy local wind loading requirements.

Internal primary roof drains and secondary roof drains are recommended means to convey water from the roof structure and into the underground stormwater drain system. Downspouts and gutters are NOT recommended as conveyance of surface drainage of stormwater may not be feasible for the site.

18.3.4.6 Painting and Protective Coatings

Detailed coating systems and finishes will be provided by the design team that are appropriate for WWTPs. Painting, protective coatings, and high-performance industrial coatings will be applied. It is recommended that the design team use the expertise of a National Association of Corrosion Engineers (NACE) Level 3 certified coatings expert to define the extent of the coating systems and applications. Design specifications and drawings will be provided that identify coating locations in various environments, including corrosive areas.

18.3.4.7 Vertical Circulation
Roof access will be a full IBC-compliant egress stair. All stairways will satisfy IBC requirements.

18.3.4.8 Architectural Screenings
Equipment screen walls will be provided to obscure exterior some process equipment from public view, as determined by the County and delivery team through design. Screen walls are recommended to limit visibility by at least 50 percent. Screen walls will be designed to allow removal of process equipment via removable panel. Screen walls will also be used as an architectural aesthetic to fit contextually within the adjacent properties.

18.3.5 Operator Spaces
Design documents will be submitted that include the layout of control rooms, restrooms, break rooms, laboratory and sample labs, and other user-oriented spaces as required. The designers will work with the County and Program Manager to develop the space adjacencies, locations, and details. Specific space needs include the following:

- Control room (in renovated DWB or SPB): sufficient for controlling plant-wide operations, redundant to the control room in the Operations and Control Building
- Separate break room from control room
- Bathroom and laboratory space
- Operations storage space (1,000 ft^2)
- Maintenance storage and working space (1,200 ft^2)

18.3.5.1 Design Goals
The operator spaces will have access to natural light and interior views to process equipment as needed. Sound attenuation will be included as needed to allow workers to work within these areas without being required to wear hearing protection. The sizes of these rooms will be approved by County staff but will accommodate at least four people. The finishes in these rooms will match other portions of the facilities as listed in the interior finishes section of this section. A specialist laboratory designer will be included in the project team for the layout of laboratory cabinets, hoods, and other specialized equipment.

18.4 Heating, Ventilation, and Air Conditioning

18.4.1 Codes and Standards
The following list of codes and standards will be followed in the design:

- Virginia Construction Code (VCC)
- Virginia Mechanical Code (VMC)

- Virginia Fuel Gas Code (VFGC)
- Virginia Energy Conservation Code (VECC)
- National Fire Protection Association (NFPA):
  - NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilation Systems
  - NFPA 90B: Standard for the Installation of Warm-Air Heating and Air-Conditioning Systems
  - NFPA 91: Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids
  - NFPA 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- American Society for Testing and Materials (ASTM)
- Steel Structures Painting Council (SSPC)
- American National Standards Institute (ANSI)
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
- Underwriters Laboratories, Inc. (UL)

18.4.2 HVAC Design Criteria

Outdoor air HVAC design conditions will be as follows (Ronald Reagan Washington National Airport, Virginia, United States, World Meteorological Organization [WMO]: 724050):

- Summer: 94.7°F dry bulb/75.5 F wet bulb
- Winter: 17.9°F dry bulb

HVAC design criteria will generally be as follows:

- Occupied spaces: 70°F winter, 75°F summer and 50 percent relative humidity (RH)
  - Split-system heat pumps
  - Manufacturer preference: Trane
- Electrical and control rooms: 55°F winter, 75°F summer and 50 percent RH
  - Positive pressurization units (PPUs)
  - Split-system heat pumps
  - Manufacturer preference: Trane
- Process areas: 55°F winter, 10°F above ambient summer temperature

- Mechanical rooms: 55°F winter, 10°F above ambient summer temperature
- Required controls: Siemens

18.4.3 HVAC Systems

The approach to heating all facilities will be evaluated by the delivery team, taking into account the operability, maintenance, controls, and sustainability goals of the Program. The delivery team will evaluate the feasibility of heating by connecting to the process steam boiler plant, installing a standalone hydronic boiler plant, using NG-fired equipment, and using equipment with electric heat. The delivery team will evaluate the feasibility of cooling using RNG/NG adsorption/absorption chillers and direct expansion (DX) split systems. The chillers require chilled water piping to cooling coils serving electrical and control room. All HVAC system evaluations shall take into account the County Board Guidance for the Fiscal Year 2023–2032 Capital Improvement Plan, noting that the County's default policy is to use high-efficiency electric heating where use of such systems is feasible.

NFPA 820 identifies process areas within WWTPs and lists the National Electrical Code (NEC) classification, minimum ventilation requirements, required materials of construction, and fire protection measures that must be incorporated. Table 18-4 below summarizes the areas in Option 1—renovate existing DWB—and the areas in Option 2—decommission existing DWB—and identifies the NFPA 820 ventilation requirements for each of the options.

Differential air pressures between unclassified spaces/ambient and classified spaced/ambient will be provided as required. All ventilation supply fans and exhaust fans will be monitored for fan failure and provided with alarms. All continuous ventilation systems that are used to reduce the classification of a space will be fitted with visual and audible alarm signaling systems within the process space and at the entrances to the process space.

18.4.3.1 Option 1: Renovate Existing Dewatering Building

NG-fired hydronic boilers are currently installed in the existing DWB for building heat. The boilers provide heating hot water for the makeup air units and unit heaters throughout the process spaces. The existing makeup air units, unit heaters, boilers, pumps, piping, controls, and all related accessories will be removed.

If a standalone plant is installed, the plant location is anticipated to be in either the mechanical room or HVAC room. New makeup air units, unit heaters, and piping will be installed. The existing exhaust fans will be removed and replaced with new exhaust fans. All new equipment will be sized and configured according to the proposed process ventilation requirements for declassifying the electrical hazard per NFPA 820.

Process spaces in the Final DWB and Digester Building will have ventilation air supplied by makeup air units located inside the building. Exhaust air will be pulled from the process spaces by inline, wall-mounted, or roof-mounted exhaust fans. Supplemental heat will be provided by unit heaters as required. Explosion-proof heaters will be provided for hazardous locations.

Acid and caustic storage rooms will be ventilated with a dedicated exhaust system. Chemicals will be evaluated, and spark-resistant fan construction and explosion-proof motors will be provided as required. Unit heaters will be provided for freeze protection.

Mechanical rooms will be ventilated for temperature control as required to maintain 10°F above ambient. Unit heaters will be provided for freeze protection.

Occupied spaces, such as break rooms and occupied control rooms, throughout all buildings will be provided with DX split-system heat pump units. Heat pumps will be mounted outside the building and indoor units will be mounted within the associated space. Ventilation air will be provided to the spaces as required.

Electrical control rooms throughout all buildings will be provided with DX split-system heat pump units. The heat pumps will be mounted outside the building and indoor units will be mounted within the associated space. The heat pumps will be provided with low ambient capability to provide cooling at low outdoor temperatures. PPU will be provided for the electrical and control rooms. Outdoor air that has passed through dual-media filters within the PPU will be supplied to the space to maintain a positive pressure in the electrical room relative to the exterior. Existing computer room air conditioning (CRAC) units may be reused to serve electrical and control rooms contingent upon the condition, capacity, and life expectancy of the equipment.

The HVAC equipment throughout all buildings will be controlled by local temperature control panels. Each control panel will be equipped with HOA switches, controls, temperature sensors, indicating lights, flow pressure switches, and alarms as required. The smoke detector signals from the temperature control panel will be connected to the fire alarm control panel. Hazardous gas detection from the PCS will be connected to the temperature control panel. Other signals, such as space temperatures or fan status, from the temperature control panel will be connected to the PCS as required for monitoring.

18.4.3.2 Option 2: Decommission Existing Dewatering Building

Process spaces in the new SPB will have ventilation air supplied by makeup air units located inside the SPB or on the roof. Exhaust air will be pulled from the process spaces by inline, wall-mounted, or roof-mounted exhaust fans. Supplemental heat will be provided by unit heaters as required. Spark-resistant fan construction and explosion-proof heaters will be provided as required. All ventilation equipment will be sized and configured according to the proposed process ventilation requirements for declassifying the electrical hazard per NFPA 820.

Mechanical rooms will be ventilated for temperature control as required to maintain 10°F above ambient. Unit heaters will be provided for freeze protection.

Occupied spaces, such as break rooms, will be provided with DX split-system heat pump units. Heat pumps will be mounted outside the SPB and indoor units will be mounted within the associated space. Ventilation air will be provided to the spaces as required.

Electrical and control rooms will be provided with DX split-system heat pump units. The heat pumps will be mounted outside the SPB and indoor units will be mounted within the associated space. The heat pumps will be provided with low ambient capability to provide cooling at low outdoor temperatures. PPUs will be provided for the electrical and control rooms. Outdoor air that has passed through dual-media filters in the PPU will be supplied to the space to maintain a positive pressure in the electrical room relative to the exterior.

The HVAC equipment throughout the SPB will be controlled by local temperature control panels. Each control panel will be equipped with HOA switches, controls, temperature sensors, indicating lights, flow pressure switches, and alarms as required. The smoke detector signals from the temperature control panel will be connected to the fire alarm control panel. Hazardous gas detection from the PCS will be connected to the temperature control panel. Other signals, such as space temperatures or fan status, from the temperature control panel will be connected to the PCS as required for monitoring.

18.5 Plumbing Design Criteria

18.5.1 Codes and Standards

The following list of codes and standards will be followed in the design:

- VCC
- Virginia Plumbing Code (VPC)
- VECC
- ASTM
- ANSI
- AWWA
- UL
- American Society of Plumbing Engineers (ASPE) Plumbing Engineering Handbook

18.5.2 Plumbing Fixtures

Emergency shower and eyewashes with tepid water per ANSI Z358.1 will be provided as required. Emergency stations will be provided with flow switches that will be tied into the PCS. Floor drains will be located throughout the SPB. Floor drains will be equipped with trap seal devices. Hose bibs will be located around the perimeter of the SPB and as required in the SPB.

18.5.3 Domestic Water

Domestic cold water and domestic hot water will be provided to each plumbing fixture as required.

The source of the SPB domestic hot water will be an NG water heater with storage tank. A domestic hot water recirculation pump and domestic hot water return will be provided to ensure that hot water is readily available at remote fixtures. The source of the tepid water for emergency fixtures will be an electric instantaneous water heater.

Potable water will be used for WPCP service water for all parts of the project. Water for domestic use and water for process use will each use an independent backflow prevention device.

18.5.4 Drainage System

A gravity flow sanitary system will be installed per local and state codes and regulations. Roof drains and secondary roof drains and associated rain leaders will channel water from the roof to the stormwater system.

18.6 Fire Protection Systems

18.6.1 Codes and Standards

The following list of codes and standards will be followed in the design:

- VCC
- Virginia Statewide Fire Prevention Code (VSFPC)
- NFPA
    - NFPA 820, 2020 Edition: Standard for Fire Protection in Wastewater Treatment and Collection Facilities
    - NFPA 72, 2019 Edition: National Fire Alarm and Signaling Code
    - NFPA 10, 2022 Edition: Standard for Portable Fire Extinguishers

Table 18-4. NFPA 820 Process Classification and Requirements

Area	Extent of Classification	NEC Classification	Required Ventilation	Required Materials of Construction	Required Fire Protection Measures	NFPA Reference
Solids Storage Tanks						
SSTs	Area under cover	Class I, Division 1	Not ventilated, or ventilated at less than 6 ACH	Non-combustible	Hydrants, portable fire extinguishers, and fire alarm system. Assume permanently installed combustible gas detection system would not be required because this area will be defined as a permitted confined space. Portable gas detection equipment would be required by the confined-space entry permit.	NFPA 820, Table 6.2.2(a), Row 11, Line a
SSTs	Area above cover. Envelope 18 inches above water surface 10 feet horizontally from wetted walls.	Class I, Division 2	Not required (open to atmosphere)	Non-combustible, limited-combustible, or low flame spread materials.	Not enclosed within the structure, no fire protection measures required.	NFPA 820, Table 6.2.2(a), Row 11, Line c
Renovated Dewatering Building (only for Option 1: Renovate Existing Dewatering Building)						
Screenings dumpster bay	Entire room	Unclassified	Not required	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers, and fire alarm	NFPA 820, Table 6.2.2(a), Row 1
Centrifuge feed pumps	Entire dry well	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 9, Line b
Future thickening room	Entire room	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 12, Line a

Area	Extent of Classification	NEC Classification	Required Ventilation	Required Materials of Construction	Required Fire Protection Measures	NFPA Reference
Truck bay/truck loading	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 13, Line a
Screen feed pump and polymer room	Entire dry well	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 9, Line b
Pre-dewatered cake storage hoppers	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 13, Line a
Solids screening room	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 9, Line b
THP feed pump room	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 9, Line b
Centrifuge room	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 12, Line a
Centrifuge control	NFPA 820 not applicable; design will comply with VCC					
Lab sample	NFPA 820 not applicable; design will comply with VCC					
Tool room, compressor room	NFPA 820 not applicable; design will comply with VCC					
Boiler room, mechanical room, HVAC room	NFPA 820 not applicable; design will comply with VCC					
Electrical room, switchgear room, MCC room	NFPA 820 not applicable; design will comply with VCC					

Area	Extent of Classification	NEC Classification	Required Ventilation	Required Materials of Construction	Required Fire Protection Measures	NFPA Reference
Stairwells, bathrooms, corridors, janitor closet	NFPA 820 not applicable; design will comply with VCC					
Solids Processing Building (only for Option 2: Decommission Existing Dewatering Building)						
Pump room	Entire dry well	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 9, Line b
Truck loading area	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 13, Line a
Screenings dumpster bay	Entire room	Unclassified	Not required	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers, and fire alarm	NFPA 820, Table 6.2.2(a), Row 1
Solids screening room	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 9, Line b
Pre-dewatered cake storage bins	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 13, Line a
Pre-dewatering room	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 12, Line a
Final dewatering room	Entire Area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 12, Line a
Break room	NFPA 820 not applicable; design will comply with VCC					
Lab	NFPA 820 not applicable; design will comply with VCC					
Boiler room	NFPA 820 not applicable; design will comply with VCC					

Area	Extent of Classification	NEC Classification	Required Ventilation	Required Materials of Construction	Required Fire Protection Measures	NFPA Reference
Mechanical room	NFPA 820 not applicable; design will comply with VCC					
Electrical room, control room	NFPA 820 not applicable; design will comply with VCC					
Stairwells, bathrooms, corridors	NFPA 820 not applicable; design will comply with VCC					
THP and Cooling Area						
THP	Entire area	Unclassified	Not required (open to atmosphere)	Non-combustible, limited-combustible, or low flame spread materials	Hydrant and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 15
THS cooling area	Entire area	Unclassified	Not required (open to atmosphere)	Non-combustible, limited-combustible, or low flame spread materials	Hydrant and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 15
Digester Building (only for Option 1: Renovate Existing Dewatering Building)						
Digester pump room	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 9, Line b
Digesters						
Digesters	Tank interior, envelope 10 ft above cover and 5 ft from any wall	Class 1, Division 1	Not enclosed, open to atmosphere	Non-combustible	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 16, Line a
	15 ft above Division 1 area over cover and 5 ft beyond	Class 1, Division 2	Not enclosed, open to atmosphere	Non-combustible	Hydrants and fire extinguishers	NFPA 820, Table 6.2.2(a), Row 16, Line b

Area	Extent of Classification	NEC Classification	Required Ventilation	Required Materials of Construction	Required Fire Protection Measures	NFPA Reference
	Division 1 area around tank walls					
Electrical	NFPA 820 not applicable; design will comply with VCC					
Final Dewatering Building (only for Option 1: Renovate Existing Dewatering Building)						
Truck loading	Entire Area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 13, Line a
Polymer room						
Final dewatered cake storage hoppers	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 13, Line a
Centrifuge room	Entire area	Unclassified	Continuously at 6 ACH	Non-combustible, limited-combustible, or low flame spread materials	Hydrants, fire extinguishers, and fire alarm systems	NFPA 820, Table 6.2.2(a), Row 12, Line a
Mechanical room	NFPA 820 not applicable; design will comply with VCC					
Electrical room, control room	NFPA 820 not applicable; design will comply with VCC					
Stairwells, bathrooms, corridors	NFPA 820 not applicable; design will comply with VCC					
Gas Handling						
Gas upgrading equipment	Within 10 ft envelope of all fixtures, appurtenances, and housing	Class 1, Division 1	Not enclosed, open to the atmosphere	Non-combustible	Not required	NFPA 820, Table 6.2.2(a), Row 20, Line a

Area	Extent of Classification	NEC Classification	Required Ventilation	Required Materials of Construction	Required Fire Protection Measures	NFPA Reference
	15 ft above Division 1 envelope and 5 ft on all sides	Class 1, Division 2	Not enclosed, open to the atmosphere	Non-combustible	Not required	NFPA 820, Table 6.2.2(a), Row 20, Line b
Flare	Within 10 ft envelope of all fixtures, appurtenances, and housing	Class 1, Division 1	Not enclosed, open to the atmosphere	Non-combustible	Not required	NFPA 820, Table 6.2.2(a), Row 20, Line a
	15 ft above Division 1 envelope and 5 ft on all sides	Class 1, Division 2	Not enclosed, open to the atmosphere	Non-combustible	Not required	NFPA 820, Table 6.2.2(a), Row 20, Line b
Odor Control						
Odor control	Areas within 3 feet of fans, dampers, flanges, vessels, etc.	Class 1, Division 2	Not enclosed, open to the atmosphere	Non-combustible, limited-combustible, or low flame spread materials	Fire extinguishers	NFPA 820, Table 4.2.2, Row 18, Line d
Odor control	Areas beyond 3 feet	Unclassified	Not enclosed, open to the atmosphere	Non-combustible, limited-combustible, or low flame spread materials	Fire extinguishers	NFPA 820, Table 4.2.2, Row 18, Line e
Chemical Building						
Chemical storage and feed room	NFPA 820 not applicable; design will comply with VCC					
Electrical Building						
MCC room	NFPA 820 not applicable; design will comply with VCC					

18.6.2 Building Height and Area
Building area limitations will be in accordance with VCC Section 506. Building height will be in accordance with VCC Section 504. Mechanical mezzanines, equipment platforms, and elevated equipment will be in accordance with VCC Section 505. Buildings designed to house special industrial processes will be exempt from the sections above in accordance with VCC Section 503.1.1.

Federal Aviation Administration (FAA) notification and coordination will be the responsibility of the design-build (DB) entity pursuant to FAA regulation, Title 14, Part 77 (link). For additional information, refer to Section 21.5.

18.6.3 Hazardous Materials
Hazardous materials will be identified in accordance with Section 307 of VCC and Chapter 50 of VFC.

18.6.4 Site Fire Flow and Hydrants
Fire hydrant locations and fire flow requirements will be in accordance with Appendices B and C of VFC respectively and Chapter 9 of VCC.

18.6.5 Fire Alarm System
The automatic fire alarm system will be designed in accordance with Chapter 907 of the VCC.

18.6.6 Fire Suppression Systems
The automatic fire sprinkler system will be designed in accordance with Chapter 903 of the VCC.

18.6.7 Fire Department Access
Fire department access will be provided in accordance with Part III Chapter 5 of VFC.

18.6.8 Occupancy Separations
Separation of occupancies will be in accordance with VCC Section 508.

18.6.9 Vertical Openings
Shafts, stairs, etc. will be designed based on Section 712 of VCC.

18.6.10 Means of Egress
Structures will be classified as F-1 Factory Occupancy with an occupant load factor of 300 ft^2 per person. The maximum common path will be limited to 75 feet. The maximum travel distance to any exit will not exceed 200 feet. Dead-end corridors will not exceed 50 feet. Each building will have a minimum of two exits from each story.

18.7 Sustainable Facility Design

Design documents will be submitted that include the Envision Rating System checklist at each milestone deliverable. Envision rating credits will be selected by the design team that are appropriate for the Program. Table 18-5 features recommended applicable goals for the Program team to achieve but is not limited to this list. (Use Envision Rating System for full list.)

Table 18-5. Sustainability Recommended Criteria

Criterion	Code
Natural lighting	5% of the floor plans will be used as ft^2 for minimum of natural light entering the building via translucent wall panels, windows, or skylights.
Photovoltaic solar panels	Investigate providing 15% of electrical power of building lighting using solar panels. The building will be designed to accommodate the weight and anchoring of future roof- or wall-mounted solar panels that could be installed at a future date.
Recyclable material	Specify materials that used recycled materials.
Regional material	Specify materials that used regional materials.
Construction waste	Manage construction waste to minimize waste going to the landfill through both materials reuse and diversion to recycling.
Noise pollution	Recommend acoustical panels as needed to reduce noise generated from leaving property lines.

19 ELECTRICAL DISTRIBUTION SYSTEM

19.1 Background and Purpose

This section describes the existing WPCP electrical distribution, anticipated future demand, and proposed criteria for new facilities. Proposed configurations are based upon preliminary concepts and will need to be conformed to the final facility design. In all cases, fully redundant distribution is required in feeders to distribution equipment. Branch circuits to specific process equipment do not need to be redundant but, where redundant equipment (e.g., redundant pumps or conveyors) is provided, branch circuits will originate at separate sources.

19.2 Existing Electrical Distribution System

This section describes the existing electrical distribution system, both plant-wide and at the North Plant.

19.2.1 Plantwide

The Arlington WPCP has two 34.5-kilovolt (kV) electrical services from Dominion Energy (DE) (see Sheet E-02). These service feeders are routed to 34.5 kV Switchgear A and B. The 34.5 kV switchgear also can be powered from the Standby Generation Facility (SGF) that has three 2,250-kilowatt (kW) generators used for standby or occasional peak shaving use. Switchgear A and B provide A and B distribution feeders, respectively, to the North and South Plant. The extents of the Re-Gen Biosolids Facilities Upgrades project are located in the North Plant, so the following sections discuss only the North Plant.

19.2.2 North Plant

The north side of the WPCP, north of S Glebe Road, has a dedicated pair of 34.5 kV A and B distribution feeders. The feeders currently serve the whole north side via Distribution Centers (DCs) 1 and 7. DC-1 has redundant 2,500-kilovolt-ampere (kVA) 34.5 kV/480-volt (V) transformers; DC-7 has redundant 1,500 kVA 34.5 kV/480 V transformers. The transformers are pad-mounted, exterior transformers while the low-voltage switchgear is located inside an adjacent Electrical Building. The 34.5 kV feeders are arranged in a selective radial configuration with no switching. If it is necessary to de-energize a transformer at one DC, the same transformer at the other DC will also be de-energized. To transfer load from one feeder to the other, one of the main secondary circuit breakers needs to be opened while closing the tie circuit breakers.

Prior to the Phase 7 expansion, DE served each of the WPCP's DC separately. As part of the SGF project, the primary feeders for each DC were routed to the new 34.5 kV switchgear. This work was done by DE and is not reflected in record drawings. It was reported that DE used either 1/0 or 2/0 American Wire Gauge (AWG) 34.5 kV cables to provide that extension. Therefore, the capacity of the feeders is at least 145 amperes (A), or 6,931 kW, at 34.5 kV with a 0.8 power factor.

19.3 Existing WPCP Electrical Demand

This section presents existing electrical demand, both plant-wide and at the North Plant, and describes generation capacity.

19.3.1 Plant-wide Demand

Power usage is monitored at each DC and stored for future reference and analysis. The two DE 34.5 kV services provide the primary power source to the plant DE totalizes the demand (sums demand coincidentally) on each feeder to provide the total WPCP demand over each 30-minute integration period. DE records and charges for distribution demand, which is the highest 30-minute kW demand over the last year. The reported distribution demand for 2020 was 4,699 kW, which represents the peak demand of the whole WPCP.

19.3.2 North Plant Demand

Power demand (kW) of individual DCs is recorded and has been provided for review. Sorted results for the North Plant indicate a peak demand of 1,610 kW in 2020 and 1,671 kW in 2021. This total includes some diversity between DC-1 and DC-7 but most readings for DC-7 indicate a maximum demand of approximately 500–600 kW. Given the 34.5 kV Feeder A and B capacity indicated above, the redundant feeders have about 5,200 kW of available capacity.

19.3.3 Generation Capacity

The WPCP has three 2,250 kW engine-generators for an installed nameplate capacity of 6,750 kW. These types of engines cannot be operated at 100 percent for a long duration. For planning purposes, a good sustained operating limit around 80 to 85 percent of nameplate capacity, or 5,600 kW, is recommended. This is adequate for the existing WPCP maximum demand but may not allow for full operation of the new biosolids treatment during a peak flow period.

Adding a generator would be challenging. There is no space at the SGF for a fourth generator. Generation added at another WPCP location would need to synchronize with the SGF and be able to control load sharing. It is recommended that a load-shedding plan be developed to drop less critical load in the event that generation is not adequate. In general, the liquid stream equipment has an immediate priority. It is recommended, when running on generation, that liquid stream equipment be given priority and only essential solids processes be operated. However, load shedding must be holistic and will be developed during detailed design to integrate the overall needs of the WPCP.

Some solids loads will be determined to be critical, such as digester mixing and biogas flare control. It will be necessary to determine through a criticality assessment if lower-priority liquid stream loads could be shed to ensure adequate capacity for these solids handling loads. If overall demand is low enough, other solids processes may be elected to run with deference to the total generation demand.

19.4 Design Approach

A preliminary demand estimate for the new biosolids facilities has been developed, and an increase of the size of the North A and B feeders is not anticipated. Refer to Drawing E-02 for the existing electrical distribution configuration. It is estimated that the existing DC-7 transformers are not adequate, and the age of the DC-7 switchgear is such that replacement is recommended. To facilitate project phasing, new 34.5 kV distribution switches will be installed in the 34.5 kV A and B feeders (refer to Drawings E-01 and E-03). These switches will allow transformers to be isolated for construction and future maintenance. The existing DC-7 will be replaced with new outdoor pad-mounted transformers and low-voltage switchgear installed in a dedicated Electrical Building similar to DC-1 transformers and switchgear.

Future biosolids area motor control centers (MCCs) or switchboards will be fed from the new DC-7 with redundant feeders. A main-tie-main configuration will be used on all switchgear, MCCs, and switchboards. In addition, the new DC-7 will include a generator tap box to facilitate the connection of a mobile generator as a third alternate source. Equipment will be organized and connected to a bus, such that any auxiliary equipment required for a process is served from the same A or B bus. Therefore, if one bus experiences an outage, all the redundant equipment served from the opposite bus can be used.

The existing biosolids process must remain active during construction. Any outages will be minimized and approved by the Owner. Redundant sources are expected to be used to the maximum extent to limit equipment that will experience an outage. Brief outages (a few hours) may be easy to accommodate. Longer-duration outages, 2 or 3 days, will need an extensive plan and schedule describing how the system will be re-energized if the redundant source fails during an outage. If an outage is expected to last more than 5 days, temporary measures will be required to provide a backup source (e.g., rental generator) during the outage. It will be possible to re-energize the process within 30 minutes from the temporary source.

The existing DC-7 provides dual services to the adjacent Potomac Yard Pump Station (PYPS). It is essential that the PYPS have dual services throughout all phases of the project. This may be accomplished with temporary generators but other alternatives meeting the dual-service requirement can be considered.

19.5 Area Classifications of New and Existing Facilities

All project areas will be classified according to the use. It may be possible for a space to have more than one classification (i.e., Wet and Hazardous). Equipment in that space will meet the requirements of all the space classifications. The NEC provides definitions for both Damp and Wet spaces. Any space exposed to moisture will be classified as Wet; the Damp classification will not be used. Space classification will be approved by the Owner.

19.5.1 Interior Spaces

Interior spaces not exposed to process flows or chemicals may be classified as Dry and Dusty. This generally applies to electrical and control rooms or office space.

All spaces containing process flow or equipment will, at a minimum, be classified as Wet. Additionally, areas where chemicals are stored, pumped or applied will be considered Corrosive. Areas exposed to process generated vapors (i.e., H_2S, CH_4, or NH_3) will also be classified as Corrosive.

19.5.2 Exterior Spaces

All exterior spaces will, at a minimum, be classified as Wet. There may also be a space near or around equipment where a corrosive or hazardous classification is also appropriate. Drawings will identify these areas and include a radius or dimensioned extent for these spaces.

19.5.3 Hazardous Areas

Electrically hazardous areas (interior or exterior) will be identified on the Drawings. NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities, will be referenced to define the type and extent of electrically hazardous areas. Other NFPA codes may be referenced to define areas not covered by NFPA 820. The code and article referenced for the classification will be included in the documents.

19.6 Electrical Design Criteria

Only equipment meeting the design criteria listed below will be used in this project. The most current edition of reference standards, codes, or listings will be used.

19.6.1 Lighting

All lighting design and equipment will meet the applicable requirements of the following:

- American National Standards Institute (ANSI) C78.377
- Institute of Electrical and Electronics Engineers, Inc. (IEEE) C62.41
- Illuminating Engineering Society of North America (IESNA) LM-79 and LM-80
- National Electrical Manufacturers Association (NEMA) 250, 410, and LE 4 and NEMA/ANSI SSL 1
- National Fire Protection Association (NFPA) 70 and 101
- Underwriters Laboratories, Inc. (UL) 248-4, 844, 924, 1012, 1310, 1598, and 8750

All lighting fixtures will be light-emitting diode (LED) fixtures rated for a minimum 50°C, a minimum lumens per watt of 120, and marine grade and/or hazardous as appropriate. Recommended manufacturers include Holophane, Crouse Hinds, and Appleton.

19.6.2 Wire and Cable

All wire and cable will meet the applicable requirements of the following:

- Insulated Cable Engineers Association (ICEA) S-58-679
- National Electrical Manufacturers Association (NEMA) ICS 4
- National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA) WC 57/S-73-532 and 70/S-95-658
- National Fire Protection Association (NFPA) 70 and 262
- Underwriters Laboratories, Inc. (UL) 44, 83, 467, 486A, 486C, 510, and 1581

Wire for process feeders or branch circuits will be XHHW-2 Lighting and receptacle circuits and #14 AWG class 1 control circuits can be THHN-2

19.6.3 Conduit

All conduit will meet the applicable requirements of the following:

- Aluminum Association (AA)
- American Iron and Steel Institute (AISI)
- National Electrical Manufacturers Association (NEMA) 250, RN 1, TC 2, and TC 3
- National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI) C80.1, C80.5, and OS 1
- National Fire Protection Association (NFPA) 70
- Underwriters Laboratories, Inc. (UL) 1, 6, 50, 360, 467, 514A, 514B, 651, 797, 870, and 1203

Exposed conduit in hazardous or corrosive spaces will be PVC-coated rigid steel (PVC-RGS) conduit. Exposed conduit in dry or wet spaces will be rigid galvanized steel (RGS) or aluminum. Buried conduit will be PVC-RGS or, in a concrete-encased ductbank, Schedule 40 PVC.

19.6.4 Variable-Frequency Drives

All VFDs will meet the applicable requirements of the following:

- American National Standards Institute (ANSI)
- Electrical Testing Laboratories (ETL)
- IEEE 399, 519, and C62.41
- National Electrical Manufacturer's Association (NEMA) 250 and MG-1
- National Fire Protection Association (NFPA) 70
- Occupational Safety and Health Administration (OSHA)
- Underwriters Laboratory, Inc. (UL) 508 and 508A

VFDs rated for 75 hp motors and less can have a six-pulse input rectifier. VFDs for 100 hp motors and higher will have an 18-pulse input rectifier or an approved active front end to mitigate harmonic impacts. In all cases, if total harmonic distortion (THD) is greater than allowed by IEEE 519 than harmonic mitigation methods will be employed. Avoid VFDs mounted in MCCs. Allen-Bradley PowerFlex VFDs are the County's preferred drive.

19.6.5 Power Monitoring

All power monitoring will meet the applicable requirements of the following:

- UL 61010A-1, EN 610101
- Accuracy: ANSI C12.20 Class 0.2, IEC/EN60687 0.2 for revenue meters.
- EMC: FCC Part 15 Subpart B Class A immunity
- Applicable IEC standards
- MODBUS TCP or Ethernet IP communication capability

19.6.6 Lightning Protection

All facilities will be provided with a lightning protection system. All lightning protection design will meet the applicable requirements of the following:

- NFPA 780: Standard for Installation of Lightning Protection Systems
- UL 96A: Standard for Installation Requirements for Lightning Protection Systems

19.6.7 Dry-Type Transformers

All dry-type transformers will meet the applicable requirements of the following:

- U.S. Department of Energy (DOE), Code of Federal Regulations (CFR) Title 10 Part 431
- IEEE C57.96

- National Electrical Manufacturers Association (NEMA) 250 and ST 20
- Underwriters Laboratories, Inc. (UL) 506 and 1561

All indoor transformers will be dry type with rating based upon 115°C temperature rise with copper windings.

19.6.8 Pad-Mounted Transformers

Exterior DS transformers will meet the applicable requirements of the following:

- IEEE 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
- IEEE C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
- IEEE C57.12.28, Standard for Pad-Mounted Equipment—Enclosure Integrity
- IEEE C57.12.34, Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers—High-Voltage: 34 500 GrdY/19 920 Volts and Below; Low-Voltage: 480 Volts and Below
- IEEE C57.12.70, Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers
- IEEE C57.12.80, Standard Terminology for Power and Distribution Transformers
- IEEE C57.12.90, Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
- IEEE C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV)
- Factory Mutual Research Corporation (FM) 3990, Approval Standard for less or non-flammable Liquid Insulated Transformers

Pad-mounted transformer rating is based upon a 55°C/65°C temperature rating and includes fans (and temperature control) to achieve a KNAN/KNAF rating. Insulating fluid will be a less-flammable, natural or synthetic ester fluid that is biodegradable per EPA Office of Prevention, Pesticides and Toxic Substances (OPPTS) 835.3100.

19.6.9 Low-Voltage Switchgear

Low-voltage, metal-enclosed switchgear will meet the requirements of the following:

- American National Standards Institute (ANSI)
- IEEE C37.20.1, Standard for Metal-Enclosed Low-Voltage (1000 VAC and below, 3200 VDC and below) Power Circuit Breaker Switchgear
- NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
- UL 1558, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

Low-voltage switchgear will be main-tie-main configured, draw-out switchgear with 100 percent rated circuit breakers.

Low-voltage switchgear will include automatic, open transition, transfer of sources in response to outages.

Recommended manufacturers include Eaton or Schneider Electric.

19.6.10 Motor Control Centers

MCCs will meet the requirements of the following:

- NEMA 250, Enclosures for Electrical Equipment (1000 Volt Maximum)
- NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 V
- NEMA ICS 18, Motor Control Centers
- UL 508, Standard for Industrial Control Equipment
- UL 845, Motor Control Centers

MCCs will be main-tie-main configured with 100 percent rated main and tie circuit breakers.

Source transfer will be manual and all motor overloads will be the electronic type.

Recommended manufacturers include Eaton or Schneider Electric.

20 CONTROL SYSTEM

20.1 Background and Purpose

This section describes the existing WPCP control system architecture, upgrades in progress, and proposed criteria for new facilities. Proposed criteria are based upon preliminary site and process control concepts and will require adaptation to conform to the final facility design.

20.2 Control System Architecture

The existing PCS at the WPCP is built upon a structure supporting redundant process area controllers with subunit process input/output (I/O) aggregation accomplished by distributed remote input/output (RIO) panels. Redundant area programmable logic controllers (PLCs) are connected to the plant backbone via area network cabinets and communicate with the plant PCS via Ethernet-IP communication protocol over a redundant, single-mode fiber ring. Communication between area PLCs and their associated RIOs is accomplished using ControlNet open industrial network protocol via multimode fiber-optic link. Monitoring and control of original equipment manufacturer (OEM) panels and VFDs are accomplished by peer-to-peer communication over Ethernet-based copper links using Modbus-TCP protocol or Ethernet-IP where supported by end devices.

Figure 20-1 presents the existing DWB communication diagram.

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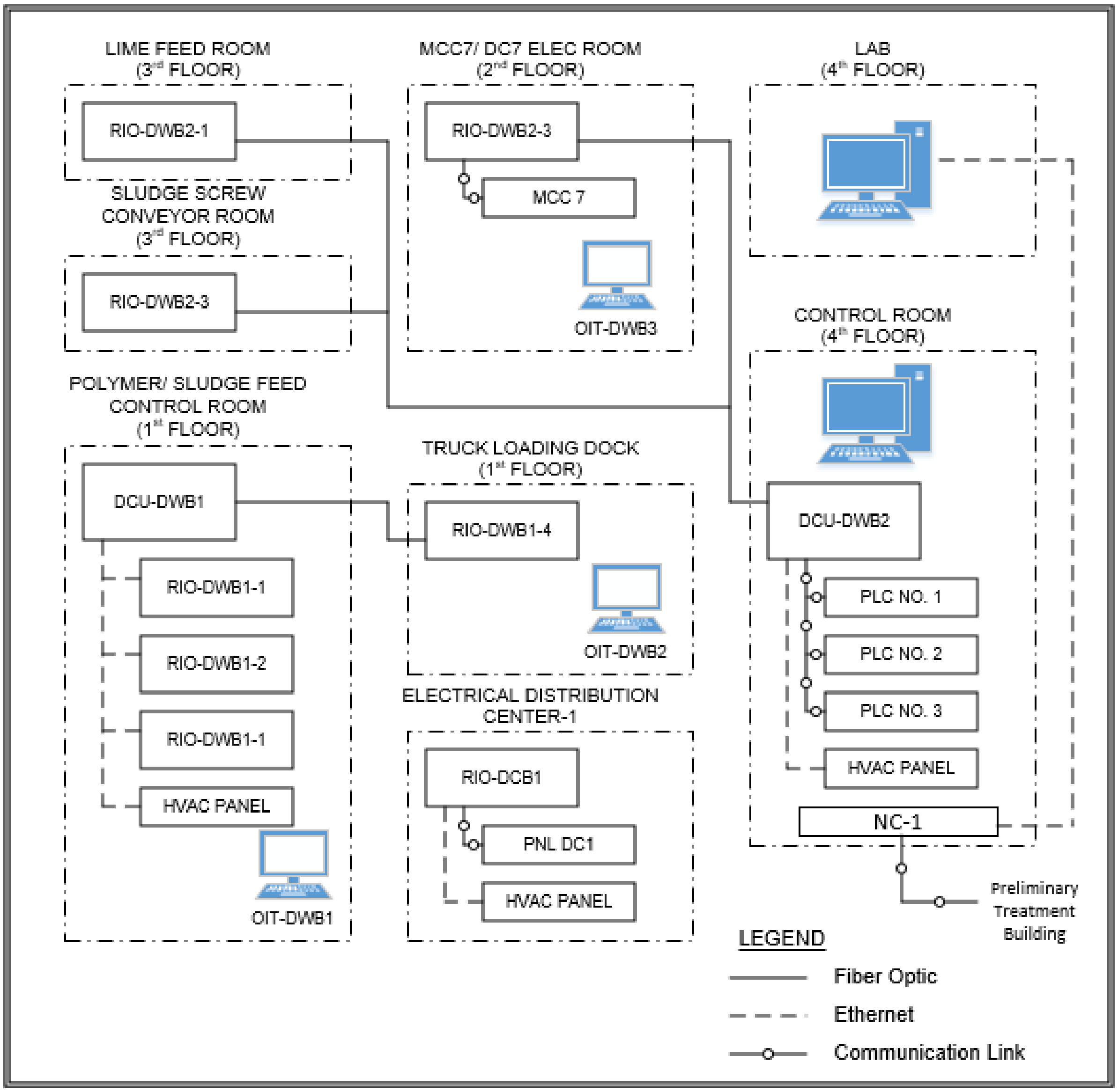


Figure 20-1. Existing Dewatering Building Communication Diagram

Central monitoring and control are accomplished with FactoryTalk v10 data acquisition from the Operations Building main control room. Rockwell ThinManager and thin clients are used to provide local visualization and operator interface in each process and subunit process area. Hach Water Information Management Software (WIMS) is used in coordination with FactoryTalk Transaction Manager for Tier 2 historical data collection. Primary and backup data acquisition servers are geographically separated. Backups of applications and data are maintained locally and off site.

A demilitarized zone (DMZ) exists between the PCS network and the WPCP enterprise network to allow for storage and access to Tier 2 historical data as well as handshaking for remote access to the PCS network.

Secure remote access to the PCS network is accomplished through the enterprise virtual private network (VPN) with multifactor authentication on the control system network.

Domain controllers are used to manage the access privileges and passwords for control system user groups.

20.3 Project Coordination

Ongoing projects related to the WPCP PCS that are scheduled for completion in 2022 include the following:

- **ControlLogix processor upgrades:** replace L63 processors with L83 processors running v33 firmware
- Network conversion:
  - Replace ControlNet networks with Ethernet-IP
  - Implement device level ring (DLR) for local I/O and RIO
  - Replace area and I/O switches

20.4 Control System Design Criteria

Standards and best practices that will be followed when performing design or construction of WPCP control systems include the following:

- Arlington County Water Control Bureau Plant Control Systems Standards, Revision 03/25/2019 (DRAFT Recommendations for Establishing Standards)
- Rockwell Automation, Ethernet Network Design, June 18, 2016
- International Society of Automation (ISA) S5.1, Instrumentation Symbols and Identification
- ISA 88, Batch Control
- ISA 101, Human Machine Interface
- ISA/IEC 62443, Security for Industrial Automation and Control Systems
- UL 508A, Standard for Industrial Control Panels
- UL 698A, Standard for Safety Industrial Control Equipment for Use in Hazardous (Classified) Locations
- NEMA 250, Enclosure Types
- NFPA 79, Electrical Standard for Industrial Machinery

- NFPA 70, National Electric Code

Unless specifically noted, the latest revision of the referenced standards will be required.

20.5 Design Approach

Options presented for modifications to the dewatering and solids handling process in preceding sections of this Plan will require modifications to the PCS network. During implementation of the modifications, the existing dewatering process operations will be maintained.

The Program will require modifications to the control system network infrastructure requiring new network drops and possible temporary connections depending upon the options selected.

Modifications to the network will maintain the network conversion project being implemented based upon the design by Rockwell for the WPCP and as described in Section 20.3. Close coordination with the network conversion project will be required to determine impact to DWB facility modifications and identify if there is an opportunity to reuse network equipment installed as part of the conversion.

If Option 2 (decommission DWB) is selected, the backbone will be modified with a tie-in to the PTB to insert the segment for the new SPB into the fiber ring for the WPCP. Once construction is completed, the segment to the existing DWB will be decommissioned.

For both facilities option considered herein, a new control room will be constructed in either the existing DWB (Option 1) or in the new SPB (Option 2). This control room will serve the operations of the solids handling facilities and serve as a backup to the Operations Building main control room. This control room will include appropriate audio/visual equipment and workstations to accomplish dewatering and WPCP operations monitoring and control. Network equipment will be located in a secure network room in the building.

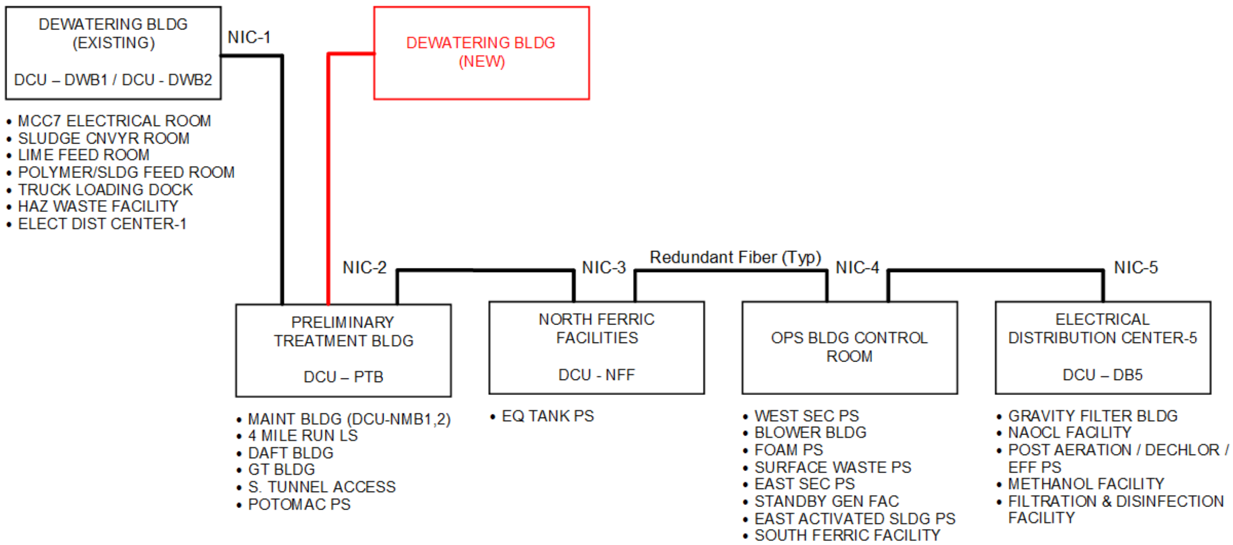


Figure 20-2. Site Communication Backbone Block Diagram

20.5.1 Equipment

Preferences for control systems equipment instrumentation include the following:

- PLCs (Table 20-1)

Control panel components (Table 20-2)

- Networking equipment (Table 20-3)
- Device level networks (Table 20-4)

Field devices (Table 20-5)

- Uninterruptible power supplies (UPS) (Table 20-6)

Table 20-1. Programmable Logic Controllers

Type	Products
Distributed control unit (DCU) panels	ControlLogix 5580 controllers (or latest version)
RIO panels	ControlLogix platform, FLEX 5000™ I/O distributed I/O platform (or latest version)
Local control panels (LCP)	CompactLogix 5380 controllers (or latest version), Micro850 and Micro870 controllers (or latest version)
Electrical switchgear	Modicon PLCs (Schneider Electric)

Table 20-2. Control Panel Components

Type	Products
Operator interface terminals (OITs)	Allen-Bradley PanelView Terminals[a]
Panel power supplies	Allen-Bradley Bulletin 1606 (or latest version), Pepperl+Fuchs, Phoenix Contact
Terminal blocks band breakers	Allen-Bradley, Phoenix Contact[b]
Relays	Allen-Bradley, Phoenix Contact

a. The County's preference is to use thin clients with touchscreen panels instead of industrial PCs.
b. The County's preference is to use circuit breakers instead of fuses whenever possible.

Table 20-3. Networking Equipment

Type	Products[a]
DCU panels	Allen-Bradley Stratix 5700 industrial access switch (or latest version)
RIO panels	Allen-Bradley Stratix 5700 industrial access switch (or latest version)
LCPs	Allen-Bradley Stratix 2500 switch (or latest version), Ethernet Tap (ETAP)
Network operations center (NOC)	Cisco Catalyst 4500X core switch (or latest version)
Distribution switch rack enclosure	Cisco Catalyst 4500X distribution switch (or latest version)
Zone enclosure	Allen-Bradley Stratix 5400 industrial access switch (or latest version)

a. The County's preference is to avoid the use of unmanaged switches whenever possible.

Table 20-4. Device-Level Networks (in order of preference)

Type	Products
Ethernet-based protocols	Flow meter, analyzers, power monitors, and APL transmitters
HART/4–20 mA	Pressure, temperature and level transmitters, actuators
Foundation Fieldbus[b]	Actuators, pH/ORP, mass flow
Wireless protocols	WirelessHART, cellular/LTE
BACnet	HVAC controls

a. Foundation Fieldbus devices will be used only when existing Fieldbus infrastructure is present.

Table 20-5. Field Devices

Type	Products[a]
Pressure transmitters	Rosemount
Temperature transmitters	Rosemount
Level transmitters (differential pressure)	Rosemount
Level transmitters (radar)	Rosemount
Flow meters (magmeter)	Endress+Hauser
Flow meters (differential type)	Rosemount
pH/ORP[b]	Yokogawa
Fixed-point gas detection	Sierra Monitoring
Dissolved oxygen/TSS	Insite
Online TSS	Valmet
Weight (load cells)	Mettler-Toledo
Electric actuators	Rotork
Variable-frequency drive	Allen-Bradley PowerFlex

a. Endress+Hauser and Rosemount are the County's primary field device manufacturers.
b. Yokogawa pH/ORP transmitters will be used with existing Foundation Fieldbus infrastructure.

Table 20-6. Uninterruptible Power Supplies

Type	Products
120 VAC output	Vertiv/Leibert GXT series
24 VDC output	Allen-Bradley 1606-XLS240-UPS, 1606-XLS480-UPS[a]

a. The ControlLogix, CompactLogix, and Flex 5000 I/O platforms have both alternating current (AC) and direct current (DC) power supply options.

20.5.2 Control Panels

For new process areas, a distributed control unit (DCU) cabinet housing redundant PLCs, local I/O, and operator interface terminal (OIT) will be used to monitor and control the process area with RIO cabinets for I/O distribution.

The DCU cabinet will be located in an environmentally controlled area such as an air-conditioned electrical room. RIO cabinets may be located in the process area near the equipment or end devices.

DCU cabinets will be designed for no more than 300 hardwired I/O. RIO cabinets will be used to allow for distribution of hardwired I/O.

For new construction, bottom conduit entry is required in DCU and RIO panels. In existing facilities, side and top entry may be permitted upon approval from the Arlington County WPCB.

20.5.3 Control Modes and Priority

PCS modes will include the following:

- **Local Manual:** Operator controls equipment from an LCP installed physically near the equipment.
- **Local Auto:** For LCPs with PLCs, this mode allows for automatic control at the LCP. Automatic control will not be duplicated at the PCS.
- **Remote PCS Manual:** Operator manually operates equipment from control operators on the HMI.
- **Remote PCS Auto:** Operator enters set points and process area equipment is automatically controlled to achieve defined control descriptions for the area.

20.5.4 Graphics

HMI graphics will be developed to meet High-Performance Human-Machine Interface (HPHMI) best practices. Workshops will be required to define the degree to which the HPHMI standards will be applied. Currently, the WPCB does not have a library of standard objects to be used by programming teams but are in development. These workshops will be used to collaboratively present and agree upon graphic standards to be applied for the process area.

20.5.5 Programming

The programming and configuration for this system will be performed by a system integrator. Ladder logic and function block programming will be acceptable programming methods.

21 PERMIT AND APPROVAL REQUIREMENTS

21.1 Background and Purpose

The Program will require communication with and oversight by two major regulating bodies throughout the design and construction phases of the Program: Arlington County's Permit Office for building and site permitting, and the Virginia Department of Environmental Quality (VDEQ) for state and federal laws and regulations associated with air quality, water quality, and water supply and land protection. The Program team will communicate with each of these regulating bodies early in the Program's development to ensure that a smooth Program is executed.

This section of the Plan details the known permitting requirements needed for the Program. The delivery team is responsible for verification of permit requirements as the design progresses and updating the register of permits as needed.

21.2 Arlington County Permitting

The Arlington County Permit Office maintains a robust website with online applications, online plan review status, online payment, and other vital permitting process and tracking needs for this Program. The delivery team should review this website for Arlington's Design Standards and Guidelines associated with buildings and stormwater within the county. The delivery team will provide completed permit applications and the appropriate supporting documentation required for each permit. The County will officially submit the permit applications to the code officials and pay associated permit fees (trade permits excluded).

21.2.1 Building Permits

Arlington County has adopted the 2018 VUSBC. Appropriate building permits must be received prior to the start of construction activities. The County will be responsible for all special inspections required based on delivery team interpretation of the code and confirmed by the code officials.

21.2.2 Trade Permits

The delivery team contractor will be responsible for applying and paying for all necessary trade permits for the work.

21.2.3 Site Plan Permitting and Zoning

The Contractor will be responsible for the Site Plan Permitting for the Program. The following reviews and permits associated with the site civil design may be required for this Program and can be obtained through the Permit Arlington system on Arlington County's website:

- Conceptual Site Plan Review (*Site Plan Applications: Official Website of Arlington County Virginia Government [arlingtonva.us]*)
- Civil Engineering Plan Review (*Civil Engineering Plan: Official Website of Arlington County Virginia Government [arlingtonva.us]*)
- Landscape Plan Review (*Landscape Plan Application: Official Website of Arlington County Virginia Government [arlingtonva.us]*)
- Chesapeake Bay Preservation Ordinance (*Chesapeake Bay Preservation Ordinance: Official Website of Arlington County Virginia Government [arlingtonva.us]*)

Additional permits may be required per Arlington County once preliminary plans have been reviewed during the County's pre-submittal processes.

As noted in Section 17.3.2, the site is zoned P-S (Public Service District). According to the Arlington County Zoning Ordinance dated 01-12-2022, wastewater treatment plans are allowed by right, therefore no zoning or special use permits are necessary.

21.2.4 Stormwater Permitting

To reduce pollution from sediment runoff and manage stormwater runoff from the land disturbance related to this Program, a land disturbance and stormwater management permit needs to be obtained from Arlington County, Virginia.

A land-disturbing activity/stormwater permit is required for any activities that disturb equal to or greater than 2,500 ft^2 of land, as required by the Erosion and Sediment Control Ordinance in Chapter 57 of the Arlington County Code, Chapter 60 of the Stormwater Management Ordinance, and the Virginia Erosion and Sediment Control Program. Based on evaluation of both design options (Option 1—renovate existing DWB, and Option 2—decommission existing DWB), expected land disturbance will be more than 2,500 ft^2 and thus a land-disturbing activity/stormwater permit will be required.

The permitting process and related permit fee details can be found on the Arlington County website: Land Disturbing Activity/Stormwater Permit Details: Official Website of Arlington County Virginia Government [arlingtonva.us]).

All land disturbance and proposed work is located outside of FEMA Flood Zone AE as depicted in the effective flood insurance rate maps dated August 19, 2013; therefore, compliance with Chapter 48, Floodplain Management, of the Arlington County Code is not anticipated. However, if at any point during the design process, work is performed within the above-mentioned flood zone, adherence to the Arlington County floodplain management ordinance will be required.

21.2.5 Other Permits

The delivery team will be responsible for identifying any other permits required and coordinating submission of these permits with the County.

21.3 Virginia Department of Environmental Quality

VDEQ administers state and federal laws and regulations for air quality, water quality, water supply, and land protection. The agency provides technical and financial assistance for air and water quality improvements projects, such as this Program. Through its local office, VDEQ issues permits, conducts inspections and monitoring, and enforces regulations and permits. For this Program, Arlington County will continue to work with the Northern Regional Office (13901 Crown Court, Woodbridge, VA 22193: (703) 583-3800).

VDEQ will require multiple permits associated with the design and construction of the Program, including a series of construction permits and an air permit update.

21.3.1 Construction Permits

VDEQ will require permits associated with the design and construction of the Program: the Certificate to Construct (CTC) and the Certificate to Operate (CTO).

21.3.1.1 Certificate to Construct

VDEQ requires a CTC for construction projects at wastewater treatment facilities. Prior to any construction activities on the Program, Arlington County must obtain a CTC from VDEQ. The delivery team engineer will be required to submit a signed and sealed statement that the design is in compliance with the requirements of the *Sewage Collection and Treatment Regulations* (Virginia Administrative Code Title 9 Section 25-790) along with a brief description of the project, including the Reliability Classification and any deviations from the *Sewage Collection and Treatment Regulations*.

Application forms for the CTC can be found on the VDEQ website and generally contain project information including the following:

- Project title
- Project location
- Receiving systems
- Project owner and project engineer
- Design sewage flow
- Virginia Pollutant Discharge Elimination System (VPDES)/Virginia Pollution Abatement (VPA) Permit number

21.3.1.2 Certificate to Operate

VDEQ requires that a CTO be obtained by Arlington County following the application and approval of a CTC earlier in the Program. The CTO is regulated under the *Sewage Collection and Treatment Regulations* (Virginia Administrative Code Title 9 Section 25-790). Nearing the end of the construction phase, the delivery team will issue a signed statement of completion that the Program has been fully commissioned and inspected and is ready to be placed into service. At this time, Arlington County will apply for the CTO for the new facilities from the VDEQ Regional Office.

Application forms for the CTO can be found on the VDEQ website and generally contain project information including the following:

- Project title
- Project location
- Receiving systems
- Project owner and project engineer
- PTL number
- Original CTC
- Design sewage flow
- VPDES/VPA Permit number
- Reliability class

After the signature from VDEQ on the CTO, it is anticipated that Arlington's VPDES permit will require full Facility Operation and Maintenance Manuals for the Program. The delivery team will prepare these documents in concert with Owner and Program Manager.

21.3.2 Air Permitting

The WPCP currently operates under Stationary Source Permit to Construct and Operate Registration 70026, issued by VDEQ and effective July 2, 2012. Although several facility changes have been made since that date, none of these changes have resulted in a requirement to modify the existing permit. The facility changes will need to be captured in the modified permit required for the Re-Gen Program, based on information provided by the County.

Based on a preliminary evaluation of each of the possible scenarios, implementation of the Program will include the installation and operation of several new sources that will require modification of the existing permit through VDEQ's minor new source review (NSR) construction permitting program. The modified facility air permit will need to be issued by VDEQ prior to beginning construction of any of the applicable equipment.

Minor NSR permits do not go through public participation unless VDEQ determines that public interest concerning air quality issues warrants it. The air permitting process should be started well in advance of when construction is scheduled to commence in order to avoid undue delays associated with the permitting process. VDEQ indicates the following time frames associated with processing and issuing a minor NSR permit:

- **Completeness review:** 30 days from receipt of application
- **Processing of application:** 90 days from receiving a complete application; 180 days if public participation is required

One key term in the application processing timeline is "complete." If VDEQ determines that additional information is required to process the submitted application, VDEQ will request that information and the time clock will pause until it receives the information and deems the application complete. The processing timeline then resumes.

21.4 Virginia Department of Labor and Industry

The Virginia Department of Labor and Industry, Boiler and Pressure Vessel Regulations has an inspection and certification program for boilers and pressure vessels within Virginia. The new steam boilers and pressure vessels (such as the THP vessels) added as part of the Program will be subject to the Virginia Boiler and Pressure Vessel Regulations (https://law.lis.virginia.gov/admincode/title16/agency25/chapter50/) in the Virginia Administrative Code.

There is no state requirement by the Commonwealth of Virginia to have a license to operate a boiler. However, the Virginia Administrative Code allows any city or county in Virginia the option of requiring certain persons to obtain a certificate from the locality. At the present time, no locality in the commonwealth requires such a certification.

21.5 Federal Aviation Administration

Pending decisions made during detailed design regarding new building construction and site plan, the project might require notice to the FAA per FAA Regulation, Title 14, Part 77. It is the responsibility of the delivery team to identify the requirements and provide the notice in a timely manner as required in FAA Regulation, Title 14, Section 77.5.

A Pre-Screening Tool can be found at the following link: Obstruction Evaluation/Airport Airspace Analysis (OE3A) (faa.gov).

The filing process can be found at the following link: Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) (faa.gov).

The forms can be found at the following link: Forms (faa.gov).

22 PROGRAM IMPLEMENTATION

22.1 Background and Purpose

The Arlington Re-Gen Program is a large, complex comprehensive upgrade to the existing solids handling processes that involves multiple delivery risks and opportunities. These risks and opportunities were evaluated to identify different delivery packages and delivery methods for ultimate design, construction, and commissioning of the Program.

22.2 Program Delivery Approach

To facilitate the evaluation of project packaging and delivery methods for implementation, the Program Manager and the County completed a thorough risk review of the Program elements. This risk review and analysis is summarized in TM No. 14: *Program Delivery Recommendation.*

During the risk review and analysis, the Program team determined that there were no significant drivers for dividing the Program into multiple delivery packages, as was done with the Master Plan 2001 (MP01) projects. The Program elements will be constructed on a tight site, with very limited space for new construction and challenging construction sequencing. In addition, the proposed solids handling processes are significantly more complex than the existing process, with numerous additional unit processes in a highly integrated facility. The existing solids handling process will also need to remain fully functional throughout construction such that the County can continue to meet all permitted treatment requirements. These risks can best be managed by a single entity responsible for all of the construction and commissioning of the new facilities.

However, one exception for a separate project delivery was identified: the existing GTs. The existing mechanical components within the GTs are near the end of their useful life and at risk of imminent failure. In addition, the GT unit process is less critical and less integrated from the remainder of the Program elements. Finally, the size of the GT rehabilitation allows for it to be designed by a County on-call engineer, through Agreement 17-348-RFP. The Program team agreed to proceed with the design and construction of the GT upgrades through an on-call engineer and constructed through a traditional competitive sealed bidding approach. This project will be titled the *Gravity Thickener Upgrades Phase 10A.*

As mentioned in Section 9, TH systems vary widely in their process configurations, equipment arrangement, and operational strategies. Additionally, the solids handling interfaces upstream and downstream of the THP are different with each technology. It is therefore necessary to select the specific THP configuration before proceeding to detailed design. The County is proceeding with a pre-selection of the THP equipment. This project will be titled *Thermal Hydrolysis Process Pre-Selection Phase 10B.*

Through the risk analysis and discussion of potential delivery approaches, the WPCB determined that the traditional competitive sealed bidding approach does not adequately address key project risks for the remaining elements of the Program. The WPCB recommended and is proceeding with the use of the DB delivery method through competitive negotiations for delivery of the major portions of the Program, as authorized by the Arlington County Purchasing Resolution (July 2021), Section 4-102(3)D. The main advantages to the WPCB of the DB delivery method for this Program are as follows:

- Single point of responsibility for design and construction, including startup and performance requirements
- Contractor input during design, both to inform the design and to allow the contractor to be more informed to accurately price the work
- Decision making informed through real-time pricing discussions
- Deliberate teaming of design and construction partners in a collaborative manner to drive innovative solutions

The DB project will be titled the *Comprehensive Biosolids Upgrades Phase 10C/D.* By selecting the DB delivery approach, Arlington County expects to secure substantial benefits for its ratepayers including ability to design to a budget and develop cost certainty, optimal risk allocations, and certainty of project design and construction scheduling. Key components of the preconstruction and design efforts will include construction sequence and phasing, MOPO, optimized facility layouts, and final site plan development with a focus on whether existing facilities should be reused. The delivery team, working collaboratively with Arlington County and Program Manager, will establish a final project configuration that will comply with the County's vision for, and the budget constraints of, the project. The delivery team will have opportunities throughout the project for innovation to improve the initial design concepts and to realize cost or schedule improvements.

22.3 Project Schedule and Sequencing

The final project schedule will be refined as delivery teams are procured. Preliminary schedules for the different phases are provided below.

22.3.1 Gravity Thickener Upgrades Phase 10A

As noted above, the GT upgrades will be designed by one of the County's on-call engineers and construction will be procured through a competitive sealed bidding (design-bid-build) approach. A preliminary timeline for Phase 10A is provided in Figure 22-1 below.

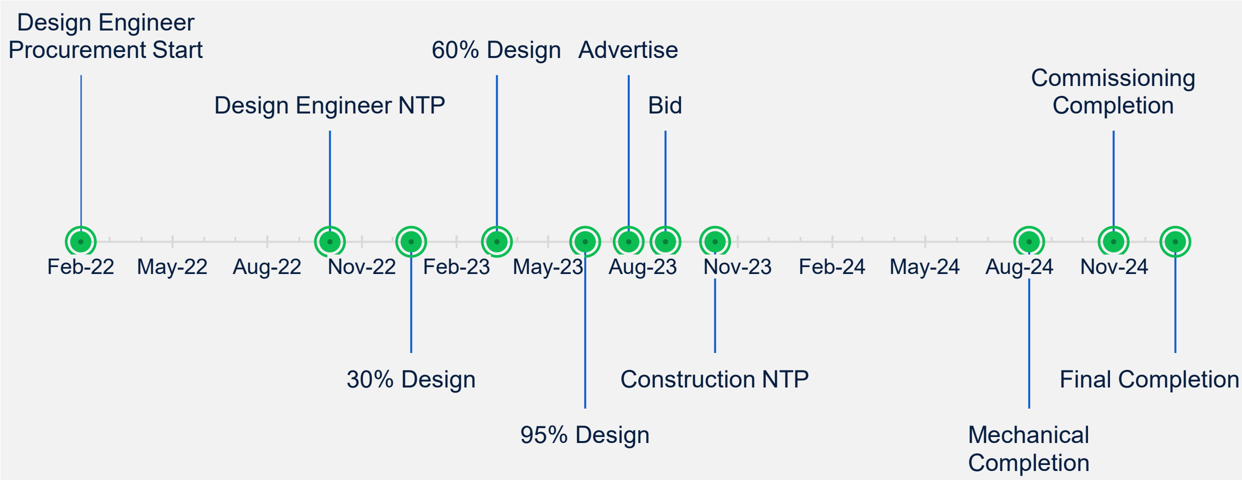


Figure 22-1. Gravity Thickener Upgrades: Phase 10A Preliminary Timeline

22.3.2 Comprehensive Biosolids Upgrades Phase 10C/D

Phase 10C/D is expected to be completed in two phases: an Early Work phase (10C) to include mass demolition and site preparation and the Main Project phase (10D) to include all structural, process, and mechanical work. Subject to approval of the County and County Board, the two phases will proceed using the same DB delivery team. A preliminary timeline for Phase 10C/D is provided in Figure 22-2 below. The overall Program is expected to continue through the end of 2028.

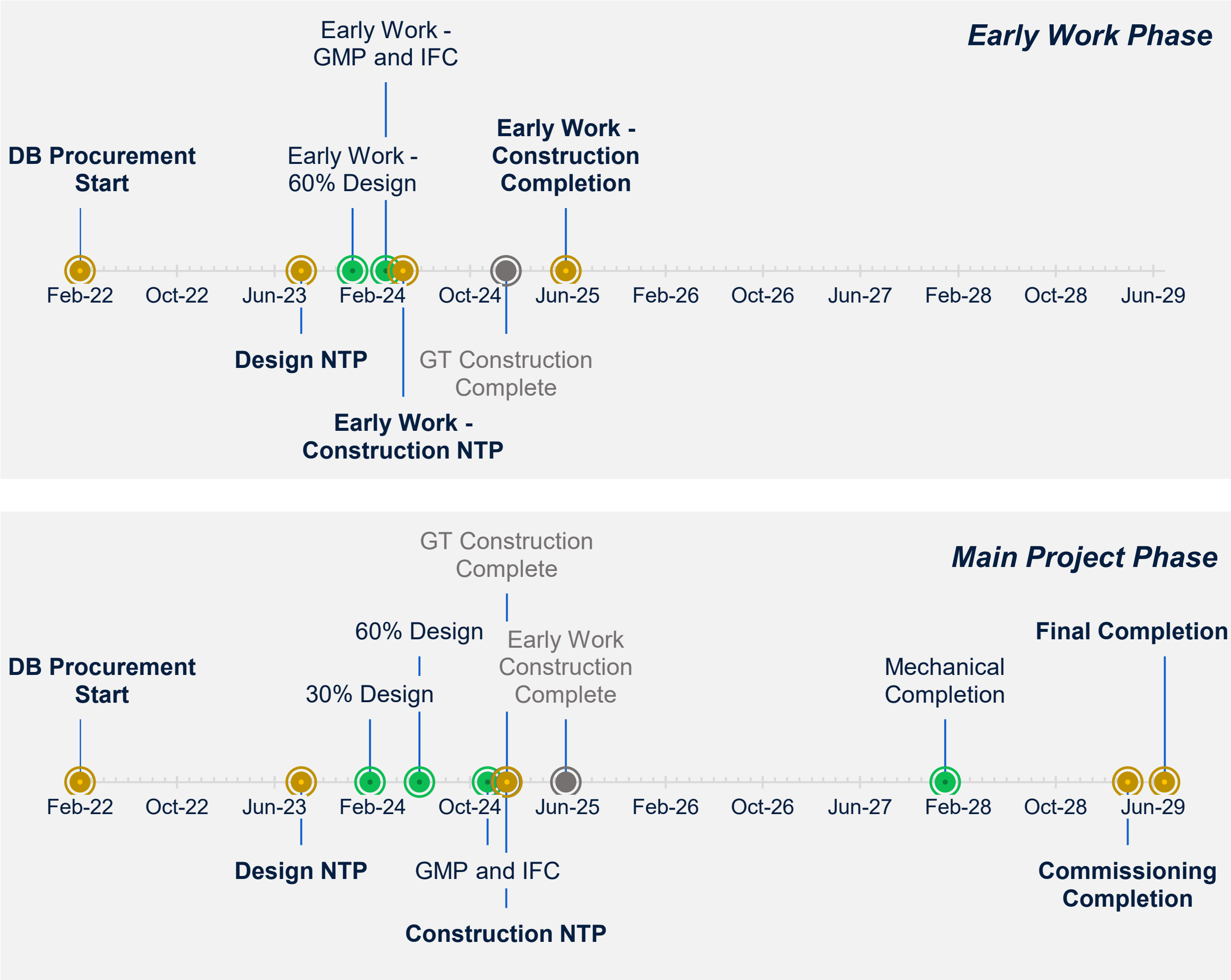


Figure 22-2. Comprehensive Biosolids Upgrades: Phase 10 Preliminary Timeline

22.3.2.1 Early Work Phase

The Early Work phase will be defined through additional bridging documents to be provided in the DB Request for Proposals (RFP), representing approximately 30 percent design of the required elements. The main components of the Early Work phase include:

- Demolition of existing Bio-building and remnants from abandoned structures, including old digesters
- Relocation of bulk chemicals (polymer and sodium hypochlorite) from Bio-building
- Rerouting of existing thickened solids lines and existing centrate drain from Bio-building
- General site preparation for main construction
- Potential early electrical gear procurement

These scope items are preliminarily discussed below. They will be further defined in the RFP bridging documents.

Relocation of Chemicals

The basement of the Bio-building includes bulk storage for emulsion polymer (dewatering) and sodium hypochlorite (odor control). There are also two abandoned $FeCl_3$ tanks. To allow for demolition of the Bio-building, the bulk storage for polymer and sodium hypochlorite must be relocated.

Existing polymer demand for dewatering is relatively low at approximately 60 to 80 gpd. An existing 6,200-gallon spare blend tank (Blend Tank 3) in the DWB polymer feed room will be repurposed as a bulk storage tank. Blend Tank 3 will provide adequate storage volume (90 days at average use). To use this tank for bulk polymer storage, the following modifications will be required:

- Provide new polymer fill connection and fill panel.
- Add level instruments for monitoring of bulk storage level and connect to the WPCP process control system. All process control will be the same as the existing operation for transfer and dilution of the polymer. The polymer tie-in location will be upstream of all control devices, with the exception that a new flow meter will be provided.
- Determine modifications to existing tank that are required based on recent inspection report. The inspection report notes missing welds on baffles. However, these baffles are not anticipated to be required when Blend Tank 3 is used as a bulk storage tank.
- Provide transfer pump and associated controls including flow meter for transferring polymer from Blend Tank 3 to Blend Tanks 1 and 2 for aging.
- Provide shelf-spare transfer pump for redundancy.
- Provide necessary piping connections for the work.

Existing sodium hypochlorite demand is approximately 130 gpd for odor control purposes. There are two options for providing sodium hypochlorite to the existing 3,300-gallon hypochlorite storage in the DWB:

- Use the existing hypochlorite fill connection at the DWB to accept partial deliveries of sodium hypochlorite. Deliveries can be coordinated to coincide with deliveries to the South Hypochlorite Facility to avoid partial delivery charges. The existing 3,300-gallon tank provides approximately 25 days of storage.
- Provide new transfer pump and use existing transfer line to pump from the South Hypochlorite Facility to the DWB. A transfer line currently exists from the South

Hypochlorite Facility to the PTB. This line would be extended from the PTB to the DWB.

Based on discussions with the County, the preferred option is to use the existing hypochlorite fill connection at the DWB to accept partial deliveries of sodium hypochlorite.

Rerouting of Utilities

Two major utilities currently pass through the existing Bio-building:

- 8-inch-diameter thickened solids line, which is looped from the SSTs to the solids wet well
- 16-inch-diameter centrate/building drain, which eventually ties in to an old 24-inch-diameter incinerator scrubber drain

Both utilities will be rerouted to the west of the existing DWB and Bio-building while being sure to avoid areas of new construction. The operation of the existing RIPS will not be changed through the relocation of these utilities. Refer to Section 16 for discussion of permanent changes to the RIPS.

Demolition

Major demolition activities are required to clear the site for the new facilities, as shown on Drawings C-03 and C-06. The Early Work phase will include the demolition of the Bio-building and potential remnants of abandoned digesters.

The Bio-building was constructed in 1977 and primarily housed two multiple-hearth incinerators. The incinerators were decommissioned with construction of the existing DWB and lime stabilization systems in the 1990s. The Bio-building is nearly completely abandoned. Existing chemicals and utilities are running through the building as mentioned above. In addition, the Arlington County Household Hazardous Materials (HHM) Facility collection area is located on the first floor in the west portion of the building. The previously adjacent Solids Filter Building and Lime Building were demolished when the existing DWB was constructed. Under all site plan scenarios, the Bio-building will be demolished. The County will relocate the HHM Facility prior to commencement of demolition.

Old Digesters 1 through 3 were demolished as a change order to Phase 7D. No records exist to confirm if the digesters were demolished completely (including foundations) or if the foundations were left in place. Investigations will continue to determine what remnants of the digesters are remaining—any remnants will be removed in the Early Work phase.

The SSTs and adjacent building housing the pumping equipment, MCCs and electrical room will ultimately be demolished but need to remain in operation, at least temporarily, during construction.

Site Preparation

During and following the major demolition activities, the site will be prepared for future construction activities. It is anticipated that this preparation will include significant supported excavation and drainage improvements to create a workable site at approximately EL 22.

Early Electrical Gear Procurement

New electrical distribution equipment will be required. As discussed in Section 22.4.2 below, this new distribution equipment could be used to power existing DC-1 and DC-7 loads such that the existing DC-7 could be removed from service to facilitate construction. Consideration will be given to early shop drawing review of the new electrical equipment to facilitate fabrication release date and arrival onsite. This is not included in the initial Early Work scope of work but may be added to the Early Work during initial design phases.

22.3.2.2 Main Project Phase

The Main Project phase will be authorized separately from the Early Work phase, and it will include all of the major process components of the facility. It will also include all startup, commissioning, and training activities. Once the site has been prepared under the Early Work phase, limited schedule and sequencing constraints will be associated with the Main Project phase. Generally, these constraints include:

- Solids handling operations will need to be maintained at all times (see Section 22.4 below).
- WPCB O&M staff will need safe access to operational facilities at all times.
- Demolition of existing SSTs or DAFT facilities cannot occur until new SSTs are constructed and commissioned.
- Startup will need to proceed in a sequential and integrated manner (see Section 22.7 below).

22.4 Maintenance of Plant Operations

MOPO will be a key consideration of project implementation moving forward. It is critical that the WPCP be able to remove solids from the process effectively and efficiently throughout construction. MOPO planning will be a considerable focus of the design and preconstruction phases of the work. Critical components of the MOPO planning include:

1. Maintaining the capability to beneficially land-apply biosolids throughout construction through a combination of:

    a. MOPO of existing DWB
    b. Temporary dewatering and/or stabilization options to allow for renovations in existing DWB
    c. Use of new facilities for dewatering and truck loading to off-site stabilization during construction

2. Maintaining electrical service to existing facilities throughout construction through a combination of:

    a. Maintaining existing electrical service
    b. Providing new electrical feed and distribution that can temporarily feed existing facilities

22.4.1 Maintaining Solids Handling Operations during Construction

Arlington County solids will continue to be produced throughout construction. The MOPO considerations will be a key decision point in selecting a final site layout (as discussed in Section 17.2).

The MOPO constraints for Option 2—decommission existing DWB—are relatively straightforward:

- Complete utility relocation, demolition, and site preparation as discussed for the Early Work phase.
- Construct new facilities completely. As envisioned, the existing DWB would remain in service throughout construction. Access for WPCB O&M staff will need to be maintained throughout construction.
- Commission new facilities.
- Demolish existing DWB truck bay extension and odor control facilities (as shown on the drawings) and SSTs.
- Decommission and/or demolish the existing DAFT and DWB.

Option 1—renovate existing DWB—would involve a significant shutdown of the existing DWB prior to new facilities being fully available for solids processing. Therefore, temporary facilities or use of new facilities for alternative purposes would be required to continue processing the solids for beneficial reuse. Note, landfilling of solids to facilitate construction will not be acceptable.

The MOPO constraints for Option 1—renovate existing DWB—would include the following:

- Complete utility relocation, demolition, and site preparation as discussed for the Early Work phase.
- Construct and commission the new Final DWB and truck loadout with temporary connections for dewatering unstabilized solids. Permanent or temporary odor control is also required for these facilities.
- Provide for stabilization of dewatered solids through one of the following:
    - On-site temporary lime stabilization, including truck loadout and odor control
    - Off-site stabilization
- Transition solids operations through new Final DWB, including any temporary facilities
- Decommission and demolish interior of existing DWB
- Construct new pre-dewatering facilities within existing DWB
- Construct new THP facilities in location of existing DWB odor control
- Commission new facilities
- Remove temporary facilities
- Decommission and/or demolish existing SSTs
- Decommission and/or demolish existing DAFT

Options for temporary lime stabilization and off-site stabilization are discussed further in Section 22.4.2 below. Other facilities outside of pre-dewatering and final dewatering would be constructed as available. Temporary dewatering could be considered in place of using the new Final DWB for dewatering unstabilized solids.

22.4.2 Temporary Facilities

Option 1—renovate existing DWB—would require stabilization of the solids either on site through temporary lime stabilization or off site. Dewatering would be through the new Final DWB and truck loadout. As noted above, landfilling of solids during construction is not acceptable.

22.4.2.1 On-site Temporary Lime Stabilization

On-site stabilization would occur by mixing lime in with the dewatered solids, similar to the current process. An example temporary lime stabilization system (without odor control) is shown in Figure 22-3 below.

Figure 22-3. Temporary Lime Stabilization in Howard County, Maryland

A temporary enclosure would be provided outside the new Final DWB to contain lime dust and odors. A temporary odor control system would treat the ventilation exhaust from the temporary stabilization structure. Because of site constraints the structure could only be large enough to house two dewatered cake trailers at a time so staging operations over the extended operations would be difficult. Additionally, because of the limitations of the temporary lime addition system the stabilized biosolids would have to be hauled off site throughout the day.

22.4.2.2 Off-site Stabilization

Off-site stabilization would involve the trucking of unstabilized dewatered solids for stabilization to another facility. The cake bins in the Final DWB would be used to store the dewatered solids and load the trucks. Use of the cake bins could provide the ability to maintain the current nighttime hauling schedule, although the cake bins would need to be decontaminated prior to receiving Class A dewatered cake. The stabilization techniques used by the off-site providers that have been contacted include lime, thermal with lime, and composting.

The following off-site stabilization providers were contacted to determine whether they could potentially accept unstabilized dewatered solids from Arlington over an extended period:

- Spotsylvania County, Virginia (composting)
- Synagro (Old Line) in Baltimore, Maryland (thermal with lime)
- Veolia in Baltimore, Maryland (composting)

- McGill in Waverly, Virginia (composting)
- Nutri-Blend in Cumberland, Virginia (lime)

Of the off-site stabilization providers listed above, only McGill and Nutri-Blend have the capacity to fully accept unstabilized dewatered solids from Arlington. Both indicated that they currently expect to have the capacity in the 2025 time frame to accept the solids, but both indicate that capacity is allotted on a first come, first served basis.

22.4.2.3 Comparison of Temporary Alternatives

Table 22-1 below provides a comparison of on-site versus off-site stabilization options. For Option 1—renovate existing DWB—it is assumed that 18 months of temporary operations would be required. The total costs for on-site and off-site composting are comparable for this duration. The costs for off-site lime are significantly higher. The lime options (on-site or off-site) will also fluctuate with the price of quicklime. Off-site hauling has less odor impact on the community because of the potential for nighttime hauling, although hauling and delivery schedules would need to be coordinated with the receiving facility. Off-site stabilization also has less of an impact on construction site constraints because of no temporary facility footprint and no lime deliveries.

Table 22-1. Temporary Stabilization Comparison

Parameter	On-site Lime Stabilization	Off-site: Composting	Off-site: Lime Stabilization
Temporary facilities and operations	$700,000	$0	$0
Annual lime usage	$560,000	$0	$0
Total annual stabilization + hauling cost [a]	$2,810,000	$2,750,000	$6,760,000
Total cost for 18 months of operation	$4,920,000	$4,130,000	$10,140,000
Odorous trailers?	Yes	Less so	Less so
Nighttime hauling?	No	Yes	Yes
Site footprint, ft^2	5,600	0	0
Lime delivery?	Yes	No	No
Backup disposal options?	Yes	Potentially	Potentially
Decontaminate cake bin?	Depends on operations	$50,000	$50,000

a. Assumes 150-mile trip and Recyc doing the hauling. McGill hauling raw cake is $3,400,000/yr. This line includes the cost of stabilization.

The decision on the temporary stabilization method will be made in conjunction with the review of site plan options with the selected delivery team. The County preference if Option 1—renovate existing DWB—is the preferred approach, would be for off-site stabilization. If that path is chosen, it is recommended to start preparing procurement documents for off-site stabilization as soon as a site plan decision is made. These contracts would reserve capacity beginning in 2025 with options to extend the contracts.

22.4.3 Electrical

The electrical service to the existing DWB must remain in service, at least partially, during construction of the new facilities. Drawings E-01, E-02, and E-03 show a suggested method to assist that effort.

The existing north plant electrical distribution comprises two 34.5 kV redundant feeders that serve DC-1 and DC-7. These feeders are configured such that an outage of one feeder removes both associated DC transformers from service. In addition, this makes it difficult to add transformers for future facilities. The recommended approach is to add distribution switches through the following sequence:

1. Take down one feeder while the other serves all loads. See Section 19.4 for outage support requirements.
2. Connect the existing DC-1 and DC-7 transformers to switch legs.
3. Follow the same process for the second feeder.

When the distribution switches have been installed, they will serve as a connection point for new DC-7. This will allow existing DC-1 and DC-7 loads to remain in service during construction. When the existing DC-7 transformers need to be removed, a pair of 480 V circuits would be run from the new DC-7 to the existing DC-7. When the existing DC-7 is replaced those two feeders can supply the new equipment.

Given the long lead time of switchgear and criticality of maintaining electrical service during construction, it is recommended that budget be allocated in the Early Work phase for initial switchgear procurement activities, including selection of equipment and shop drawing review. The equipment could be released immediately upon approval of the Main Project phase.

22.5 Demolition of Existing Facilities

As discussed in Section 22.3.2.1 above, mass demolition of existing facilities will be required. In addition, selective demolition will be required to integrate new facilities with the existing facilities.

22.5.1 Mass Demolition and Existing Foundations

The selected site plan option may impact the extent of planned demolition of concrete and deep foundations. Some deep foundations below demolished structures could be repurposed to reduce the construction cost of new support systems. The same could apply to existing concrete foundations (and other elements, such as integrally cast walls), whether at grade or pile supported. In either case, all of the locations and sizes of the existing piles and foundations to be repurposed should be confirmed for location and geometry. Pile load tests on existing piles may be appropriate to verify capacity assumptions. Should none of the existing construction be incorporated into the selected site plan option, the in situ piles would need to be cut off at appropriate levels and locations would need to be verified not to interfere with new deep foundation construction. Also, the proximity of new piles to existing piles would be evaluated for any effect due to group capacity reduction.

All foundation design and geotechnical evaluations will be completed by the delivery team.

22.5.2 Select Demolition

Select demolition will be required in certain areas to integrate new facilities with existing facilities. The select demolition will need to be properly planned and coordinated to ensure continued service and MOPO and to avoid damage to existing operational facilities.

22.5.3 Hazardous Materials

Limited quantities of hazardous materials, namely asbestos-containing materials (ACM) and lead paint, are known to be present in facilities that will be demolished. Previous hazardous-materials studies were completed, most recently in 2003. The Program Manager and the County may revisit these studies and provide additional investigations prior to the DB RFP. Delivery teams will be fully responsible for mitigating any hazardous materials during demolition, including compliance with all laws, rules, and regulations. All available hazardous-materials survey information will be provided to prospective delivery teams in the DB RFP.

22.6 Startup and Commissioning

A commissioning program will be collaboratively developed with the delivery team. The commissioning program will include the three stages listed below:

- **Planning:** includes developing the plan; identifying a commissioning team; and developing WPCP O&M manuals, standard operating procedures (SOPs), and a training plan
- **Individual equipment testing:** includes defining and conducting the field equipment testing procedures, including installation checks (Manufacturer's Certificate of Proper Installation), preliminary and pre-final (dry and wet) testing, and open- and closed-loop testing (witnessed combined-loop testing) for all equipment that interfaces with the WPCP process control system
- **Startup testing (operational demonstration):** includes functional testing of equipment systems and processes, meeting Performance Guarantees (PGs) and standard specifications, all leading to beneficial occupancy of the entire system
- **Training:** includes training O&M personnel through both process and vendor-led training sessions

The delivery team will define all commissioning requirements in the project specifications. Additional information will be included with the scope of the DB RFP.

PGs will be discussed and developed with the delivery team as the design phase of the project progresses. All PGs will be fully defined and finalized by the time of guaranteed maximum price (GMP) determination. Acceptance testing will be required separately from the PGs on all equipment, and the delivery teams will be responsible for defining those testing requirements. Preliminary concepts for PGs are provided in Table 22-2 below.

Table 22-2. Preliminary PG Concepts

Facility	Criteria	Description
Entire facility	Operational reliability	Operate all project facilities for a prescribed duration over multiple days without operational/process issues. All facilities operated in automatic mode continuously. Feed rate would match solids production at startup/current operating conditions.
Entire facility	Maximum throughput	Achieve throughput of 68 dtpd through all facilities, including digestion, for a prescribed duration. Matches 2052 peak 3-day design condition. Will need to be carefully coordinated with County operations staff to avoid process upsets.
End product	Proof of Class A product	Fecal coliform, salmonellae, enteric virus, and viable helminth densities.
All unit processes	Demonstrate equipment capacity and reliability	All process equipment will be functionally tested for a prescribed duration over multiple days. Equipment will operate in automatic mode at specified design capacity continuously to demonstrate reliability and capacity.
Solids screens	Solids screenings moisture content	Compacted screenings will have a minimum dry solids content to be determined, with no standing water in the screenings dumpster.
Solids storage tanks	Confirm SST mixing efficacy	Demonstrate that the SSTs are well mixed.
Pre-dewatering centrifuges	Capacity and performance	Achieve specified cake solids, capture efficiency, and polymer consumption at the design throughput capacity and turndown conditions.
Pre-dewatered cake storage bins	Cake storage bin watertight	Cake bins will be tested hydrostatically to confirm watertightness of cake bin.
Pre-dewatered cake storage bins	Watertight gates under bins	Cake bins will be tested hydrostatically to confirm watertightness of gates or live bottom at bottom of bins.
THP	Cake dilution system	Dilute to specified THP feed concentration (+/- 1%) when operating in fully automatic operation.
THP	Throughput capacity	Demonstrate that the entire THP system can process the design capacity solids throughput and flow rates.
THP	Steam consumption	Steam usage per try don of solids throughput will not exceed the prescribed values. Steam usage will not exceed a maximum instantaneous steam demand.
THP	THS flow split	Demonstrate that the THS flow control valves and flow meters control the THS flow split within 5% accuracy range.

Facility	Criteria	Description
Steam	Steam production	Achieve required steam output from each boiler system. Demonstrate turndown requirements are met for each steam boiler.
Steam boiler	Boiler feedwater conditioning confirmation	Sampling to confirm chemical dosing is adequate for steam boiler performance.
Steam boiler	Emission limits	Achieve required air emission limits required for the boiler system.
THS cooling	Adequate cooling capacity	Confirmation system can transfer prescribed Btu/hr during automatic operations at a prescribed worst-case scenario condition.
THS cooling	Digester temperature control	Maintain digester temperature at a prescribed temperature range for a prescribed period.
Digester	Secondary digester operation	Operate the secondary digesters as a primary digester and confirm performance is similar to the primary digesters.
Digester	Confirm digester mixing efficacy	Demonstrate at least 90% of the primary digester is active volume at a prescribed throughput rate.
Final dewatering	Centrifuge performance	Achieve specified cake solids, capture efficiency, and polymer consumption at the design throughput capacity and turndown conditions.
Final dewatering	Cake storage bin watertight	Cake bins will be tested hydrostatically to confirm watertightness of cake bin.
Final dewatering	Watertight gates under bins	Cake bins will be tested hydrostatically to confirm watertightness of gates or live bottom at bottom of bins.
Gas cleaning system	System throughput capacity	Demonstrate through testing and calculations that the system can achieve the prescribed throughput rate when operating in automatic mode without significant equipment failure. Demonstrate turndown requirements are met for the system.
Gas cleaning system	Gas quality	Demonstrate cleaned gas quality meets required criteria.
Flare	Flare capacity	Demonstrate maximum and minimum capacity of flare.
Flare	Flare emissions	Achieve required flare emission limits.
Odor control	Performance	Verify required odorant removal through testing and sampling.

22.7 Contractor Laydown/Storage Areas and WPCP Access

Space on site is very limited for contractor laydown and storage and off-site facilities may be required. The County and Program Manager will work with the delivery team to identify space on site that could be used and how access to existing facilities for WPCB staff will be maintained. It is anticipated that the trailer complex constructed for MP01 projects on the corner of Fern and Glebe will be rebuilt and contain all necessary facilities for the delivery team and Program Manager. The Arlington County Department of Environmental Services (DES) is currently renovating the vacant lot across 31st Street S from the WPCP, and it is anticipated that this lot could be used for delivery team parking and limited storage. Once the Early Work phase is complete, the areas of the old digesters and Bio-building can be used for limited laydown and storage. All excavated materials will likely need to be taken off site as there are very limited areas for stockpiling soils on site.

WPCP access to the existing DWB will need to be maintained while the DWB is in use and will likely be from behind the NMB or exterior to the WPCP through Gate 3 off of 31st Street S or Gate 1 off of S Eads Street.

22.8 Neighborhood Impacts during Construction

The County and Program Manager will work with the delivery team on constraints relative to neighborhood impacts. Key considerations will include:

- Work hour and weekend work limitations
- Evaluation of deep foundation types and construction methods
- Limitations on pile driving operations if driven piles are required
- Truck traffic patterns
- Parking limitations

The Program Manager and County will implement a robust community outreach plan to keep neighbors informed of ongoing construction activities and the impacts that such activities may have on the surrounding neighborhoods.

22.9 Envision Verification

As discussed in Section 2, the Re-Gen Program will be aligned with the Arlington County Facility Sustainability Policy and will pursue an Envision Silver verification as one of the means for supporting Arlington County's Sustainability Goals. During preliminary design, Arlington County, facilitated by the Program Manager, completed an internal assessment of the Program, including a review of the Program's sustainable attributes, as well as the potential effort required to earn recognition through the Envision verification process, ensuring that the Program scope is aligned with the Envision scope. As the Program enters detailed design and construction, the discussions will continue to refine the credit levels of achievement and determine the documentation needs and responsibilities required to submit the Program's projects for verification.

In alignment with the Program's SMP, at key design and construction milestones, the Program Manager will conduct an Envision review with the delivery team, assessing the Program elements relative to the Envision scorecard, adjusting as the Program progresses. The Program is targeting Envision Silver verification via Pathway A (Design and Post-construction), allowing for the Program and team members to have the benefits of the preliminary award designation before the construction phase is completed. The Program Manager will continue to lead coordination and organization efforts for verification in preparation for compiling credit packages for the verification submission. The delivery team will be responsible for implementing Envision-aligned sustainability criteria, as well as generating, collecting, and supplying design and construction-phase supporting documentation required to support credits being submitted for verification. This collaborative process between Arlington County, the Program Manager, and the delivery team will ensure that the Program supports Arlington County' Sustainability Goals and results in an Envision verification that reflects the sustainable attributes of the Program and its overall benefit to Arlington County and the surrounding community.

22.10 Opinion of Probable Program Costs

The Program Manager developed an overall opinion of probable Program costs, as described below.

22.10.1 Opinion of Probable Construction Costs

The first step in defining the overall Program costs was development of an opinion of probable construction costs (OPCC). The OPCC is based on the facilities identified in this Plan and is considered a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International (AACE). AACE Class 4 estimates are typically done at the feasibility or study phase of a project and have an expected range of accuracy of -30 percent to +50 percent.

The OPCC is a combination of direct and indirect costs. Direct costs are based on building layouts and quantity takeoffs, estimated using a combination of manufacturer quotations, the Program Manager's database pricing, similar project costs, and historical data. Where areas have not yet been sufficiently defined to complete quantity takeoffs, factored costs (as a percentage of other direct costs) were applied. These factored costs are identified in Table 22-3 below.

Table 22-3. Factored Direct Costs

Table redacted

Indirect costs are included as percentages and these are based on experience, current market conditions, and historical data. Indirect percentages are identified in Table 22-4 below. Note, no sales tax is included as it is assumed that the Program is exempt from state and local taxation per Code of Virginia 58.1-3660.

Table 22-4. Factored Indirect Costs

Table redacted

The OPCC was done in current-day dollars—escalation to midpoint of construction is done separately and discussed further in Section 22.10.3 below. In addition, no market volatility factor was included. The current construction market is extremely volatile, influenced by the global COVID-19 pandemic and supply-chain issues. As construction of the Re-Gen Program is not expected to start until 2024, it is not possible to predict market volatility at that time.

The total OPCC for Option 1—renovate existing DWB, and Option 2—decommission existing DWB—is provided in Table 22-5 below by facility, including all factored direct and indirect costs.

Table 22-5. Arlington Re-Gen Opinion of Probable Construction Costs

Table redacted

Note, the discrepancy between the options for screening and dewatering and anaerobic digesters is related to the configuration of the buildings for the options. Option 1 has separate buildings for pre-dewatering, final dewatering, and digestion control—the Digester Control Building is allocated to anaerobic digesters. Option 2 has a single combined SPB and no Digester Control Building. All building costs are allocated to screening and dewatering.

Assumptions used in developing the OPCC are provided below:

- The Program will be built in two phases as described above.
- The work of each phase will be completed uninterrupted, with only one mobilization and demobilization.
- The Program trades will work a standard work week.
- Phase 10A will be competitively bid, with a minimum of three bidders.
- Phase 10C/10D will be competitively bid in "bid packages" with a minimum of three bidders per bid package.
- All regulatory approvals will be obtained prior to mobilization.
- Subcontractors and trade labor can be procured locally or within a radius that does not require per diem upcharges.
- No off-site laydown and staging area will be provided.

- Water and power for construction activities are available on site at no cost to the contractor.
- Landfill for disposal of non-contaminated construction debris is within a 20-mile round trip of the Program site.

The OPCC does not include any of the following:

- Cost associated with accelerated schedules
- Off-site storage facilities
- Site security measures
- Extended warranty costs
- Extreme weather conditions that would affect working days/lost productivity
- Cost increases related to recently imposed tariffs
- Costs associated with endangered-species mitigation
- Special coatings on the interior of SSTs
- Replacement of the roofing system on the existing DWB
- Interior painting of the existing DWB

22.10.2 Opinion of Probable Program Costs

Program costs include all costs required to execute the Program. In addition to construction, these costs include pre-construction services for the DB phase (Phase 10C/D), design services, design services during construction (SDC), Program management services, and administrative costs for the County. The total opinion of probable Program costs is provided in Table 22-6 below.

Table 22-6. Arlington Re-Gen Opinion of Probable Program Costs

Table redacted

Section 22.10.3 Redacted

23 PLANNING CONSIDERATIONS FOR FUTURE FACILITIES

23.1 Background and Purpose

This section presents descriptions, design criteria, footprints, and additional information for the following facilities that could potentially be constructed after the Arlington Re-Gen Project:

- FOG Receiving Facility
- Sidestream Treatment Facility
- Post-Processing Facility (heat drying and pyrolysis)

The primary purpose of this section is to provide the delivery team with adequate information to account for the layout and site requirements of future facilities during the design and construction of the Arlington Re-Gen Project. This section is not intended to prescribe specific design details of the future facilities.

The delivery team must evaluate the footprint requirements based on the design criteria established herein and set aside area on the site plan for the future FOG Receiving and Sidestream Treatment Facilities.

Additionally, the delivery team must estimate the footprint requirements for future Post-Processing Facilities but is not required to provide space if the project team determines that it is infeasible to fit the facilities on site.

23.2 Fats, Oils, and Grease Receiving Facility

This section summarizes the conceptual design elements of a potential future FOG Receiving Facility at the Arlington WPCP. The benefits of a FOG Receiving Facility include:

- Increased biogas production from anaerobic digestion of FOG
- Ability to screen FOG and remove debris, reducing the risk of damage to downstream processes such as THP and improving biosolids end product quality
- Ability to equalize FOG and maintain a relatively consistent feed flow and load to the THP and anaerobic digesters, enhancing process stability and performance
- Ability to heat FOG to reduce risk of stratification or solidification, as well as to achieve a relatively consistent feed temperature to the THP
- Provides an environmentally responsible disposal option for grease haulers
- Provides revenue opportunities for the County from tipping fees

23.2.1 Basis of Design

Anticipated FOG quantities were approximated from publicly available information and per capita metrics. A detailed FOG study and/or market analysis is recommended to refine the estimate. Table 23-1 presents conceptual estimates for current and future FOG deliveries.

Table 23-1. Anticipated FOG Quantities

Design Condition	Grease Production in Arlington County, lb/d [a]	Grease in Plant Influent, lb/d [b]	FOG Deliveries Anticipated, lb/d [c]	FOG Deliveries Anticipated, gpd [d]
23.0 mgd (year 2020)	14,000	5,000	9,000	18,000
30.8 mgd (year 2045)	19,000	6,000	13,000	26,000

a. Grease production was estimated by multiplying the current/projected population of Arlington County by 22.68 lb of total grease per year per capita (National Renewable Energy Laboratory 1998).

b. Estimate of grease in plant influent was provided by Pretreatment Program staff at Arlington County Department of Environmental Services.

c. FOG deliveries anticipated (lb/d) was calculated as grease production minus grease in plant influent.

d. FOG deliveries anticipated (gpd) was calculated assuming an average 6% solids concentration.

e. Values shown are annual averages.

23.2.2 FOG Receiving Facility Description and Design Criteria

The introduction of FOG to THP requires a higher level of treatment than a conventional digestion system would need. To promote process stability and consistent biogas production, a relatively consistent feed flow, load, and temperature is required.

The FOG Receiving Facility must meet the following design and quality parameters:

- The FOG Receiving Facility will be designed to receive, process, and store a maximum 3-day production rate at 40 mgd buildout conditions.
- FOG will be screened to 5 mm or less.
- FOG will be concentrated to 7–9 percent TS prior to feeding the THP.
- FOG will be heated downstream of the receiving screens to prevent it from congealing.
- FOG will be heated while being transferred from the FOG Receiving Facility to the connection location at the THP system, just prior to the preheating/reactor feed unit.
- The FOG Receiving Facility will have sufficient storage capacity to provide a constant flow to the THP system.
- A truck loading scale and washdown area will be provided at or near the FOG Receiving Facility.

Figure 23-1 depicts a recommended process flow diagram for the proposed FOG Receiving Facility, based on a similarly sized facility at the Atlantic Treatment Plant in Virginia Beach, Virginia.

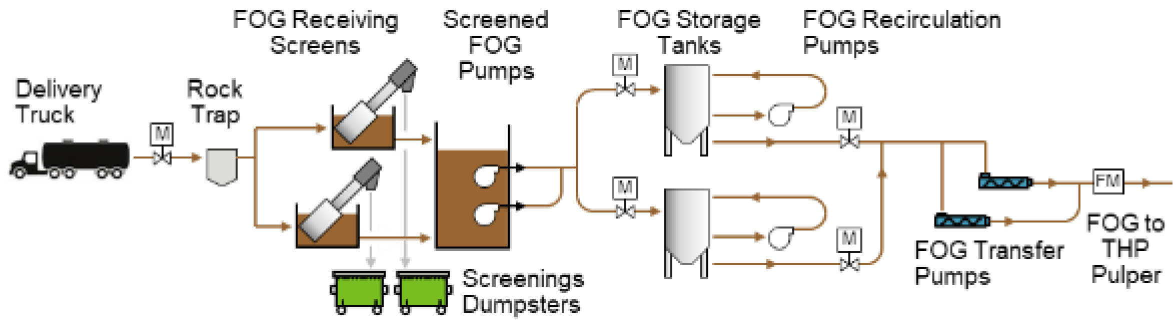


Figure 23-1. FOG Receiving Facility Process Flow Diagram

The future FOG Receiving Facility is assumed to consist of the following major equipment:

- One rock trap
- Two (one duty + one standby) 5 mm FOG receiving screens
- Two (one duty + one standby) screened FOG pumps (submersible chopper pumps)
- Two (one duty + one standby) 14,000-gallon storage tanks
- Cone-bottom steel tanks are shown, with immersion HEXs heated from the hot water system. delivery team
- Two (one per storage tank) tank recirculation pumps
- Two (one duty + one standby) FOG transfer pumps

Multiple hot water washdown and flushing connections are recommended throughout the system, for ease of cleanup and maintenance. The receiving screens will have sufficient hot water supply to clean the screen if it is blinded with FOG.

A conceptual layout for the FOG Receiving Facility is provided in Figure 23-2. The dimensions of the facility are approximately 85 feet long by 35 feet wide. These dimensions do not include space for the following additional components:

- Delivery truck access for unloading, queuing, weighing, and washdown. The washdown area will be contained with a curb, provide hot water hose bibs, and drain to the plant drain.
- Ancillary FOG heating equipment, such as hot water pumps and spray water HEXs (approximately 16 feet by 8 feet of indoor space; can be located in a nearby building)

- Odor control for treatment of foul air from FOG storage tank headspace, screened FOG pump wet well, and FOG receiving screens

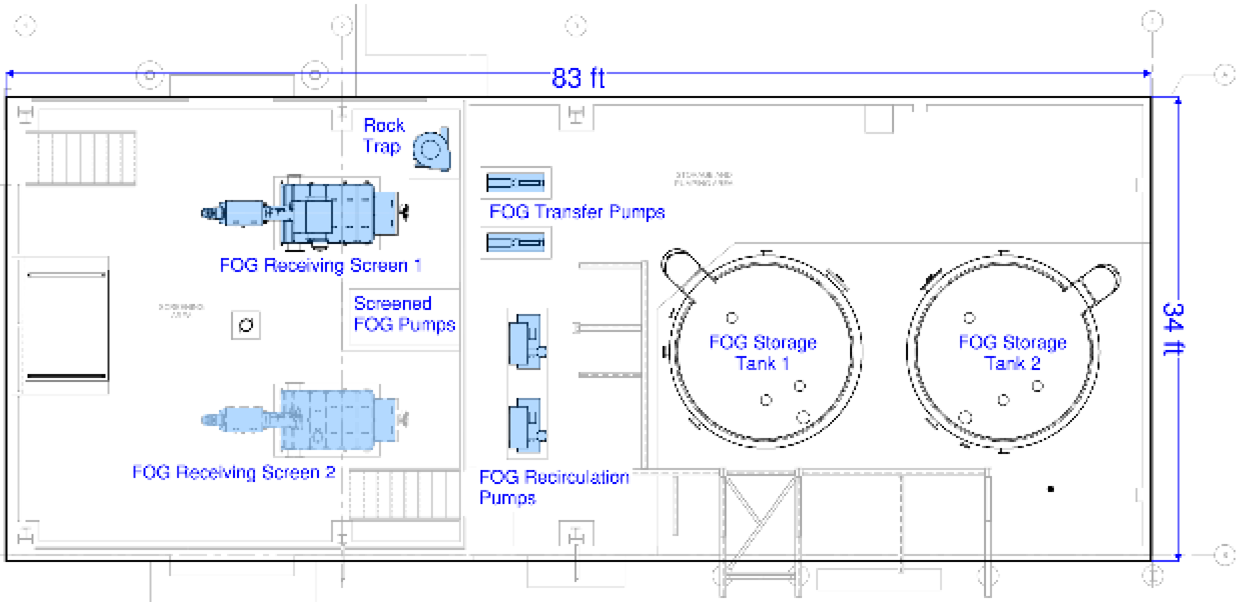


Figure 23-2. FOG Receiving Facility Conceptual Layout

The location of the future FOG Receiving Facility should consider the following:

- Traffic flow for FOG delivery trucks, including truck queuing for peak periods
- Distance to THP (shorter distance is recommended for minimizing FOG pumping and heating requirements)
- Location of other future facilities, such as sidestream treatment and future post-processing

The location of the FOG Receiving Facility depends on which of the two shortlisted site layout options is selected. Further information on the site layout options is presented in Section 17 of this Plan. Potential locations of the FOG Receiving Facility are as follows:

- **Option 1: renovate existing Dewatering Building.** If the existing DWB is renovated, the future FOG Receiving Facility could potentially be located east of the SSTs or in the location of the existing DAFT Building (which is planned to be decommissioned).
- **Option 2: decommission existing Dewatering Building.** If the existing DWB is decommissioned, the future FOG Receiving Facility could be located on the northern corner of the site, the location of the existing DAFT Building, or the current location of the existing DWB.

23.3 Sidestream Treatment Facility

The THP/AD process will generate a concentrated nitrogen recycle stream from final dewatering, which will increase the nitrogen load to the WPCP. This section presents the basis of design for the sidestream nitrogen recycle load as well as process descriptions and design criteria for the two treatment options: the baseline approach of treating the full nitrogen recycle load in the mainstream activated solids process, and a dedicated sidestream deammonification nitrogen removal process. These treatment approaches were evaluated in TM No. 8: *Recycle Management and Sidestream Treatment*.

Initially the nitrogen recycle load will be treated in the activated solids process, as discussed in Section 16.3, resulting in several impacts to that process. Methanol use will increase significantly, and it is likely that supplemental alkalinity will be required. Chemical demands and chemical storage and feed facilities for the existing activated solids process must be further evaluated and expanded as required. Additional aeration will also be required.

Space will be reserved for a future sidestream deammonification process, which will be selected and constructed at a later date. The new solids processing facilities will be designed to accommodate this future sidestream process, with consideration for centrate and dilution water conveyance to the process and return flow from the process. While sidestream deammonification requires construction of a new facility, the operating costs are significantly less than those for full mainstream treatment because of less overall methanol use, supplemental alkalinity, energy for aeration, and solids production. Postponing design and construction of a new deammonification process to a future project will allow for additional local experience treating TH recycles in similar processes. The design criteria and economic justification for a new sidestream deammonification process can also be confirmed based on full-scale operating data for mainstream treatment at Arlington WPCP.

23.3.1 Basis of Design

Final dewatering nitrogen recycle load projections are summarized in Table 23-2 below. These loads are based on assumptions for VSr and nitrogen content of the THP feedstock and were informed by THP/AD pilot testing conducted in collaboration with Virginia Tech. The ammonia-nitrogen concentration in the anaerobic digester is expected to be approximately 2,000 mg/L with a 9 percent TS feed to the digester. The filtrate will also contain approximately 400 mg/L of soluble total Kjeldahl nitrogen (sTKN). Without sidestream treatment, the final dewatering recycle would increase the total Kjeldahl nitrogen (TKN) load to the aeration basins by approximately 15 to 20 percent. The values in Table 23-2 represent continuous operation, but in practice final dewatering will be operated approximately 5.5 days per week, resulting in higher daily loads during dewatering operation. Equalization should be provided to maintain a consistent loading to the process. The flow rate does not include dilution water that may be added before final dewatering or at the feed point to a sidestream deammonification process. A “design midpoint” condition of 28 mgd plant flow is included for evaluation of typical loads between startup and the design condition.

Table 23-2. Projected Final Dewatering Sidestream Flows and Loads

Condition	Plant Effluent Flow (mgd)	Recycle Ammonia Load (lb/d)	Recycle Flow before Dilution (gpd)
Design midpoint annual average	28.0	1,550	100,000
Design year annual average	30.8	1,710	110,000
Design year maximum month	36.7	2,240	144,000
Buildout annual average	40.0	2,250	143,000

The THP/AD process also produces refractory dissolved organic nitrogen (rDON), which is not removed by sidestream or mainstream biological treatment and will contribute to plant effluent organic nitrogen. The rDON generated from THP was estimated based on conversion of 2.2 percent of the total nitrogen (TN) fed to THP, resulting in an additional 0.35 mg/L of effluent organic nitrogen. Table 23-3 illustrates the expected change in effluent TN due to rDON, assuming a similar level of treatment in the future. Current discharge permit limits are also listed. It should be noted that because of rDON, effluent organic nitrogen will increase with THP, and maintaining the current effluent TN will require using more methanol to achieve additional denitrification.

Table 23-3. Example Effluent Nitrogen Concentrations with THP-generated rDON

Effluent Nitrogen Species	Average Effluent, 2018–2020 (mg/L)	Effluent with THP-generated rDON (mg/L)	Effluent Limits (mg/L)
rDON from THP	-	0.35	-
Organic nitrogen (without THP)	0.7	0.7	-
Ammonia N	0.0	0.0	1.0/2.7 Apr.–Oct.[a] 3.5/4.2 Nov.–Mar.[a]
NO_x	1.8	1.8	-
TN	2.5	2.85	3.0[b]

a. Weekly/monthly ammonia limits.
b. Annual TN limit.

23.3.2 Sidestream Treatment Description and Design Criteria

This section describes the process configuration for sidestream treatment of the final dewatering nitrogen recycle. A dedicated sidestream deammonification process is recommended for future treatment of the nitrogen recycle load. Sidestream deammonification takes advantage of the warm, concentrated recycle stream to remove nitrogen in a compact footprint and with less air and chemicals compared to mainstream treatment. The deammonification process converts a portion of the ammonia to nitrite aerobically by ammonia-oxidizing bacteria (AOB), and anaerobic ammonia-oxidizing biomass (anammox) consumes the combination of ammonia and nitrite. These reactions occur simultaneously in one reactor at low dissolved oxygen (DO) conditions. This process is successful on sidestreams because the warm temperature increases activity of the slow-growing anammox biomass, and the dewatering stream provides a consistent ammonia load to the process.

Benefits of sidestream deammonification include:

- **Less aeration:** Deammonification has 60 percent less oxygen demand than full nitrification/denitrification and operates at a low DO concentration.
- **Less supplemental alkalinity:** Deammonification typically operates without supplemental alkalinity.
- **Less methanol:** Supplemental carbon is not used in the process.
- **Less solids production:** Deammonification has a low biomass yield and avoids biomass growth from supplemental carbon.

Sidestream deammonification systems typically achieve nearly 85 percent ammonia removal and 75 percent TN removal without supplemental alkalinity. Some systems are designed to add a small amount of supplemental alkalinity, typically in the form of sodium hydroxide, to improve system performance or replace alkalinity consumed by upstream chemical addition. The nitrogen that is not removed in the sidestream process will be returned to the mainstream treatment process.

While multiple vendors have provided systems for deammonification downstream of THP, a single system, ANITA™ Mox, was used as the basis for conceptual design. A separate process selection evaluation should be conducted prior to detailed design.

The process configuration is shown schematically in Figure 23-3. Centrate will likely be pumped from the final dewatering process to an equalization tank. Pumping requirements will depend on the deammonification system location and equalization tank elevation and must be considered in the design of the final dewatering facility. Centrate will be pumped from the equalization tank to the deammonification reactor, and dilution water will be added. The ANITA™ Mox system is a continuous-flow process, where anammox biomass is retained on plastic media. Suspended biomass will be wasted periodically from the return activated solids (RAS) with a motorized valve. With THP, the ANITA™ Mox is configured as an integrated fixed-film activated solids

(IFAS) process with a clarifier. Aeration is typically operated continuously in the ANITA™ Mox IFAS system to maintain a DO concentration of 0.2 to 0.5 mg/L. Effluent from the process will be returned to the plant drain.

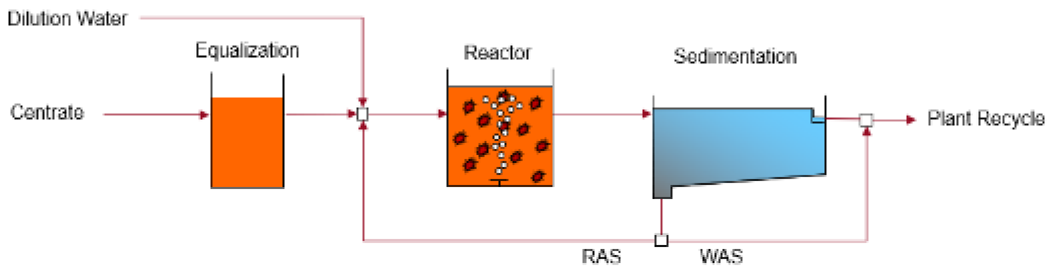


Figure 23-3. ANITA™ Mox IFAS General Process Flow Diagram

The design of the sidestream deammonification process must consider the following aspects:

- **Full-scale THP/AD and final dewatering performance:** The system design should consider the typical centrate nitrogen and TSS concentrations observed after startup of the THP/AD facilities.
- **Impacts of THP:** Because of biological inhibition, deammonification systems downstream of THP are designed for lower nitrogen loading rates compared to systems paired with conventional anaerobic digestion.
- **Centrate equalization:** Deammonification systems achieve better nitrogen removal performance when the nitrogen load is consistent. The size of the equalization tank should be refined during detailed design, with consideration to dewatering schedule and the selected deammonification process. For conceptual design the equalization tank was sized based on 24 hours of equalization volume at design average conditions.
- **Centrate dilution:** Dilution water is required to help mitigate biological inhibition, which has been attributed to chemical oxygen demand (COD) in the THP recycle stream, and to control temperature rise in the reactor because of the exothermic biological process. Dilution ratios are typically in the range of 1:1 to 2:1.
- **Process temperature:** Deammonification systems perform best when operated between 25°C and 35°C. The biological process is exothermic, which can cause the operating temperature to exceed this range if there is low dilution water flow, warm dilution water, or covered equalization or reactor tanks.
- **Odor control:** THP recycle streams have a high ammonia concentration, which results in a strong ammonia odor near the equalization tank. The ammonia is

expected to dissipate quickly and not result in off-site odors. Because the deammonification process is aerobic it has low odor potential.

- **Foam management:** Deammonification reactors often generate foam. Surface spray and surface wasting can be implemented to knock down and waste foam from the process.

The structures, equipment, and instrumentation for the ANITA™ Mox system are listed in Table 23-4. The proposed configuration includes one reactor and one clarifier. The use of one large reactor rather than parallel reactors results in lower construction cost and simpler operation and monitoring. Reactor volume is based on the nitrogen loading rate at design maximum month conditions. The ANITA™ Mox vendor recommended a design loading rate of 1.0-kilogram nitrogen per cubic meter per day (kg-N/m^3/d), which results in a reactor volume of approximately 0.34 MG.

Table 23-4. Sidestream Treatment Equipment and Instrumentation

Structure	Size and Details
Equalization tank	0.11 MG, 35 ft × 21 ft × 20 ft SWD
Reactor	0.34 MG, 50 ft × 45 ft × 20 ft SWD
Clarifier	35 ft × 13 ft × 13 ft SWD
Building	Two levels, 35 ft × 16 ft
Equipment	Quantity and Details
Plastic carrier media	20,900 ft^3
Media retention screens	2
Medium-bubble diffusers	5 grids
Airlift pumps for foam control	5
Hybrid screw blowers with VFD	1 duty/1 standby, 125 hp ea.
Top-entry mixer with VFD	1, 20 hp
Reactor feed pumps with VFD	1 duty/1 standby, 7.5 hp ea.
RAS/WAS pumps with VFD	1 duty/1 standby, 5 hp ea.
Chain and flight clarifier mechanism	1
Equipment	Quantity and Details
PLC control panel	1
RAS/WAS control valves	2
RAS/WAS flow meters	2
Reactor feed flow meter	1
Dilution water flow control valve	1
Dilution water flow meter	1
Air supply flow meter	1
Level indication transmitter: equalization	1
Level float: reactor and equalization	2
DO probe: reactor	1
pH probe: reactor	1
Nitrate probe: reactor	1
Ammonia analyzer: reactor and equalization	1

A conceptual layout for the sidestream treatment system is shown in Figure 23-4. Common wall construction was used where possible, and tank dimensions in the figure account for typical wall thicknesses. The building is configured between the tanks with pumps on the lower level for RAS/WAS and feeding from the equalization tank to the reactor. The upper level would be used for blowers, VFDs, and controls. The reactor and clarifier would not be covered because it is an aerobic process with relatively low odor, similar to aerobic activated solids. The equalization tank may be covered if there is a need to limit ammonia odors in the selected location. The location for future sidestream deammonification is expected to be near the existing SSTs, and the configuration will depend on the overall facility layout.

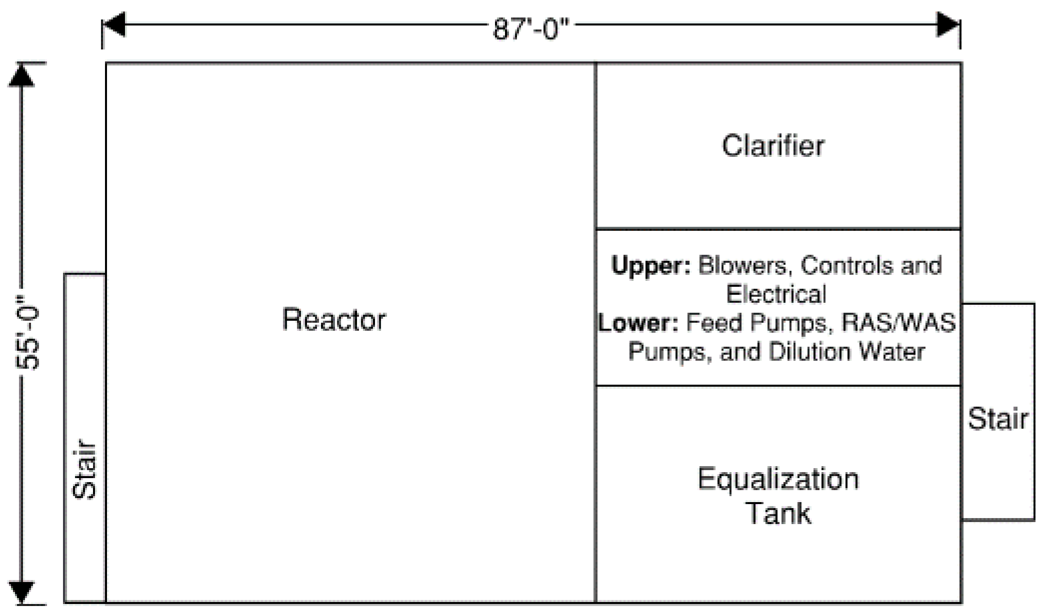


Figure 23-4. Sidestream Deammonification Conceptual Facility Layout

23.4 Future Solids Post-Processing Facility

This section summarizes the conceptual design elements of potential post-processing facilities at the Arlington WPCP. Two technologies were considered: heat drying and pyrolysis.

Heat drying consists of applying heat to dewatered cake to further reduce the moisture content of the final product. Typically, biosolids drying processes are designed to achieve a solids content of 90 percent or greater, to meet the EPA's requirements for Class A. However, as the dewatered product from the Program will already be Class A, it is not critical to achieve a 90 percent solids content for the dried product (60–70 percent may be acceptable). The benefits of heat drying include:

- 60 percent volume reduction of final product, compared to dewatered cake
- 60 percent lower annual hauling costs because of fewer wet tons hauled per year
- Higher-value product: easier to handle and spread, more end use markets, and potentially lower annual hauling costs because of enhanced product marketability

Pyrolysis consists of heating dried solids at 500°C in the absence of oxygen, to produce the following end products: biochar (similar to activated carbon), pyrolysis gas (similar to biogas, consisting primarily of methane, hydrogen, carbon monoxide, and carbon dioxide), and pyrolysis oil (a high-energy tar). The benefits of pyrolysis include:

- 90 percent volume reduction of final product, compared to dewatered cake
- 90 percent lower annual hauling costs because of fewer wet tons hauled per year
- Potential destruction of per- and polyfluoroalkyl substances (PFAS) and other contaminants of emerging concern
- Generation of biochar, which may have a higher market value than Class A biosolids
- Opportunities for additional energy generation from pyrolysis gas and pyrolysis oil

It should be noted that drying and pyrolysis of THP solids is an emerging biosolids management strategy. There are fewer than ten facilities in the world that dry THP solids, and there are no full-scale pyrolysis facilities that process only biosolids. Further evaluation would be needed to refine the design concept and process feasibility.

23.4.1 Basis of Design

Conceptual facility plans were based on the 40.0 mgd buildout condition. The solids loadings from Section 3 are summarized in Table 23-5.

Table 23-5. Final Dewatered Cake Solids Production

Design Condition	Total Solids Load (dtpd)		
	Average	Peak 30-day	Peak 14-day
23.0 mgd	14	19	20
30.8 mgd	19	25	27
40.0 mgd	25	32	35

Notes: Solids loads above represent average weekly solids production based on a 24/7 schedule; the actual loading to post-processing will be higher because the system will not be operated 24/7.

The project team reviewed the basis of design for the post-processing facilities at Workshop 7.2 on November 18, 2021. A redundant train was determined to be unnecessary because the Class A cake could be hauled off site in the event that the post-processing is taken out of service.

The post-processing facilities would be sized for annual average conditions. The project team agreed it would not be necessary to size for peak loading conditions. During peak conditions, the County could pursue one of the following options:

- Reduce the loading to the post-processing facilities by diverting the excess dewatered cake directly to truck loading for land application.
- Increase the throughput of the dryer, resulting in a dried solids concentration below the target value of 90 percent. While not ideal, partial heat drying to 60–70 percent would still reduce the volume of solids hauled off site and enhance product marketability.

The post-processing facilities would be sized to operate 24 hours per day, 6 days per week, to allow 1 day per week of maintenance. The design criteria for heat drying are summarized in Table 23-6.

Table 23-6. Drying Facility Design Loading

Design Condition	Dryer Feed			Dryer Output		Tons Water Evaporated per Hour
	Dry Tons per Hour	Percent Solids	Wet Tons per Hour	Target Percent Solids	Wet Tons per Hour	
40.0 mgd, average	1.2	33%	3.7	90%	1.4	2.3
40.0 mgd, peak 30-day	1.6	33%	4.7	65%	2.4	2.3
40.0 mgd, peak 14-day	1.7	33%	5.2	60%	2.8	2.3

Notes: Flows and loads were developed assuming a 132 hours (6 days) per week operating schedule. The target percent solids for peak conditions were back-calculated assuming a 2.3-ton per hour evaporation capacity.

23.4.2 Drying Facility Description and Design Criteria

The drying facility would meet the following design and quality parameters:

- The dryer will be designed and sized to achieve 90 percent solids at the annual average solids production rate at 40 mgd buildout conditions. As shown in Table 23-6, the total evaporative capacity of the system is approximately 2.3 tons of water per hour.
- The system will include a dryer feed cake bin, sized to provide a minimum of 8 hours of storage at average conditions.
- The drying technology and configuration will have successful operational experience with processing of THP solids. Belt dryers are recommended, as drum dryers have been observed to generate excessive amounts of dust when processing THP solids.
- The drying facility will have one or two silos for dried biosolids storage, sized for a minimum of 24 hours of total storage at average conditions.

Figure 23-5 presents a simplified overall process flow diagram of a future drying facility at the Arlington WPCP. A future dryer feed cake bin is shown in the figure, but it may also be possible to instead use the final dewatered cake bin as the dryer feed cake bin and install dryer feed pumps in the truck loadout area below the bin.

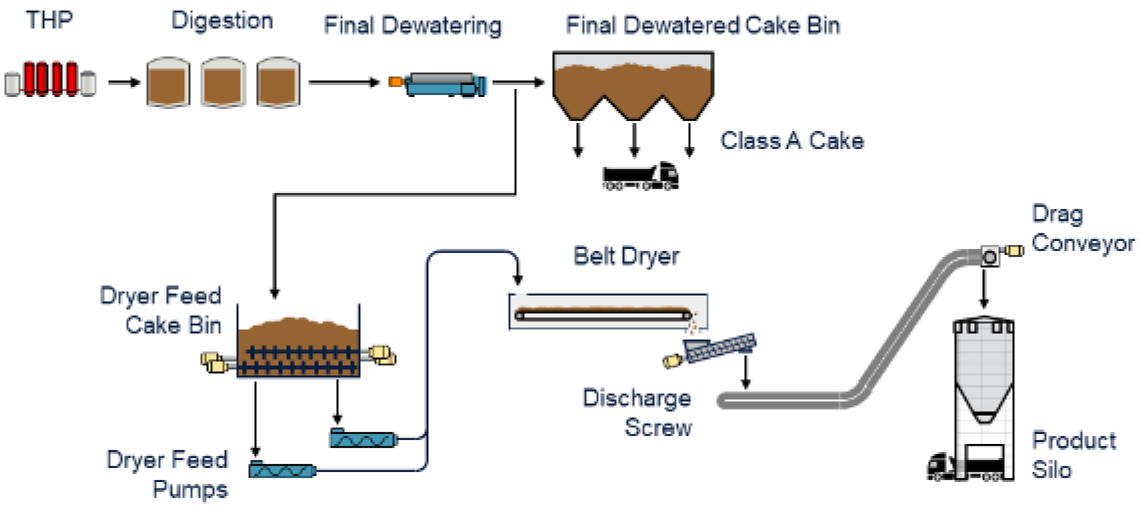


Figure 23-5. Drying Facility Process Flow Diagram

Conceptual layouts for the drying facility are provided in Figure 23-6 (plan view) and Figure 23-7 (section view). The dimensions of the facility are approximately 100 feet long by 50 feet wide, not including area for truck loading/wet cake bin, product storage silo, and odor control. The dimensions of the facility will vary depending on the manufacturer. For the purposes of this Plan, conceptual equipment sizing was provided by belt dryer manufacturers Griffin, Haarslev, Veolia, and Huber.

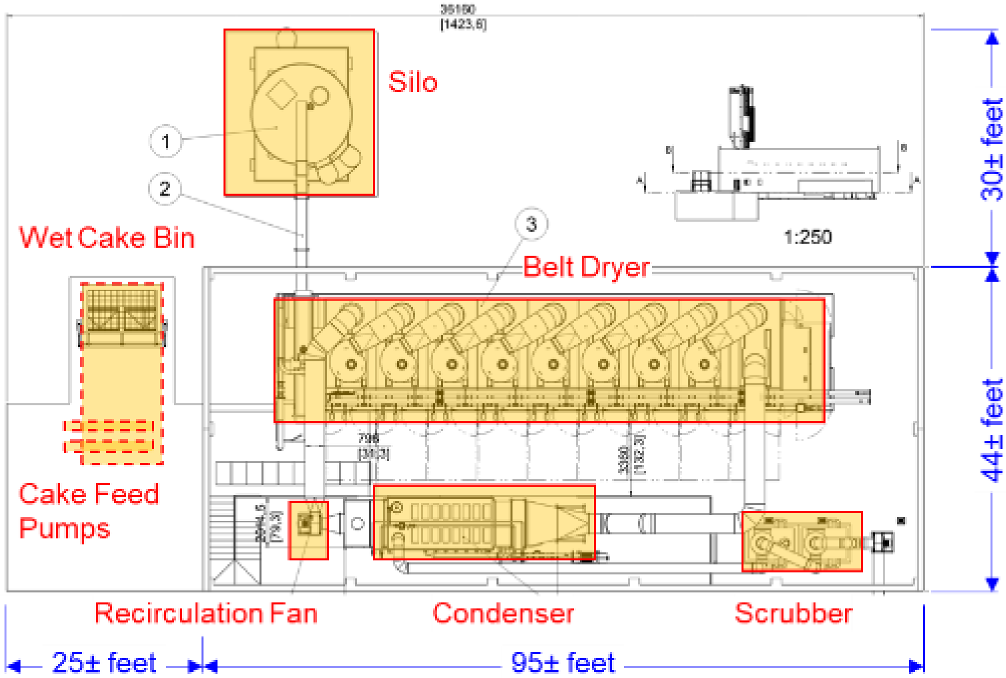


Figure 23-6. Drying Facility Conceptual Layout: Plan View (Source: Huber)

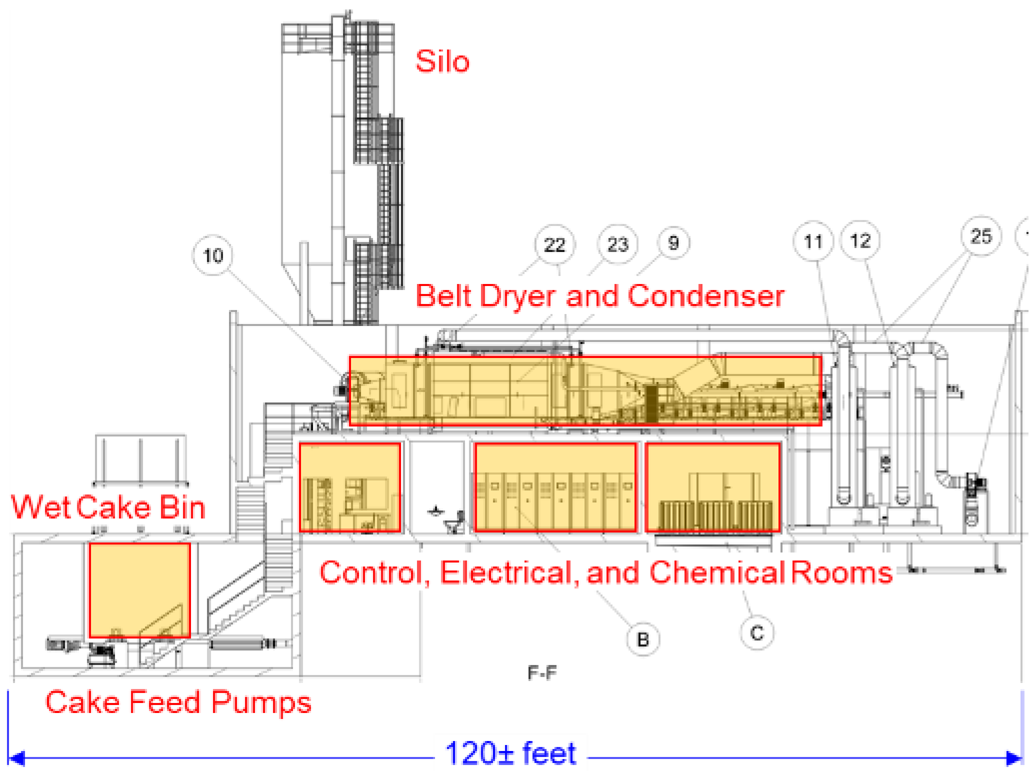


Figure 23-7. Drying Facility Conceptual Layout: Section View (Source: Huber)

The location of the future drying facility should consider the following:

- Traffic flow for biosolids haulers, including provisions for unloading both dewatered cake and dried product
- Distance to final dewatering (shorter distance is critical to minimize pumping of cake)
- Location of other future facilities, such as sidestream treatment and FOG receiving

The location of the drying facility depends on which of the two shortlisted site layout options is selected. Further information on the site layout options is presented in Section 17 of this Plan. Potential locations of the drying facility are as follows:

- **Option 1: renovate existing Dewatering Building.** If the existing DWB is renovated, the future drying facility could potentially be located above the proposed Digester Building. The Digester Building would have to be designed and constructed to accommodate the loads from the drying facility. It is unlikely that the drying facility could be constructed along S Eads Street because of the limited site footprint.
- **Option 2: decommission existing Dewatering Building.** If the existing DWB is decommissioned, the future drying facility could be constructed adjacent to the proposed SPB, in the location of the existing DWB, as shown in Drawing C-007.

23.4.3 Pyrolysis Facility Description and Design Criteria

Pyrolysis is an emerging technology in the biosolids industry, with no full-scale installations to date in the United States. Several pilot facilities are in operation or in design. Leading manufacturers include BioForceTech, CharTech, and Kore Infrastructure.

The pyrolysis system would be designed and sized to process the annual average solids production rate at 40 mgd buildout conditions. As shown in Table 23-6, the total quantity of dried solids is estimated to be 1.4 wet tons per hour at 90 percent solids.

Figure 23-8 presents a simplified overall process flow diagram of a future pyrolysis facility at the Arlington WPCP. A dryer is required upstream of the pyrolysis reactor, as the process requires the feed to be at 80 to 90 percent solids concentration.

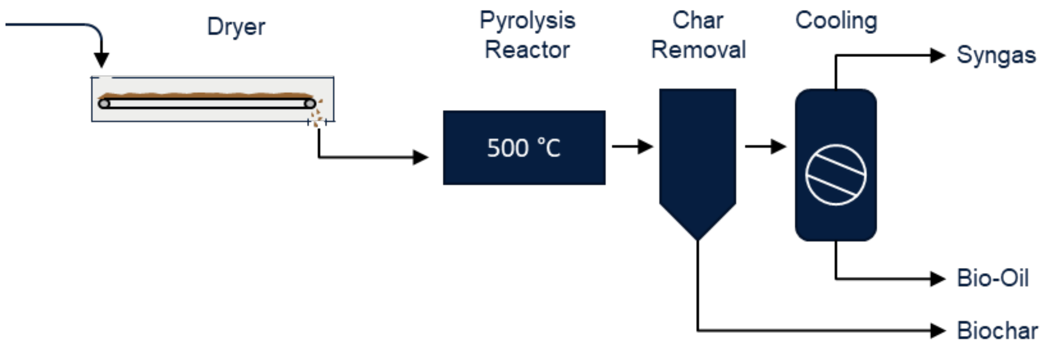


Figure 23-8. Pyrolysis Facility Process Flow Diagram

Conceptual layouts for pyrolysis are not provided in this Plan, as the three manufacturers contacted offered vastly different facility dimensions, ranging from 50 by 50 feet to 140 by 64 feet.

The location of the future pyrolysis facility should consider the following:

- Traffic flow for biosolids haulers, including provisions for unloading dewatered cake, dried product, and biochar
- Distance to dryer facility (shorter distance is preferable to minimize conveyance)
- Location of other future facilities, such as sidestream treatment and FOG receiving

The location of the pyrolysis facility depends on which of the two shortlisted site layout options is selected. Further information on the site layout options is presented in Section 17 of this Plan. Potential locations of the pyrolysis facility are as follows:

- **Option 1: renovate existing Dewatering Building.** If the existing DWB is renovated, it is unlikely that a drying and pyrolysis facility could fit in the area adjacent to final dewatering.
- **Option 2: decommission existing Dewatering Building.** If the existing DWB is decommissioned, the future dryer and pyrolysis facility could be constructed adjacent to the proposed SPB, in the location of the existing DWB, as shown in Drawing C-006.

ARLINGTON COUNTY, VIRGINIA
WATER POLLUTION CONTROL PLANT

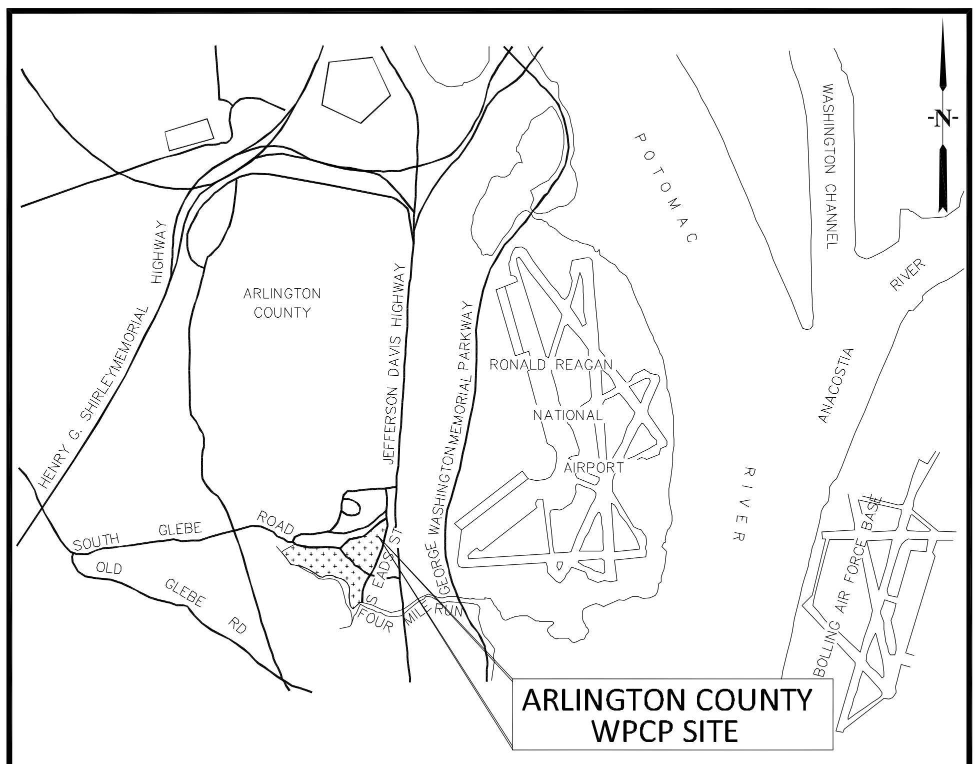
ARLINGTON
VIRGINIA

RE-GEN
BIOSOLIDS FACILITIES UPGRADES

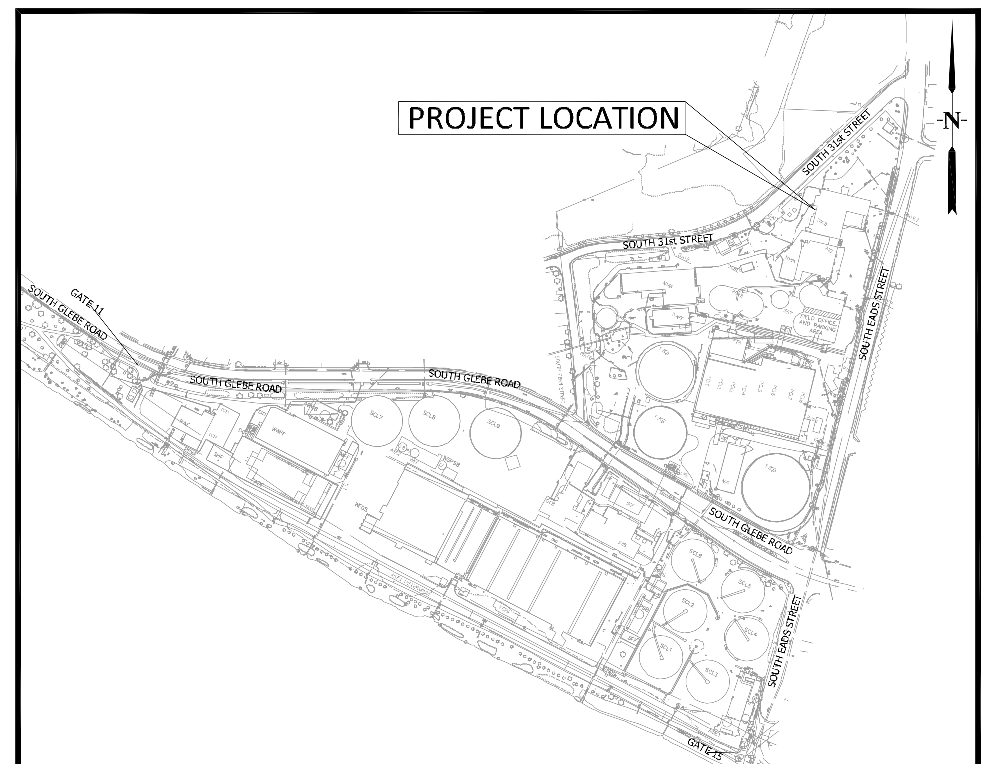
FACILITIES PLAN

VOLUME 2 OF 3

DECEMBER 2022



VICINITY MAP



LOCATION PLAN

OWNER:
ARLINGTON COUNTY WPCP
3402 S. GLEBE ROAD
ARLINGTON, VA 22202

HDR

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GENERAL

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- G-002 DRAWING INDEX AND ABBREVIATIONS
- G-003 GENERAL LEGEND AND SYMBOLS
- G-004 EXISTING OVERALL SOLIDS PROCESS FLOW DIAGRAM
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- G-006 OVERALL SOILDS PROCESS FLOW DIAGRAM 2
- G-007 OVERALL GAS AND STEAM PROCESS FLOW DIAGRAM 1
- G-008 SOLIDS MASS BALANCE - 2052 DESIGN YEAR (30.8 MGD)

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- C-002 EXISTING SITE PLAN - UNDERGROUND UTILITIES
- C-003 RENOVATE DEWATERING BUILDING - DEMOLITION PLAN
- C-004 RENOVATE DEWATERING BUILDING - SITE PLAN
- C-005 RENOVATE DEWATERING BUILDING - GRADING PLAN
- C-006 DECOMMISSION DEWATERING BUILDING - DEMOLITION PLAN
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- M-200 RENOVATE DEWATERING BUILDING - SOLIDS STORAGE TANKS - PLANS
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- M-202 DECOMMISSION DEWATERING BUILDING - SOLIDS STORAGE TANKS - PLANS
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- M-300 RENOVATE DEWATERING BUILDING - DEWATERING BUILDING - DEMOLITION PLAN AT EL 25.00
- M-301 RENOVATE DEWATERING BUILDING - DEWATERING BUILDING - ODOR CONTROL SYSTEM DEMOLITION PLAN AND SECTION
- M-302 RENOVATE DEWATERING BUILDING - DEWATERING BUILDING - DEMOLITION PLAN AT EL 43.00
- M-303 RENOVATE DEWATERING BUILDING - DEWATERING BUILDING - DEMOLITION PLAN AT EL 66.00
- M-304 RENOVATE DEWATERING BUILDING - DEWATERING BUILDING - DEMOLITION PLAN AT EL 82.00
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- M-306 RENOVATE DEWATERING BUILDING - SCREENING AND PRE-DEWATERING BUILDING DEMOLITION PLAN AT EL 43.00
- M-307 RENOVATE DEWATERING BUILDING - SCREENING AND PRE-DEWATERING BUILDING DEMOLITION PLAN AT EL 66.00
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- M-351 DECOMMISSION DEWATERING BUILDING - SOLIDS PROCESS BUILDING - PLAN AT EL 42.00
- M-352 DECOMMISSION DEWATERING BUILDING - SOLIDS PROCESS BUILDING - PLAN AT EL 60.00
- M-353 DECOMMISSION DEWATERING BUILDING - SOLIDS PROCESS BUILDING - PLAN AT EL 74.33
- M-354 DECOMMISSION DEWATERING BUILDING - SOLIDS PROCESS BUILDING - PARTIAL PLANS 1
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- M-702 RENOVATE DEWATERING BUILDING - FINAL DEWATERING BUILDING - PLAN AT EL 70.60
- M-703 RENOVATE DEWATERING BUILDING - FINAL DEWATERING BUILDING - SECTION 1
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- M-800 GAS UPGRADING - PLAN
- M-801 GAS INTERCONNECT - PLAN
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- E-002 PROPOSED ONE-LINE DIAGRAM
- E-003 EXISTING SITE PLAN

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- I-101 THICKENED PRIMARY SOLIDS PUMPING - PROCESS AND INSTRUMENTATION DIAGRAM
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- I-202 SCREEN FEED PUMPS - PROCESS AND INSTRUMENTATION DIAGRAM
- I-300 PRE-DEWATERING CENTRIFUGE FEED PUMPS - PROCESS AND INSTRUMENTATION DIAGRAM
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- I-302 CAKE BIN AND THP FEED PUMPS - PROCESS AND INSTRUMENTATION DIAGRAM
- I-303 PRE-DEWATERING POLYMER - PROCESS AND INSTRUMENTATION DIAGRAM
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- I-601 DEAERATOR - PROCESS AND INSTRUMENTATION DIAGRAM
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- I-604 BOILER BLOWDOWN SEPARATOR - PROCESS AND INSTRUMENTATION DIAGRAM
- I-700 FINAL DEWATERING CENTRIFUGE - PROCESS AND INSTRUMENTATION DIAGRAM
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- I-901 ODOR CONTROL FACILITY A PROCESS AND INSTRUMENTATION DIAGRAM
- I-902 ODOR CONTROL CHEMICAL FEED PROCESS AND INSTRUMENTATION DIAGRAM

ABBREVIATIONS

AS	AIR SUPPLY
ALP	AIR LOW PRESSURE
APPROX	APPROXIMATELY
BBD	BOILER BLOWDOWN
BCT	BOILER CHEMICAL TREATMENT
BFP	BELT FILTER PRESS
BFW	BOILER FEED WATER
BM	BENCHMARK, BEAM
BMP	BEST MANAGEMENT PRACTICES
BYP	BYPASS
CA	COMPRESSED AIR
℄	CENTERLINE
CCK	CAKE
CCT	CENTRATE
CDR	CHEMICAL DRAIN
CHEX	COOLING HEAT EXCHANGER
CHD	CHORD
CHH	COMMUNICATION OR CONTROL HANDHOLE
CHP	COMBINED HEAT AND POWER
CI	CURB INLET
CIP	CAST-IN-PLACE
CIRC	CIRCULATION, CIRCULAR
CKT	CIRCUIT
CL	CENTERLINE, CLASS, CLOSE
CLKG	CAULKING
CONC	CONCENTRATION, CONCENTRATED, CONCRETE
COND	CONDENSATE
COW	COUNTY WATER
CUW	CHLORINATED UTILITY WATER
CUYD	CUBIC YARD
CWR	COOLING WATER RETURN
CWS	COOLING WATER SUPPLY
DBR	DIRTY BACKWASH RETURN
DEG	DEGREE
DEG C	DEGREE CENTIGRADE
DEG F	DEGREE FAHRENHEIT
Ø	DIAMETER
DG	DIGESTER GAS
DN	DOWN
DR	DRAIN
DS	DIGESTED SLUDGE
DSR	DIGESTED SLUDGE RECYCLE
DSRF	DIGESTED SLUDGE RECYCLE PLUS FEED
DTON	DRY TON
DW	DILUTION WATER
EH	ENGINE EXHAUST
EL	ELEVATION
EX, EXIST	EXISTING
EXH	EXHAUST
F	DEGREES FAHRENHEIT
FA	FOUL AIR
FAD	FOUL AIR DUCT
FFE	FINISHED FLOOR ELEVATION
FG	FINISHED GRADE
FH	FIRE HYDRANT
FIT	FLOW INDICATING TRANSMITTER
FL	FLOOR
FLA	FULL LOAD AMPERES
FLT	FILTRATE
FM	FLOW METER, FORCE MAIN
FOG	FATS OIL AND GREASE
FS	FLASH STEAM
GEN	GENERAL, GENERATOR
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GTI	GRAVITY THICKENER INFLUENT
GTO	GRAVITY THICKENER OVERFLOW
HB	HOSE BIB
HDG	HIGH PRESSURE DIGESTER GAS
HEX	HEXAGONAL, HEAT EXCHANGER
HOA	HAND/OFF/AUTO
HOR	HAND/OFF/REMOTE
HT - LOOP	HIGH TEMPERATURE LOOP (JACKET WATER)
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
H2S	HYDROGEN SULFIDE
IN	INCH
INF	INFLUENT
IN WC	INCHES WATER COLUMN

LB/D	POUNDS PER DAY
LBVS	POUND OF VOLATILE SOLIDS
LE	LEVEL ELEMENT
LIT	LEVEL INDICATING TRANSMITTER
LO	LOADOUT
LOD	LIMITS OF DISTURBANCE
LS	LEVEL SWITCH, LIMIT SWITCH
LSH	LEVEL SWITCH
L-STOP	LOCAL STOP
LSL	LEVEL SWITCH LOW
LT - LOOP	LOW TEMPERATURE LOOP (AFTER COOLER)
MCC	MOTOR CONTROL CENTER
MFR	MANUFACTURER
MG	MILLION GALLONS
mg/L	MILLIGRAMS PER LITER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE, METAL HALIDE, MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MOV	MOTOR OPERATED VALVE
MPC	MEDIUM PRESSURE CONDENSATE
MPS	MEDIUM PRESSURE STEAM
MW	MAKE UP WATER
N/A	NOT APPLICABLE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NG	NATURAL GAS (NG)
NGM	NATURAL GAS METER
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN, NUMBER
NOS	NUMBERS
NTS	NOT TO SCALE
NaOH	SODIUM HYDROXIDE
OA	ODOROUS AIR
OCS	ODOR CONTROL STATION
OFLW	OVERFLOW
ORP	OXIDATION REDUCTION POTENTIAL
OVRF	OVERFLOW
PD	PLANT DRAIN
PDS	DIFFERENTIAL PRESSURE SWITCH
PDSH	DIFFERENTIAL PRESSURE SWITCH HIGH
PDSL	DIFFERENTIAL PRESSURE SWITCH LOW
PEW	PLANT EFFLUENT WATER
PG	PROCESS GAS
PGCON	PROCESS GAS CONDENSATE
PGU	PROCESS GAS UNIT
PIT	PRESSURE INDICATING TRANSMITTER
PL	PROPERTY LINE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PMP	PUMP
PNL	PANEL
POLY	POLYMER
POLYS	POLYMER SOLUTION
PS	PIPE SUPPORT, PRESSURE SWITCH, PUMP STATION, PRIMARY SLUDGE
PSH	PRESSURE SWITCH HIGH
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAGE
PSL	PRESSURE SWITCH LOW
PW	POTABLE WATER
Q	RATE OF FLOW
QTY	QUANTITY
RAS	RETURN ACTIVATED SLUDGE
RG	RAW GAS
RNG	RENEWABLE NATURAL GAS
RDB	RENOVATE DEWATERING BUILDING
SCE	SECONDARY CLARIFIER EFFLUENT
SC	SCUM
SCFM	STANDARD CUBIC FEET PER MINUTE
SDB	SOLIDS DISTRIBUTION BOX
SDS	STORED DIGESTED SOLIDS
SEPT	SEPTAGE
SHC	SODIUM HYPOCHLORITE
SL	SLUDGE
SNT	SUPERNATANT
SR	SCRUBBER RECIRCULATION
SST	STAINLESS STEEL
STD	STANDARD
STL	STEEL
STS	SCREENED THICKENED SLUDGE
SUL	SULFURIC ACID
SWM	STORMWATER MANAGEMENT

TBD	TO BE DETERMINED
T/GRADE	TOP OF GRADE
THP	THERMAL HYDROLYSIS PROCESS
THPF	THERMAL HYDROLYSIS FEED (SOLIDS CAKE)
THS	THERMALLY HYDROLYZED SLUDGE
THSR	THERMALLY HYDROLYZED SOLIDS RECYCLE
TIT	TEMPERATURE INDICATING TRANSMITTER
	THICKENED SOLIDS, TEMPERATURE SWITCH
TPS	THICKENED PRIMARY SLUDGE
TSH	TEMPERATURE SWITCH HIGH
TSL	TEMPERATURE SWITCH LOW
TS	THICKENED SLUDGE
TSS	TOTAL SUSPENDED SOLIDS
TW	???????
TWAS	THICKENED WASTE ACTIVATED SLUDGE
TYP	TYPICAL
UG	UNDERGROUND
UGE	UNDERGROUND ELECTRIC
UGT	UNDERGROUND TELEPHONE
UNO	UNLESS NOTED OTHERWISE
UON	UNLESS OTHERWISE NOTED
UV	UTILITY VAULT, ULTRAVIOLET
W/O	WITHOUT
WAS	WASTE ACTIVATED SLUDGE
WSE	WATER SURFACE ELEVATION
YH	YARD HYDRANT

ABBREVIATION NOTES:

1. THESE ABBREVIATIONS APPLY TO THE ENTIRE SET OF DRAWINGS.
2. LISTING OF ABBREVIATIONS DOES NOT IMPLY THAT ALL ABBREVIATIONS ARE USED IN THE DRAWINGS.

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

DRAWING INDEX AND ABBREVIATIONS

0 1" 2"

FILENAME G-002.dwg

SCALE NOT TO SCALE

SHEET **G-002**

GENERAL SYMBOLOGY

ARROW INDICATES DIRECTION OF TRUE/PLAN NORTH

N

PLAN
1/4" = 1'-0"
PLAN TITLE

SECTION LETTER
FLAG INDICATES DIRECTION OF SECTION CUT
X
XXX
SHEET WHERE SECTION IS LOCATED
SECTION CUT MARKER

SECTION LETTER
X SECTION
XXX 3" = 1'-0"
SHEET WHERE DETAIL WAS CALLED OUT *
SECTION TITLE

DETAIL NUMBER
#
XXX
SHEET WHERE DETAIL IS LOCATED *
DETAIL MARKER
FOR REFERENCING DETAILS INCLUDED IN DRAWING SET.

XXXXXXXXX
DETAIL MARKER
FOR REFERENCING DETAILS BOUND IN SPECIFICATIONS OR SEPARATE VOLUME.

DETAIL NUMBER
X DETAIL
XXX 3" = 1'-0"
SHEET WHERE DETAIL WAS CALLED OUT *
DETAIL TITLE

ELEVATION NUMBER
ARROW INDICATES POINT OF VIEW
SHEET WHERE ELEVATION IS LOCATED *
X
XXX
SINGLE ELEVATION OR PHOTO MARKER

A
ELEVATION NUMBER
ARROW INDICATES POINT OF VIEW ELEVATION
D X B
XXX
INDICATES SHEET WHERE ELEVATION IS LOCATED
C
MULTIPLE ELEVATION OR PHOTO MARKER

ELEVATION IDENTIFICATION NUMBER
X ELEVATION
XXX 3" = 1'-0"
SHEET WHERE POINT OF VIEW MARKER CAN BE FOUND *
ELEVATION TITLE

* EXCEPTIONS WHERE THE SHEET NUMBER IS REPLACED BY A DASH (-).
1) FOR COMMON DETAILS, SECTIONS, ELEVATIONS OR DETAILS THAT ARE CUT OR CALLED OUT ON MULTIPLE SHEETS.
2) SECTIONS, ELEVATIONS OR DETAILS THAT ARE LOCATED ON THE SAME SHEET THEY ARE CUT OR CALLED OUT ON.

GENERAL LEGEND AND SYMBOLS NOTES:

1. THIS SHEET IS A STANDARD SHEET SHOWING COMMON SYMBOLOGY. NOT ALL SYMBOLS ARE NECESSARILY USED ON THIS PROJECT.
2. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FOR USAGE.

TARGET ELEVATION

ARCHITECTURAL

ROOM NAME XX-XX	ROOM NUMBER
XXX	DOOR NUMBER
A	COLUMN GRID LINE
X	WALL TYPE

KEY NOTE DESIGNATION

KEY NOTE NUMBER
#

IDENTIFICATION SYMBOLOGY

PIPING

FIGURE — 36-NPW — EXAMPLE
LINE SIZE — 36"
SERVICE — NON POTABLE WATER

CIVIL SYMBOLOGY

CO	CLEAN OUT
	MANHOLE
	FIRE HYDRANT
YH	YARD HYDRANT
	TRUCK, WB-67
	TRUCK, WB-40
	TRUCK, SU-30
	BENCHMARK
	TEST PITS
BR-1	BORING
	VALVE (GENERIC)
	LIGHT POLE
	POWER POLE
10	CONTOUR

CIVIL SYMBOLOGY CONTINUED

	VEGETATION
X 10.3	SPOT ELEVATION
T	TRANSFORMER
CB	CATCH BASIN
PD	PROCESS DRAIN MANHOLE
SD	STORM DRAIN MANHOLE
SS	SANITARY SEWER MANHOLE
	PIPE SUPPORT (FOR PIPE LARGER THAN 12" DIA.)
	CONCRETE WASHOUT

EXISTING CIVIL CONDITIONS

	EXISTING VALVE
	EXISTING PIPELINE
	EXISTING LARGE PIPELINE
	EXISTING LIGHT POLE
	EXISTING POWER POLE
10	EXISTING CONTOUR
	EXISTING VEGETATION
X 10.3	EXISTING SPOT ELEVATION
X	EXISTING FENCE

LINE SYMBOLOGY

T	TELEPHONE LINE
E	ELECTRIC LINE
F	FIBER OPTIC
C	COMMUNICATION
	HANDRAIL AND GUARDRAIL
	PIPELINE
	LARGE PIPELINE
	DRAINAGE FLOW
	NATURAL WATERWAY
X X	BARBED WIRE CHAIN LINK FENCE
	CHAIN LINK FENCE
XX XX	TEMPORARY BARRIER
	PROPERTY LINE
	CENTERLINE
SF	SILT FENCE
	EASEMENT
	ALUMINUM COVER
	LIMITS OF CONSTRUCTION
	ROW
	LIMITS OF WETLANDS
	VEGETATED SWALE
	MATCH LINE
	DRAINAGE DITCH
	COLUMN GRID LINE/CENTERLINE

EQUIPMENT SYMBOLOGY

- ARCHIMEDES SCREW
- CENTRIFUGE
- CENTRIFUGAL PUMP
- CHEMICAL FEED PUMP
- COMPRESSOR
- DOUBLE DISC POSITIVE DISPLACEMENT PUMP
- GRINDER
- HEAT EXCHANGER
- RADIATOR
- U-TUBE HEAT EXCHANGER
- TUBE IN TUBE HEAT EXCHANGER
- MIXER - PROPELLER TYPE
- M OR M — MOTOR
- PLATE TYPE HEAT EXCHANGER
- PROGRESSING CAVITY PUMP
- ROTARY LOBE PUMP
- POSITIVE DISPLACEMENT PUMP
- INCLINED BELT CONVEYOR
- SCREW CONVEYOR
- SHELL AND TUBE TYPE HEAT EXCHANGER
- SLUDGE GATE / WEIR GATE
- VERTICAL TURBINE CAN PUMP
- EDUCTOR
- SOLIDS SCREEN
- POSITIVE DISPLACEMENT BLOWER

PIPING AND VALVE SYMBOLOGY

- BALL VALVE
- BUTTERFLY VALVE
- DIAPHRAGM VALVE
- GATE VALVE
- GLOBE VALVE
- KNIFE GATE VALVE
- NEEDLE VALVE
- PINCH VALVE
- PLUG VALVE
- THREE WAY BALL VALVE
- THREE WAY PLUG VALVE
- BALL CHECK VALVE
- CHECK VALVE
- DOUBLE DISK CHECK VALVE
- CONE VALVE
- OR — PRESSURE RELIEF VALVE
- PRESSURE REDUCING VALVE
- X — AIR RELEASE VACUUM VALVE
A = AIR RELEASE
V = VACUUM
- AIR RELEASE VALVE
- PRESSURE REGULATING VALVE
- BACK PRESSURE VALVE
- S — SOLENOID VALVE
- 36"-RWI — TYPICAL PIPE LINE CALLOUT
- OA DAMPER
- BACKFLOW PREVENTER
- M — FLOW METER
- NGM — NATURAL GAS METER
- UNION
- WYE-STRAINER
- FLEXIBLE HOSE OR TUBING
- FLEXIBLE PIPING CONNECTION
- LINE SIZE CHANGE
- LINE TURNING DOWN
- LINE TURNING UP
- BLIND FLANGE
- PIPE BREAK
- V-PORT BALL VALVE
- THREE-WAY CONTROL VALVE

NOTE:
1. VALVES SHOWN AS BLACK /SOLID ARE TO INDICATE NORMALLY CLOSED VALVES.

- 3-WAY VALVE
- 4-WAY VALVE
- CALIBRATION POT
- BASKET STRAINER
- QUICK CONNECT
- PNEUMATIC ACTUATOR
- SUCTION DIFFUSER-STRAINER
- PUMP DISCHARGE (TRIPLE DUTY) VALVE
- THERMOSTATIC MIXING VALVE
- INJECTION RING
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- COMPRESSION SLEEVE TYPE COUPLING
- FLANGED COUPLING ADAPTER (FCA)
- FLEXIBLE CONNECTION
- HARNESSED MECHANICAL COUPLING
- EXPANSION COUPLING/JOINT
- PRESSURE GAUGE (WITH COCK)
- TRAP
- QUICK DISCONNECT CAM & GROOVE COUPLING
- CAP OR PLUG
- CO — INTERIOR CLEANOUT
- HOSE BIBB -1
- HOSE BIBB -2
- HR — HOSE REEL
- FD-X — FLOOR DRAIN

X = TYPE DESIGNATED IN SPECIFICATIONS

- PIPE IN SECTION
- BU — BELL UP (PLAN)
- BU — BELL UP (SECTION OR SCHEMATIC)
- D — DRAIN (SECTION OR SCHEMATIC)

A	12/2022	FACILITIES PLAN
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PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

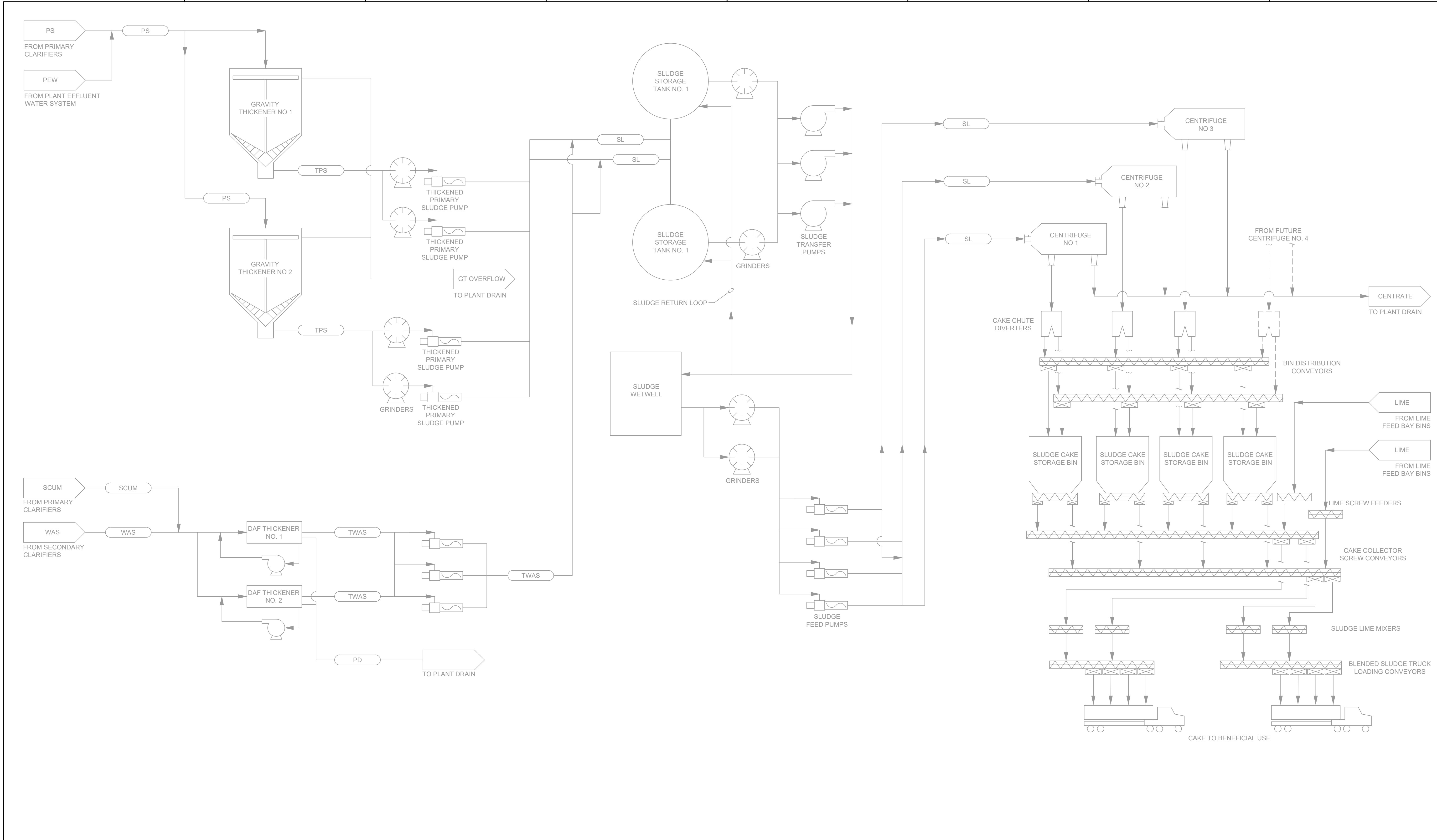
ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

GENERAL LEGEND AND SYMBOLS

0 1" 2"

FILENAME G-003.dwg
SCALE NOT TO SCALE
SHEET G-003



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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

EXISTING OVERALL SOLIDS PROCESS FLOW DIAGRAM

0 1" 2"

FILENAME G-004.dwg
SCALE NOT TO SCALE

SHEET G-004

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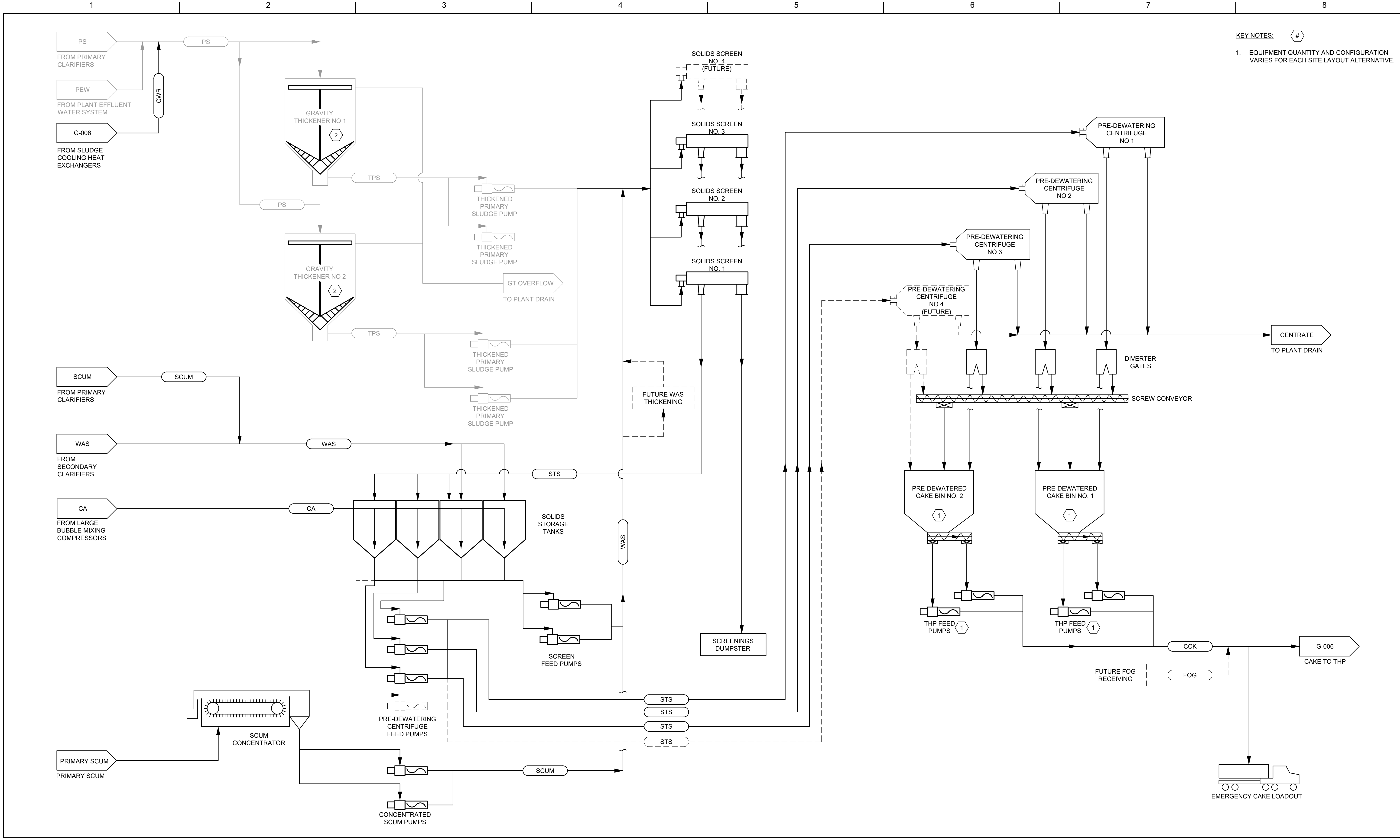
1 2 3 4 5 6 7 8



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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

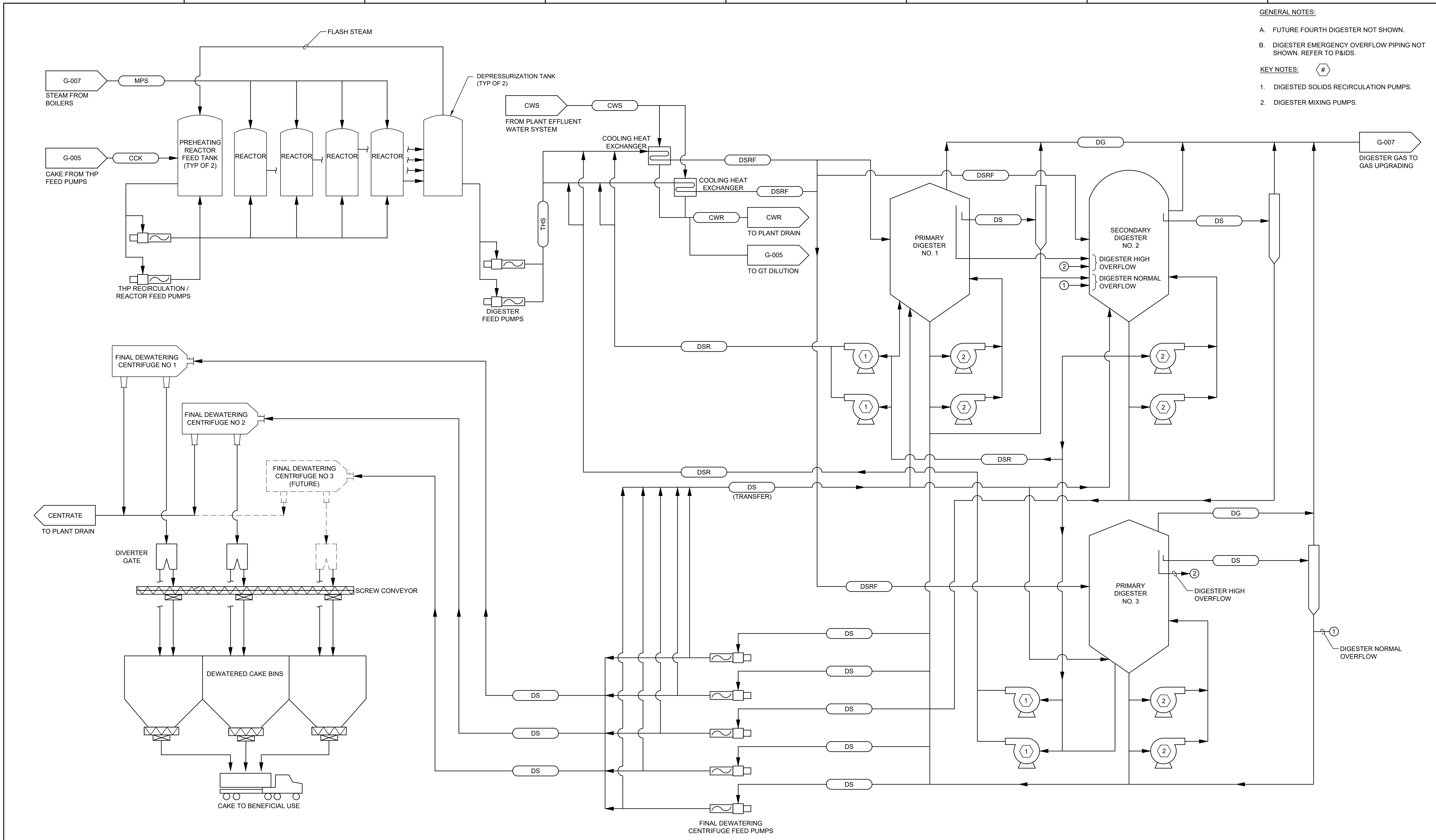
OVERALL SOLIDS PROCESS FLOW DIAGRAM 1

0 1" 2"

FILENAME G-005.dwg

SCALE NOT TO SCALE

SHEET **G-005**



GENERAL NOTES:

A. FUTURE FOURTH DIGESTER NOT SHOWN.

B. DIGESTER EMERGENCY OVERFLOW PIPING NOT SHOWN. REFER TO P&IDS.

KEY NOTES: #

1. DIGESTED SOLIDS RECIRCULATION PUMPS.

2. DIGESTER MIXING PUMPS.

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DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

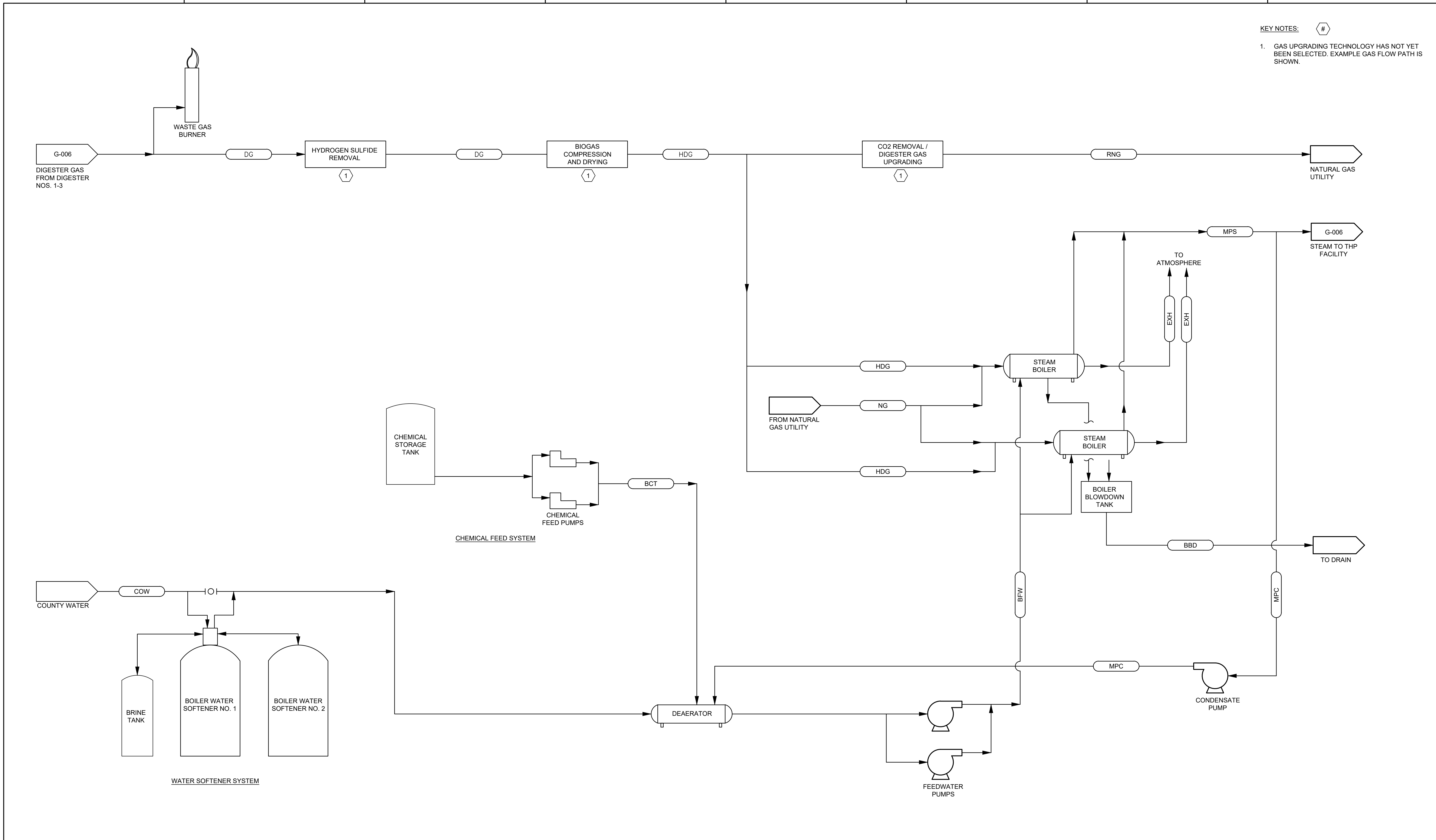
OVERALL SOLIDS PROCESS FLOW DIAGRAM 2

0 1" 2"

FILENAME G-006.dwg

SCALE NOT TO SCALE

SHEET **G-006**



PROJECT MANAGER	BALCHUNAS, BRIAN
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DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

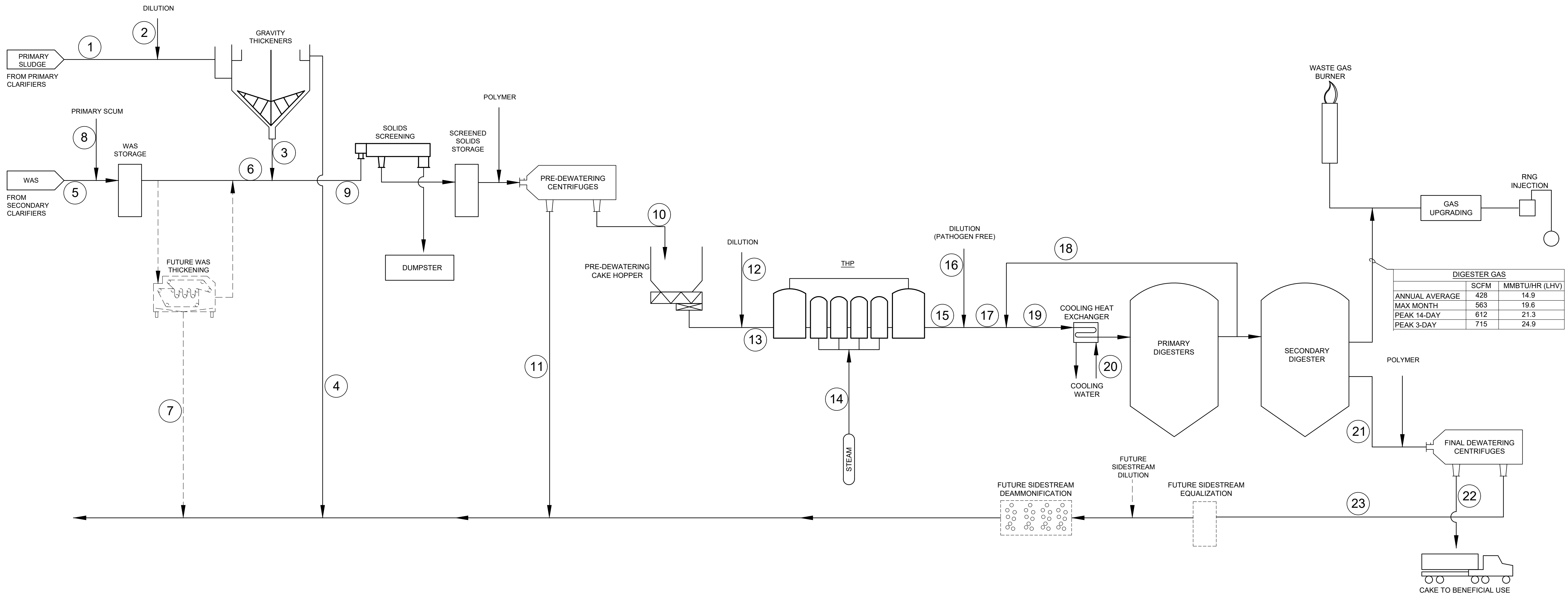
ARLINGTON COUNTY WPCP RE-GEN

OVERALL GAS AND STEAM PROCESS FLOW DIAGRAM

0 1" 2"

FILENAME G-007.dwg
SCALE NOT TO SCALE

SHEET G-007



DIGESTER GAS

	SCFM	MMBTU/HR (LHV)
ANNUAL AVERAGE	428	14.9
MAX MONTH	563	19.6
PEAK 14-DAY	612	21.3
PEAK 3-DAY	715	24.9

MASS BALANCE DATA TABLE

	PROCESS FLOW	PS	GT DILUTION	TPS	GTO	WAS	WAS TO SCREENS	WAS THICK RECYCLE	PRIMARY SCUM	SCREEN FEED	PRE DEWATER CAKE	PRE DEWATER RECYCLE
	FLOW IDENTIFIER	1	2	3	4	5	6	7	8	9	10	11
ANNUAL AVERAGE	TS LOAD (LB-TS / D)	53,464	-	50,791	2,673	29,228	35,634	-	6,406	86,425	82,104	4,321
	VS LOAD (LB-TS / D)	44,532	-	42,305	2,227	21,161	26,927	-	5,766	69,232	65,771	3,462
	CONCENTRATION (LB-TS / LB)	0.010	-	0.040	0.000	0.010	0.008	-	0.005	0.016	0.250	0.001
	VOLATILE FRACTION (VS / TS)	0.83	-	0.83	0.83	0.72	0.76	-	0.90	0.80	0.80	0.80
	FLOW (GAL / D)	641,053	1,008,000	152,250	1,496,803	350,454	504,084	-	153,631	656,334	39,378	627,319
PEAK 14 - DAY	TS LOAD (LB-TS / D)	77,983	-	74,084	3,899	39,750	49,103	-	9,353	123,187	117,028	6,159
	VS LOAD (LB-TS / D)	64,972	-	61,723	3,249	28,779	37,197	-	8,418	98,920	93,974	4,946
	CONCENTRATION (LB-TS / LB)	0.010	-	0.040	0.000	0.010	0.009	-	0.006	0.017	0.250	0.001
	VOLATILE FRACTION (VS / TS)	0.83	-	0.83	0.83	0.72	0.76	-	0.90	0.80	0.80	0.80
	FLOW (GAL / D)	935,049	1,008,000	222,074	1,720,975	476,617	649,417	-	172,800	871,491	56,128	830,133
PEAK 3 - DAY	TS LOAD (LB-TS / D)	91,832	-	87,240	4,592	45,303	56,322	-	11,019	143,562	136,384	7,178
	VS LOAD (LB-TS / D)	76,518	-	72,692	3,826	32,799	42,717	-	9,917	115,409	109,638	5,770
	CONCENTRATION (LB-TS / LB)	0.010	-	0.040	0.000	0.010	0.009	-	0.008	0.018	0.250	0.001
	VOLATILE FRACTION (VS / TS)	0.83	-	0.83	0.83	0.72	0.76	-	0.90	0.80	0.80	0.80
	FLOW (GAL / D)	1,101,101	1,008,000	261,512	1,847,590	543,203	716,003	-	172,800	977,515	65,412	929,316

	PROCESS FLOW	PULPER DILUTION	PULPER FEED W/ DILUTION	STEAM	THS	THS DILUTION	THS W/ DILUTION	DSR	DSRF	COOLING WATER	DS	CAKE	FINAL DEWATER RECYCLE
	FLOW IDENTIFIER	12	13	14	15	16	17	18	19	20	21	22	23
ANNUAL AVERAGE	TS LOAD (LB-TS / D)	-	82,104	-	82,104	-	82,104	202,252	284,355	-	40,450	38,428	2,023
	VS LOAD (LB-TS / D)	-	65,771	-	65,771	-	65,771	120,586	186,357	-	24,117	22,911	1,206
	CONCENTRATION (LB-TS / LB)	-	0.165	-	0.142	-	0.090	0.044	0.052	-	0.044	0.330	0.002
	VOLATILE FRACTION (VS / TS)	-	0.80	-	0.80	-	0.80	0.60	0.66	-	0.60	0.60	0.60
	FLOW (GAL / D)	20,286	59,664	9,845	69,509	39,875	109,384	546,920	656,304	460,000	109,384	7,728	139,164
PEAK 14 - DAY	TS LOAD (LB-TS / D)	-	117,028	-	117,028	-	117,028	202,252	319,279	-	57,445	54,572	2,872
	VS LOAD (LB-TS / D)	-	93,974	-	93,974	-	93,974	121,083	215,057	-	34,391	32,671	1,720
	CONCENTRATION (LB-TS / LB)	-	0.165	-	0.142	-	0.090	0.044	0.054	-	0.044	0.330	0.002
	VOLATILE FRACTION (VS / TS)	-	0.80	-	0.80	-	0.80	0.60	0.67	-	0.60	0.60	0.60
	FLOW (GAL / D)	28,915	85,043	14,032	99,075	56,837	155,912	546,900	702,812	650,000	155,912	7,728	197,630
PEAK 3 - DAY	TS LOAD (LB-TS / D)	-	136,384	-	136,384	-	136,384	202,252	338,636	-	66,833	63,491	3,342
	VS LOAD (LB-TS / D)	-	109,638	-	109,638	-	109,638	121,312	230,951	-	40,087	38,083	2,004
	CONCENTRATION (LB-TS / LB)	-	0.165	-	0.142	-	0.090	0.044	0.050	-	0.044	0.330	0.002
	VOLATILE FRACTION (VS / TS)	-	0.80	-	0.80	-	0.80	0.60	0.68	-	0.60	0.60	0.60
	FLOW (GAL / D)	33,697	99,109	16,353	115,462	66,238	181,700	635,951	817,652	720,000	181,700	7,728	229,929

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MECHANICAL	C. MOLINE
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INSTRUMENTATION	
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DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

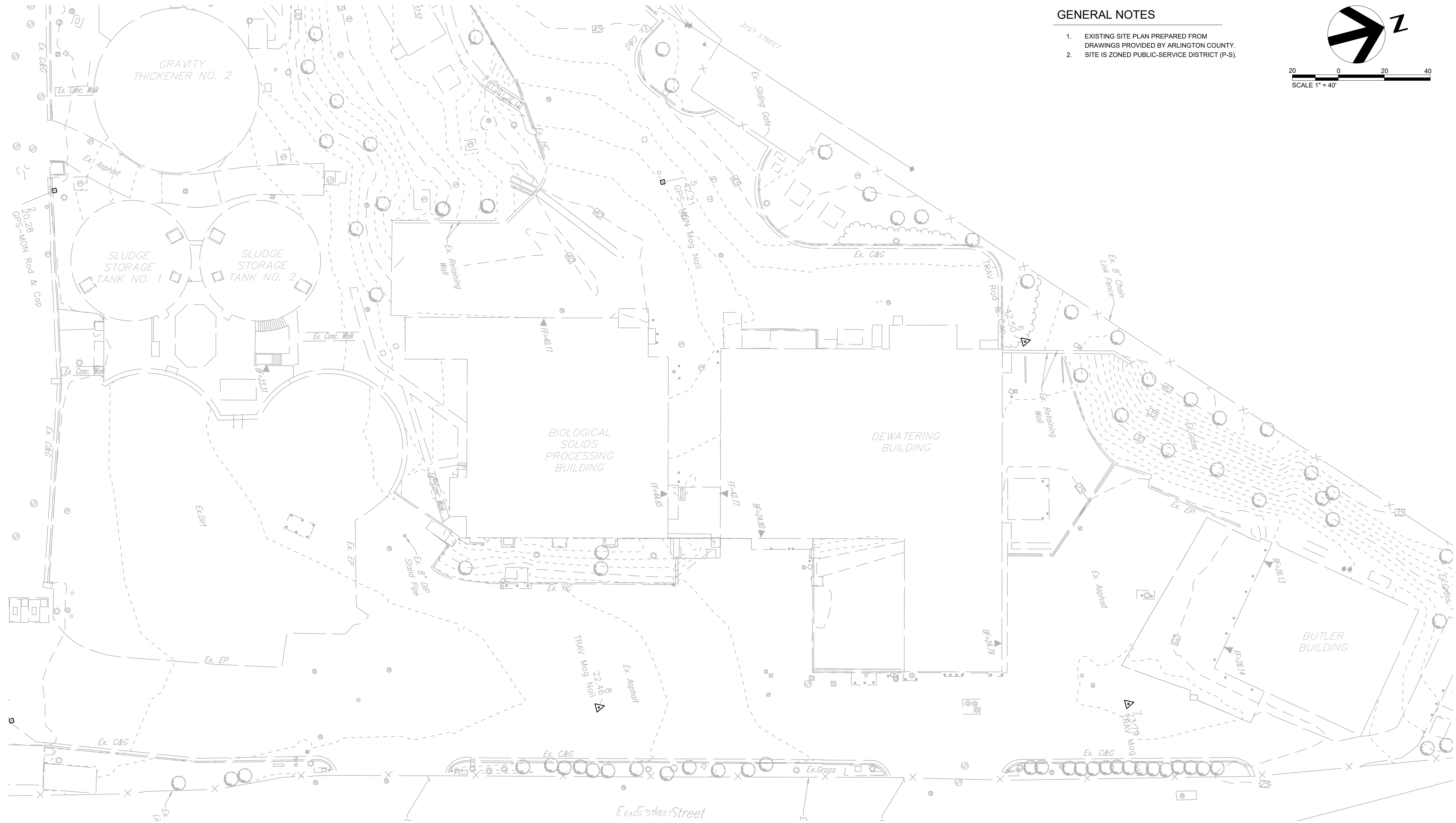
SOLIDS MASS BALANCE
2052 DESIGN YEAR - (30.8 MGD)

0 1" 2"

FILENAME G-008.dwg
SCALE NOT TO SCALE
SHEET **G-008**

GENERAL NOTES

1. EXISTING SITE PLAN PREPARED FROM DRAWINGS PROVIDED BY ARLINGTON COUNTY.
2. SITE IS ZONED PUBLIC-SERVICE DISTRICT (P-S).



PROJECT MANAGER	BALCHUNAS, BRIAN
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DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON COUNTY WATER POLLUTION CONTROL BIOSOLIDS REGEN

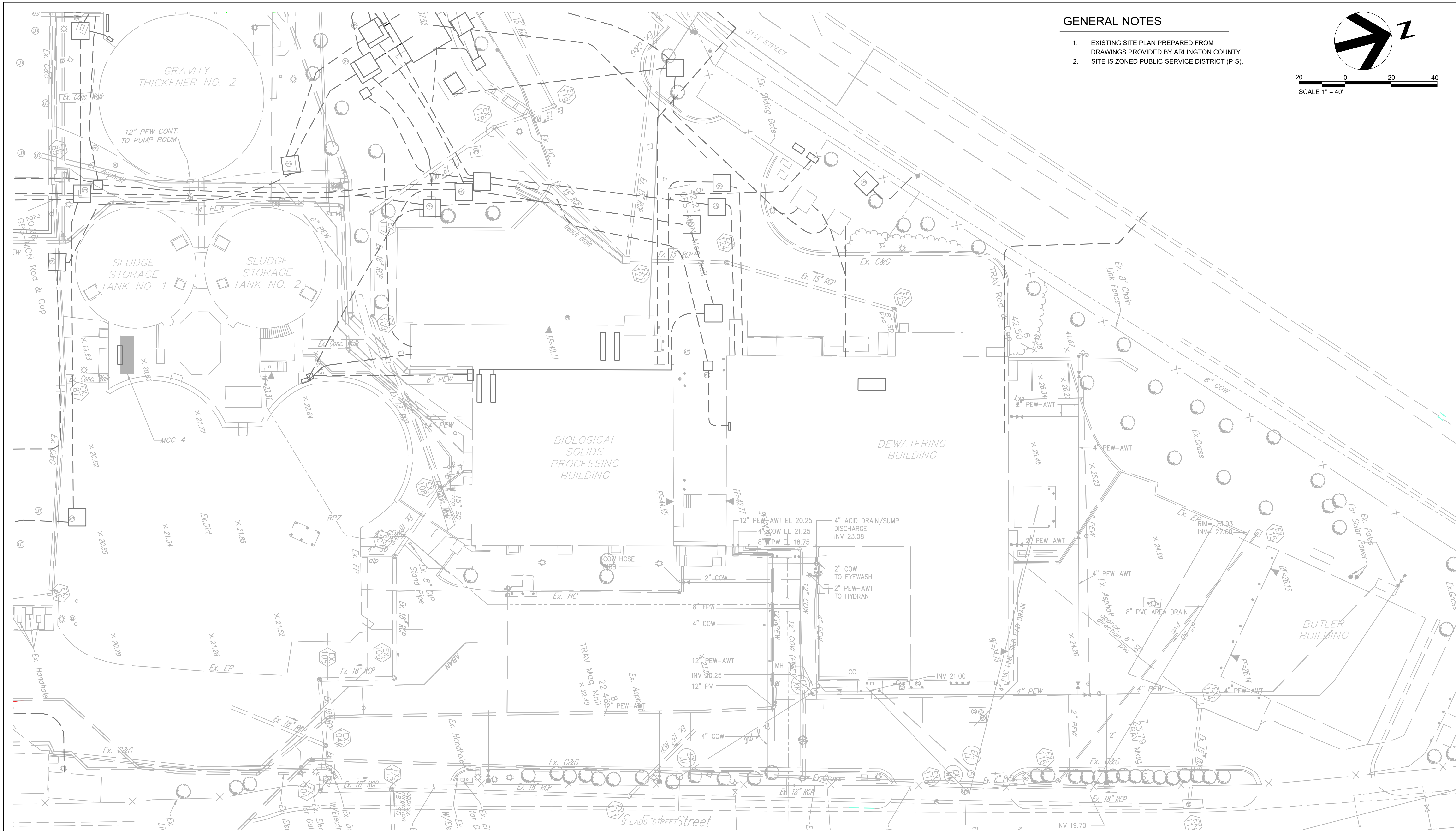
EXISTING SITE PLAN

0 1" 2"

FILENAME C-001.DWG

SCALE 1" = 40'

SHEET C-001



GENERAL NOTES

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2. SITE IS ZONED PUBLIC-SERVICE DISTRICT (P-S).

SCALE 1" = 40'

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DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

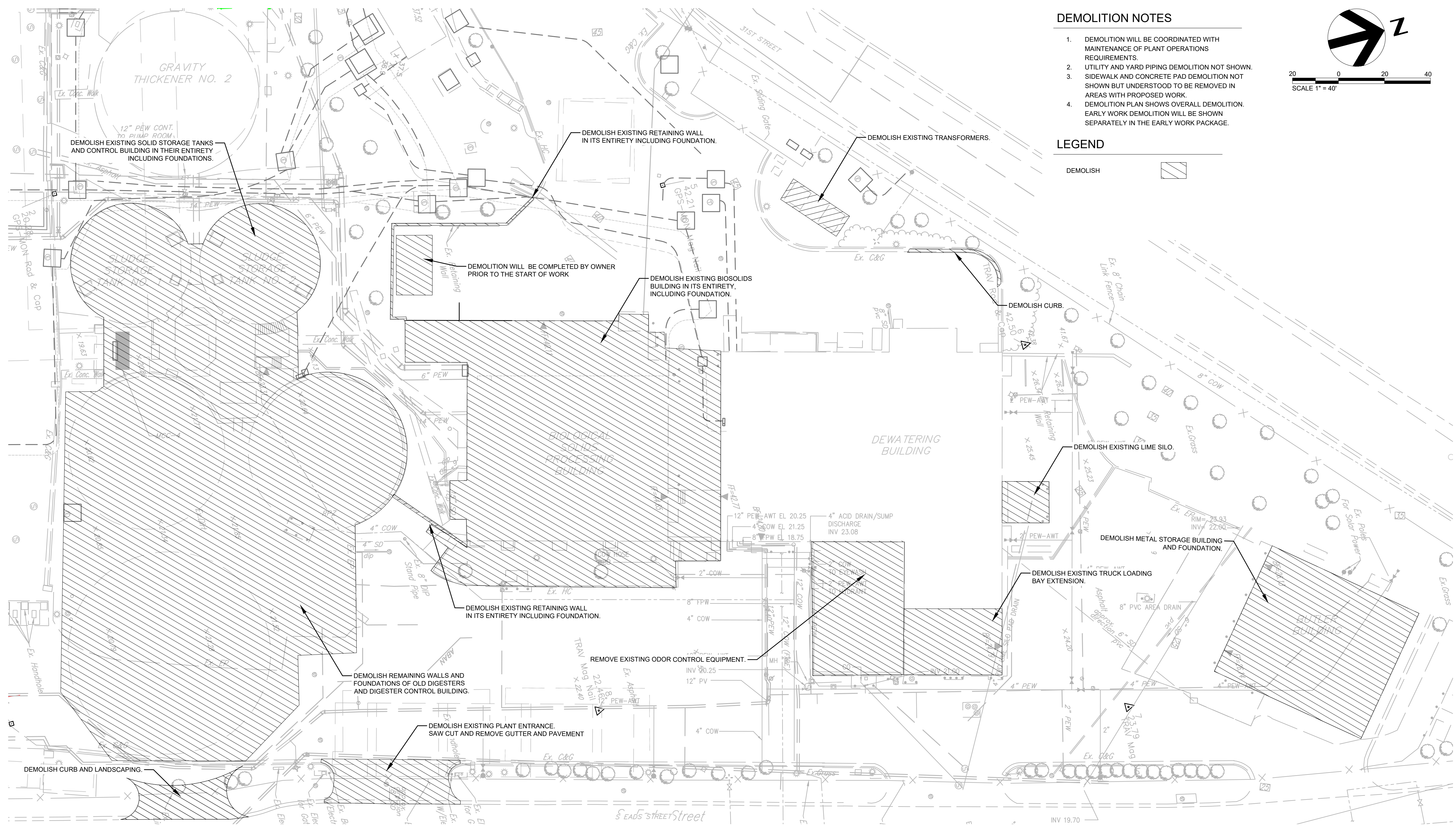
ARLINGTON COUNTY WATER POLLUTION CONTROL BIOSOLIDS REGEN

EXISTING SITE PLAN UNDERGROUND UTILITIES

FILENAME C-002.DWG

SCALE 1" = 40'

SHEET C-002



DEMOLITION NOTES

1. DEMOLITION WILL BE COORDINATED WITH MAINTENANCE OF PLANT OPERATIONS REQUIREMENTS.
2. UTILITY AND YARD PIPING DEMOLITION NOT SHOWN.
3. SIDEWALK AND CONCRETE PAD DEMOLITION NOT SHOWN BUT UNDERSTOOD TO BE REMOVED IN AREAS WITH PROPOSED WORK.
4. DEMOLITION PLAN SHOWS OVERALL DEMOLITION. EARLY WORK DEMOLITION WILL BE SHOWN SEPARATELY IN THE EARLY WORK PACKAGE.

LEGEND

DEMOLISH

HDR

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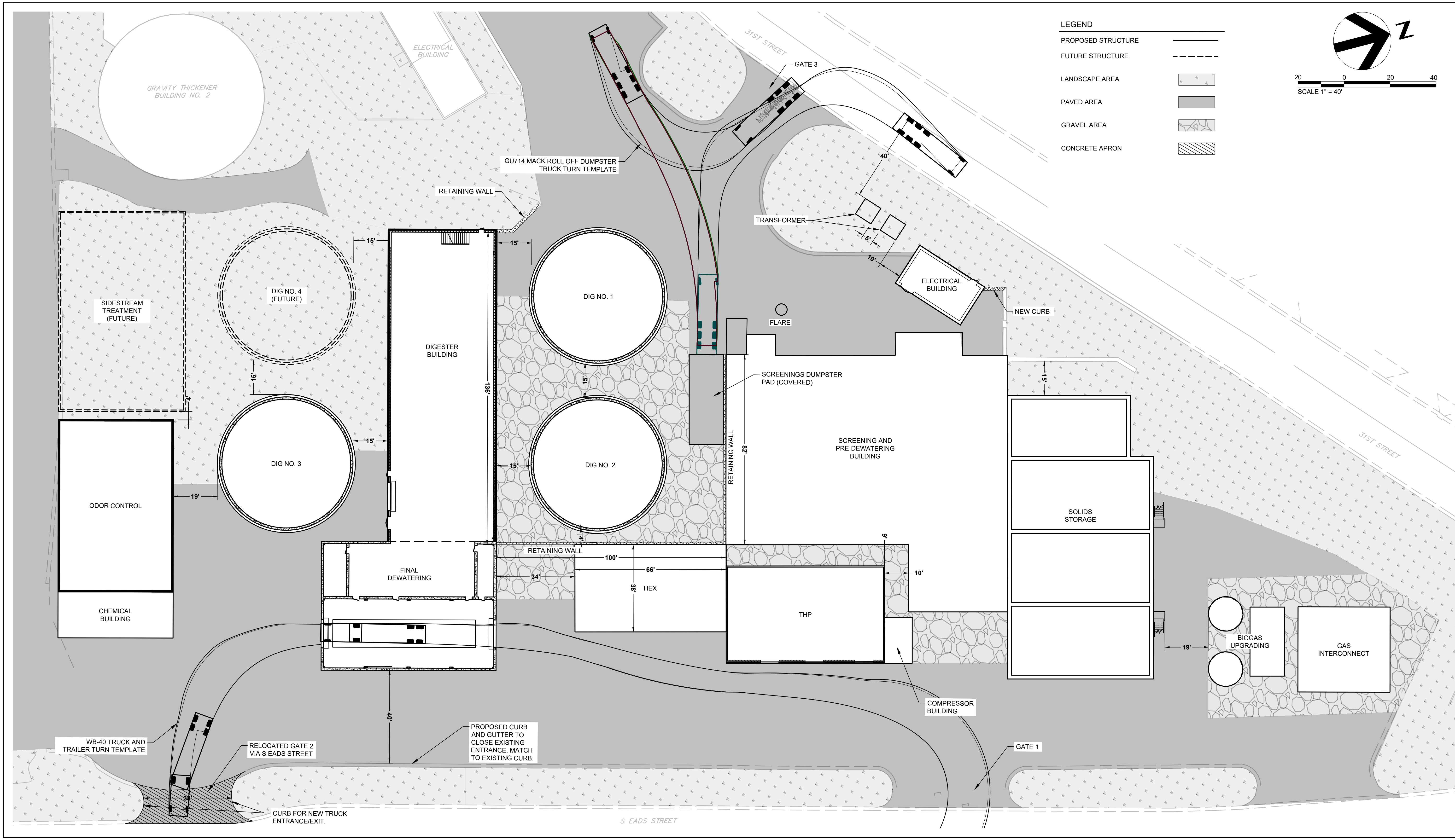
ARLINGTON COUNTY WATER POLLUTION CONTROL BIOSOLIDS REGEN

RENOVATE DEWATERING BUILDING DEMOLITION PLAN

FILENAME C-003.DWG

SCALE 1" = 40'

SHEET C-003



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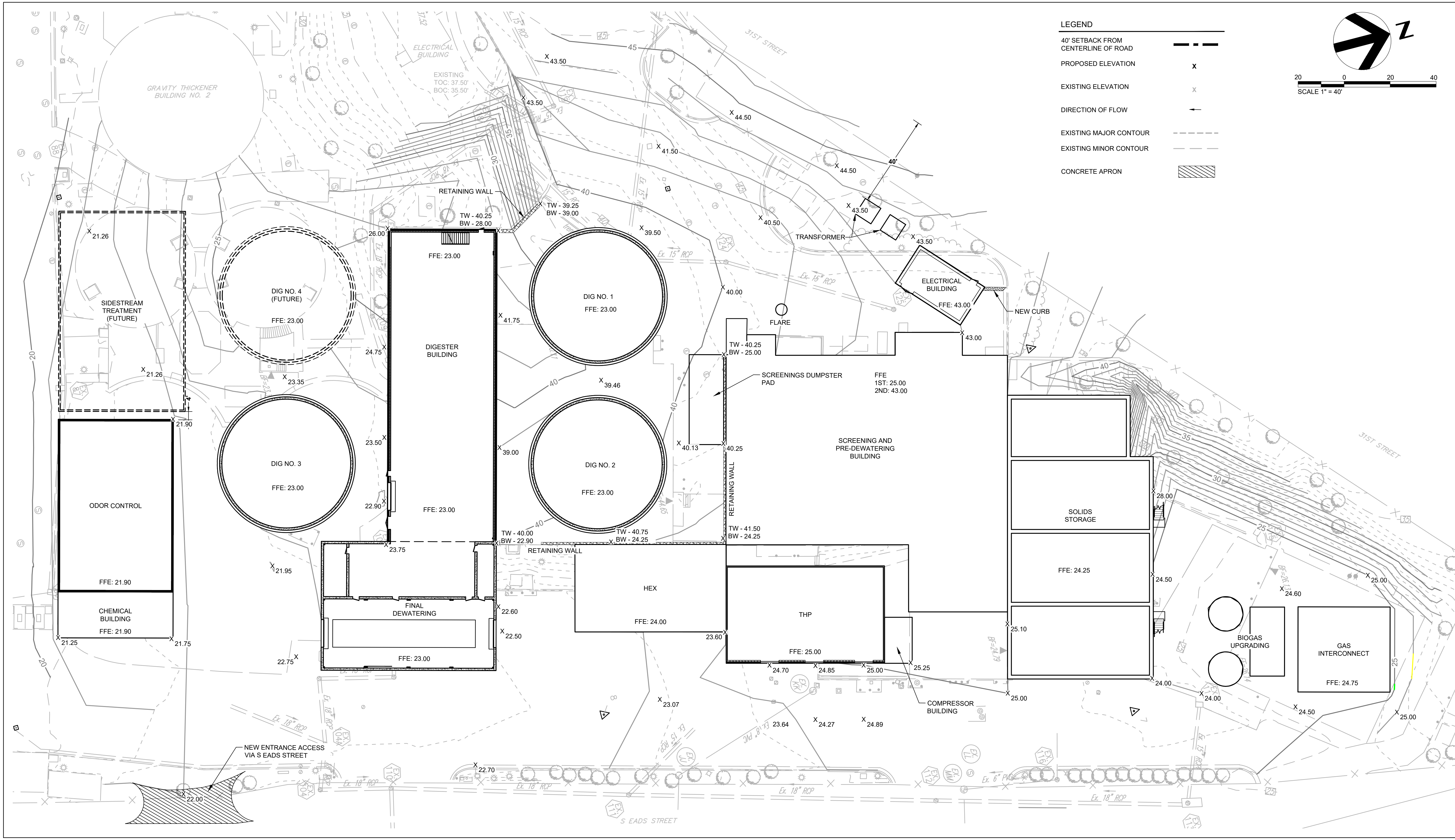
ARLINGTON COUNTY WATER POLLUTION CONTROL BIOSOLIDS REGEN

RENOVATE DEWATERING BUILDING SITE PLAN

FILENAME C-004.DWG
SCALE 1" = 40'
SHEET C-004



![HDR]

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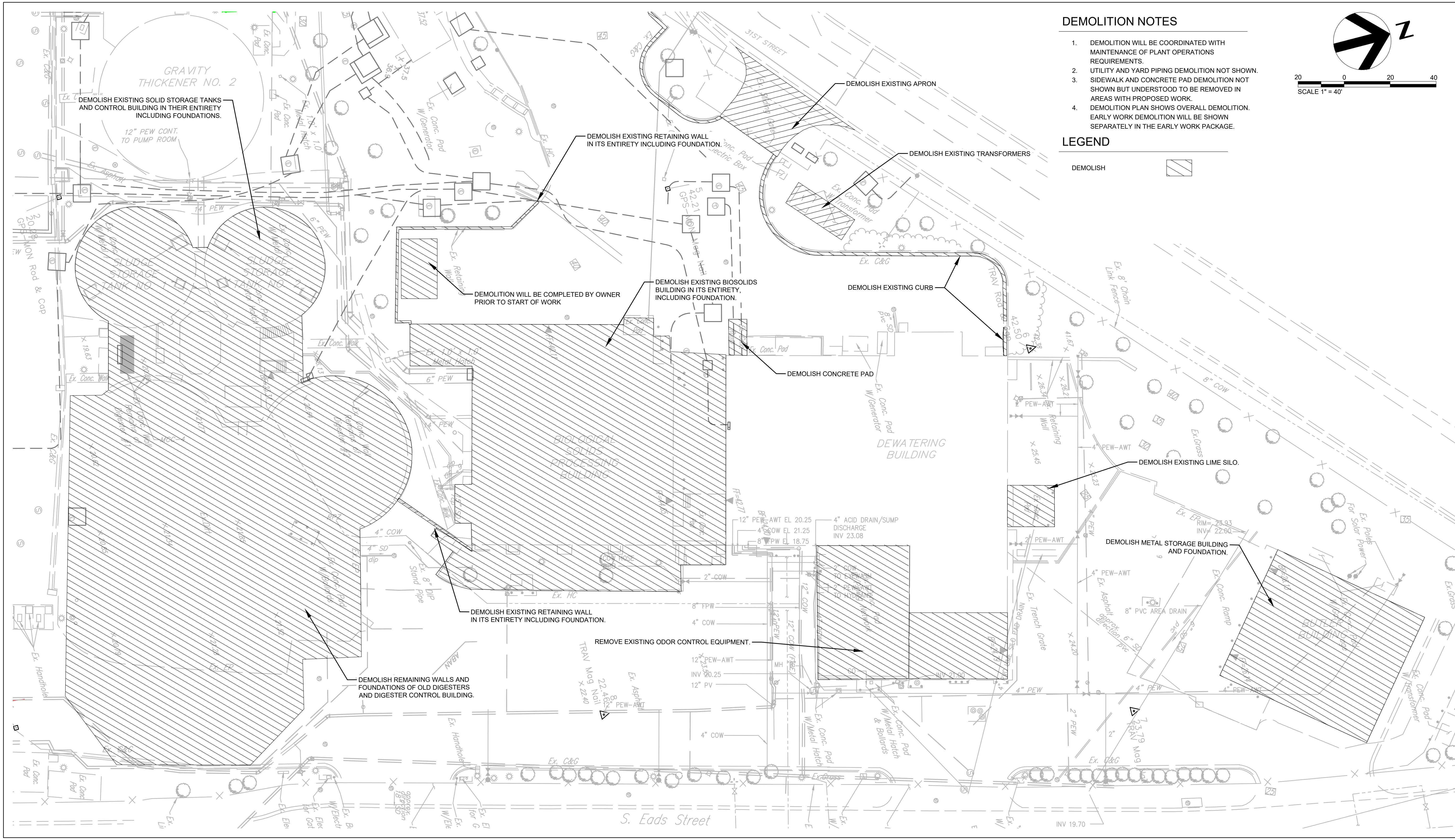
ARLINGTON COUNTY WATER POLLUTION CONTROL BIOSOLIDS REGEN

RENOVATE DEWATERING BUILDING GRADING PLAN

0 1" 2"

FILENAME	C-005.DWG
SCALE	1" = 40'

SHEET C-005



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ARLINGTON COUNTY WATER POLLUTION CONTROL BIOSOLIDS REGEN

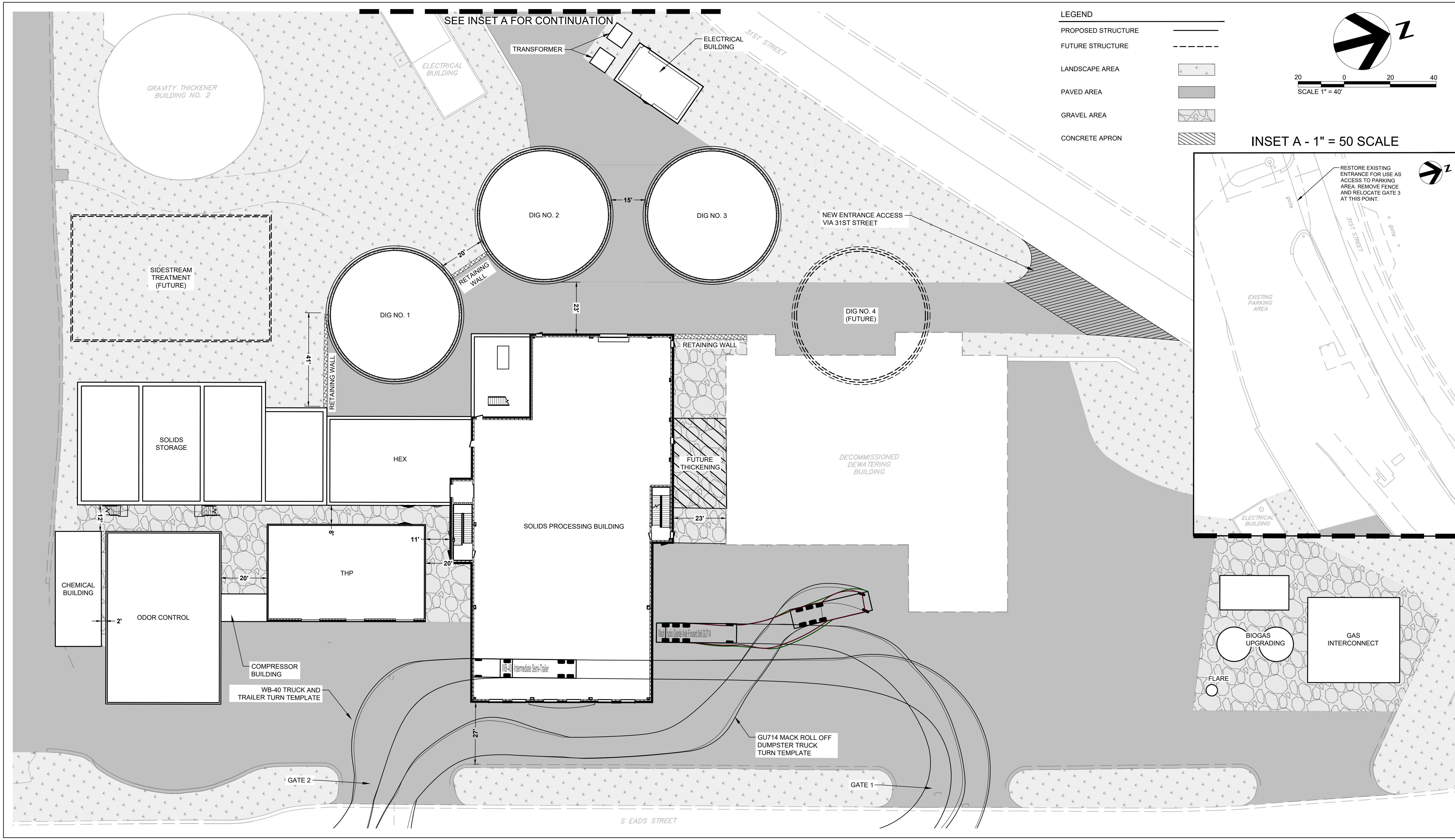
DECOMMISSION DEWATERING BUILDING DEMOLITION PLAN

0 1" 2"

FILENAME C-006.DWG

SCALE 1" = 40'

SHEET C-006



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ARLINGTON COUNTY WATER POLLUTION CONTROL BIOSOLIDS REGEN

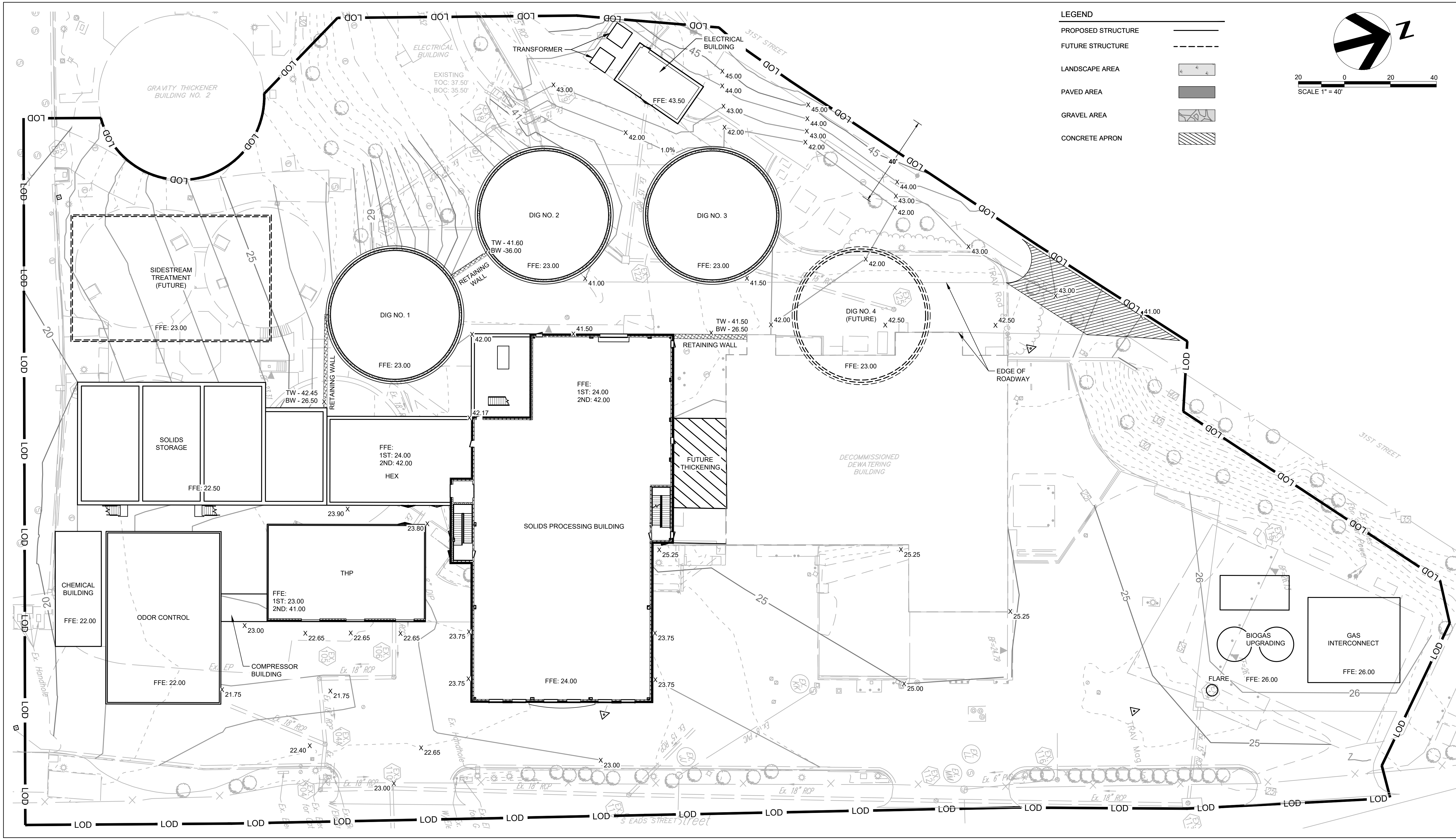
DECOMMISSION DEWATERING BUILDING SITE PLAN

0 1" 2"

FILENAME C-007.DWG

SCALE 1" = 40'

SHEET C-007



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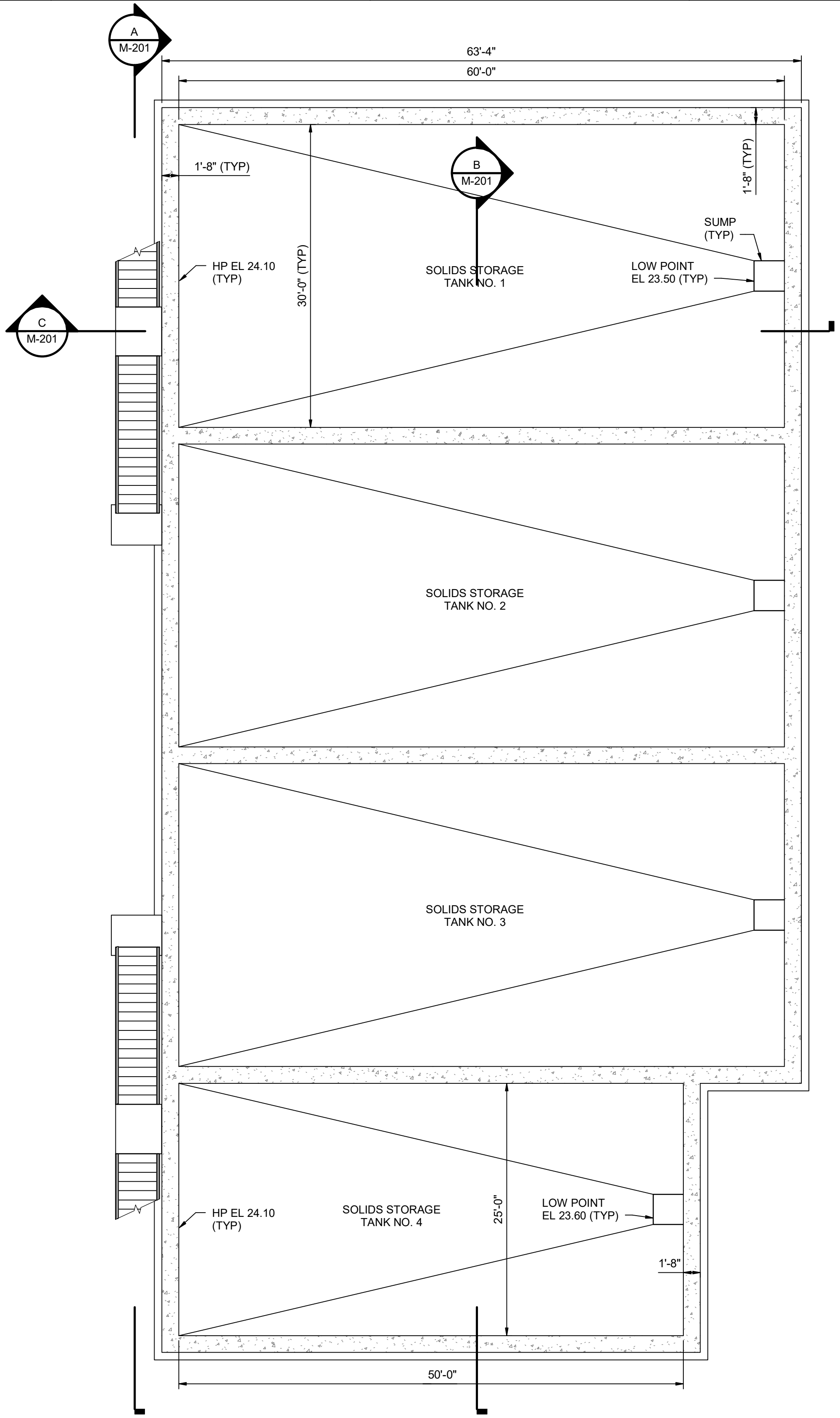
ARLINGTON COUNTY WATER POLLUTION CONTROL BIOSOLIDS REGEN

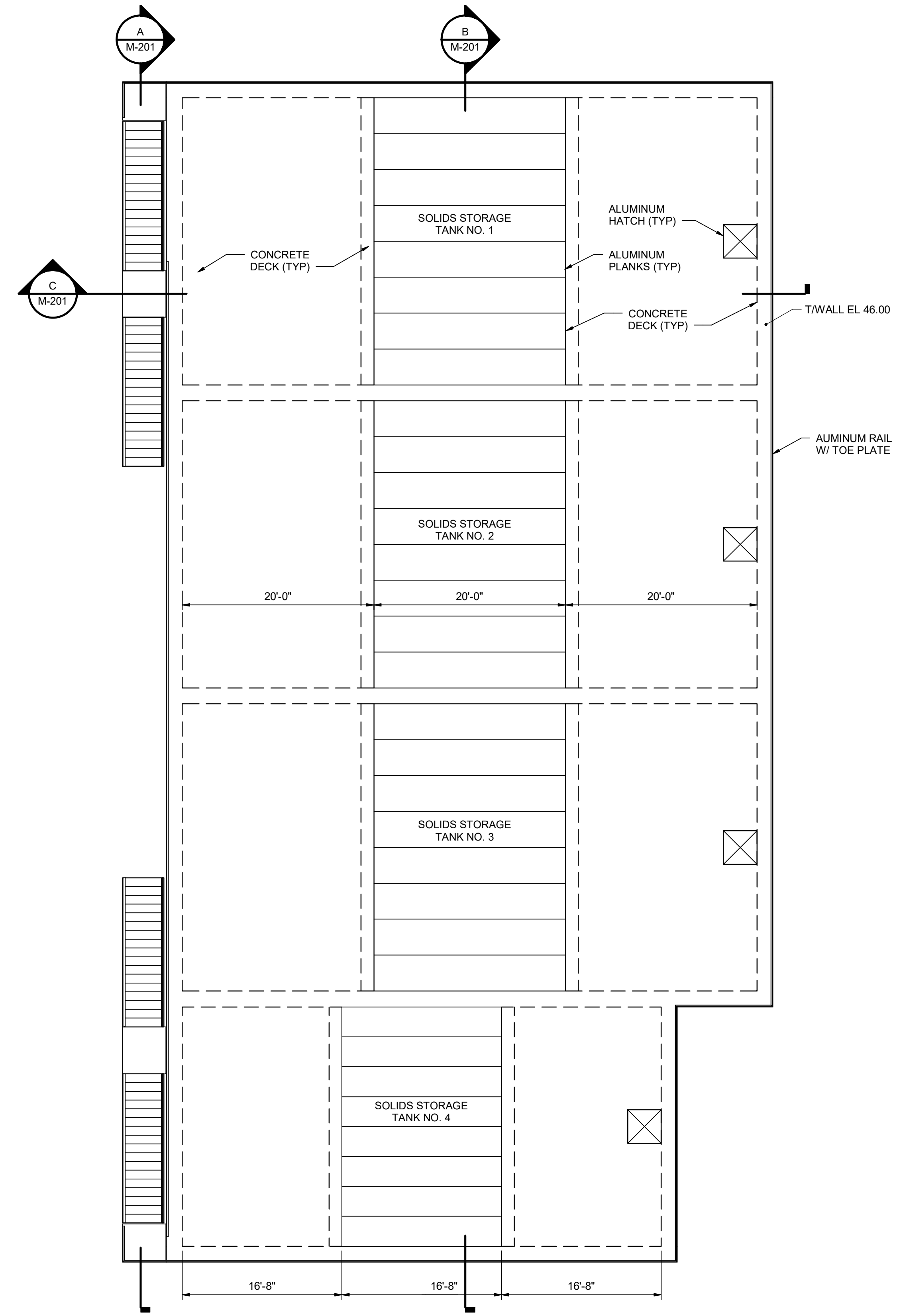
DECOMMISSION DEWATERING BUILDING GRADING PLAN

FILENAME C-008.DWG
SCALE 1" = 40'
SHEET C-008



PLAN AT EL 24.00

1/8" = 1'-0"



PLAN AT EL 46.00

1/8" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

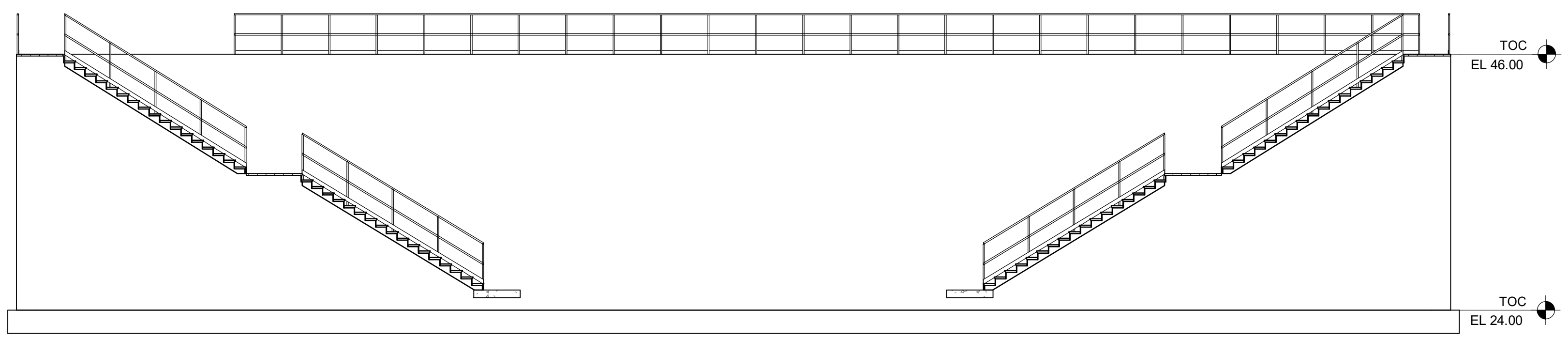
RENOVATE DEWATERING BUILDING SOLIDS STORAGE TANKS PLAN

FILENAME 10263882-40-S_v20.rvt

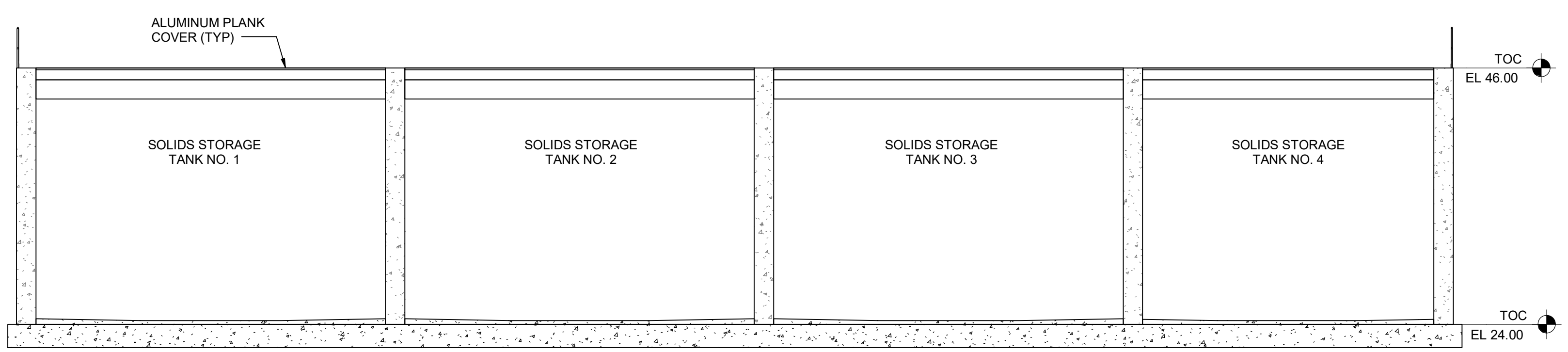
SCALE 1/8" = 1'-0"

SHEET M-200

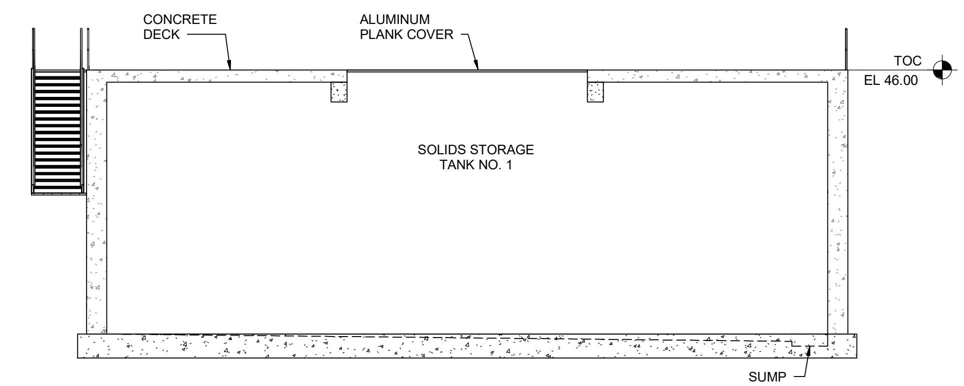
1 2 3 4 5 6 7 8



A M-200 SECTION
1/8" = 1'-0"



B M-200 SECTION
1/8" = 1'-0"



C M-200 SECTION
1/8" = 1'-0"

D C B A

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-40_opt2-S_v20.rvt
6/30/2022 9:03:51 AM

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

ARLINGTON
VIRGINIA

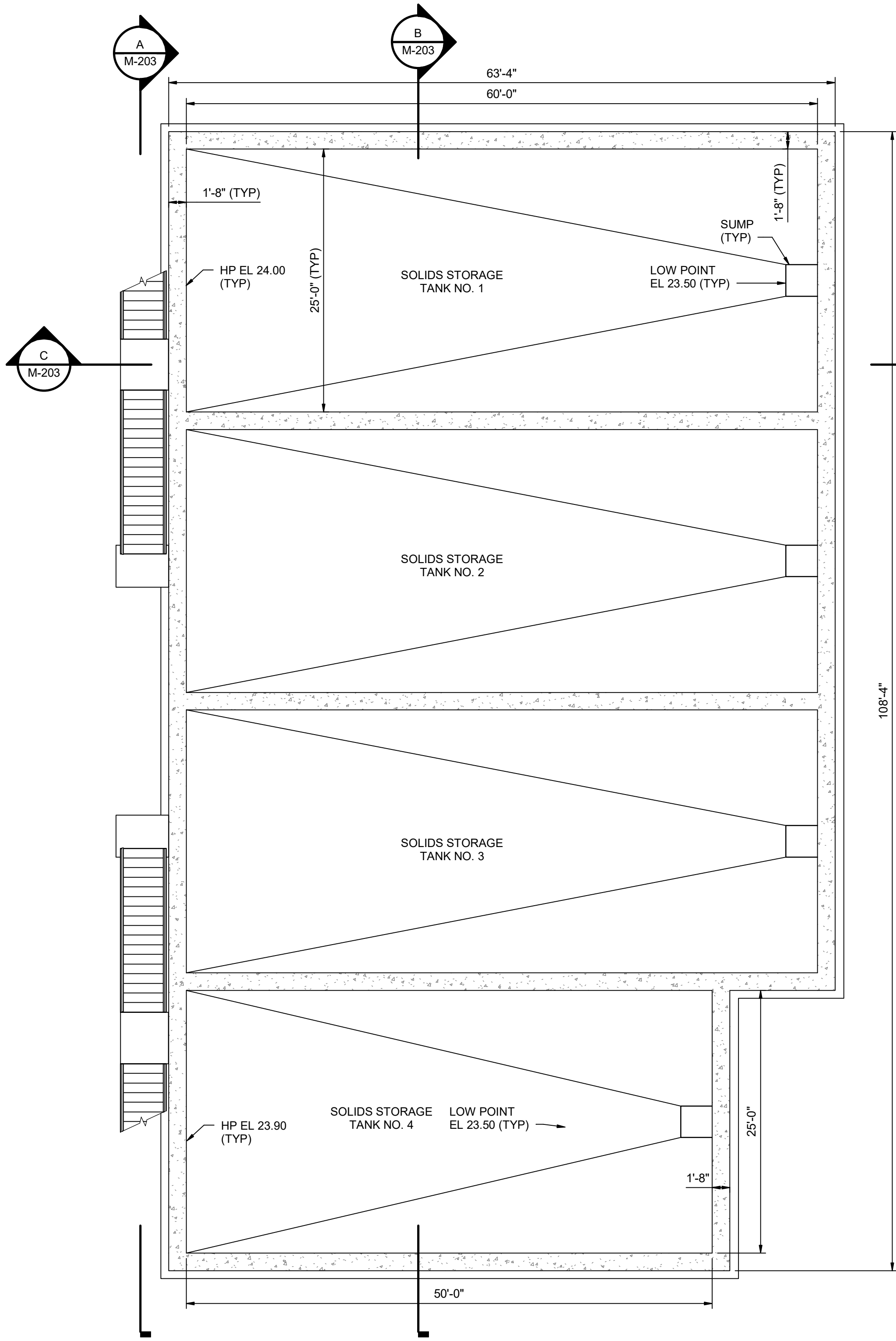
ARLINGTON COUNTY
WPCP
RE-GEN

RENOVATE DEWATERING BUILDING
SOLIDS STORAGE TANKS SECTIONS

0 1" 2"

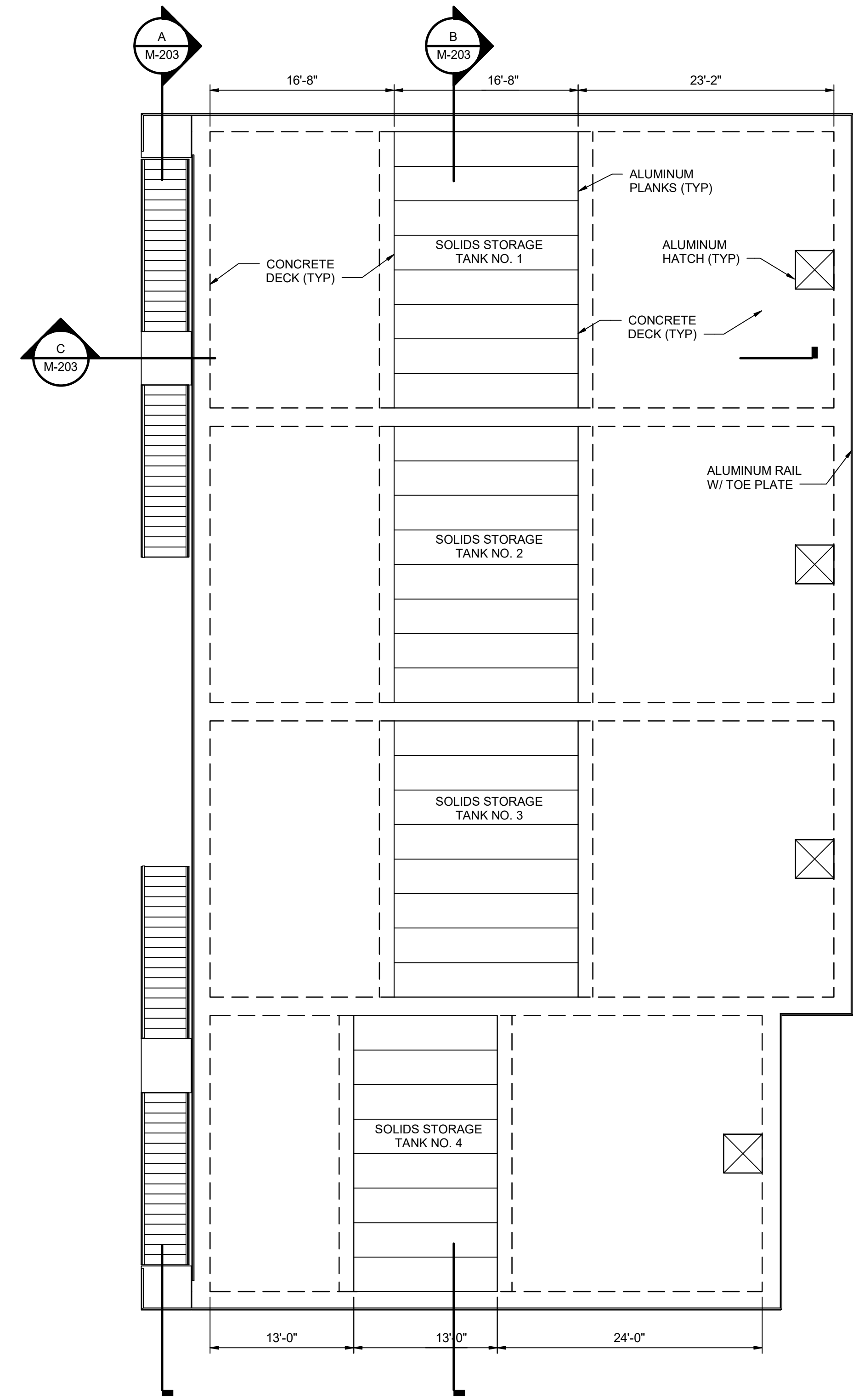
FILENAME 10263882-40-S_v20.rvt
SCALE 1/8" = 1'-0"

SHEET
M-201



FIRST FLOOR PLAN AT EL 24.00

1/8" = 1'-0"



PLAN AT EL 46.00

1/8" = 1'-0"

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-40-S_v20.rvt
6/30/2022 9:03:18 AM

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

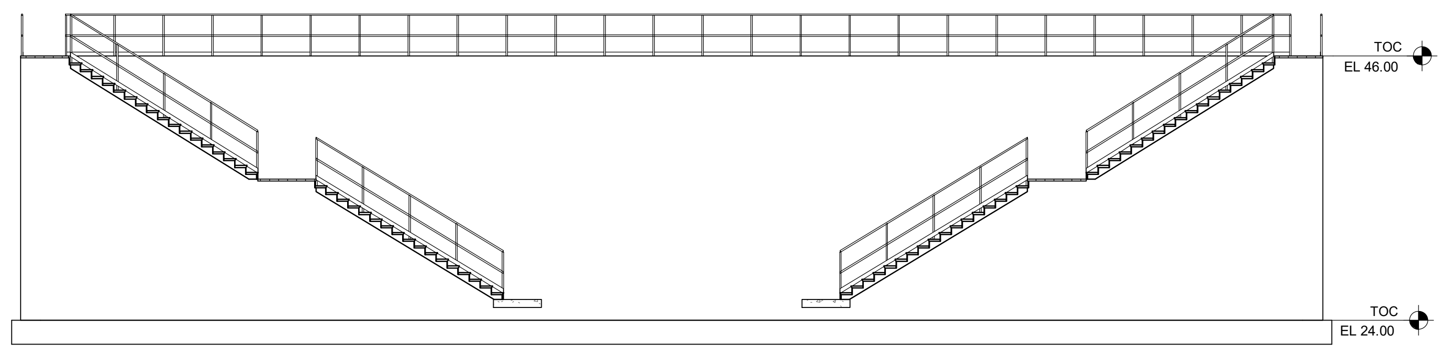
DECOMISSION DEWATERING BUILDING SOLIDS STORAGE TANKS PLANS

0 1" 2"

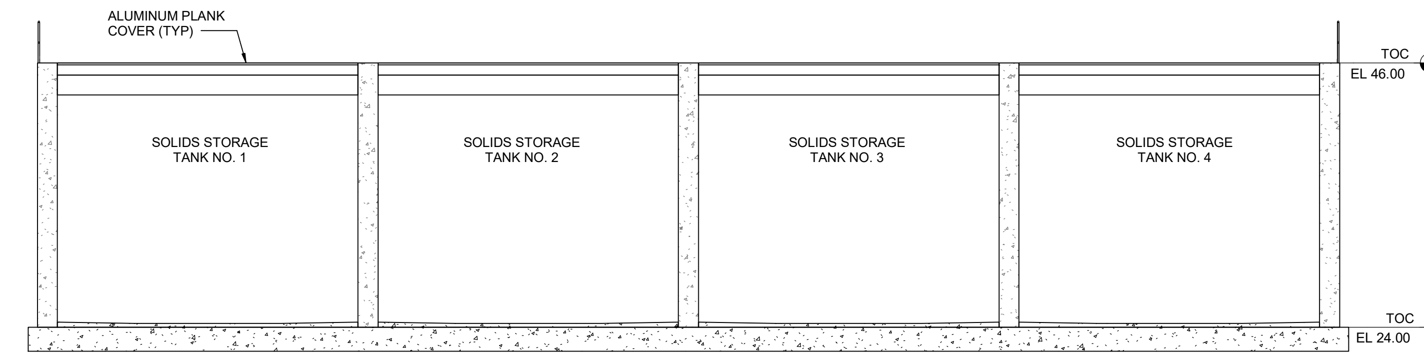
FILENAME 10263882-40-S_v20.rvt

SCALE 1/8" = 1'-0"

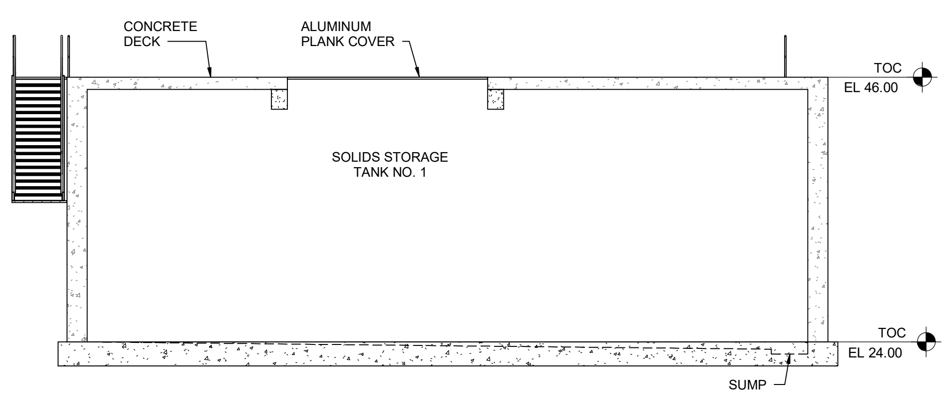
SHEET M-202



A
M-202
SECTION
1/8" = 1'-0"



B
M-202
SECTION
1/8" = 1'-0"



C
M-202
SECTION
1/8" = 1'-0"

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-40-S_v20.rvt
6/30/2022 9:03:18 AM

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

**DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION**

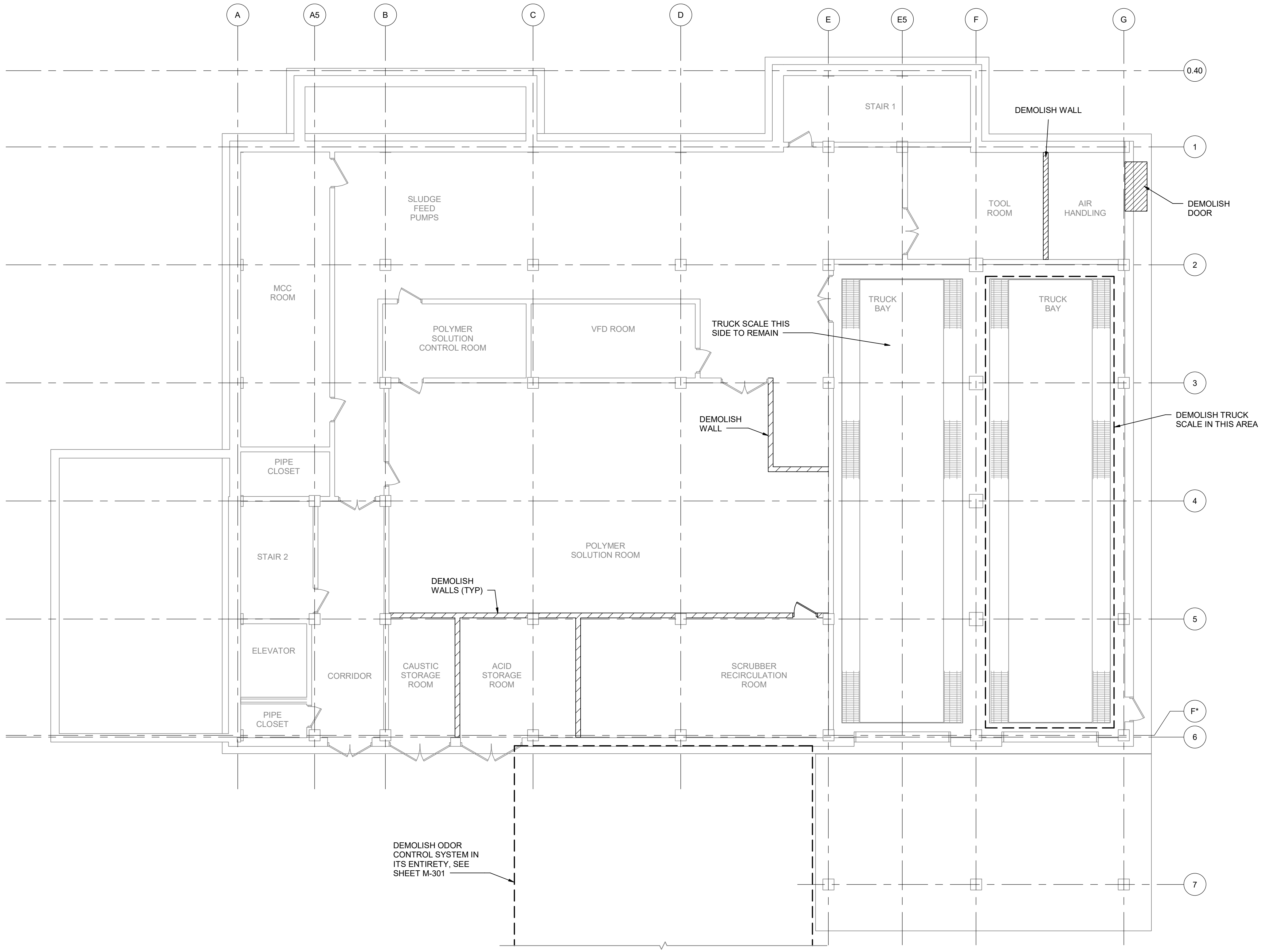
ARLINGTON
VIRGINIA

**ARLINGTON COUNTY
WPCP
RE-GEN**

**DECOMISSION DEWATERING BUILDING
SOLIDS STORAGE TANKS SECTIONS**

0 1" 2"

FILENAME	10263882-40-S_v20.rvt
SCALE	1/8" = 1'-0"
SHEET	M-203



PLAN AT EL 25.00
1/8" = 1'-0"

GENERAL NOTES

1. ALL INTERIOR MECHANICAL, ODOR CONTROL (INCLUDING EXTERIOR), HOISTS, BRIDGE CRANE, ELECTRICAL, HVAC, LIGHTING, CONDUITS, ETC TO BE DEMOLISHED TO LEAVE BARE SHELL UNLESS OTHERWISE NOTED. REFER TO CONTRACT 93-02-WPC PHASE 3A SOLIDS PROCESSING FACILITIES FOR DETAILS OF FACILITIES.
2. DEMOLISH WALLS AS SHOWN.

LEGEND

DEMOLISHED ITEMS

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING
DEWATERING BUILDING
DEMOLITION PLAN AT EL 25.00

0 1" 2"

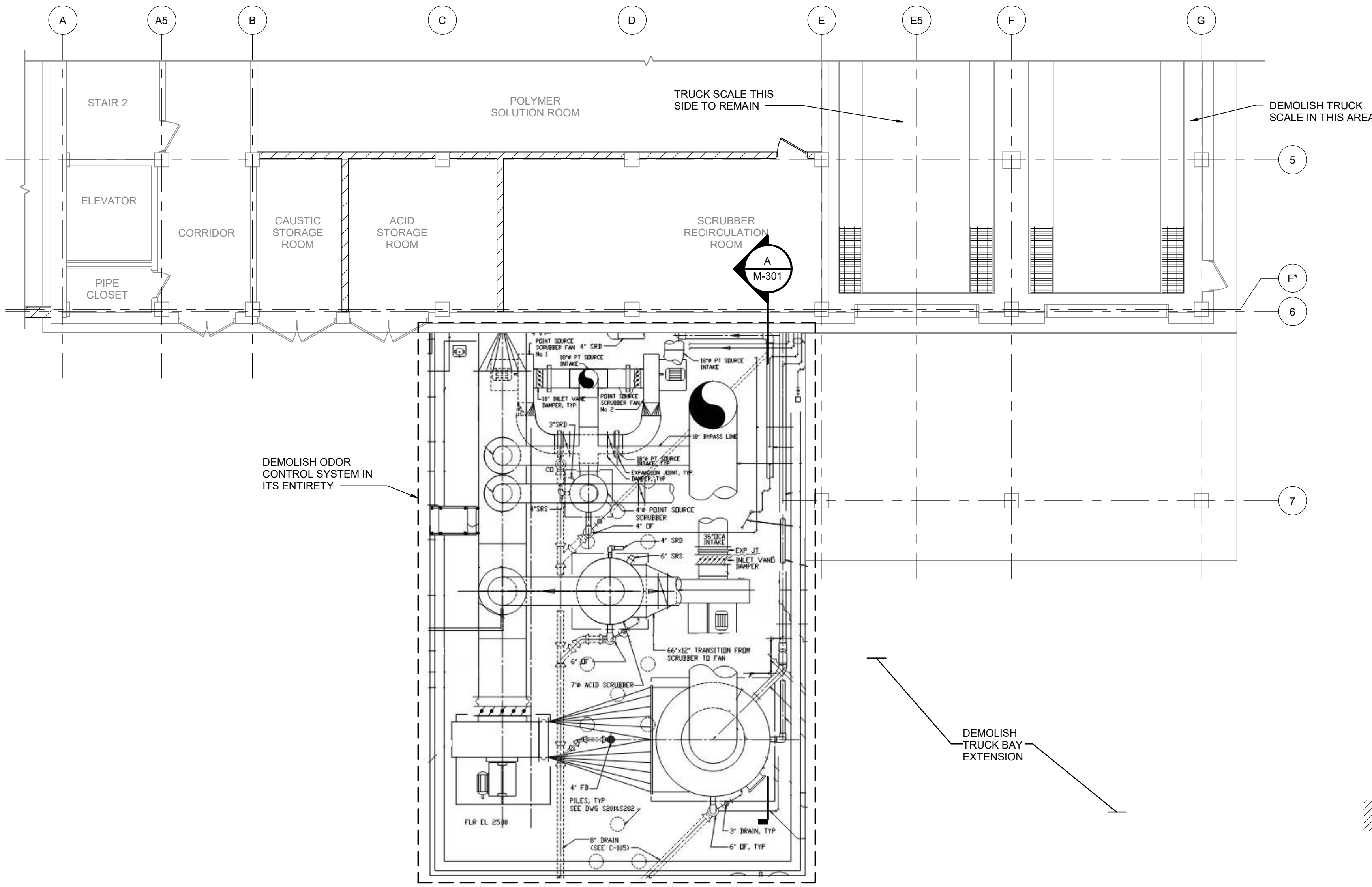
FILENAME 10263882-01-D_v20.rvt

SCALE 1/8" = 1'-0"

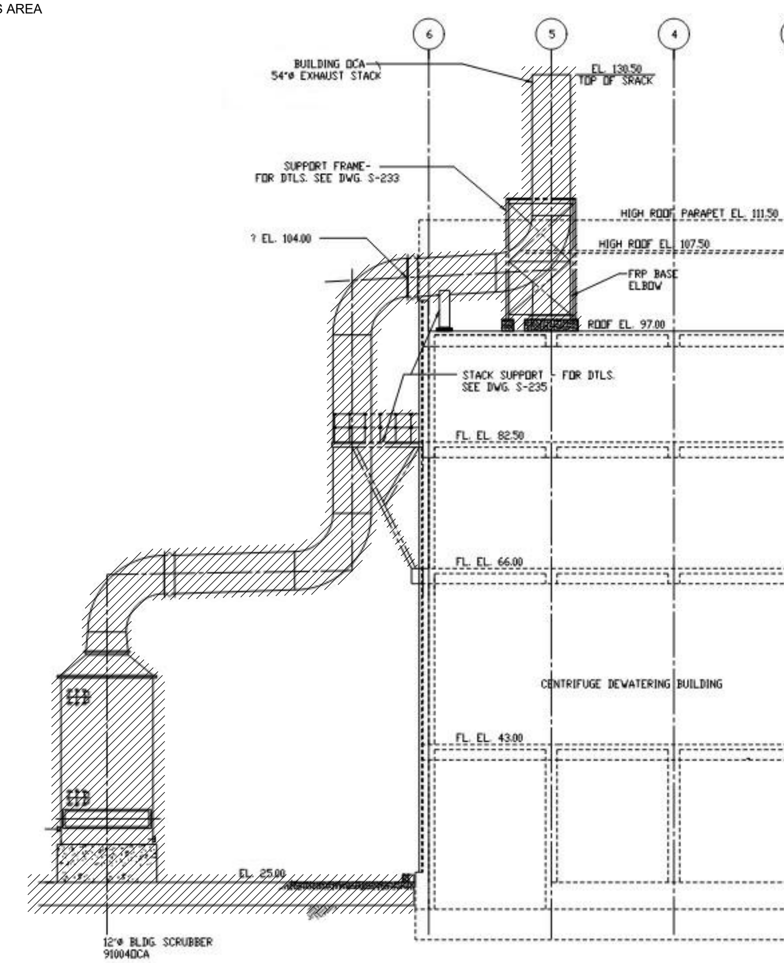
SHEET M-300

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-01-D_v20.rvt
6/30/2022 4:41:21 PM

1 2 3 4 5 6 7 8



PLAN AT EL 25.00
1/8" = 1'-0"



A
M-301
FOUL AIR SECTION DEMO
1/8" = 1'-0"

GENERAL NOTES

1. ALL INTERIOR MECHANICAL, ODOR CONTROL (INCLUDING EXTERIOR), HOISTS, BRIDGE CRANE, ELECTRICAL, HVAC, LIGHTING, CONDUITS, ETC TO BE DEMOLISHED TO LEAVE BARE SHELL UNLESS OTHERWISE NOTED. REFER TO CONTRACT 93-02-WPC PHASE 3A SOLIDS PROCESSING FACILITIES FOR DETAILS OF FACILITIES.
2. DEMOLISH WALLS AS SHOWN.

LEGEND

DEMOLISHED ITEMS

D C B A

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

ARLINGTON VIRGINIA

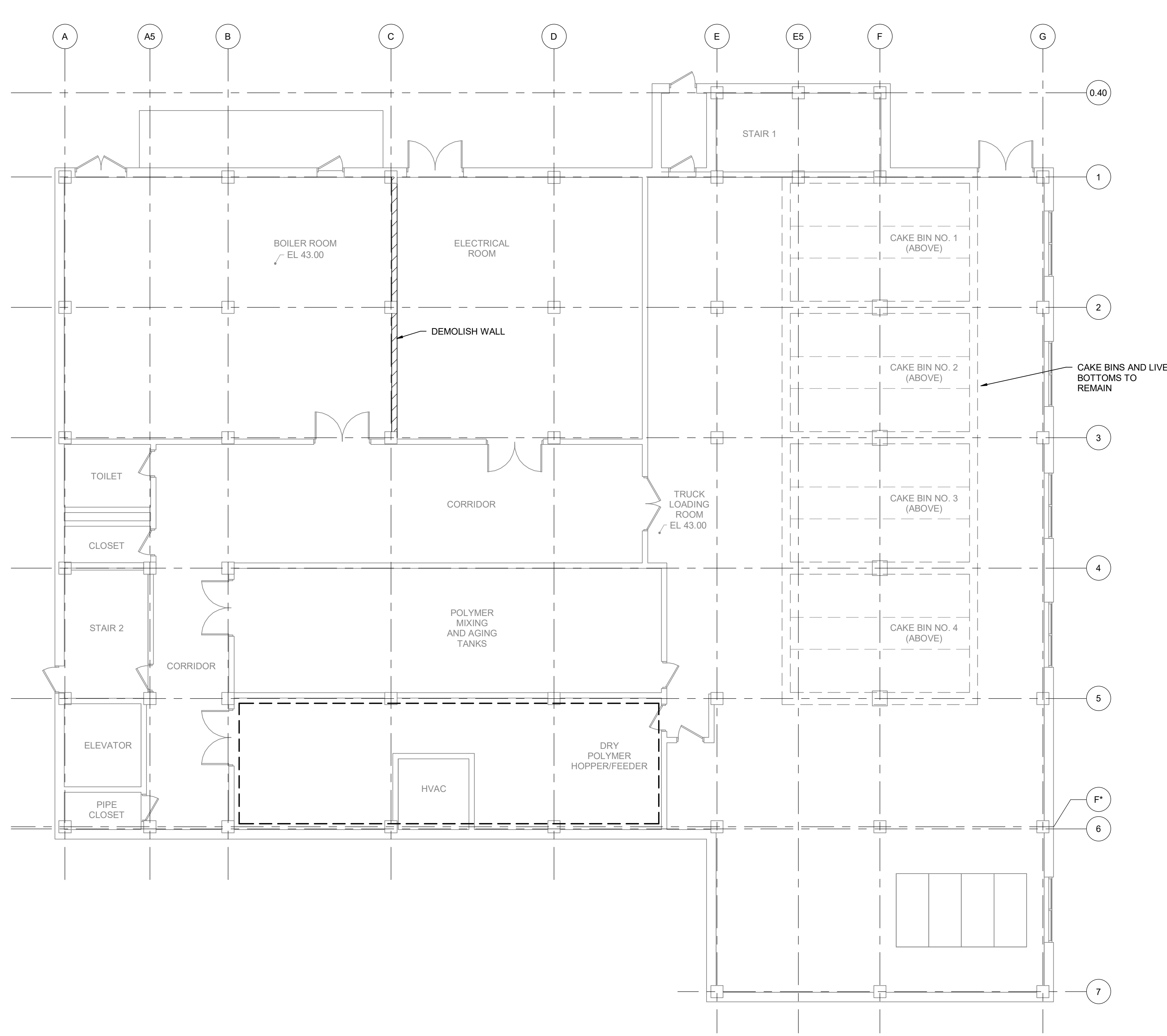
ARLINGTON COUNTY
WPCP
RE-GEN

RENOVATE DEWATERING BUILDING
DEWATERING BUILDING
ODOR CONTROL SYSTEM DEMOLITION PLAN AND SECTION

0 1" 2"

FILENAME 10263882-01-D_v20.rvt
SCALE 1/8" = 1'-0"
SHEET M-301

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-01-D_v20.rvt
6/30/2022 9:06:42 AM



PLAN AT EL 43.00

1/8" = 1'-0"

GENERAL NOTES

1. ALL INTERIOR MECHANICAL, ODOR CONTROL (INCLUDING EXTERIOR), HOISTS, BRIDGE CRANE, ELECTRICAL, HVAC, LIGHTING, CONDUITS, ETC TO BE DEMOLISHED TO LEAVE BARE SHELL UNLESS OTHERWISE NOTED. REFER TO CONTRACT 93-02-WPC PHASE 3A SOLIDS PROCESSING FACILITIES FOR DETAILS OF FACILITIES.
2. DEMOLISH WALLS AS SHOWN.

LEGEND

DEMOLISHED ITEMS

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

ARLINGTON
VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

RENOVATE DEWATERING BUILDING
DEWATERING BUILDING
DEMOLITION PLAN AT EL 43.00

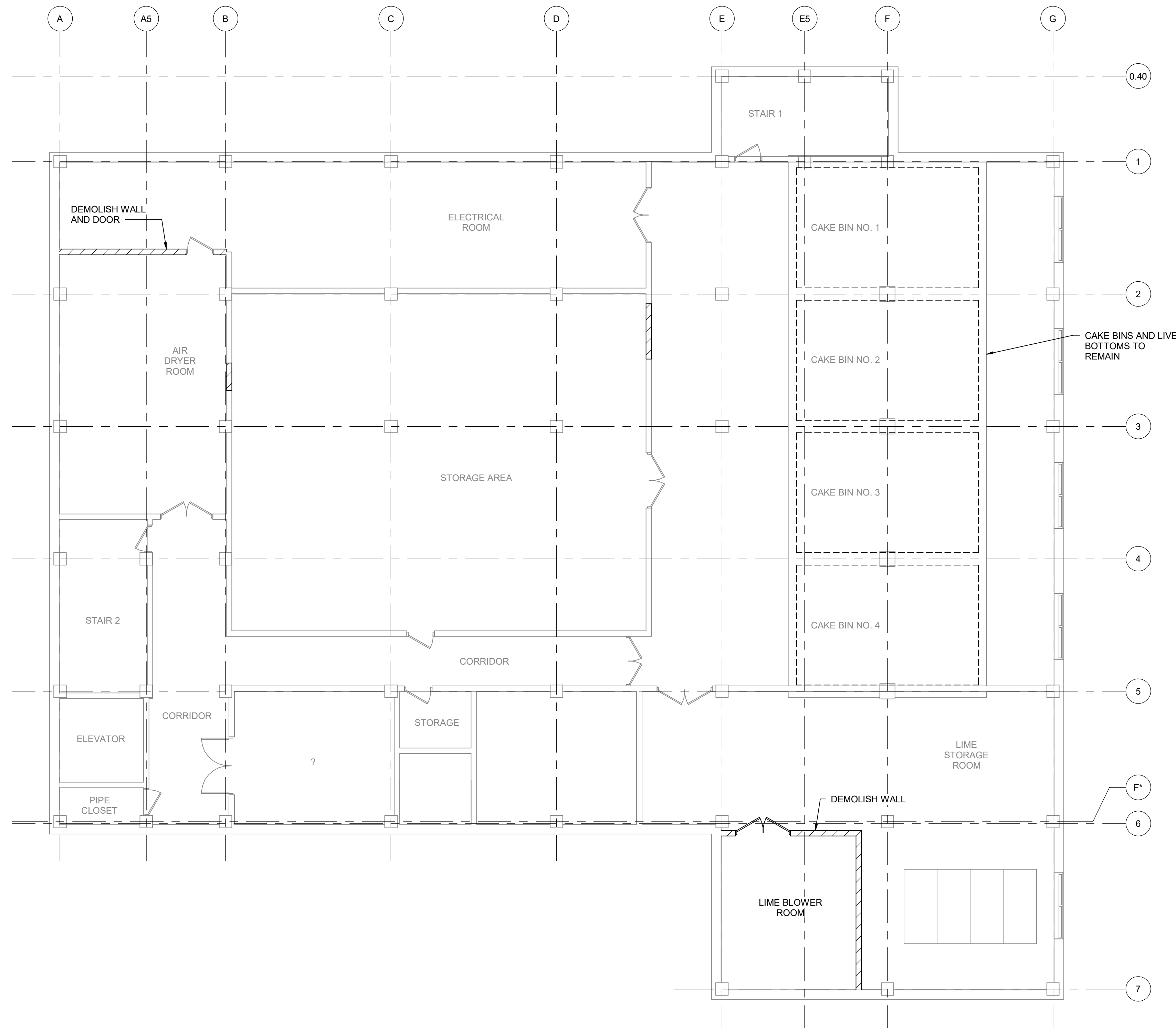
0 1" 2"

FILENAME 10263882-01-D_v20.rvt

SCALE 1/8" = 1'-0"

SHEET M-302

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-01-D_v20.rvt
6/30/2022 9:06:42 AM



PLAN AT EL 66.00
1/8" = 1'-0"

GENERAL NOTES

1. ALL INTERIOR MECHANICAL, ODOR CONTROL (INCLUDING EXTERIOR), HOISTS, BRIDGE CRANE, ELECTRICAL, HVAC, LIGHTING, CONDUITS, ETC TO BE DEMOLISHED TO LEAVE BARE SHELL UNLESS OTHERWISE NOTED. REFER TO CONTRACT 93-02-WPC PHASE 3A SOLIDS PROCESSING FACILITIES FOR DETAILS OF FACILITIES.
2. DEMOLISH WALLS AS SHOWN.

LEGEND

DEMOLISHED ITEMS

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-01-D_v20.rvt
6/30/2022 9:06:43 AM

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

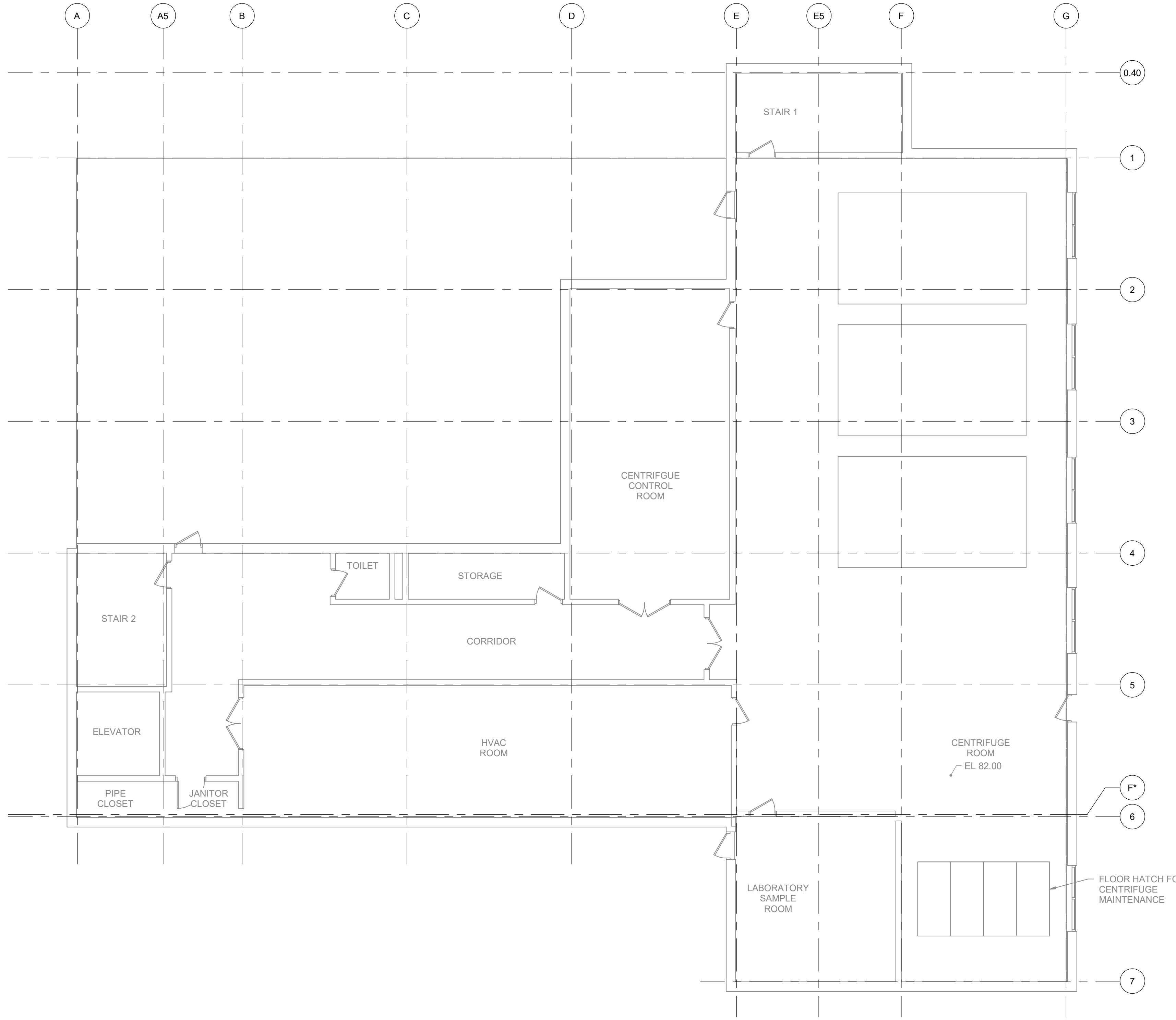
ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING DEWATERING BUILDING DEMOLITION PLAN AT EL 66.00

0 1" 2"

FILENAME 10263882-01-D_v20.rvt
SCALE 1/8" = 1'-0"
SHEET M-303



GENERAL NOTES

1. ALL INTERIOR MECHANICAL, ODOR CONTROL (INCLUDING EXTERIOR), HOISTS, BRIDGE CRANE, ELECTRICAL, HVAC, LIGHTING, CONDUITS, ETC TO BE DEMOLISHED TO LEAVE BARE SHELL UNLESS OTHERWISE NOTED. REFER TO CONTRACT 93-02-WPC PHASE 3A SOLIDS PROCESSING FACILITIES FOR DETAILS OF FACILITIES.
2. DEMOLISH WALLS AS SHOWN.

LEGEND

DEMOLISHED ITEMS

PLAN AT EL 82.00

1/8" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

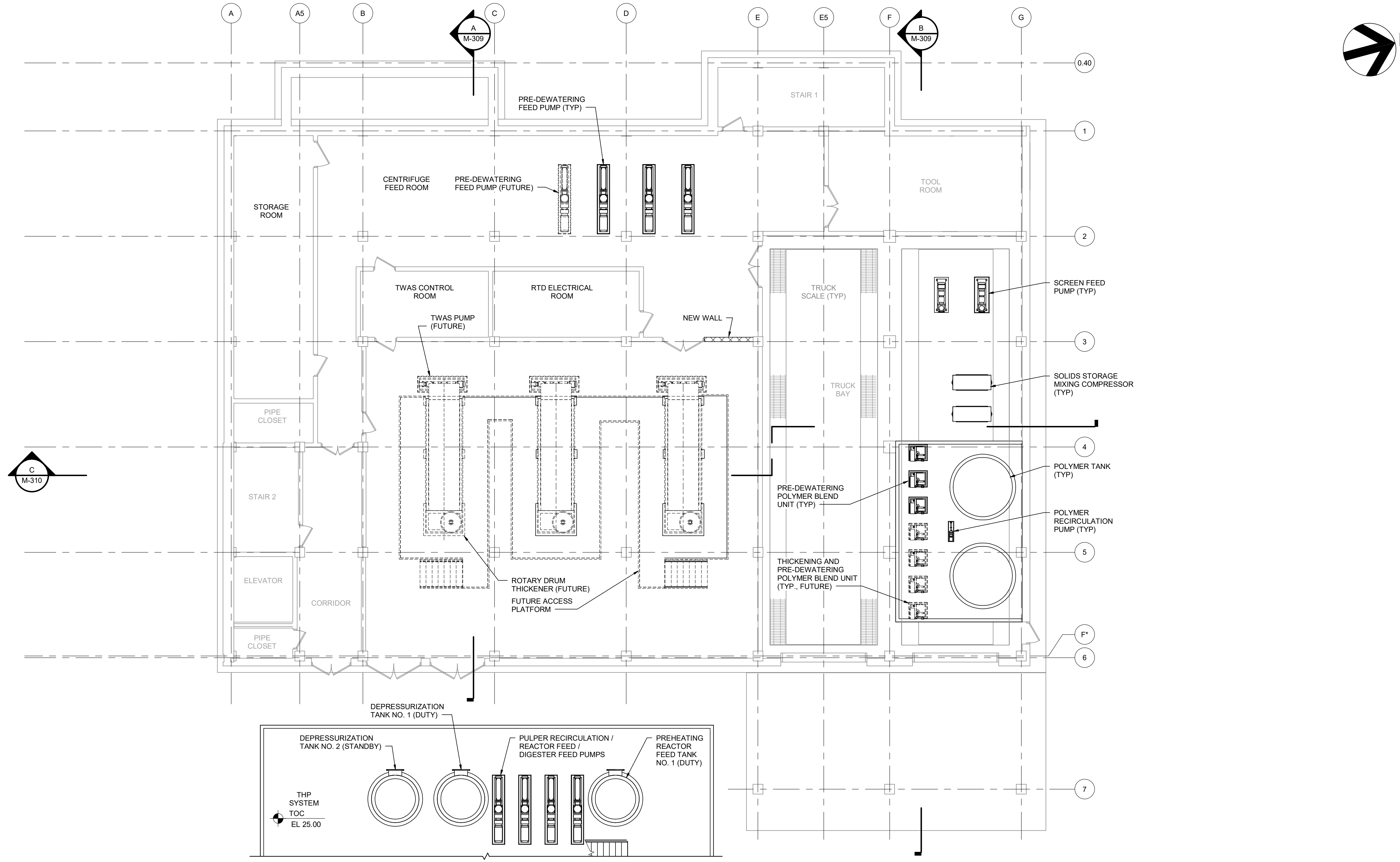
RENOVATE DEWATERING BUILDING
DEWATERING BUILDING
DEMOLITION PLAN AT EL 82.00

0 1" 2"

FILENAME 10263882-01-D_v20.rvt

SCALE 1/8" = 1'-0"

SHEET M-304



PLAN AT EL 25.00
1/8" = 1'-0"

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-01-D_v20.rvt
6/30/2022 9:06:44 AM

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

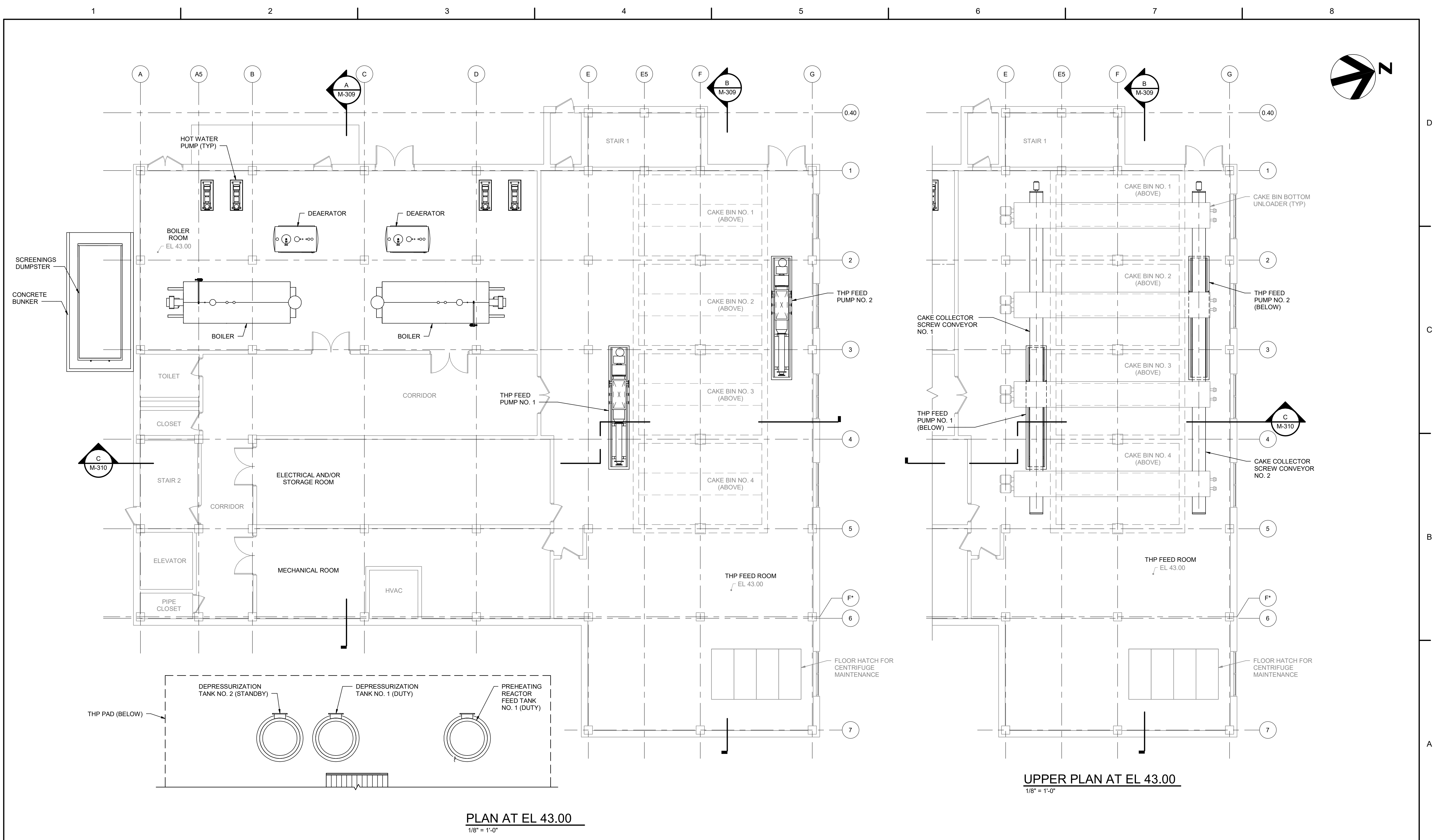
DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

RENOVATE DEWATERING BUILDING
SCREENING AND PRE-DEWATERING BUILDING
PLAN AT EL 25.00

FILENAME 10263882-01-D_v20.rvt
SCALE 1/8" = 1'-0"
SHEET M-305



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6/30/2022 9:06:44 AM

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

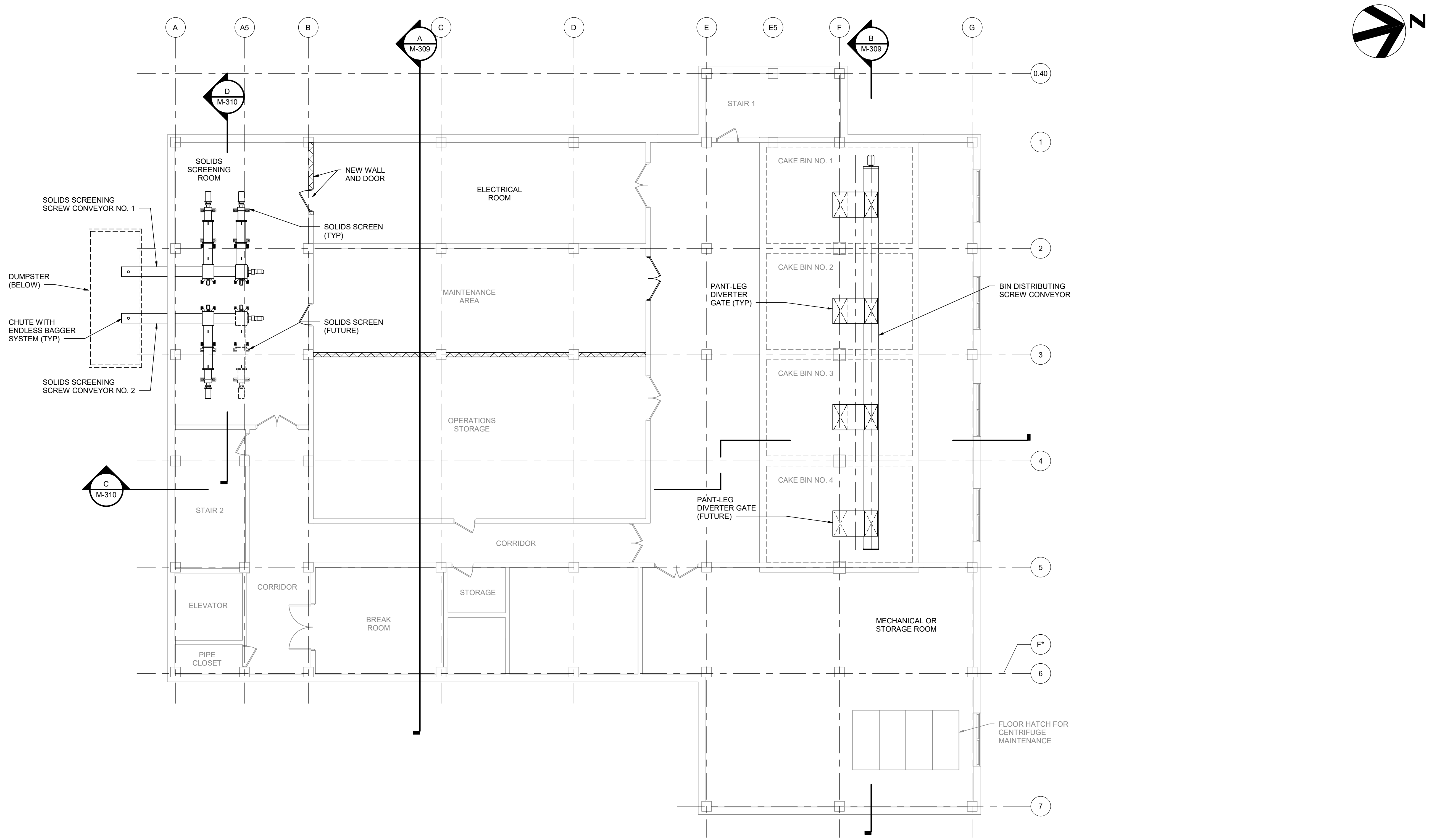
ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING SCREENING AND PRE-DEWATERING BUILDING PLAN AT EL 43.00

0 1" 2"

FILENAME	10263882-01-D_v20.rvt
SCALE	1/8" = 1'-0"

SHEET **M-306**



PLAN AT EL 66.00
1/8" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

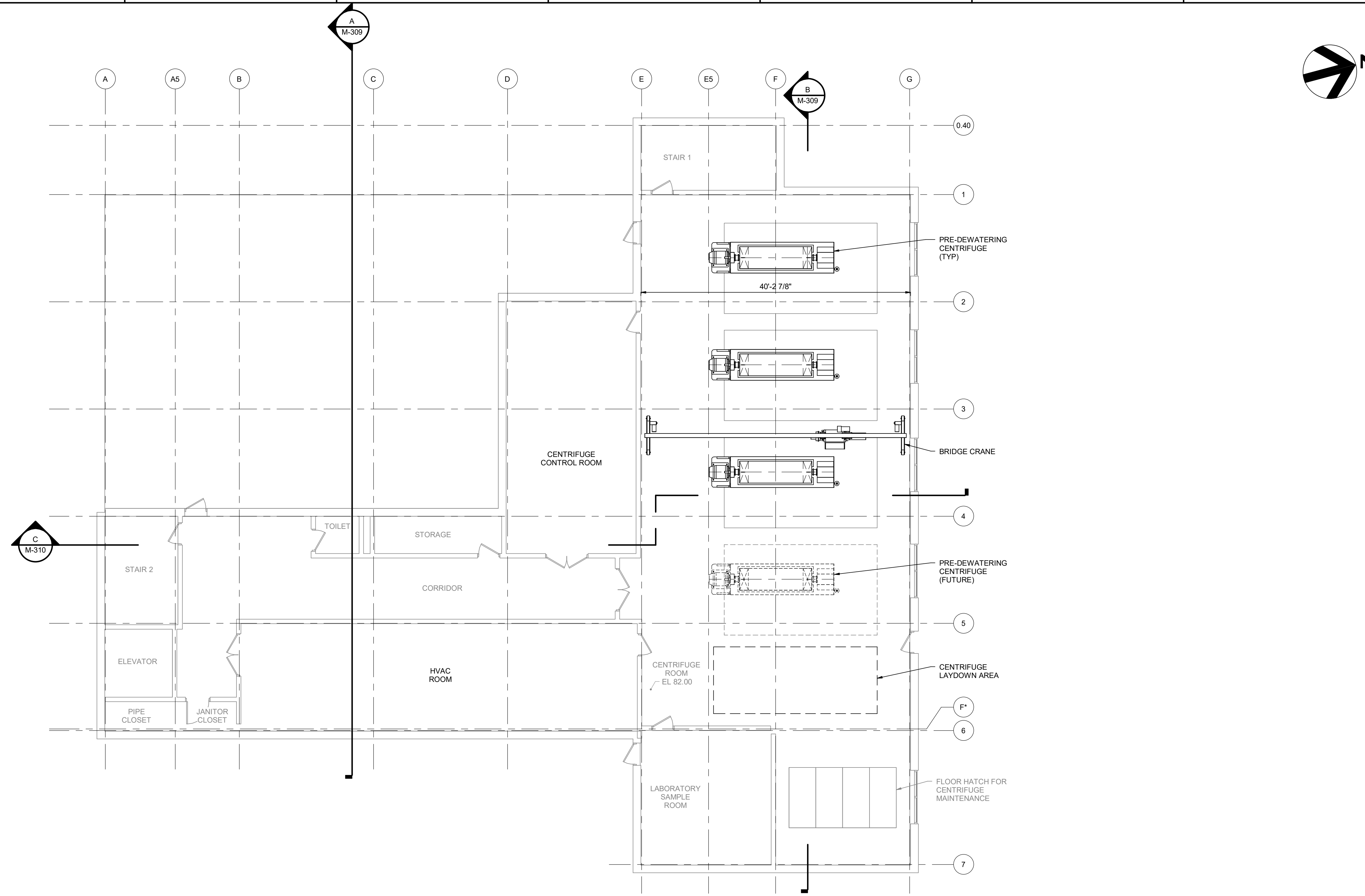
ARLINGTON VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

RENOVATE DEWATERING BUILDING
SCREENING AND PRE-DEWATERING BUILDING
PLAN AT EL 66.00

FILENAME 10263882-01-D_v20.rvt
SCALE 1/8" = 1'-0"
SHEET M-307

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-01-D_v20.rvt
6/30/2022 9:06:45 AM



PLAN AT EL 82.00

1/8" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING SCREENING AND PRE-DEWATERING BUILDING PLAN AT EL 82.00

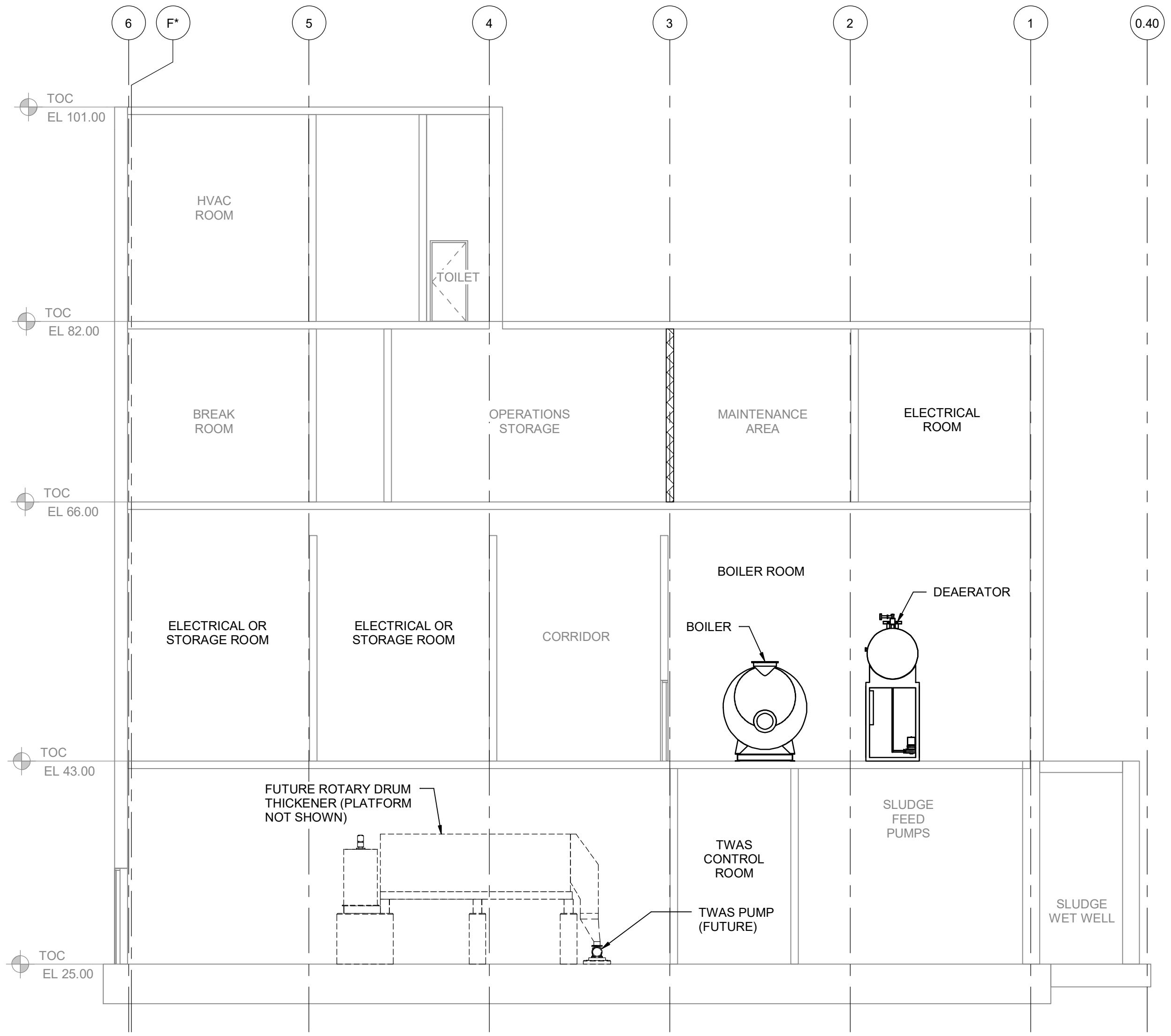
0 1" 2"

FILENAME 10263882-01-D_v20.rvt

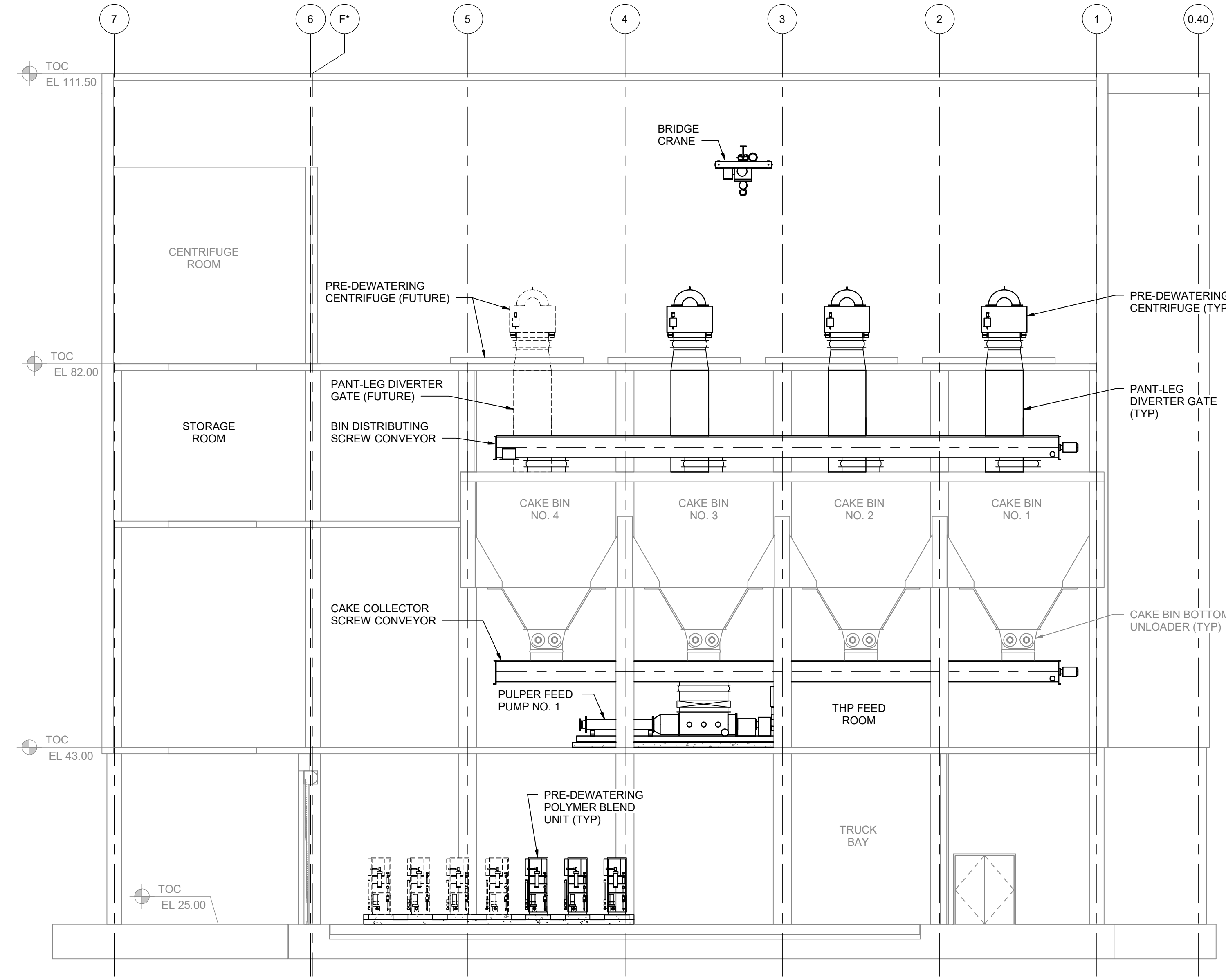
SCALE 1/8" = 1'-0"

SHEET **M-308**

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-01-D_v20.rvt
6/30/2022 9:06:45 AM



A SECTION
M-305 1/8" = 1'-0"



B SECTION
M-305 1/8" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

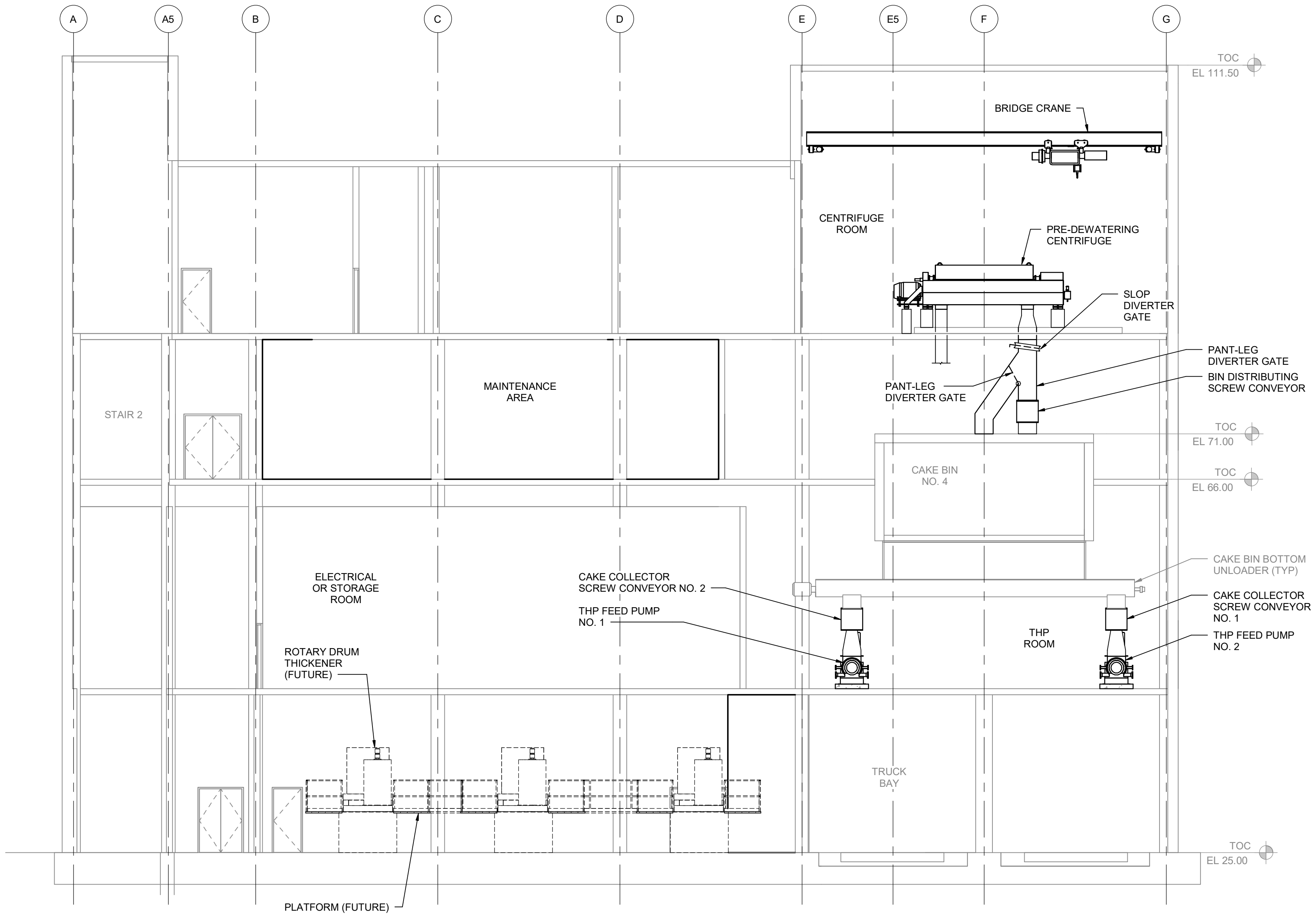
ARLINGTON VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

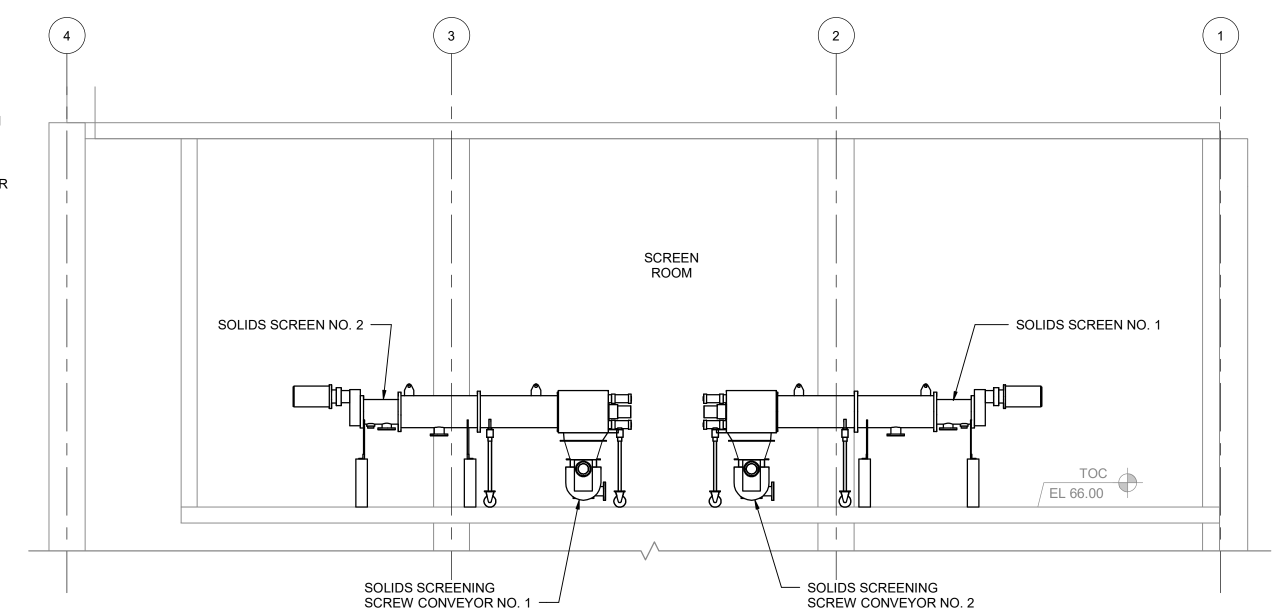
RENOVATE DEWATERING BUILDING SCREENING AND PRE-DEWATERING BUILDING SECTIONS 1

0 1" 2"

FILENAME 10263882-01-D_v20.rvt
SCALE 1/8" = 1'-0"
SHEET M-309



C SECTION
M-305 1/8" = 1'-0"



D SECTION
M-307 1/4" = 1'-0"

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-01-D_v20.rvt
6/30/2022 9:06:46 AM

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

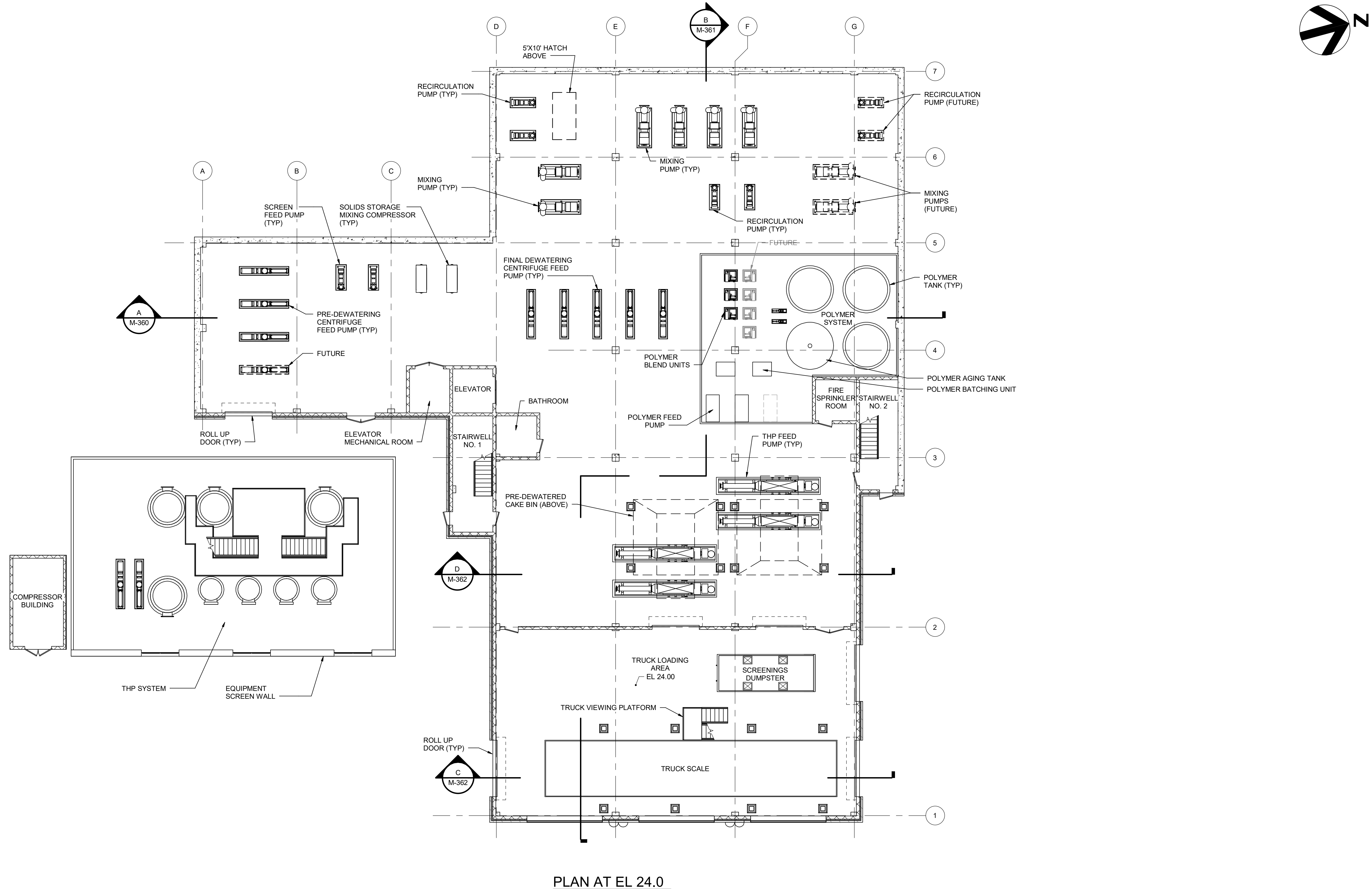
ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING SCREENING AND PRE-DEWATERING BUILDING SECTIONS 2

0 1" 2"

FILENAME 10263882-01-D_v20.rvt
SCALE As indicated

SHEET M-310



PLAN AT EL 24.0

3/32" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

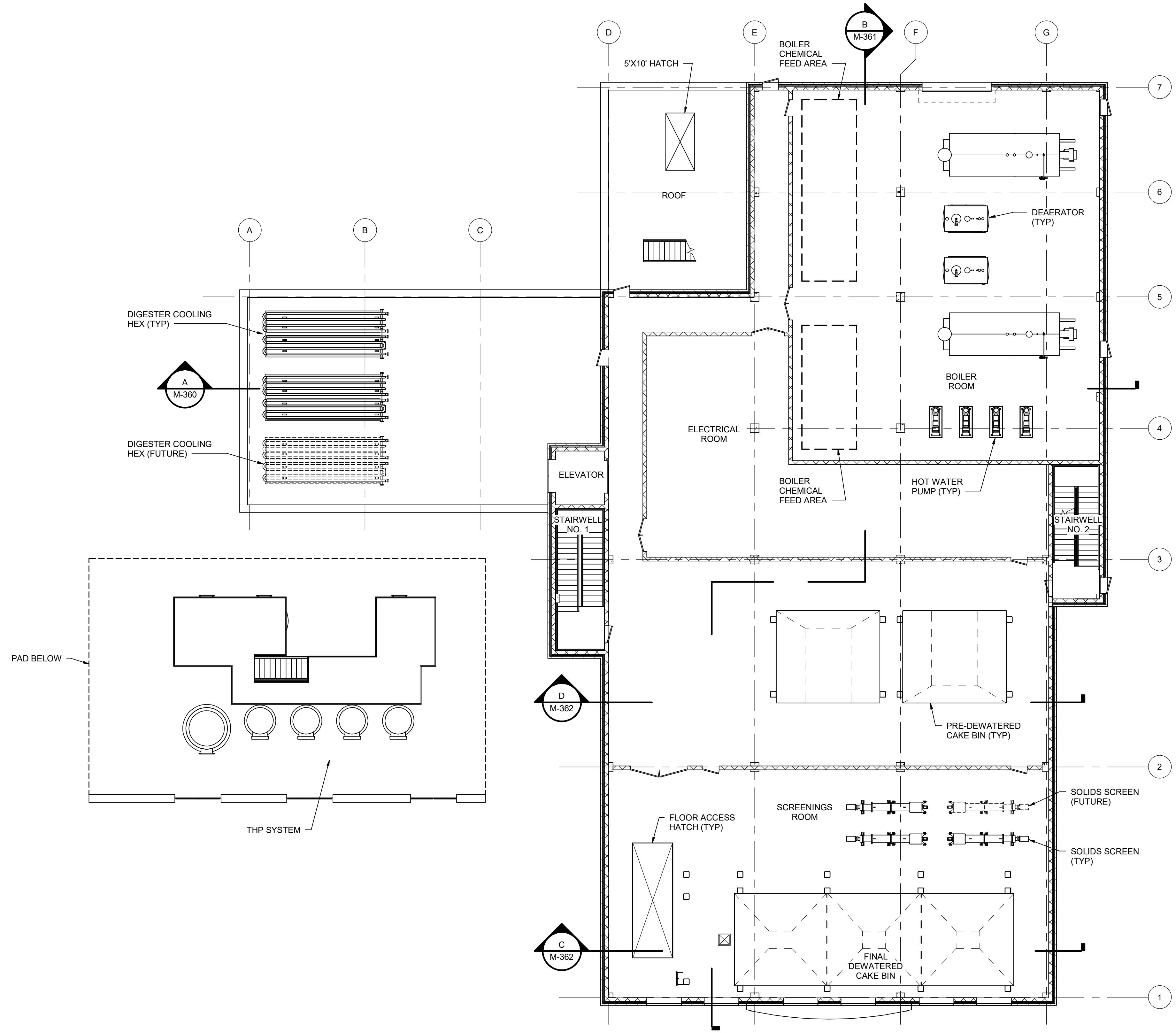
DECOMISSION DEWATERING BUILDING
SOLIDS PROCESSING BUILDING
PLAN AT EL 24.00

FILENAME 10263882-10-D_v20.rvt

SCALE 3/32" = 1'-0"

SHEET M-350

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-10-D_v20.rvt
6/30/2022 9:08:37 AM



PLAN AT EL 42.00
3/32" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

DECOMISSION DEWATERING BUILDING SOLIDS PROCESSING BUILDING PLAN AT EL 42.00

FILENAME 10263882-10-D_v20.rvt
SCALE 3/32" = 1'-0"
SHEET M-351

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-10-D_v20.rvt
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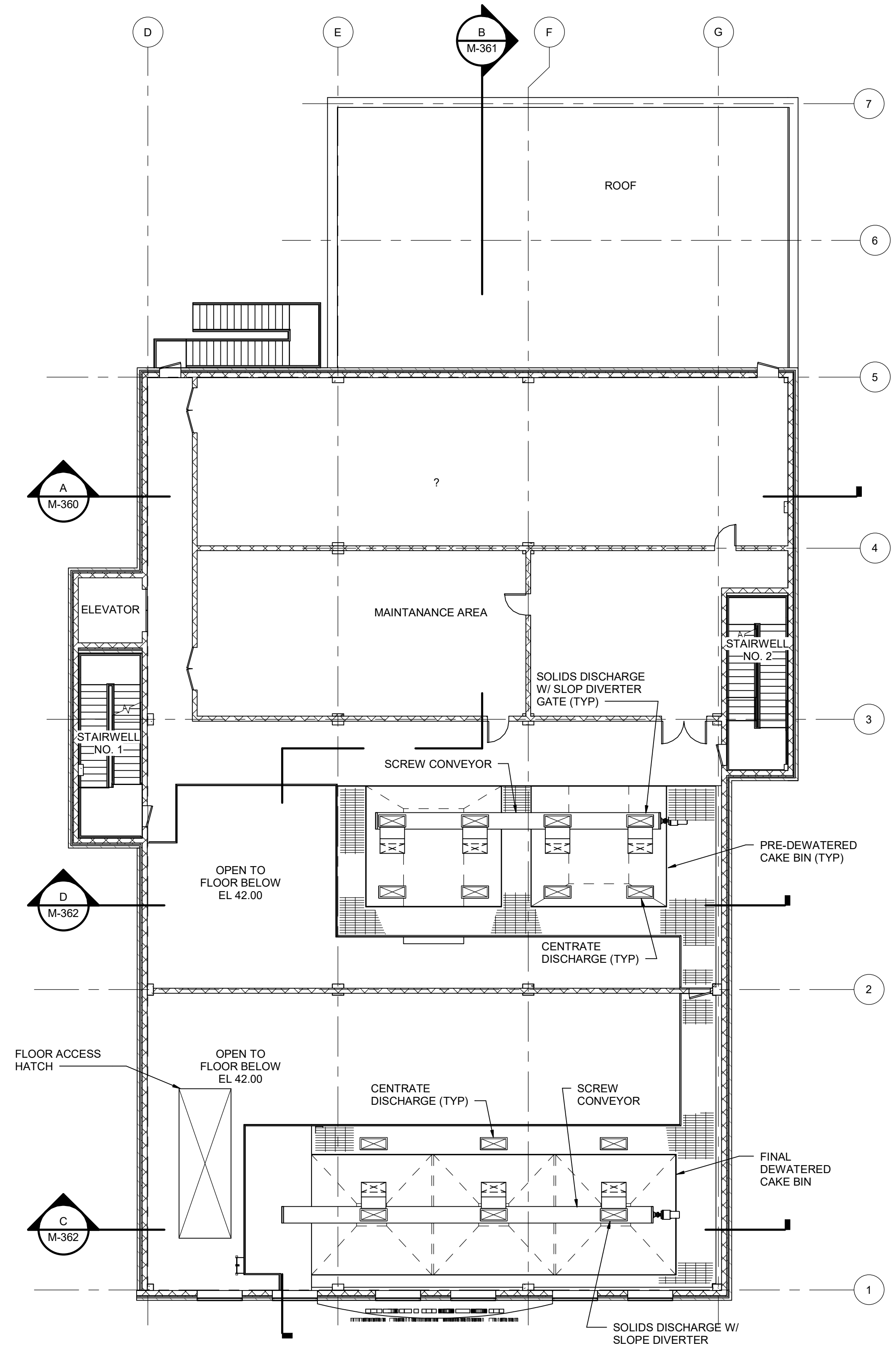

PLAN AT EL 60.00

3/32" = 1'-0"

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

DECOMISSION DEWATERING BUILDING SOLIDS PROCESSING BUILDING PLAN AT EL 60.00

0 1" 2"

FILENAME 10263882-10-D_v20.rvt

SCALE 3/32" = 1'-0"

SHEET M-352

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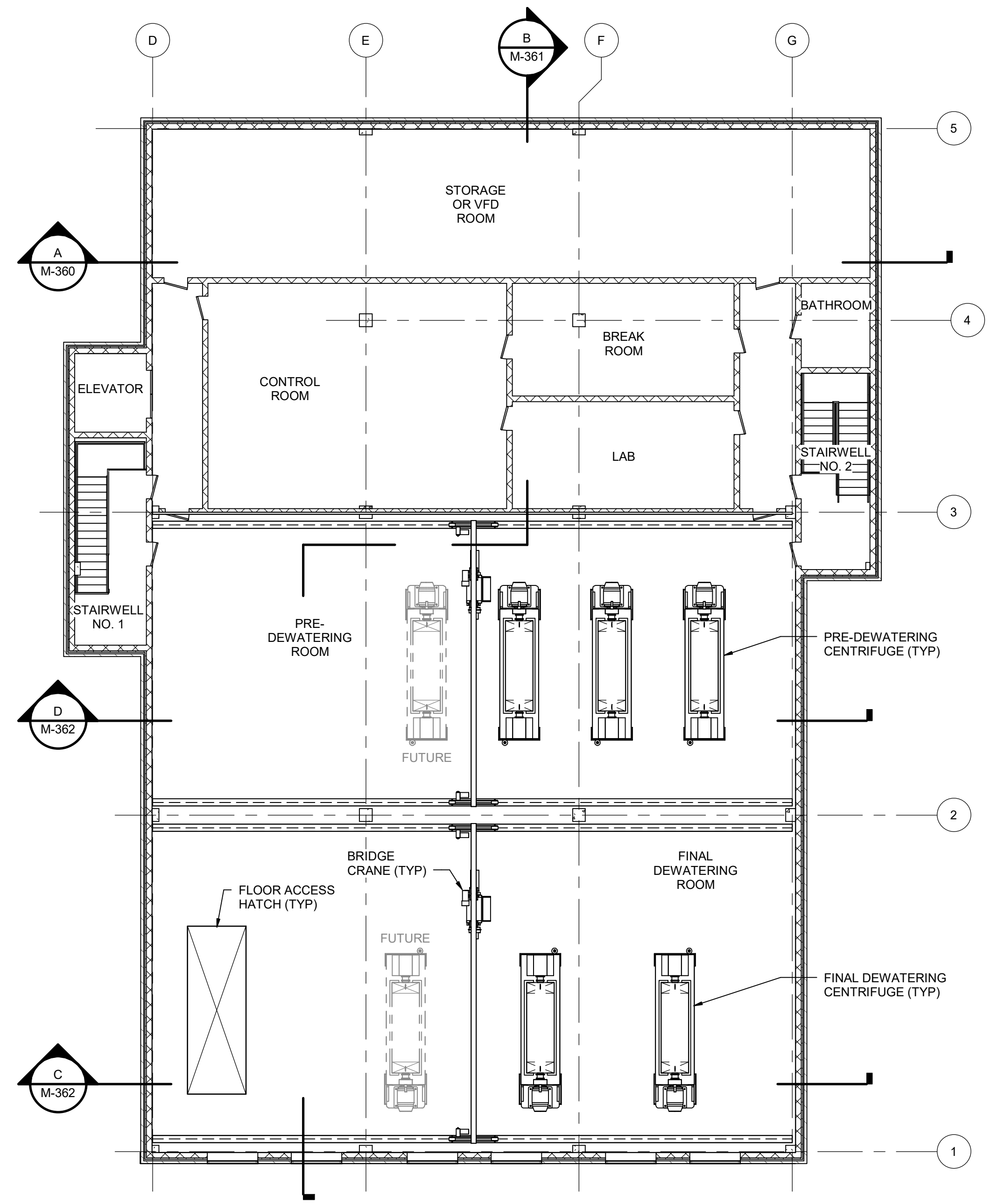

PLAN AT EL 74.33
3/32" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT
FACILITIES PLAN
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CONSTRUCTION

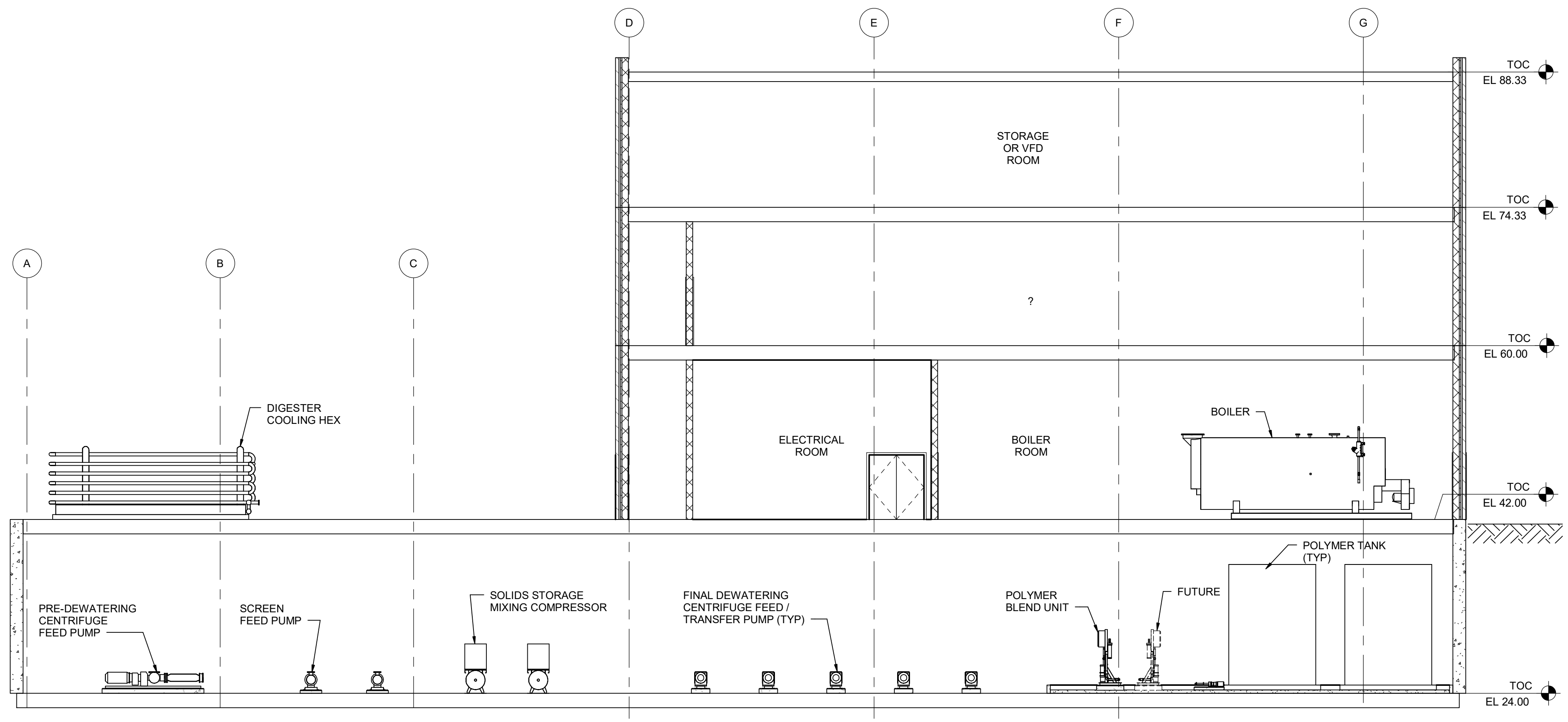
ARLINGTON VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

DECOMISSION DEWATERING BUILDING
SOLIDS PROCESSING BUILDING
PLAN AT EL 74.33

0 1" 2"

FILENAME 10263882-10-D_v20.rvt
SCALE 3/32" = 1'-0"
SHEET M-353



A
M-350
SECTION
1/8" = 1'-0"

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-10-D_v20.rvt
6/30/2022 9:08:40 AM

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

DECOMISSION DEWATERING BUILDING SECTIONS 1

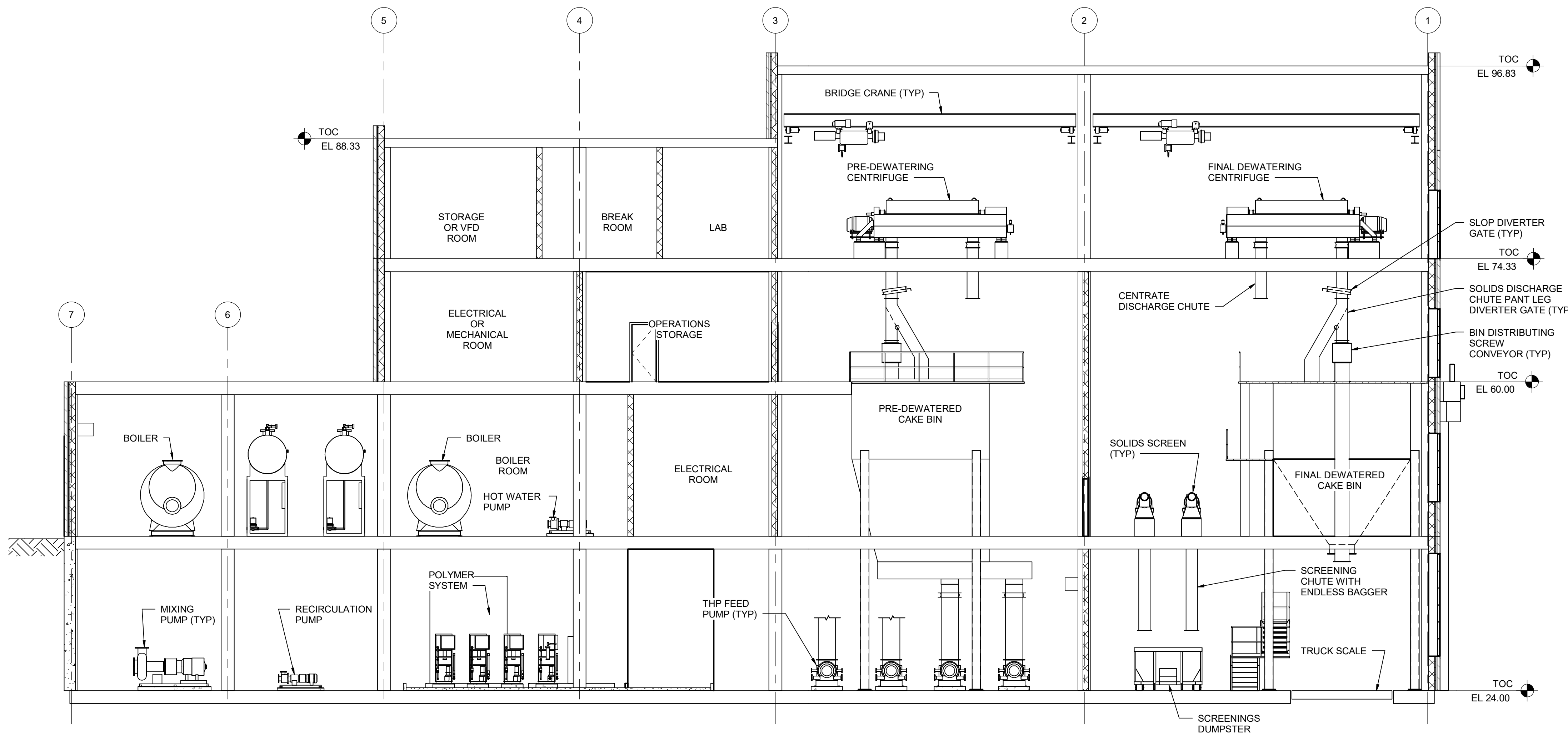
0 1" 2"

FILENAME 10263882-10-D_v20.rvt

SCALE 1/8" = 1'-0"

SHEET **M-360**

1 2 3 4 5 6 7 8



B
M-350
SECTION
1/8" = 1'-0"

D C B A

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

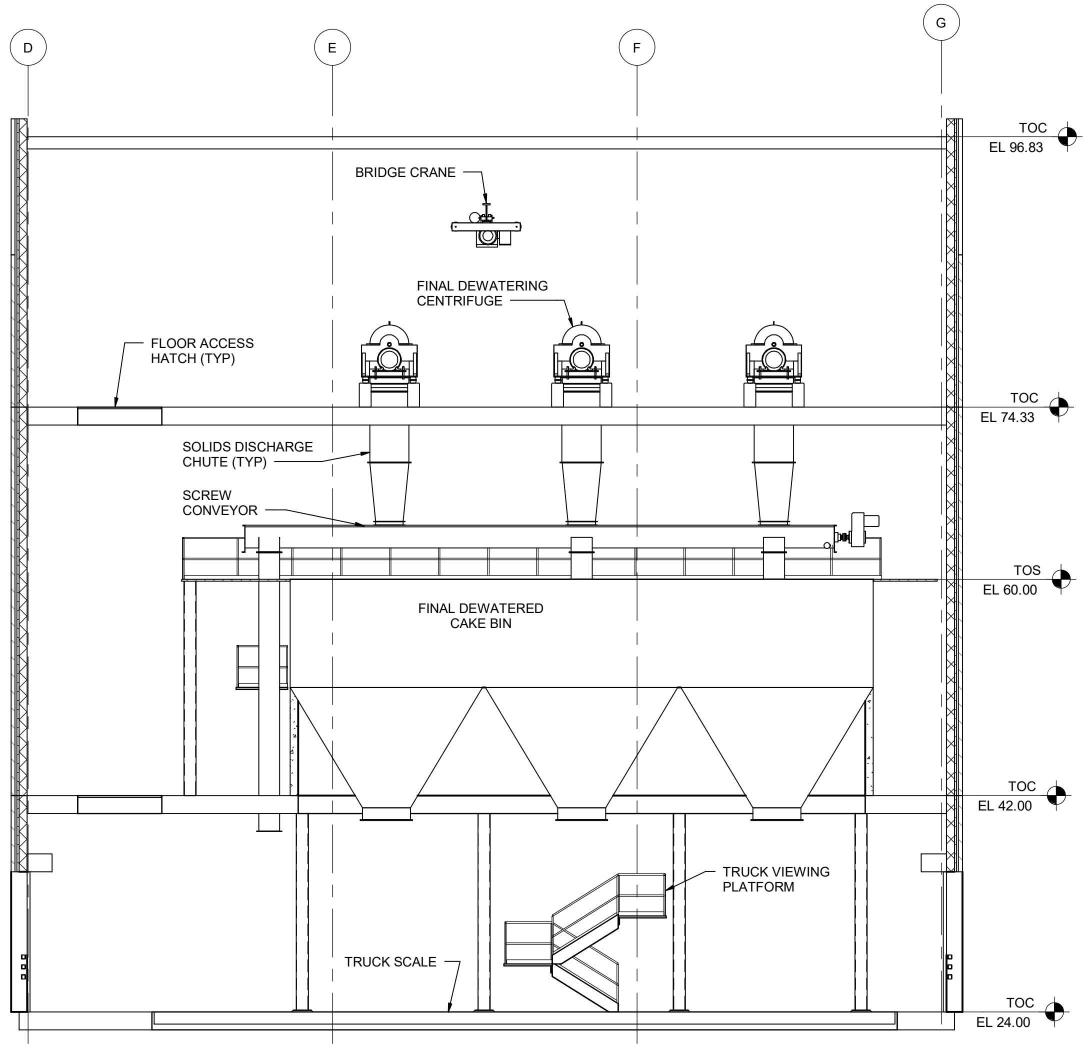
ARLINGTON
VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

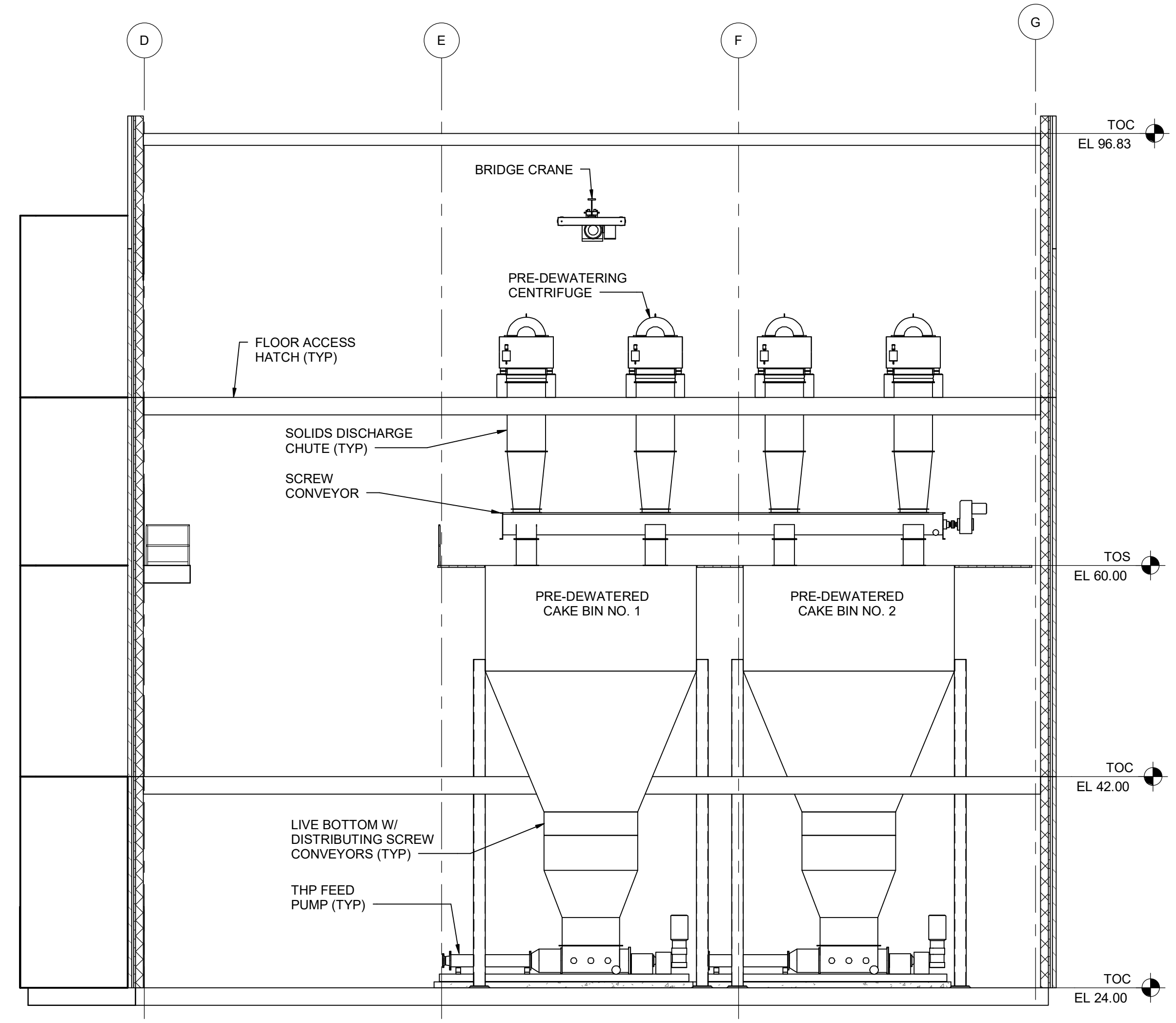
DECOMISSION DEWATERING BUILDING
SECTIONS 2

0 1" 2"

FILENAME 10263882-10-D_v20.rvt
SCALE 1/8" = 1'-0"
SHEET M-361



C
M-350
SECTION
1/8" = 1'-0"



D
M-350
SECTION
1/8" = 1'-0"

A	12/2022	FACILITIES PLAN
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

DECOMISSION DEWATERING BUILDING SECTIONS 3

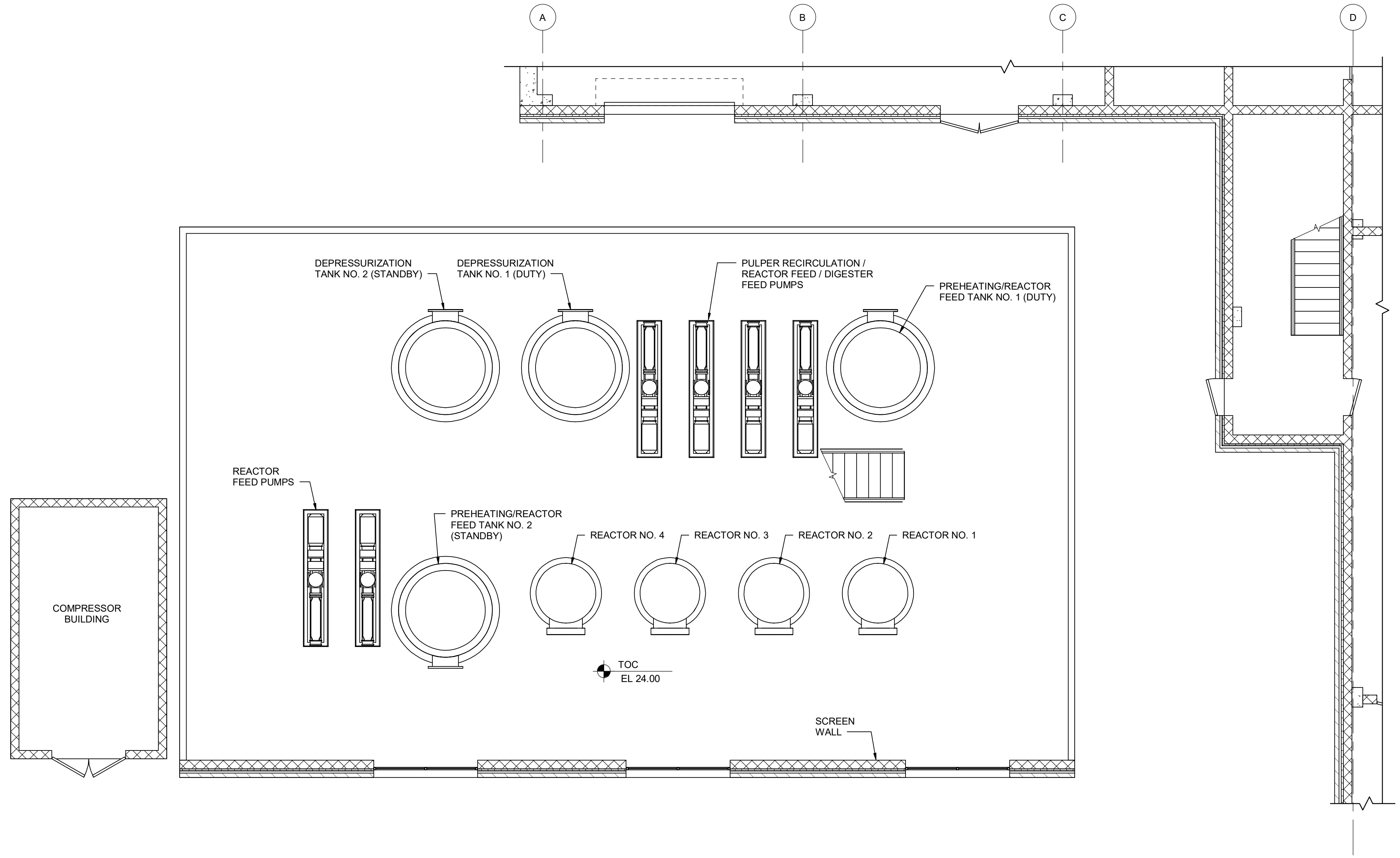
0 1" 2"

FILENAME 10263882-10-D_v20.rvt
SCALE 1/8" = 1'-0"
SHEET **M-362**

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-10-D_v20.rvt
6/30/2022 9:08:41 AM

GENERAL NOTES

1. MAINTAIN 10' CLEAR AROUND PRE-FABRICATED THERMAL HYDROLYSIS SYSTEM.



PLAN AT EL 24.00

3/16" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

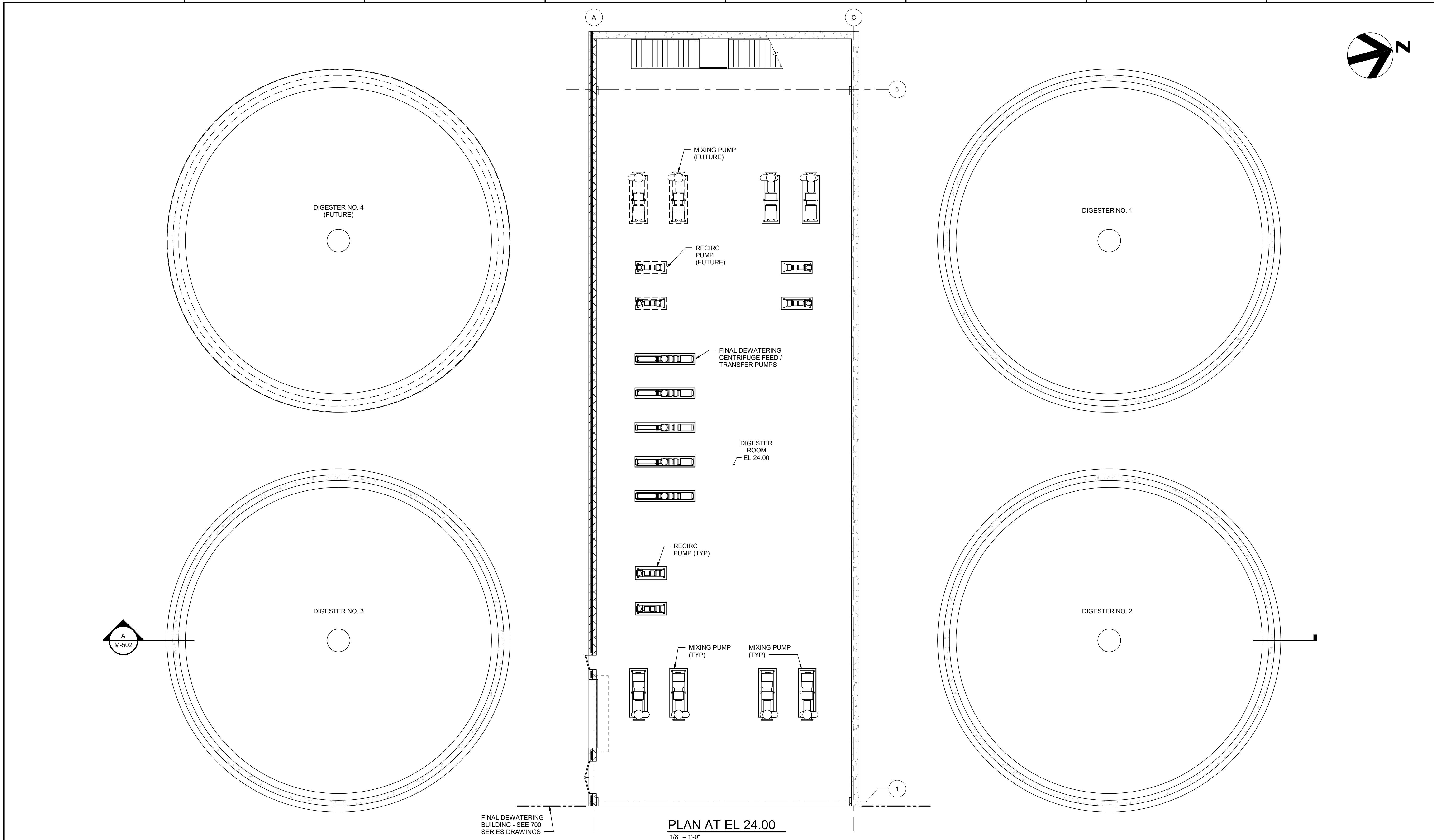
THERMAL HYDROLYSIS PROCESS PLAN

0 1" 2"

FILENAME 10263882-10-D_v20.rvt

SCALE 3/16" = 1'-0"

SHEET M-400



PLAN AT EL 24.00
1/8" = 1'-0"

A	12/2022	FACILITIES PLAN
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING DIGESTER FACILITY - PLAN 1

0 1" 2"

FILENAME 10263882-30-D_v20.rvt
SCALE 1/8" = 1'-0"
SHEET M-500

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-30-D_v20.rvt
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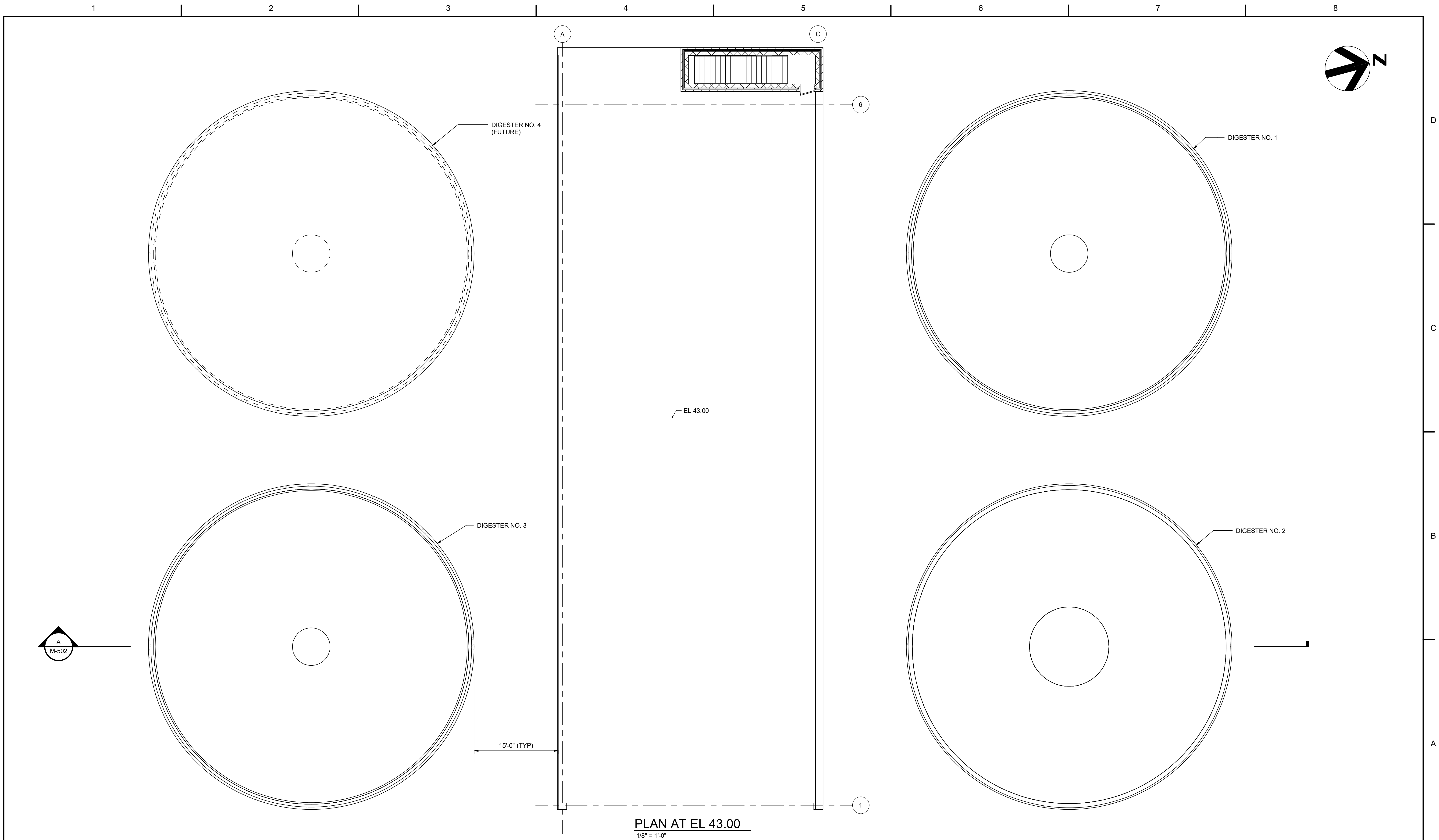


HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

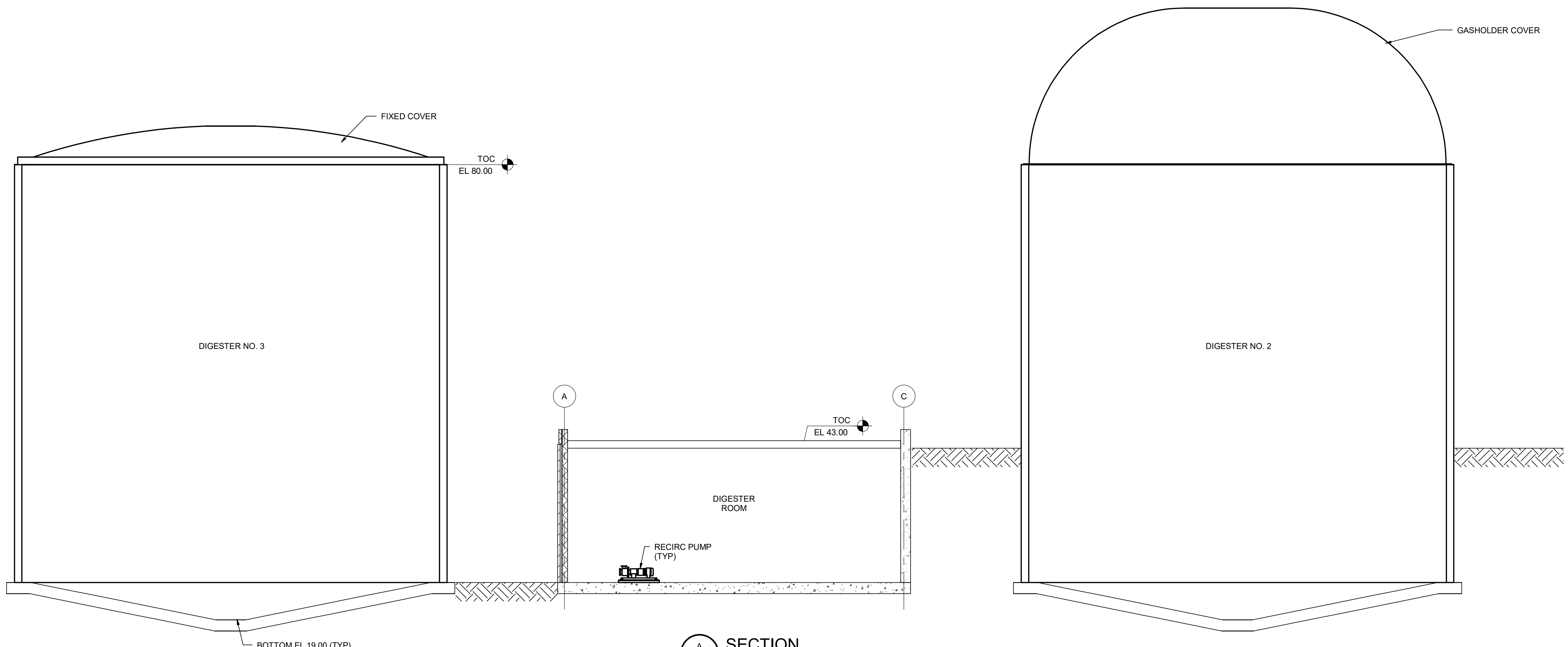
RENOVATE DEWATERING BUILDING DIGESTER FACILITY - PLAN 2

0 1" 2"

FILENAME 10263882-30-D_v20.rvt

SCALE 1/8" = 1'-0"

SHEET **M-501**



A
M-500
SECTION
1/8" = 1'-0"

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-30-D_v20.rvt
6/30/2022 9:11:10 AM

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

**DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION**

ARLINGTON
VIRGINIA

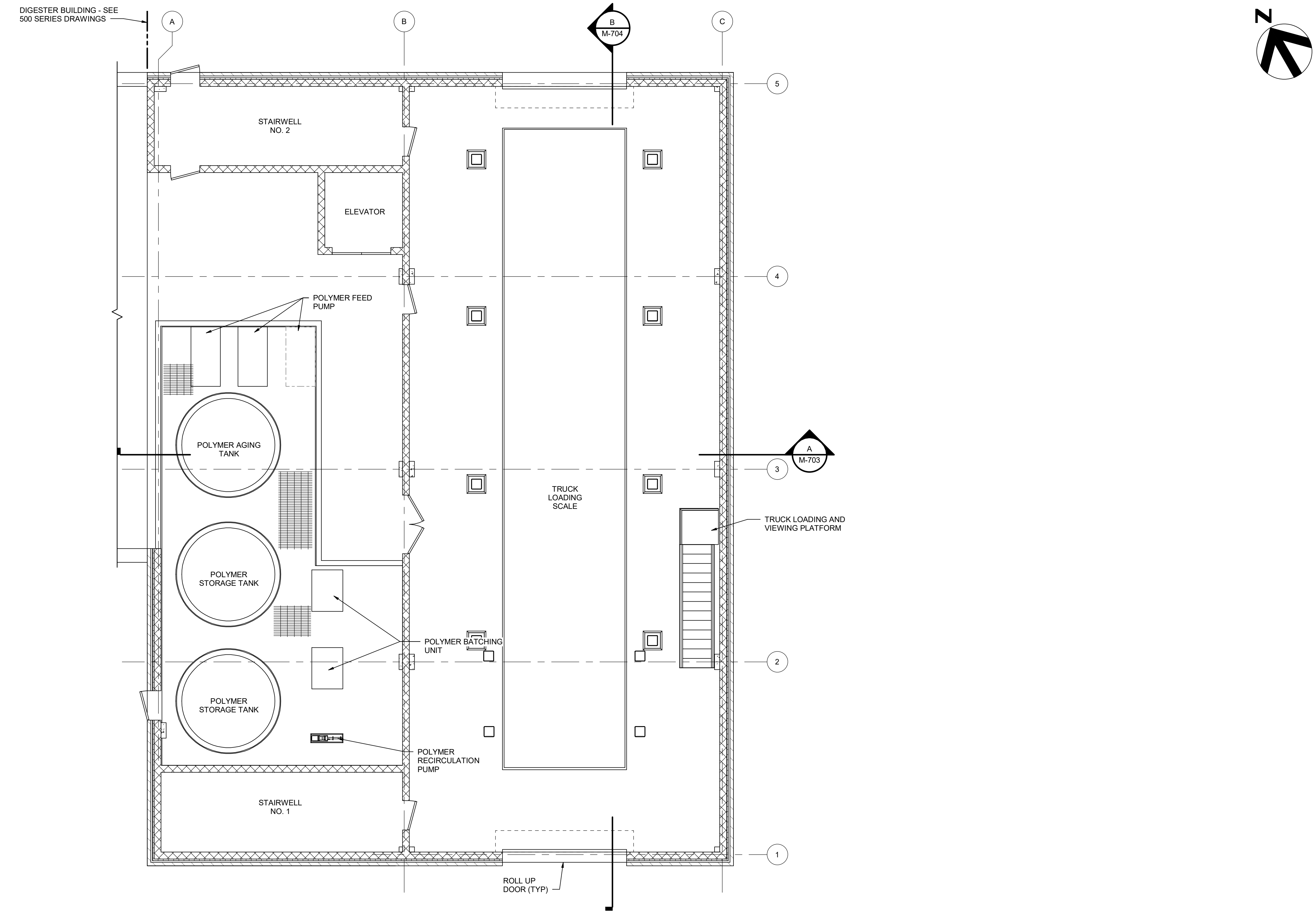
**ARLINGTON COUNTY
WPCP
RE-GEN**

**RENOVATE DEWATERING BUILDING
DIGESTER FACILITY - SECTION**

0 1" 2"

FILENAME 10263882-30-D_v20.rvt
SCALE 1/8" = 1'-0"

SHEET
M-502



PLAN AT EL 24.00

3/16" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

RENOVATE DEWATERING BUILDING
FINAL DEWATERING BUILDING - PLAN AT EL 24.00

FILENAME 10263882-20-D_v20.rvt

SCALE 3/16" = 1'-0"

SHEET M-700

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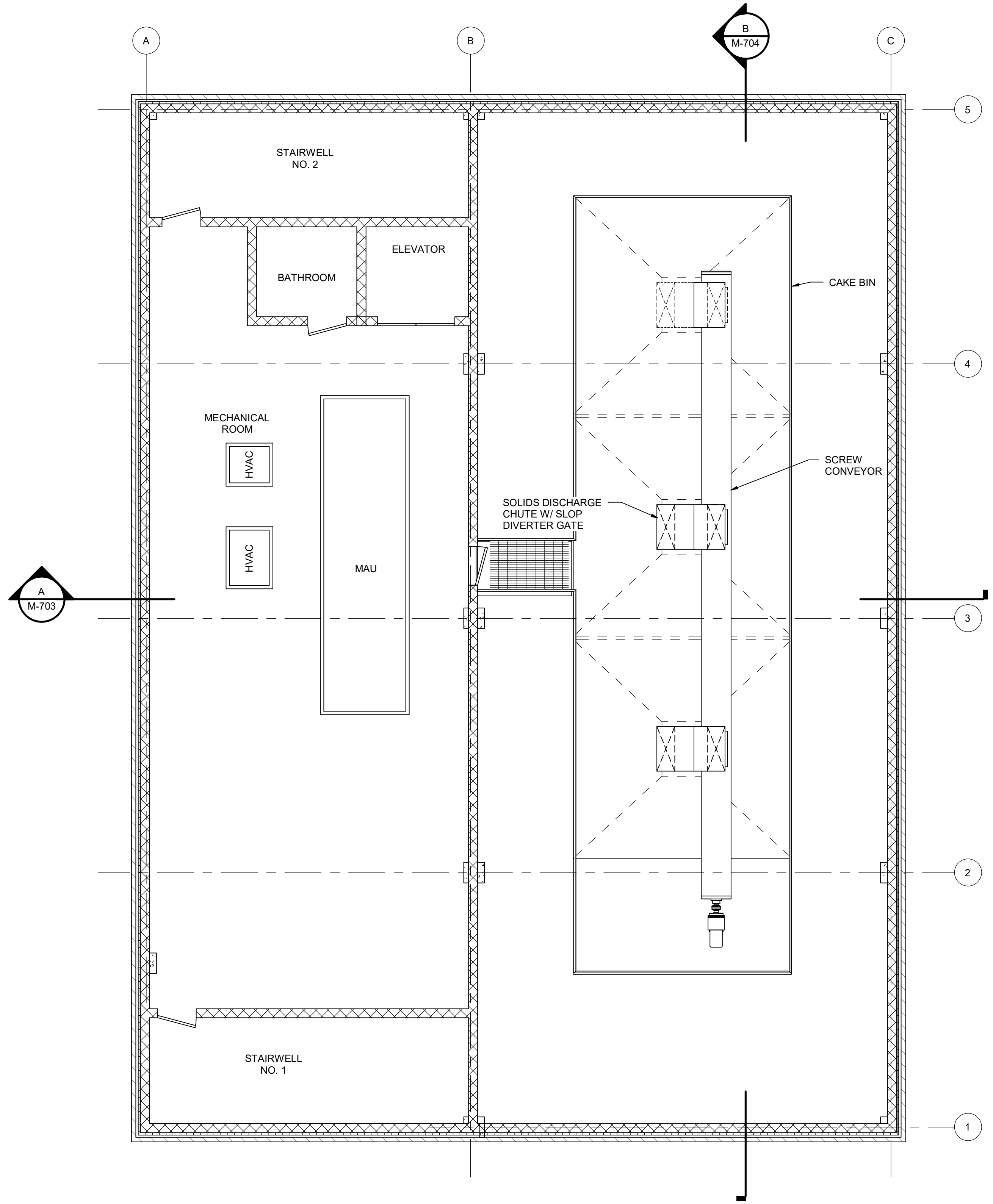

PLAN AT EL 59.95
3/16" = 1'-0"

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

RENOVATE DEWATERING BUILDING
FINAL DEWATERING BUILDING - PLAN AT EL 59.95

0 1" 2"

FILENAME 10263882-20-D_v20.rvt
SCALE 3/16" = 1'-0"
SHEET M-701

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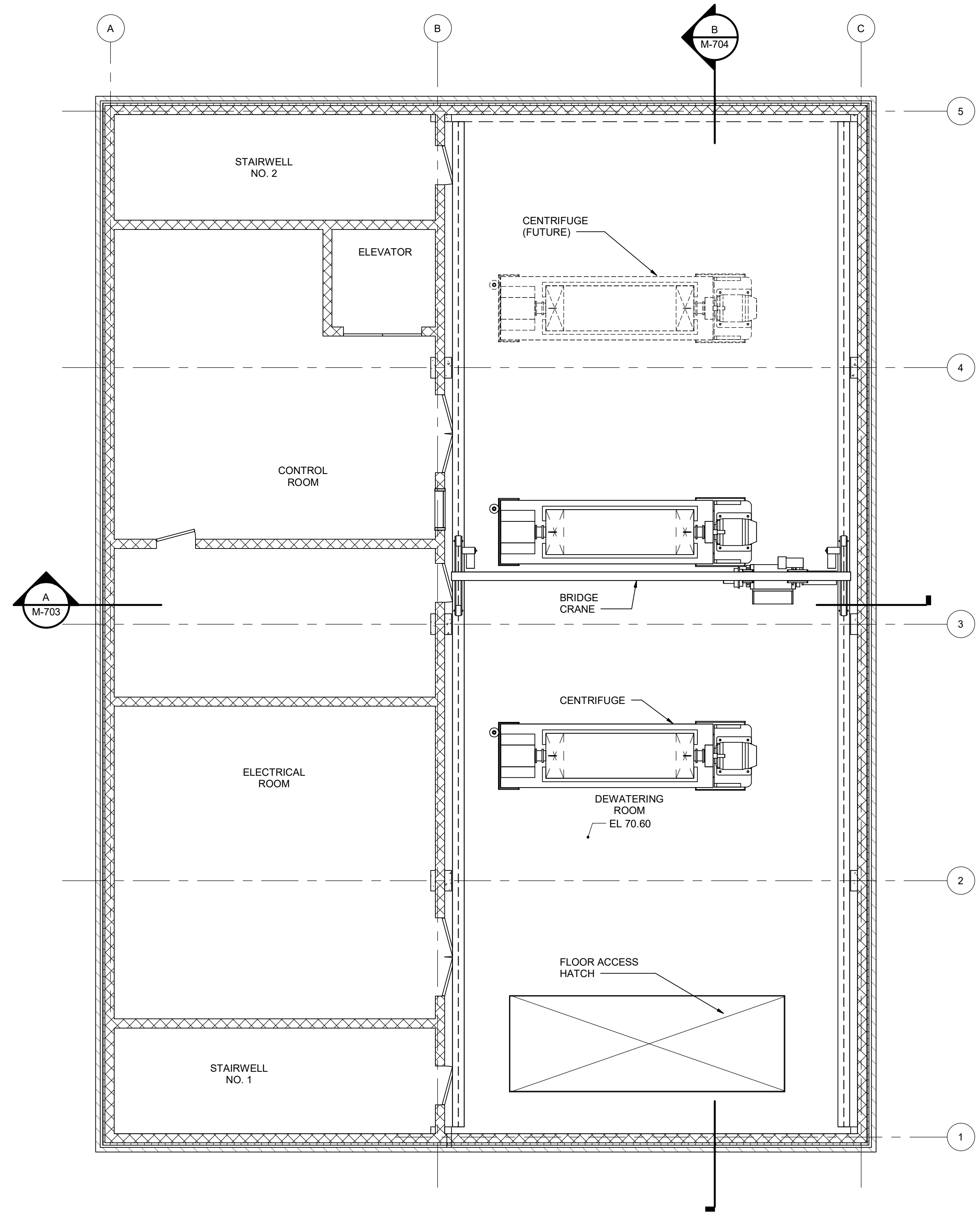

PLAN AT EL 70.60

3/16" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING
FINAL DEWATERING BUILDING - PLAN AT EL 70.60

0 1" 2"

FILENAME 10263882-20-D_v20.rvt

SCALE 3/16" = 1'-0"

SHEET M-702

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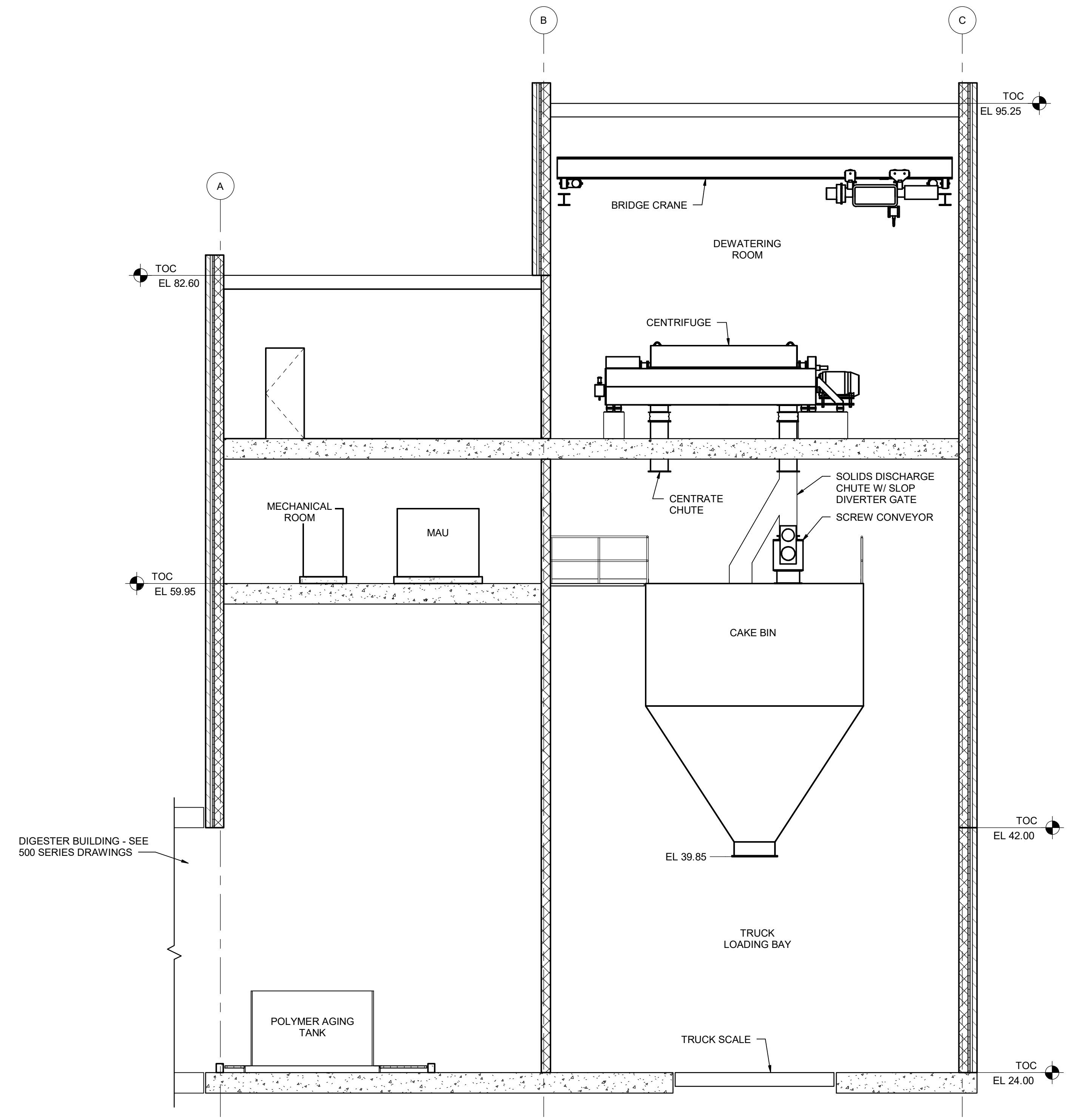

A
M-700
SECTION
3/16" = 1'-0"

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING
FINAL DEWATERING BUILDING - SECTION 1

0 1" 2"

FILENAME 10263882-20-D_v20.rvt
SCALE 3/16" = 1'-0"
SHEET M-703

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-20-D_v20.rvt
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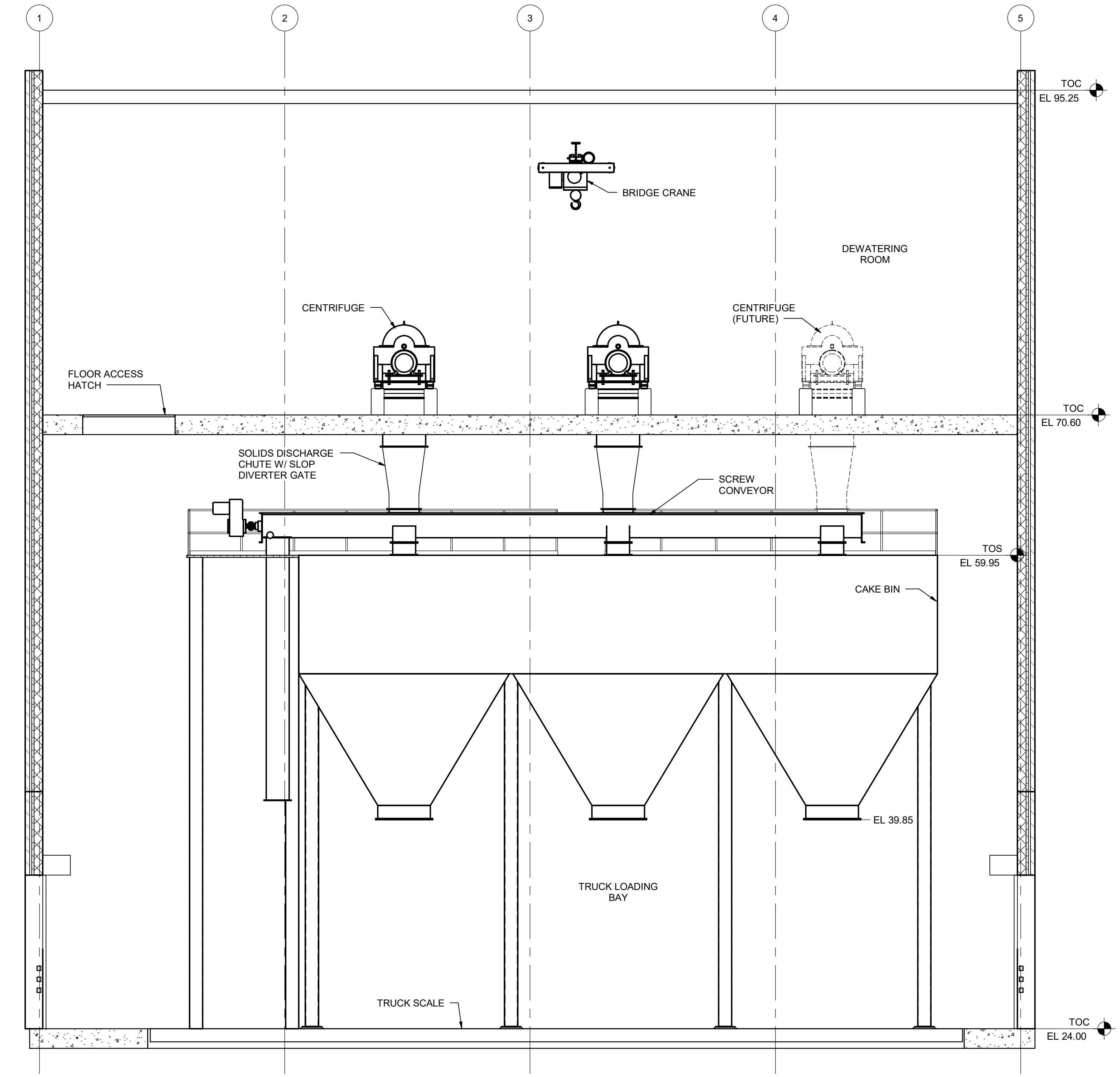

B
M-700
SECTION
3/16" = 1'-0"

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING
FINAL DEWATERING BUILDING - SECTION 2

FILENAME 10263882-20-D_v20.rvt
SCALE 3/16" = 1'-0"
SHEET M-704

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-20-D_v20.rvt
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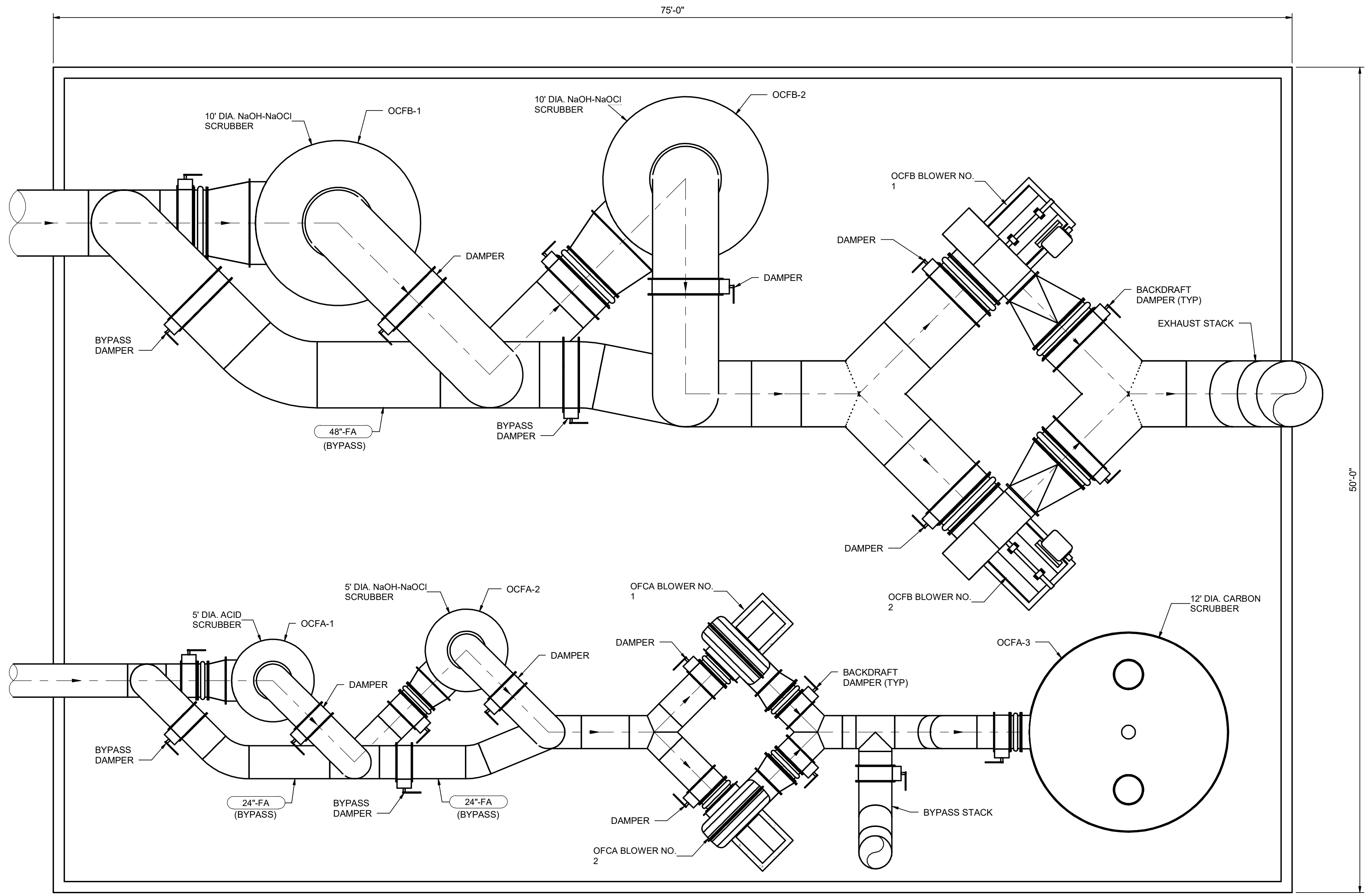

FOUL AIR SYSTEM PLAN

1/4" = 1'-0"

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

ODOR CONTROL SYSTEM PLAN

0 1" 2"

FILENAME 10263882-50-D_v20.rvt

SCALE 1/4" = 1'-0"

SHEET **M-900**

BIM 360://10263882_ARL_Biosolids_Program_Management_2020/10263882-50-D_v20.rvt
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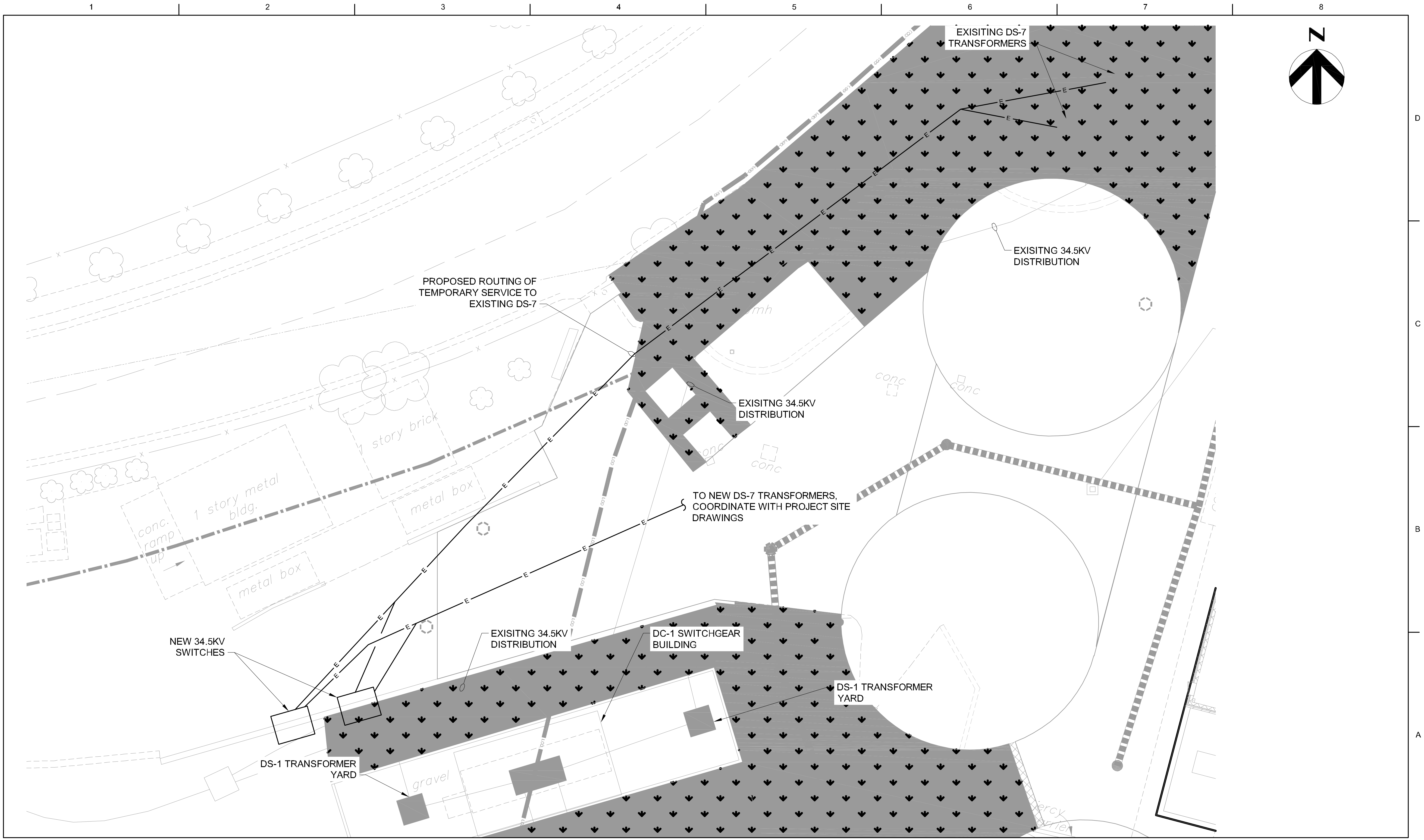

C:\PWWORKING\east01\d1907715\E-001.dwg, 12/16/2022 10:55:44 AM, TLOKEY

HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

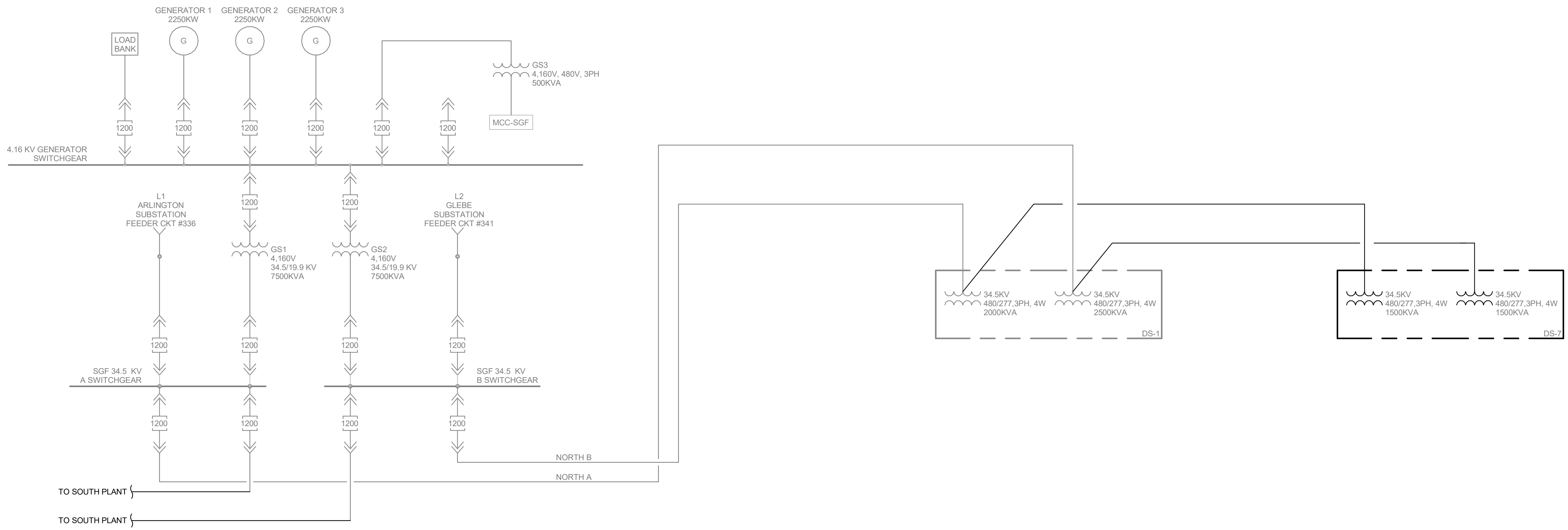
ELECTRICAL SITE PLAN

0 1" 2"

FILENAME E-001.dwg

SCALE 1" = 10'

SHEET **E-001**



ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

**DRAFT
FACILITIES PLAN
NOT FOR
CONSTRUCTION**

ARLINGTON VIRGINIA

**ARLINGTON COUNTY
WPCP
RE-GEN**

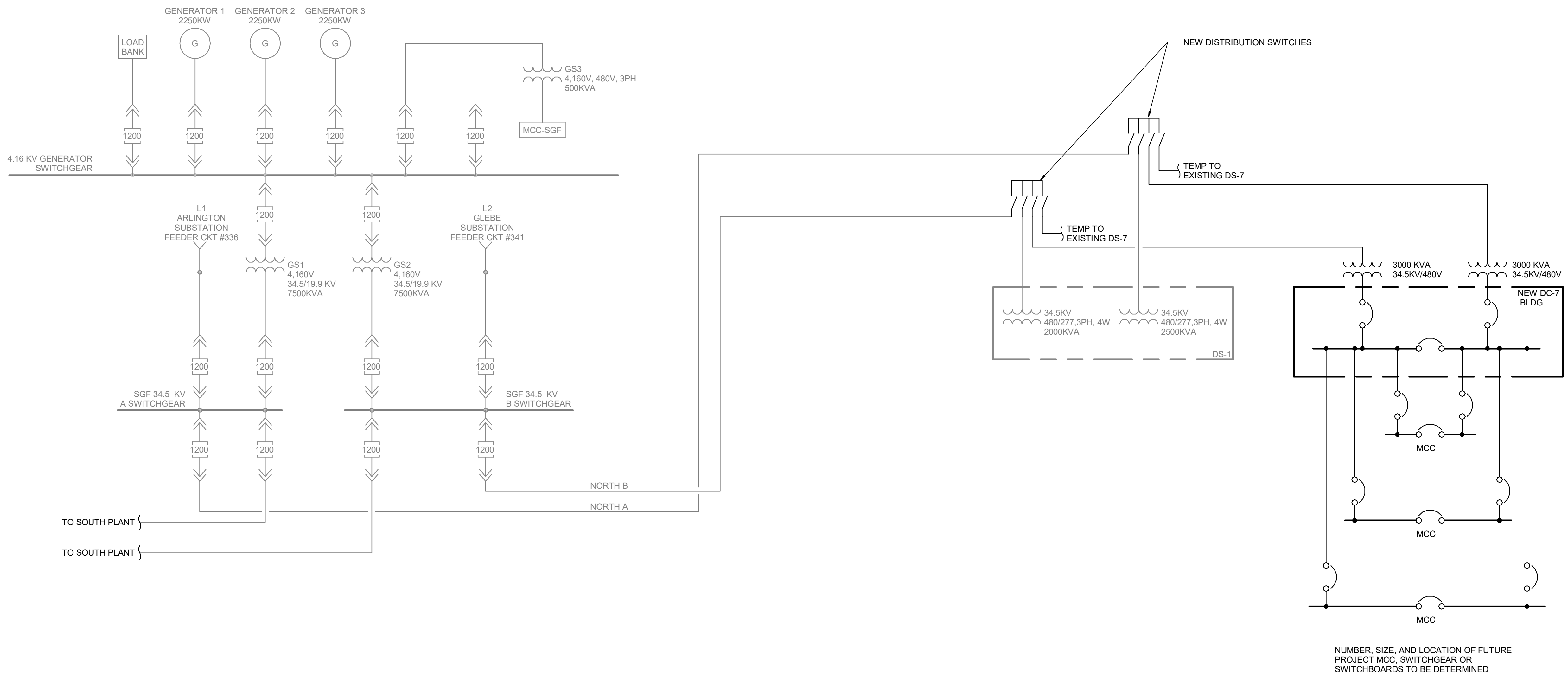
EXISTING ONE-LINE DIAGRAM

0 1" 2"

FILENAME 10263882-02-E_v20.rvt

SCALE NONE

SHEET **E-02**



HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

REVISED ONE-LINE DIAGRAM

0 1" 2"

FILENAME	10263882-02-E_v20.rvt
SCALE	NONE
SHEET	E-03

1 2 3 4 5 6 7 8

PRIMARY ELEMENT SYMBOLOGY

- ORIFICE PLATE
- PITOT TUBE OR ANNUBAR
- FI ROTAMETER
- SONIC OR ULTRASONIC FLOWMETER
- M MAGNETIC FLOWMETER
- FT MASS DISPERSION FLOWMETER
- FLUME
- WEIR
- PROPELLER OR TURBINE METER
- VENTURI TUBE
- FLOAT SWITCH
- TE TEMPERATURE ELEMENT WITH THERMOWELL
- FG SIGHT FLOW GLASS
- TD THERMAL DISPERSION METER
- ULTRASONIC LEVEL TRANSMITTER
- RADAR TYPE LEVEL TRANSMITTER
- DIFFERENTIAL PRESSURE FLOW METER

LINE TYPES

- MAIN PROCESS LINE
- SECONDARY PROCESS LINE
- AUXILIARY PROCESS LINE
- DIRECTION OF FLOW
- PNEUMATIC SIGNAL
- ELECTRICAL SIGNAL
- HYDRAULIC SIGNAL
- SOFTWARE OR DATA LINK
- SIGNAL CONNECTION
- CROSSOVER - NO CONNECTION
- X X CAPILLARY

CROSS REFERENCE SYMBOLOGY

- Y-3 CONTINUATION ON SHEET Y-3
- Y-3 CONTINUATION ON SHEET Y-3

INSTRUMENT SYMBOLOGY

- LOCALLY MOUNTED FIELD INSTRUMENTATION
- MOUNTED ON PANEL FRONT
- MOUNTED INSIDE PANEL
- XXX FRONT PANEL MOUNTED ON AUXILIARY PANEL (SUBSCRIPT INDICATES PANEL)
- MOUNTED INSIDE AUXILIARY PANEL
- PILOT LIGHT
- INSTRUMENT FUNCTIONS SHARING COMMON HOUSING
- I COMPLEX INTERLOCK AS DEFINED IN CONTROL DIAGRAM OR IN SPECIFICATIONS
- SHARED DISPLAY, SHARED CONTROL, FIELD MOUNTED
- SHARED DISPLAY, SHARED CONTROL, PRIMARY LOCATION - NORMALLY ACCESSIBLE TO OPERATOR
- PROGRAMMABLE LOGIC CONTROL, PRIMARY LOCATION - NORMALLY ACCESSIBLE TO OPERATOR
- PROGRAMMABLE LOGIC CONTROL, FIELD MOUNTED

ACTUATOR SYMBOLOGY

- X OPERATOR ABBREVIATIONS:
  M = MOTOR
  P = PNEUMATIC
  S = SOLENOID
- FLOAT OPERATOR
- SPRING-OPPOSED SINGLE-ACTING PNEUMATIC CYLINDER
- DOUBLE-ACTING PNEUMATIC CYLINDER
- PNEUMATIC DIAPHRAGM
- PNEUMATIC DIAPHRAGM WITH POSITIONER

TYPES OF POWER SUPPLY

A	PLANT COMPRESSED AIR
IA	INSTRUMENTATION AIR
ES	ELECTRIC SUPPLY
NG	NATURAL GAS
HYD	HYDRAULIC

INSTRUMENT IDENTIFICATION LETTERS

	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USERS CHOICE			CONTROL	CLOSED
D	USERS CHOICE	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME; RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USER'S CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECH. ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

MISCELLANEOUS INSTRUMENTATION ABBREVIATIONS

AI	ANALOG INPUT
AO	ANALOG OUTPUT
CL2	CHLORINE (ANALYZER MODIFIER)
CO	CARBON MONOXIDE (ANALYZER MODIFIER)
CO2	CARBON DIOXIDE (ANALYZER MODIFIER)
COMB	COMBUSTIBLES (ANALYZER MODIFIER)
COND	CONDUCTIVITY (ANALYZER MODIFIER)
DEN	DENSITY (ANALYZER MODIFIER)
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
DO	DISSOLVED OXYGEN (ANALYZER MODIFIER)
E/P	VOLTAGE TO PNEUMATIC
H2S	HYDROGEN SULFIDE (ANALYZER MODIFIER)
HCL	HYDROGEN CHLORIDE (ANALYZER MODIFIER)
I/O	INPUT/OUTPUT
I/P	CURRENT TO PNEUMATIC
NOX	NITROGEN OXIDE (ANALYZER MODIFIER)
OI	OPERATOR INTERFACE
OIT	OPERATOR INTERFACE TERMINAL
O2	OXYGEN (ANALYZER MODIFIER)
P&ID	PROCESS AND INSTRUMENTATION DIAGRAM
SS	SUSPENDED SOLIDS (ANALYZER MODIFIER)
TURB	TURBIDITY (ANALYZER MODIFIER)
WAN	WIDE AREA NETWORK

CONTROL SWITCH NOTATION ABBREVIATIONS

XXX XXXX XXX

ACK	ACKNOWLEDGE
E-STOP	EMERGENCY STOP
FAIL	FAILURE
FOR	FORWARD-OFF-REVERSE
FR	FORWARD-REVERSE
FS	FAST-SLOW
HA	HAND-AUTO
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
LL	LEAD-LAG
LLS	LEAD-LAG-STANDBY
LOR	LOCAL-OFF-REMOTE
LR	LOCAL-REMOTE
LS	LEAD-STANDBY
MA	MANUAL-AUTO
OAC	OPEN-AUTO-CLOSE
OC	OPEN-CLOSE
OO	ON-OFF
OSC	OPEN-STOP-CLOSE
RJ	RUN-JOG
RJR	RUN-JOG-REVERSE
SIL	SILENCE
SS	START-STOP

VALVES

- BALL VALVE
- BUTTERFLY VALVE
- CONE VALVE
- CHECK VALVE
- DOUBLE-DISK CHECK VALVE
- BALL CHECK VALVE
- DIAPHRAGM VALVE
- GATE VALVE
- GLOBE VALVE
- KNIFE GATE VALVE
- NEEDLE VALVE
- PINCH VALVE
- PLUG VALVE
- THREE-WAY BALL VALVE
- THREE-WAY PLUG VALVE
- PRESSURE-REDUCING VALVE
- PRESSURE-REGULATING VALVE
- THREE-WAY CONTROL VALVE
- OR PRESSURE-RELIEF VALVE
- X AIR-RELEASE VACUUM VALVE
  A = AIR RELEASE
  VAC = VACUUM
- LUBRICATED PLUG VALVE
- NORMALLY CLOSED VALVE (FILLED IN)

MISCELLANEOUS SYMBOLOGY

- PROGRESSIVE CAVITY PUMP
- PROGRESSIVE CAVITY CAKE PUMP
- M MIXER - PROPELLER TYPE
- SUMP PUMP
- CHEMICAL FEED PUMP
- CENTRIFUGAL PUMP
- M MOTOR
- BAG FILTER
- FLEXIBLE CHUTE
- CALIBRATION COLUMN
- SIGHT GLASS
- FLEXIBLE CONNECTION
- R ROTAMETER
- QUICK DISCONNECT COUPLING WITH BALL VALVE (CAMBI'S INTERPRETATION)
- GRINDER
- 3W C 3W=NPW, THE "C" STANDS FOR A SEAL WATER CONTROL UNIT
- D DRAIN
- DT D DRIP TRAP
- DRAIN WITH CONCRETE CONTAINMENT
- SLIDE GATE
- REDUCER
- PULSATION DAMPENER
- FLAME ARRESTER

D C B A

GENERAL NOTES:

1. THIS IS A STANDARD INSTRUMENTATION SYMBOLOGY AND ABBREVIATIONS SHEET. LISTING OF SYMBOLS AND ABBREVIATIONS DOES NOT IMPLY ALL SYMBOLS AND ABBREVIATIONS HAVE BEEN USED ON THIS PROJECT.
2. SEE PROCESS, MECHANICAL AND PLUMBING LEGEND SHEET FOR MISCELLANEOUS PIPING SYMBOLS.
3. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FOR USAGE.
4. VALVE SYMBOLS SHOWN HERE ARE APPLICABLE ONLY TO INSTRUMENTATION DIAGRAMS. SEE PROCESS, MECHANICAL AND PLUMBING LEGEND SHEET FOR VALVE SYMBOLS USED ELSEWHERE ON THE SHEETS.

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HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

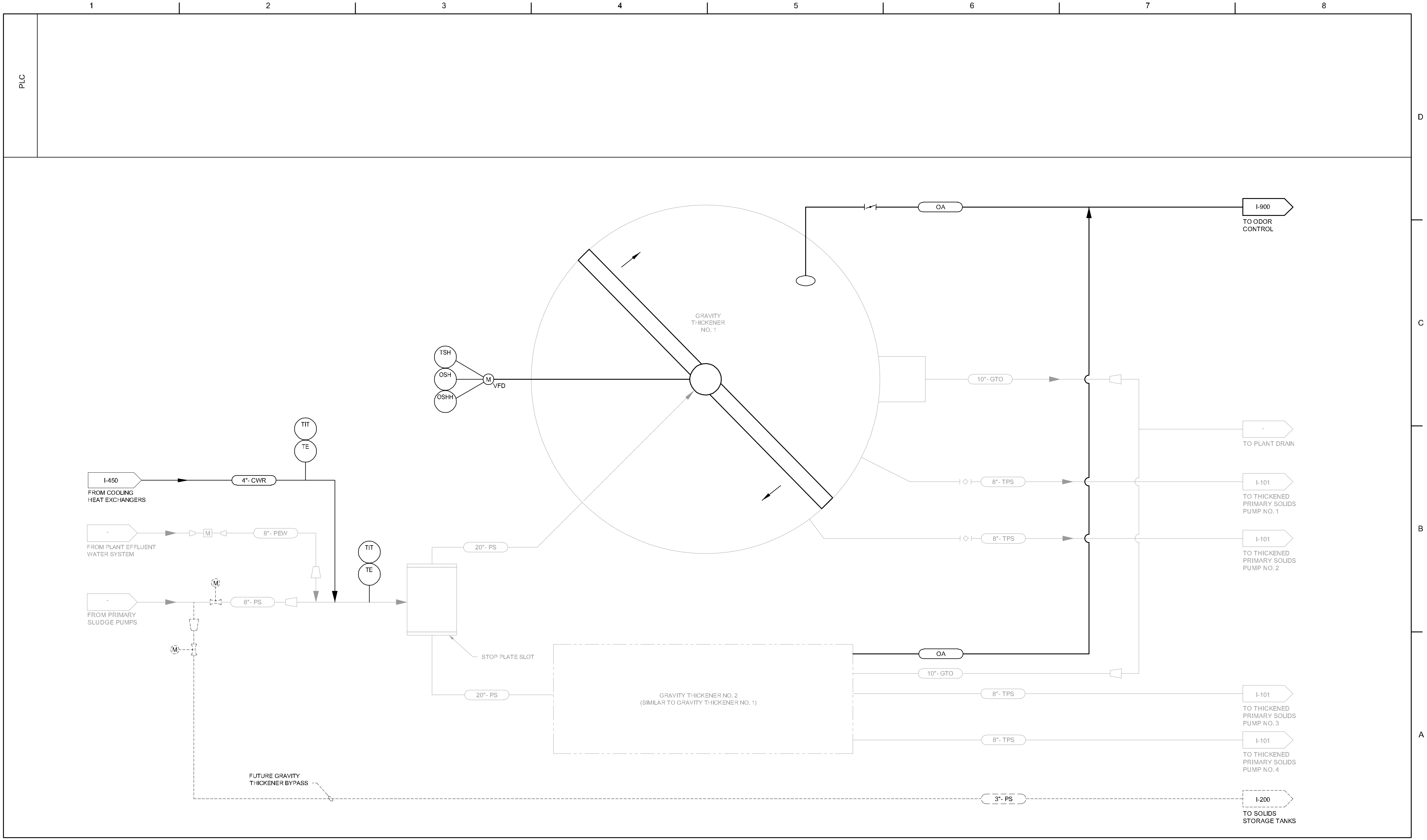
INSTRUMENTATION LEGEND AND SYMBOLS

0 1" 2"

FILENAME I-001.dwg

SCALE NOT TO SCALE

SHEET **I-001**



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ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
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PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

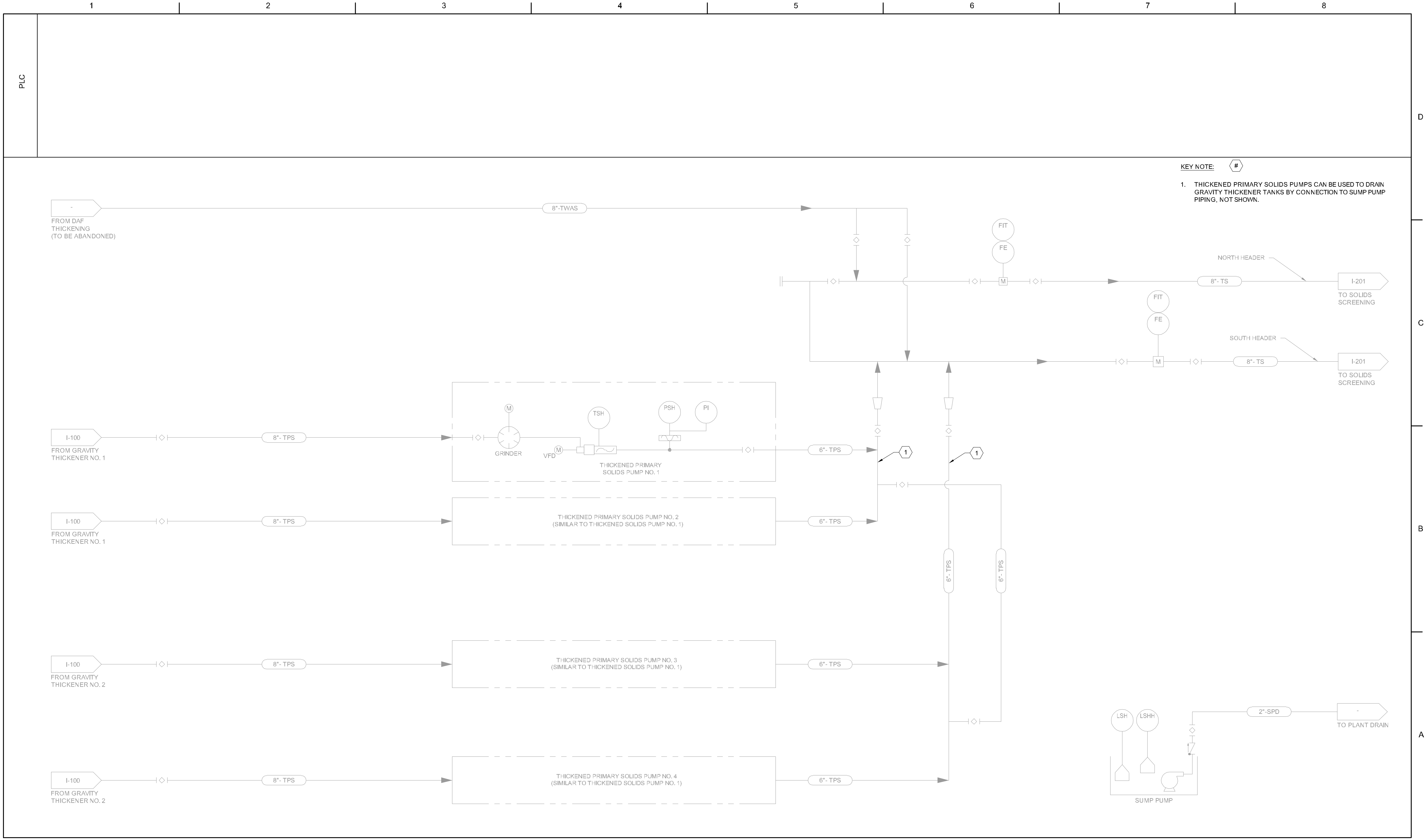
GRAVITY THICKENING PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-100.dwg

SCALE NOT TO SCALE

SHEET **I-100**



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HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

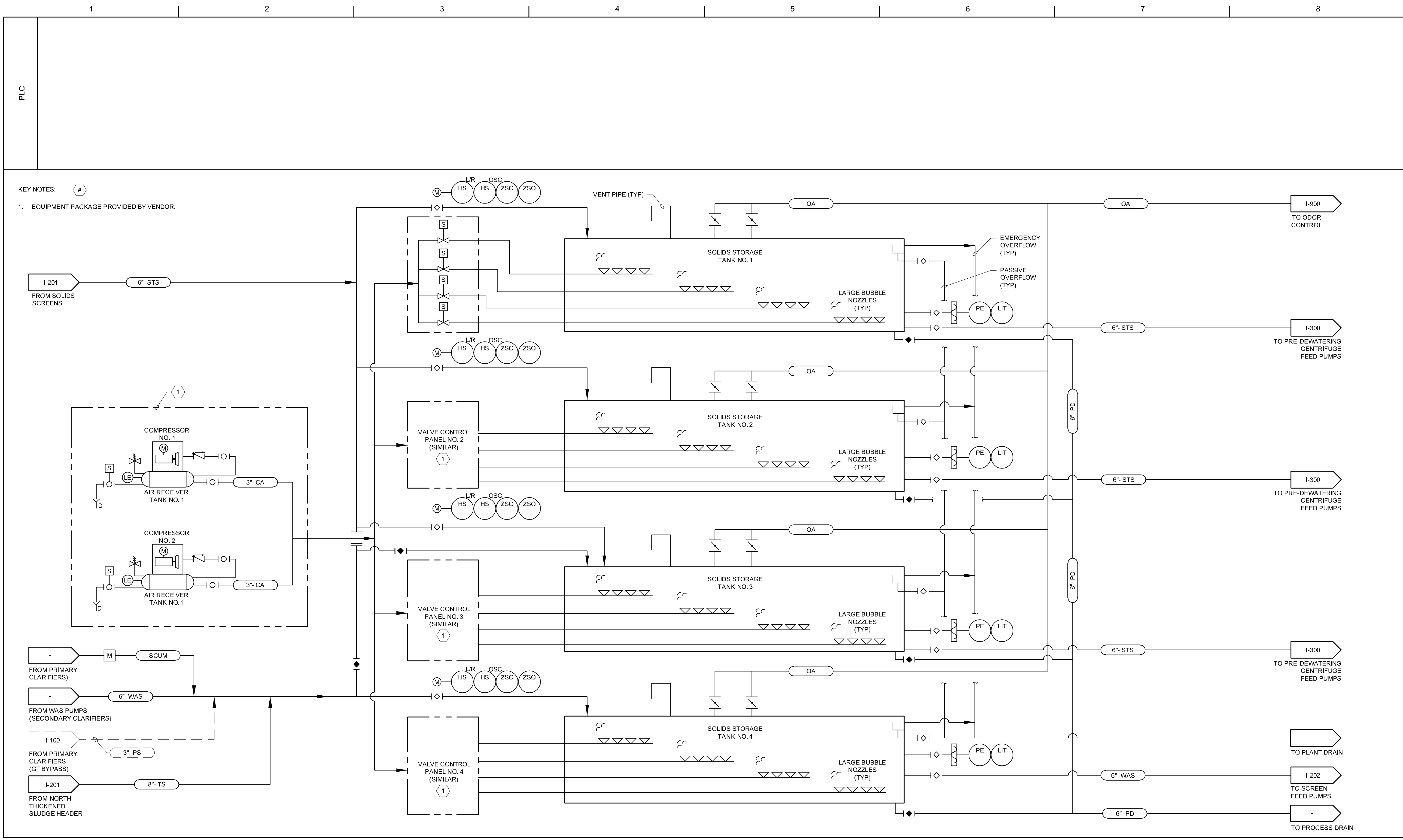
THICKENED PRIMARY SOLIDS PUMPING PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-101.dwg

SCALE NOT TO SCALE

SHEET I-101



PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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A	12/2022	FACILITIES PLAN

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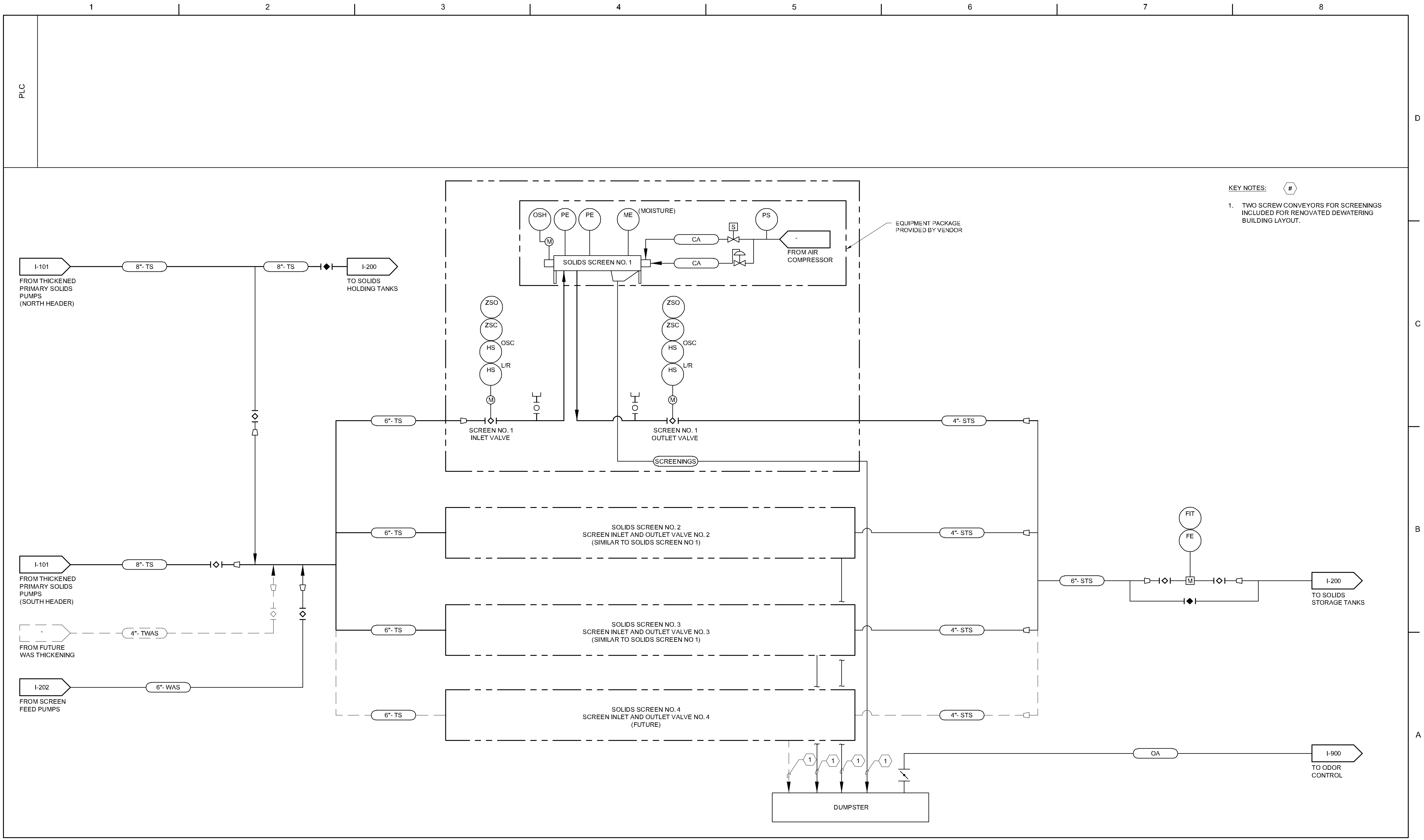
RE-GEN

SOLIDS STORAGE
PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-200.dwg
SCALE NOT TO SCALE
SHEET I-200



PROJECT MANAGER BALCHUNAS, BRIAN

CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

SOLIDS SCREENING PROCESS AND INSTRUMENTATION DIAGRAM

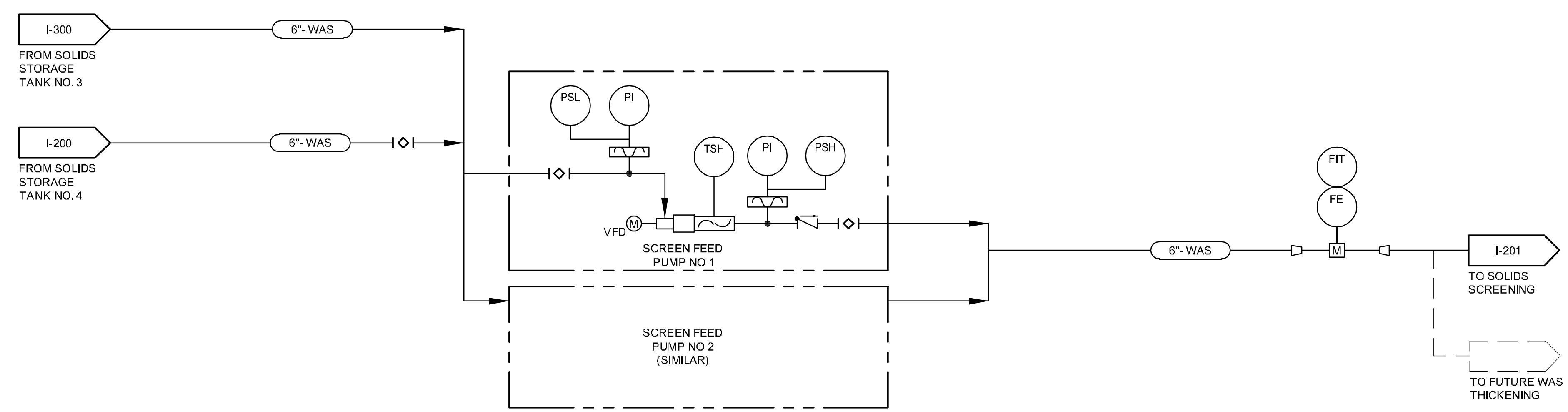
0 1" 2"

FILENAME I-201.dwg

SCALE NOT TO SCALE

SHEET I-201

PLC



A	12/2022	FACILITIES PLAN
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
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INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON
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WPCP
RE-GEN

SCREEN FEED PUMPS
PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-202.dwg
SCALE NOT TO SCALE
SHEET I-202

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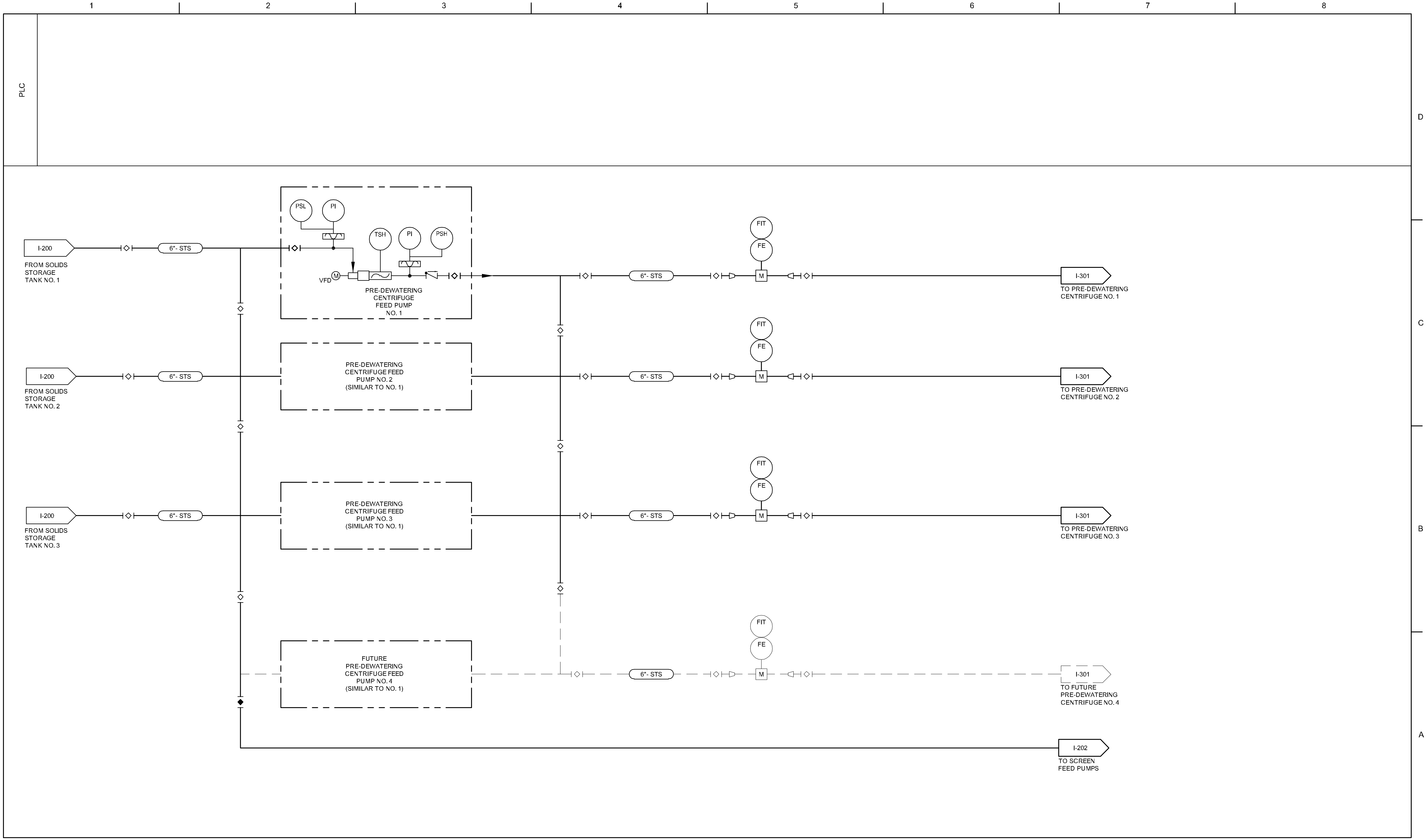

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HDR

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

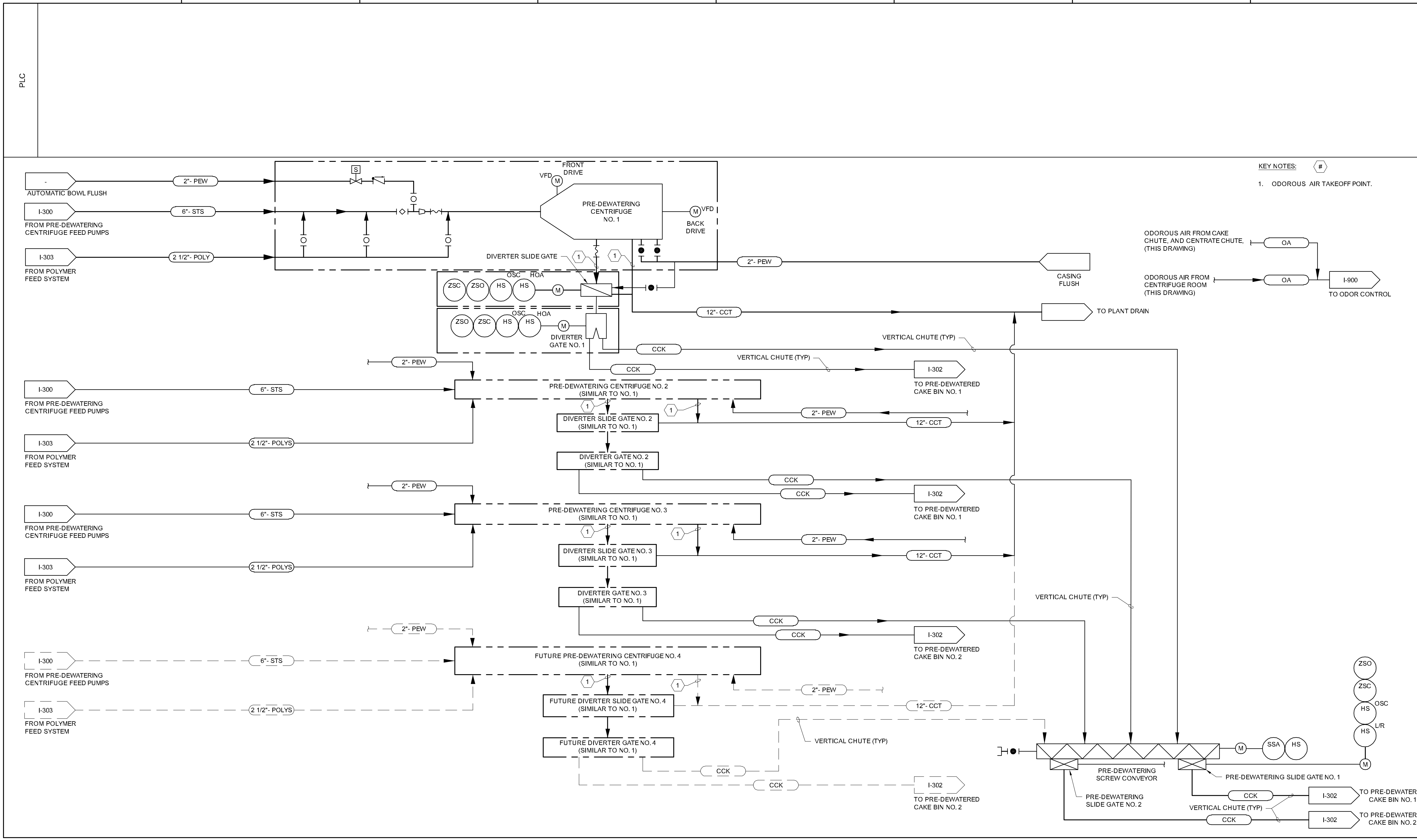
ARLINGTON COUNTY WPCP RE-GEN

PRE-DEWATERING CENTRIFUGE FEED PUMPS PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME	I-300.dwg
SCALE	NOT TO SCALE

SHEET **I-300**



PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

PRE-DEWATERING CENTRIFUGE PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-301.dwg

SCALE NOT TO SCALE

SHEET **I-301**

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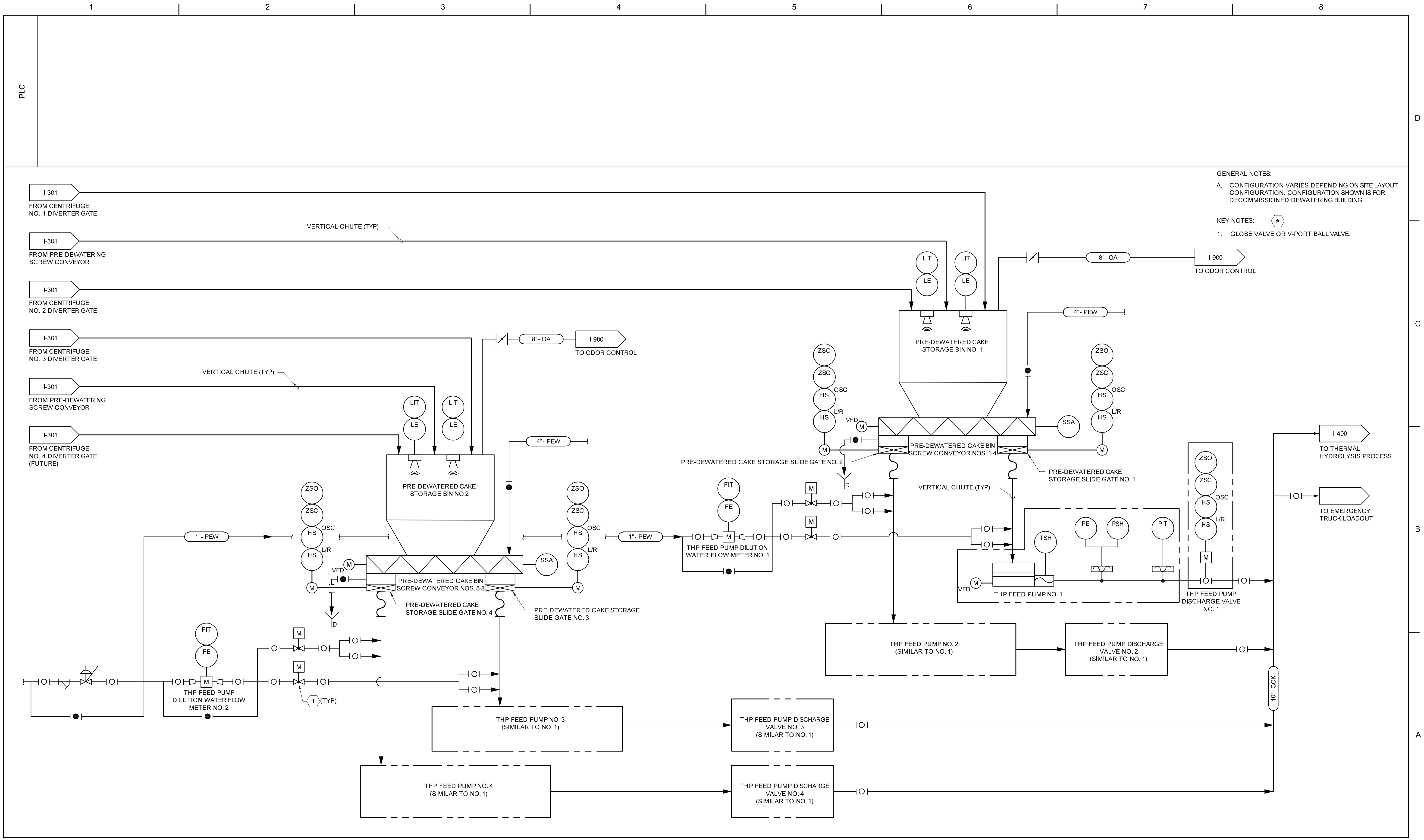

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ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

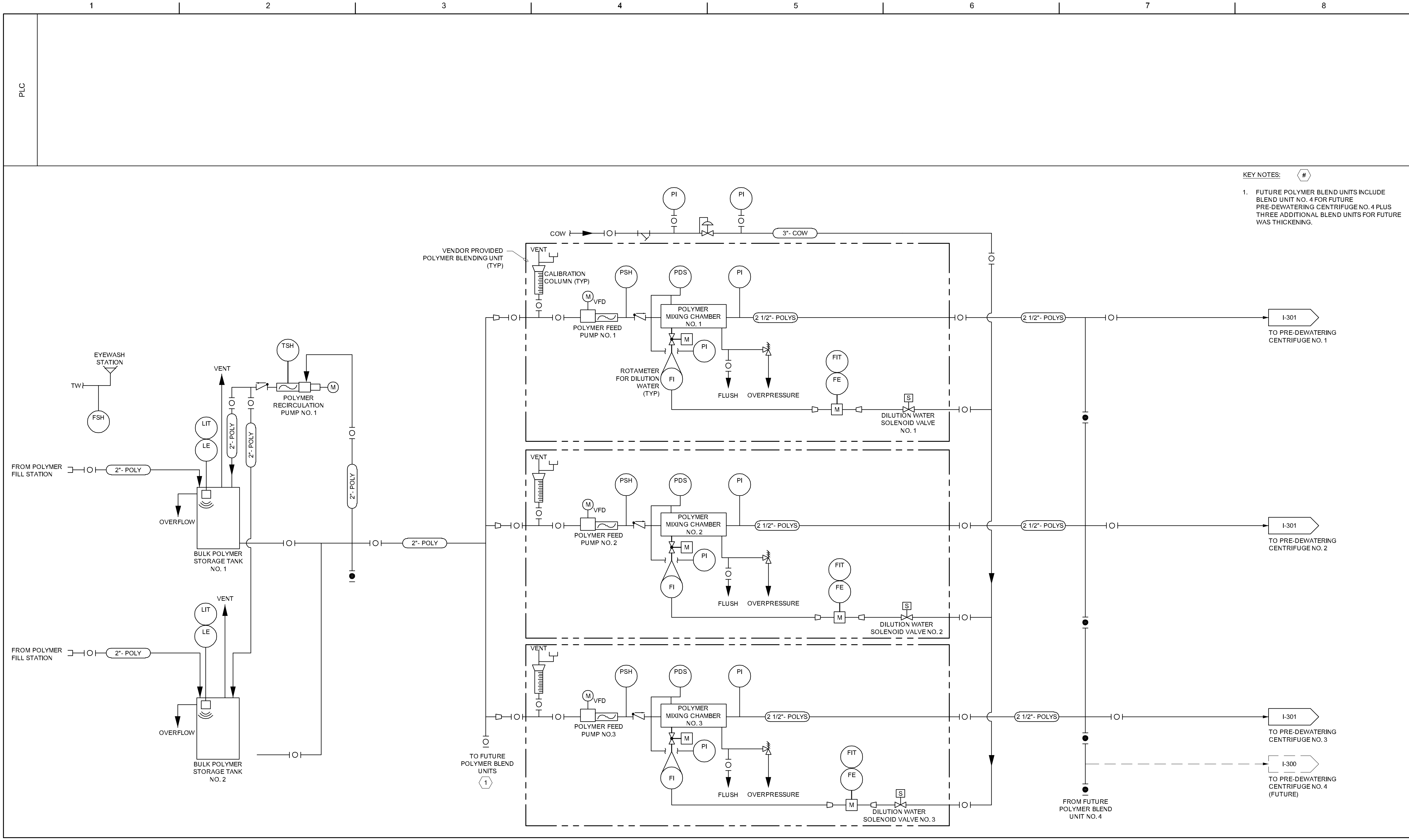
CAKE BIN AND THP FEED PUMPS PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-302.dwg

SCALE NOT TO SCALE

SHEET **I-302**



A	12/2022	FACILITIES PLAN
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

PRE-DEWATERING POLYMER PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-303.dwg

SCALE NOT TO SCALE

SHEET **I-303**

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PLC

GENERAL NOTES:

A. THP SYSTEM HAS NOT BEEN SELECTED. GENERAL PROCESS CONNECTIONS ARE SHOWN.

B. FLUSHING CONNECTIONS ARE REQUIRED AND ARE NOT SHOWN.

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ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

THERMAL HYDROLYSIS PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-400.dwg

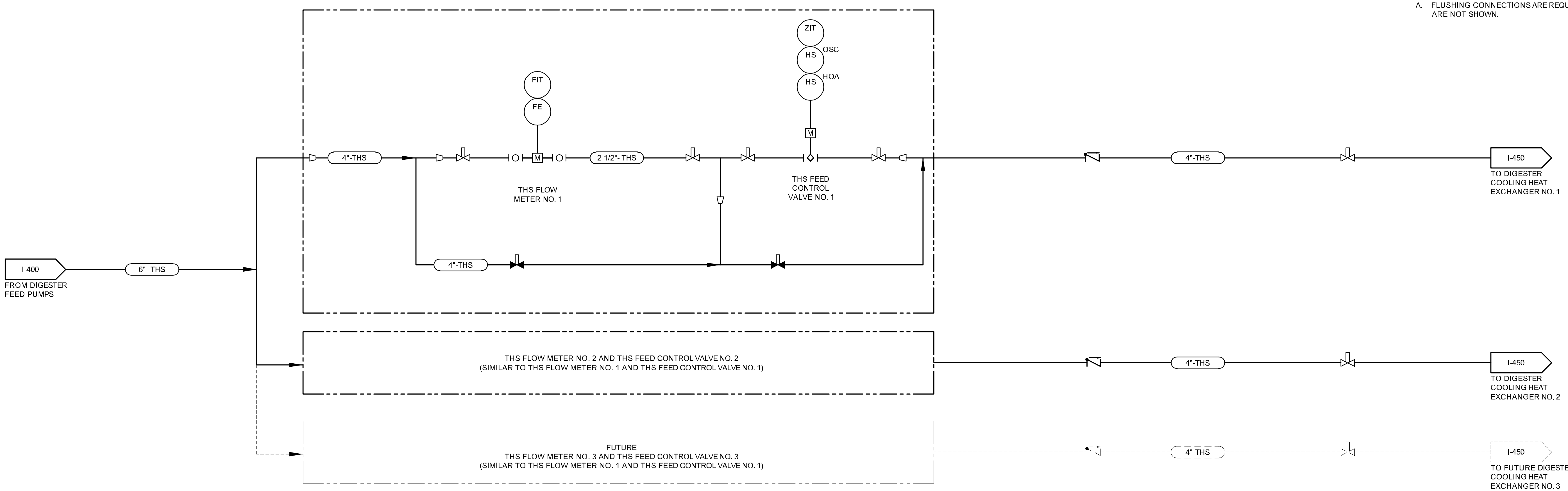
SCALE NOT TO SCALE

SHEET **I-400**

PLC

GENERAL NOTES:

A. FLUSHING CONNECTIONS ARE REQUIRED AND ARE NOT SHOWN.



ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

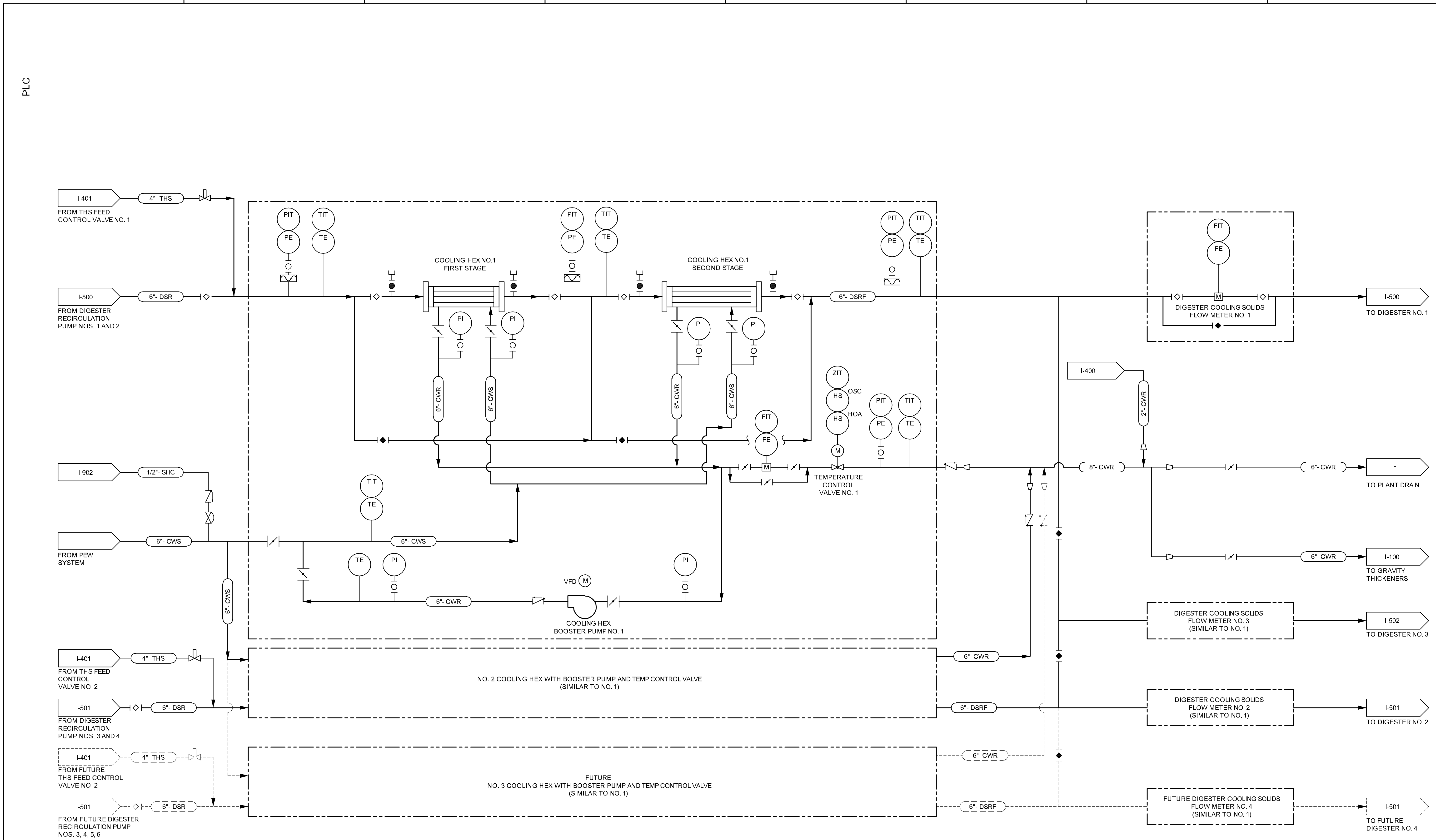
THS FEED CONTROL VALVE PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-401.dwg

SCALE NOT TO SCALE

SHEET **I-401**



A	12/2022	FACILITIES PLAN
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

SOLIDS COOLING SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

FILENAME I-450.dwg

SCALE NOT TO SCALE

SHEET I-450

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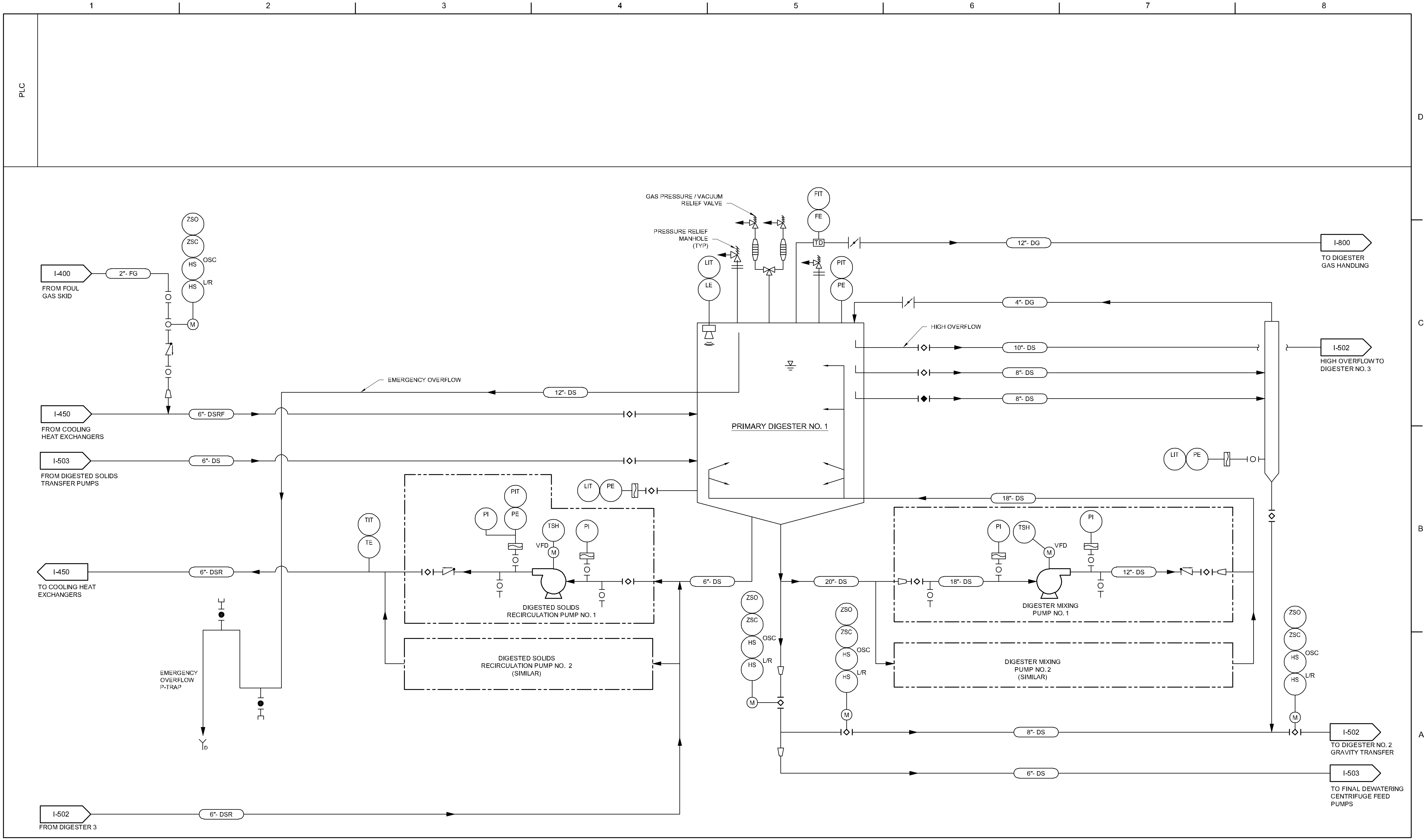

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

HDR

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

PRIMARY DIGESTER NO. 1 PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-500.dwg

SCALE NOT TO SCALE

SHEET **I-500**

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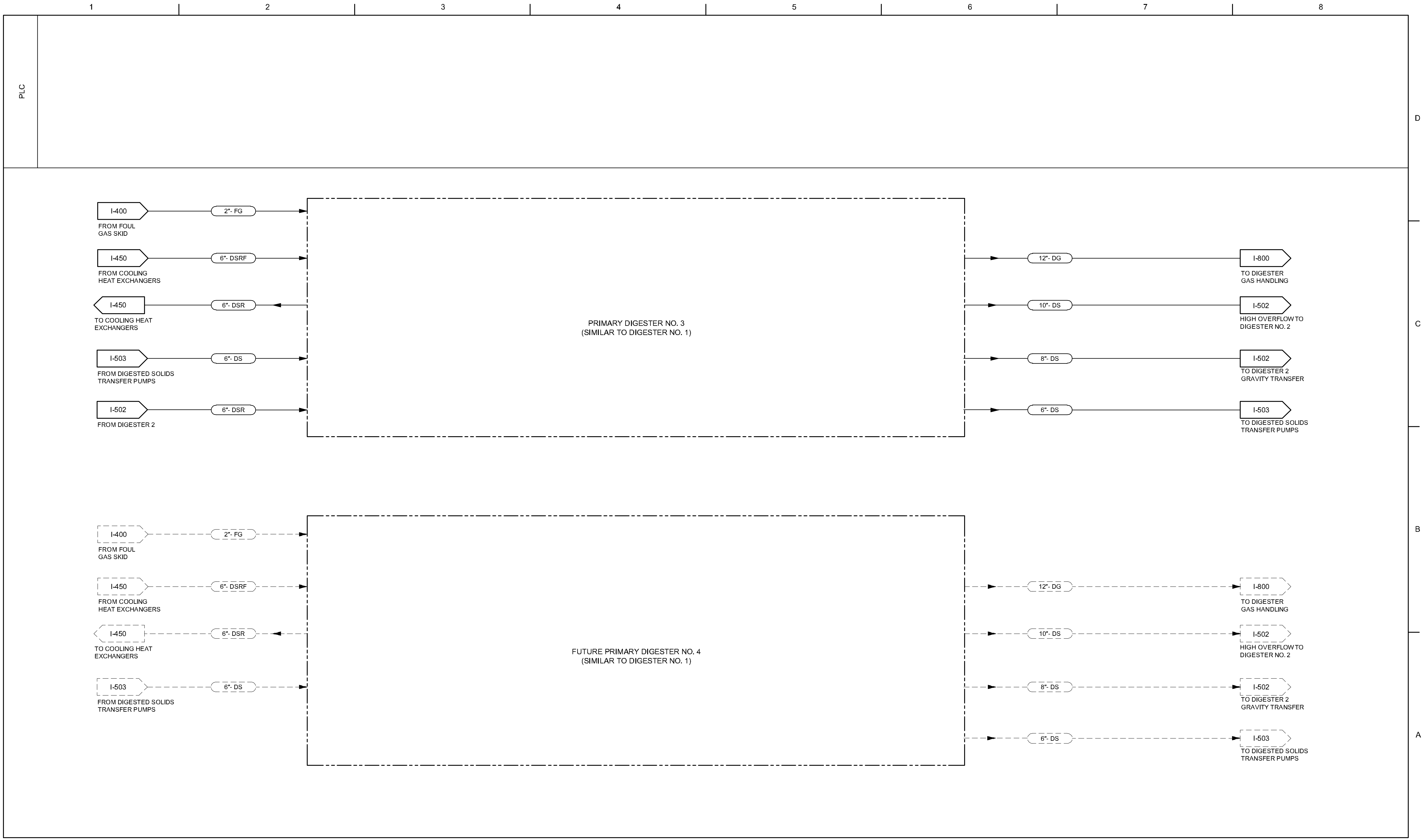


PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

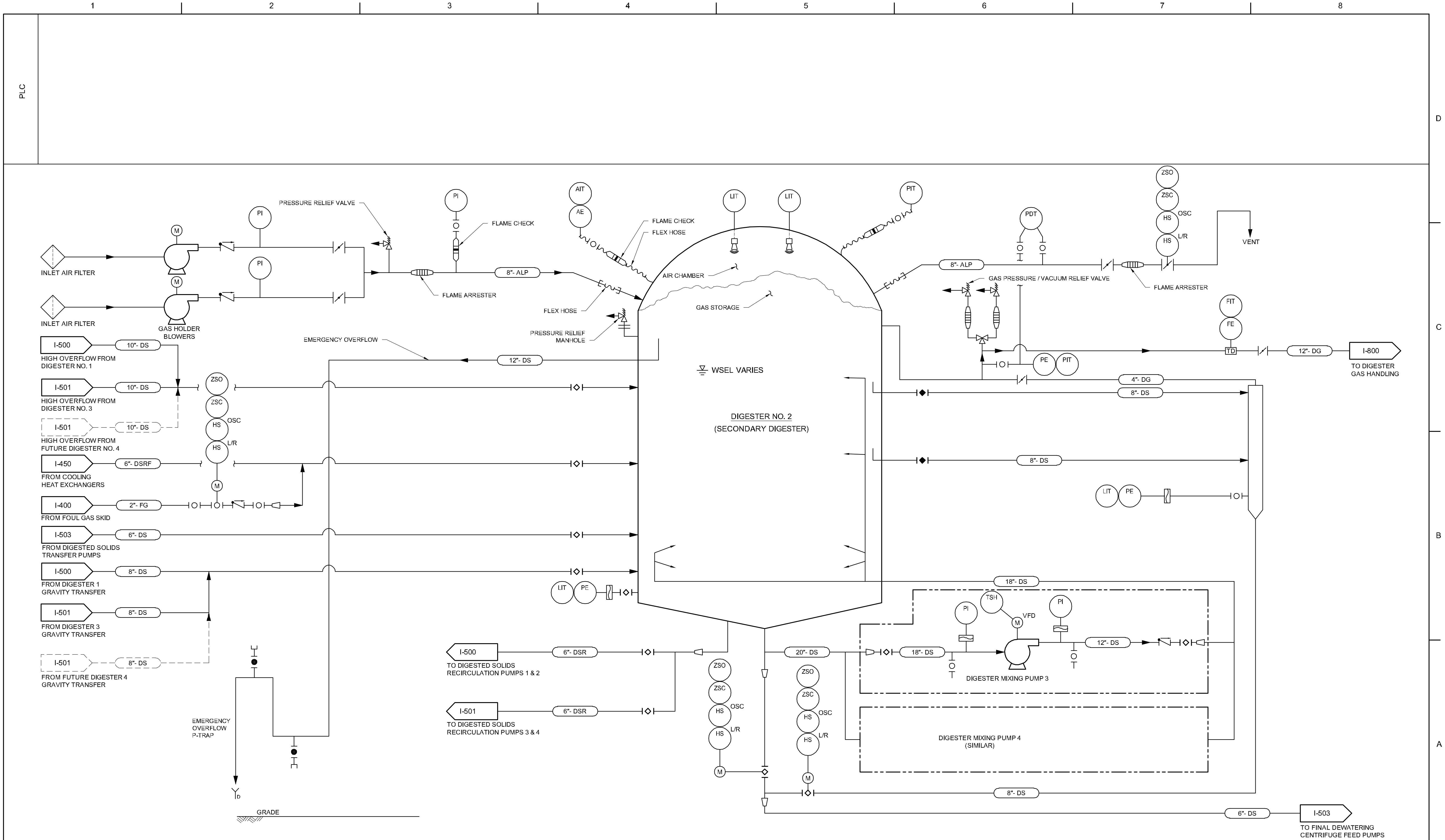
ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

PRIMARY DIGESTER NO. 3
PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-501.dwg
SCALE NOT TO SCALE
SHEET I-501



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ISSUE	DATE	DESCRIPTION
A	12/2022	FACILITIES PLAN

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

DRAFT FACILITIES PLAN NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

SECONDARY DIGESTER NO. 2 PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-502.dwg

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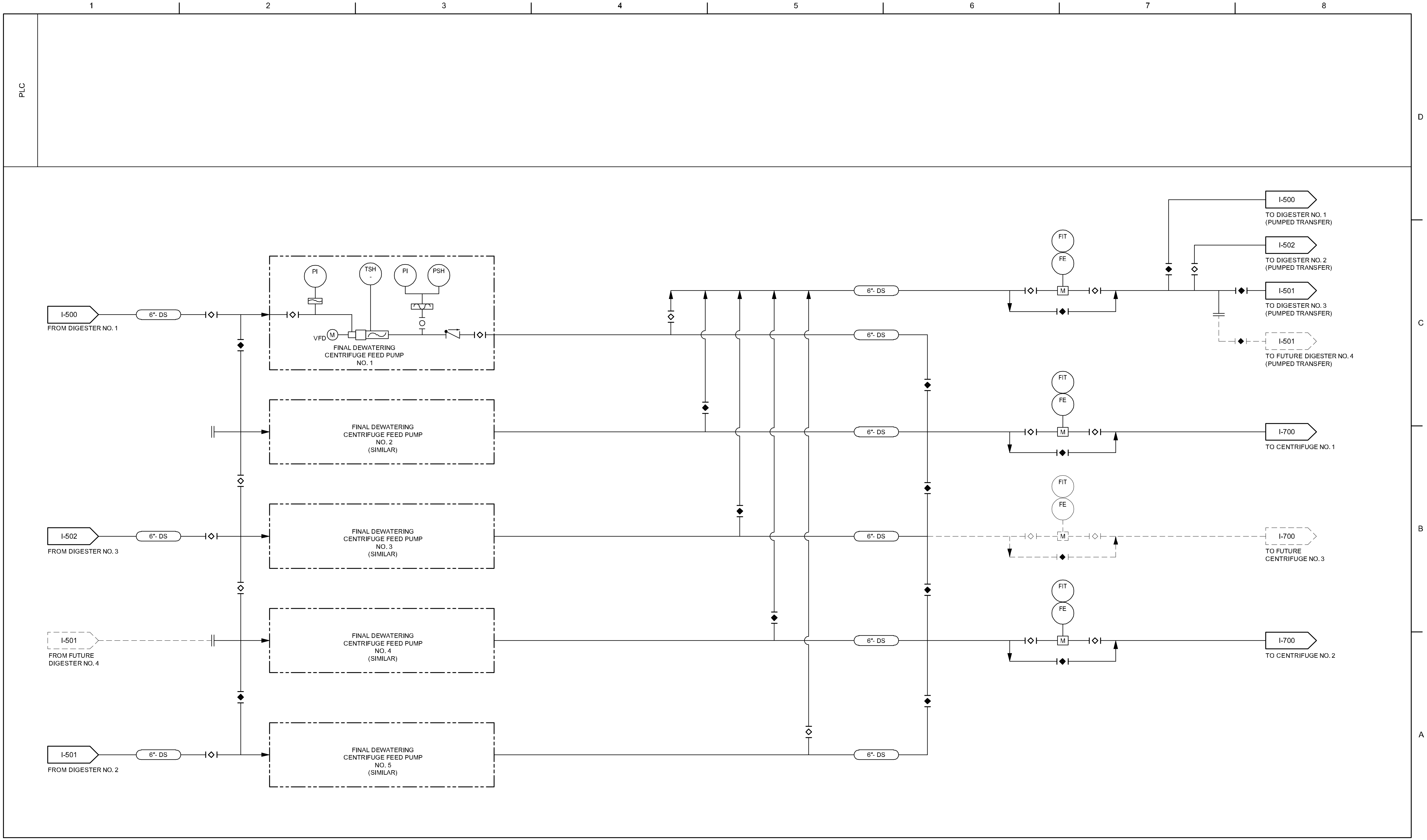

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CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
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ARLINGTON COUNTY WPCP RE-GEN

DIGESTED SOLIDS TRANSFER PUMPS PROCESS AND INSTRUMENTATION DIAGRAM

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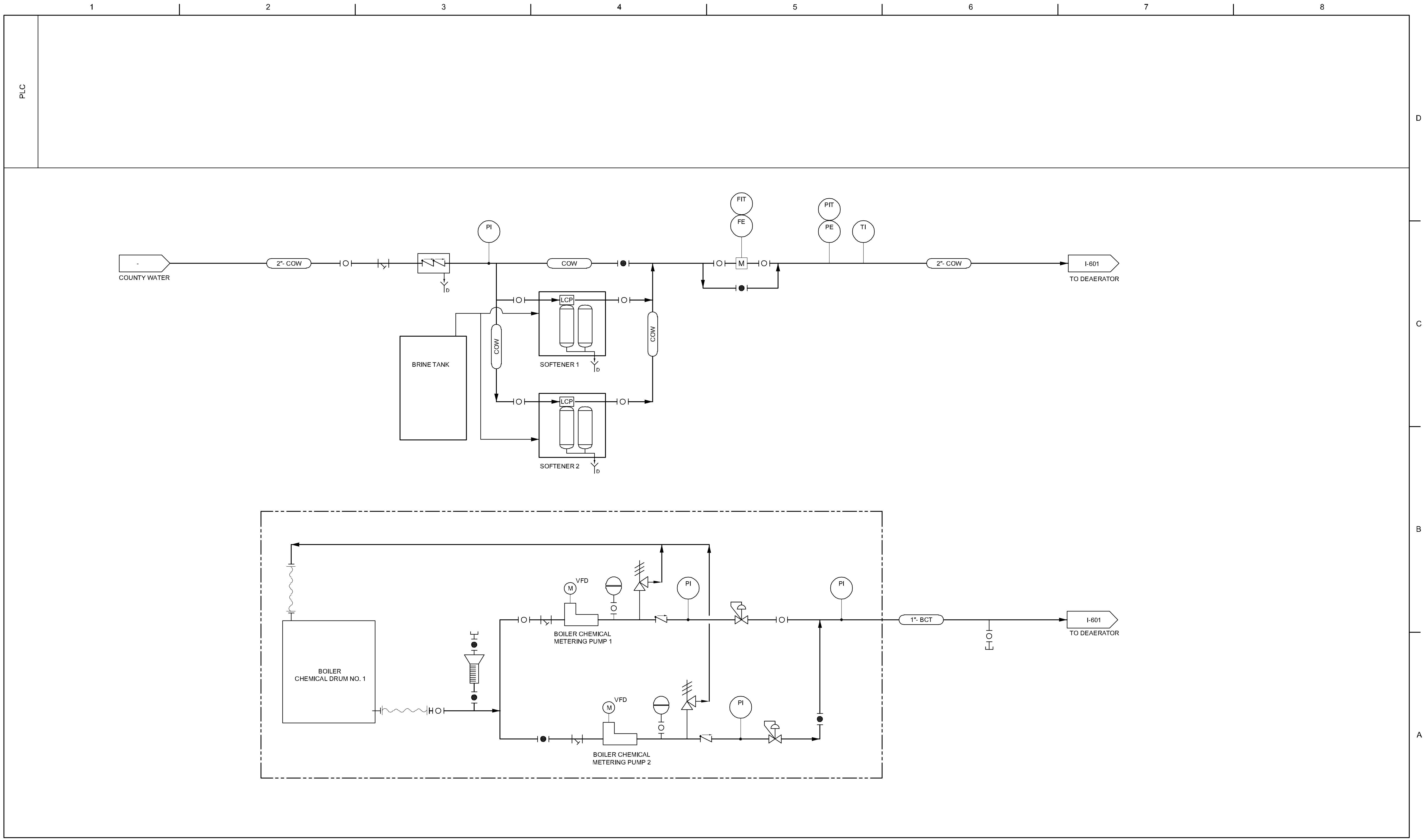

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BOILER FEEDWATER PRETREATMENT
AND CHEMICAL FEED
PROCESS AND INSTRUMENTATION DIAGRAM

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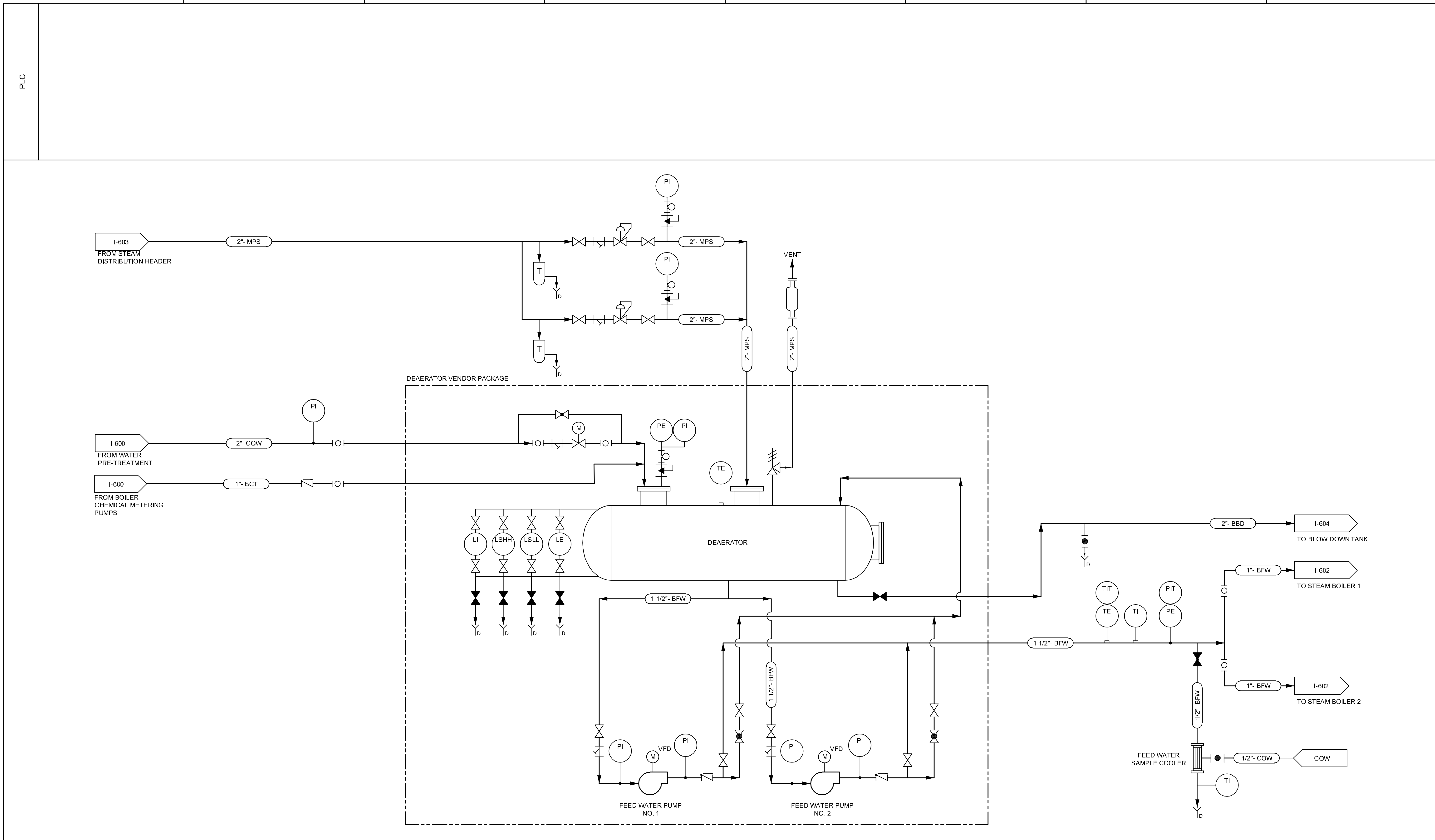

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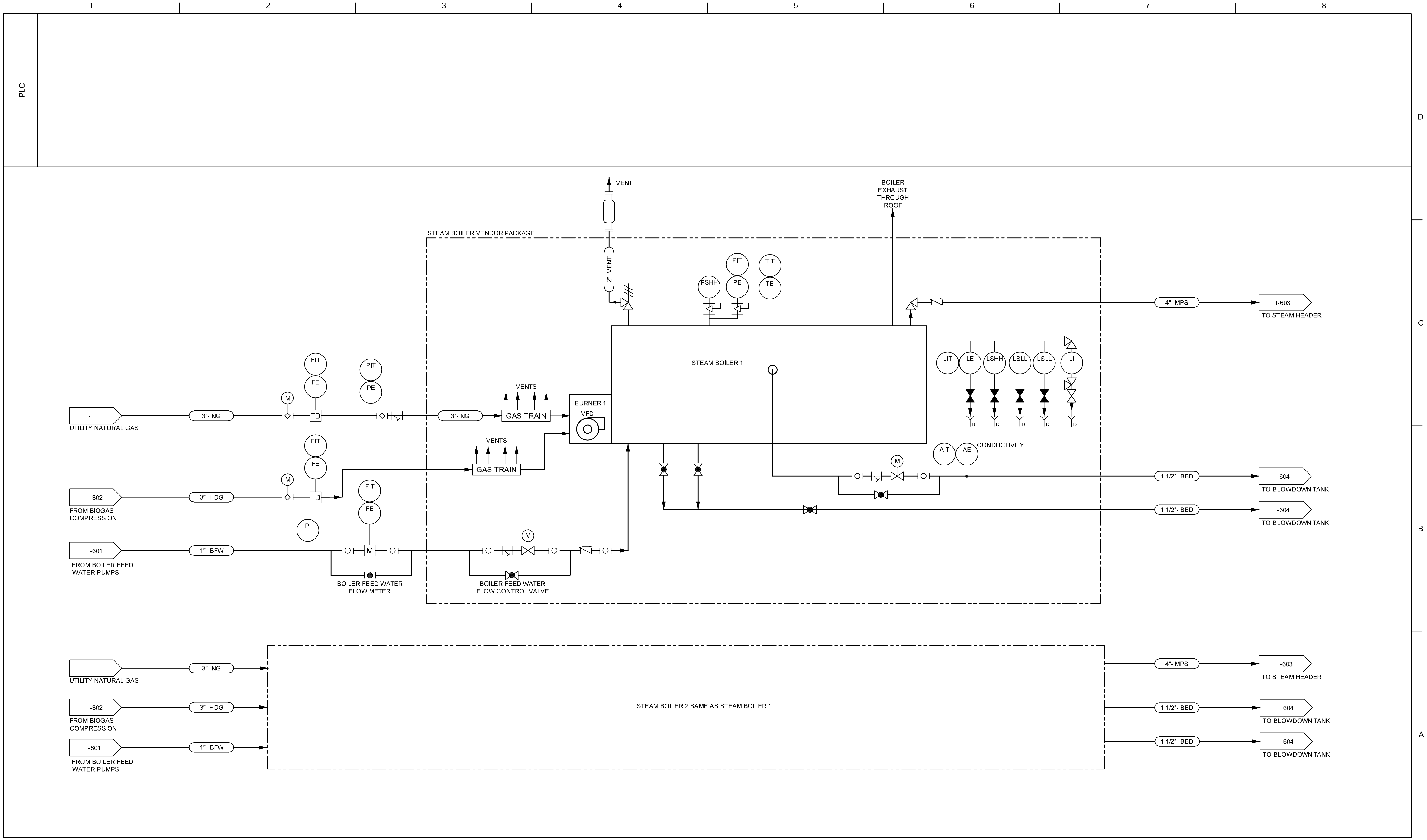

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ARLINGTON COUNTY WPCP RE-GEN

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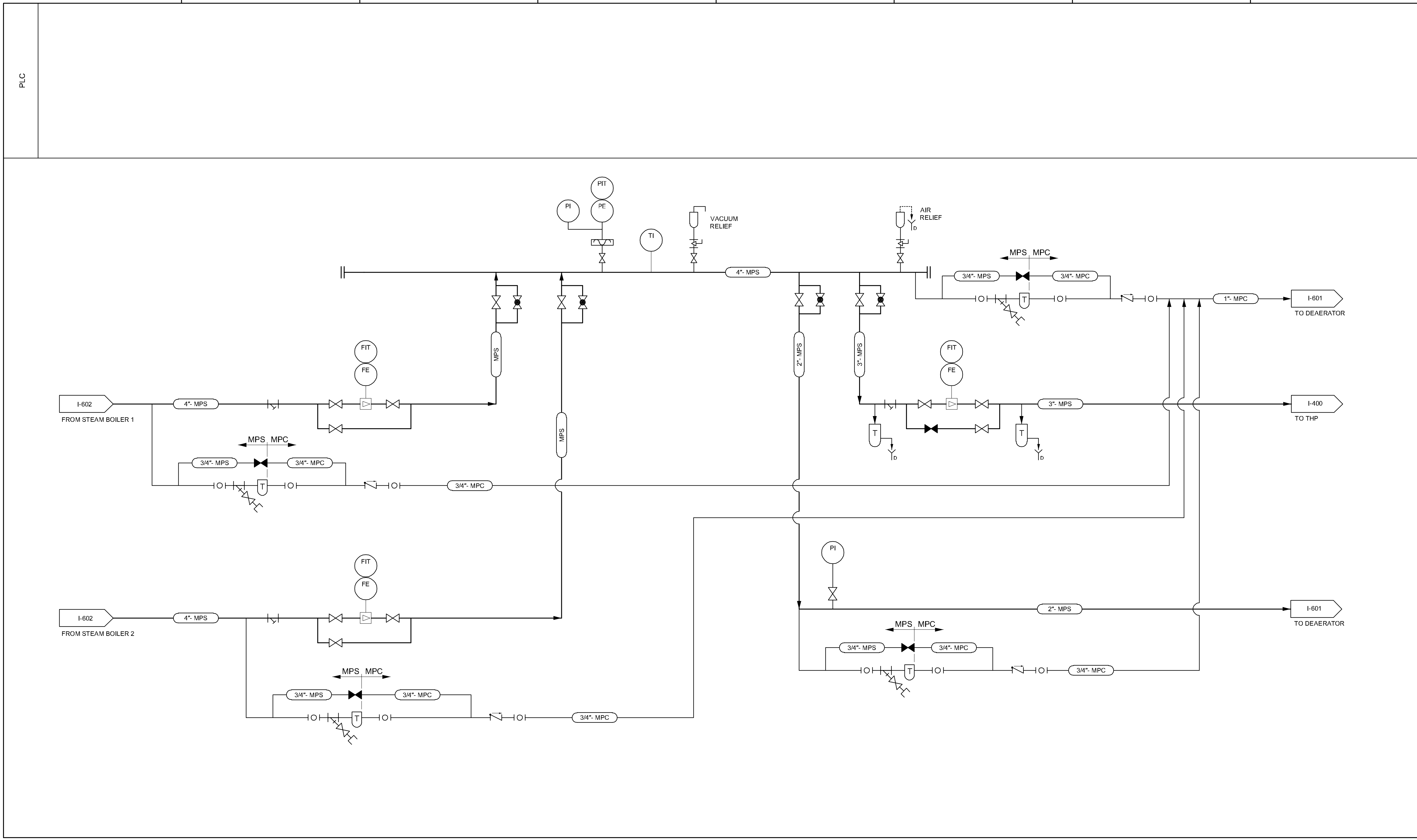

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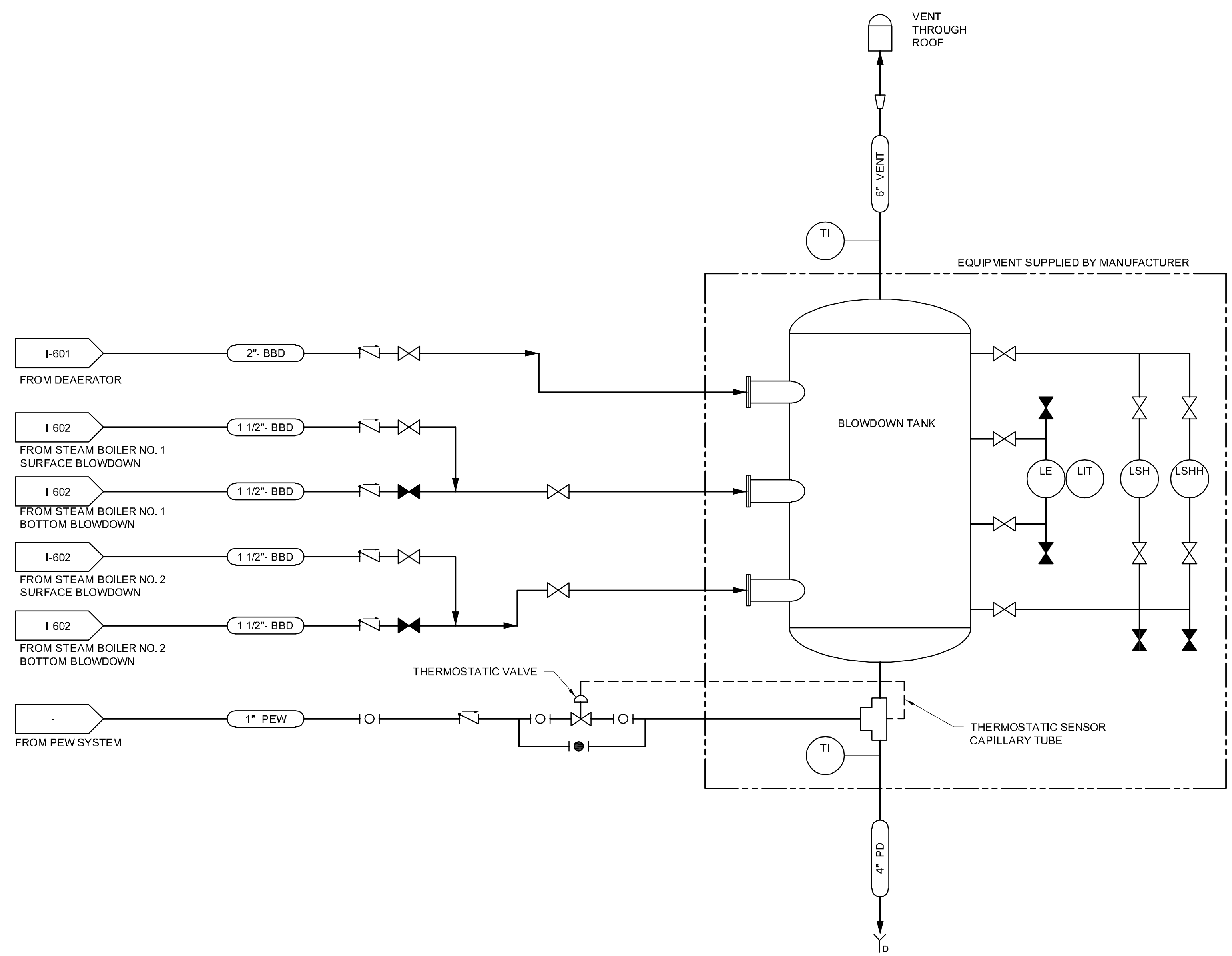

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BOILER BLOWDOWN SEPARATOR PROCESS AND INSTRUMENTATION DIAGRAM

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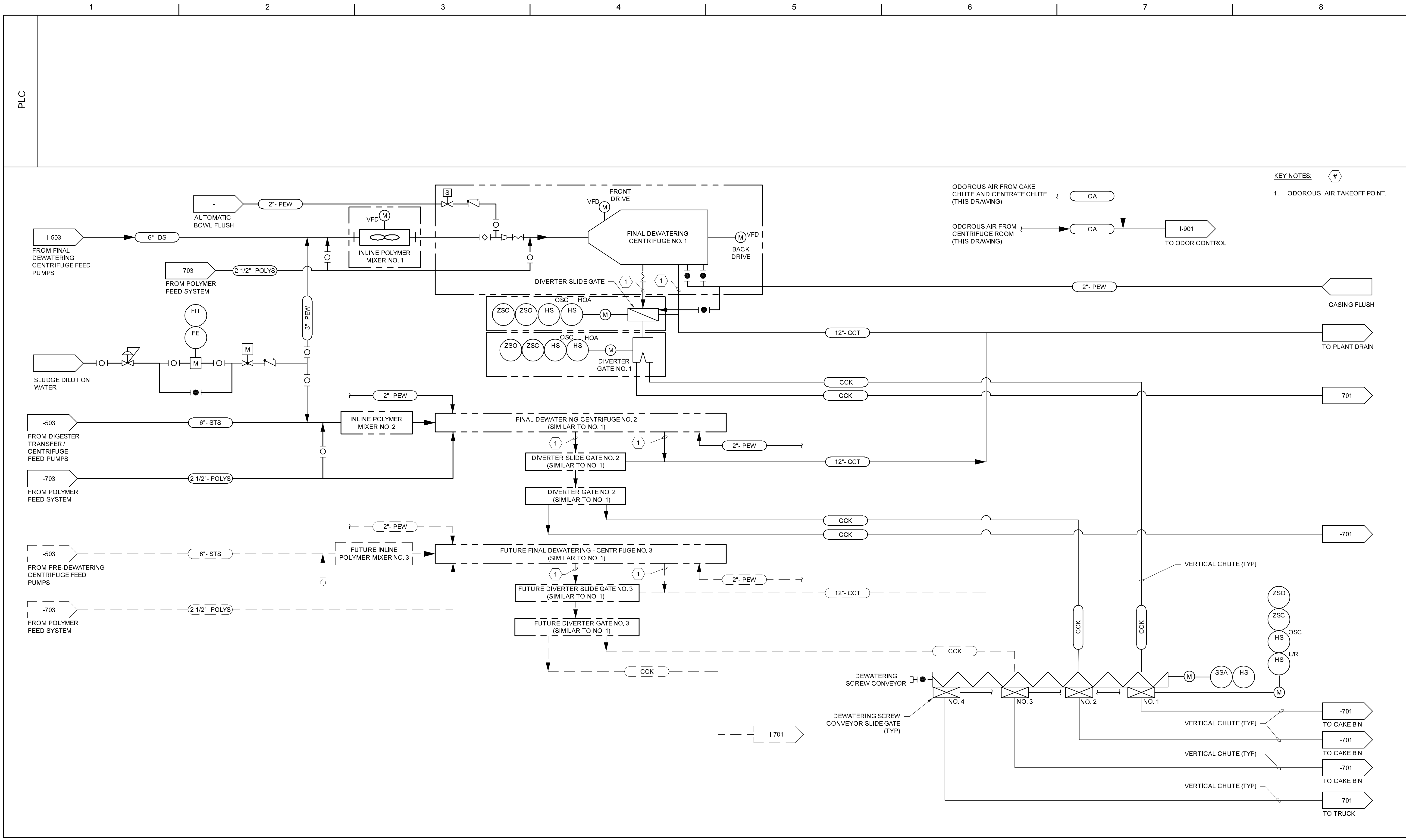

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FINAL DEWATERING CENTRIFUGE PROCESS AND INSTRUMENTATION DIAGRAM

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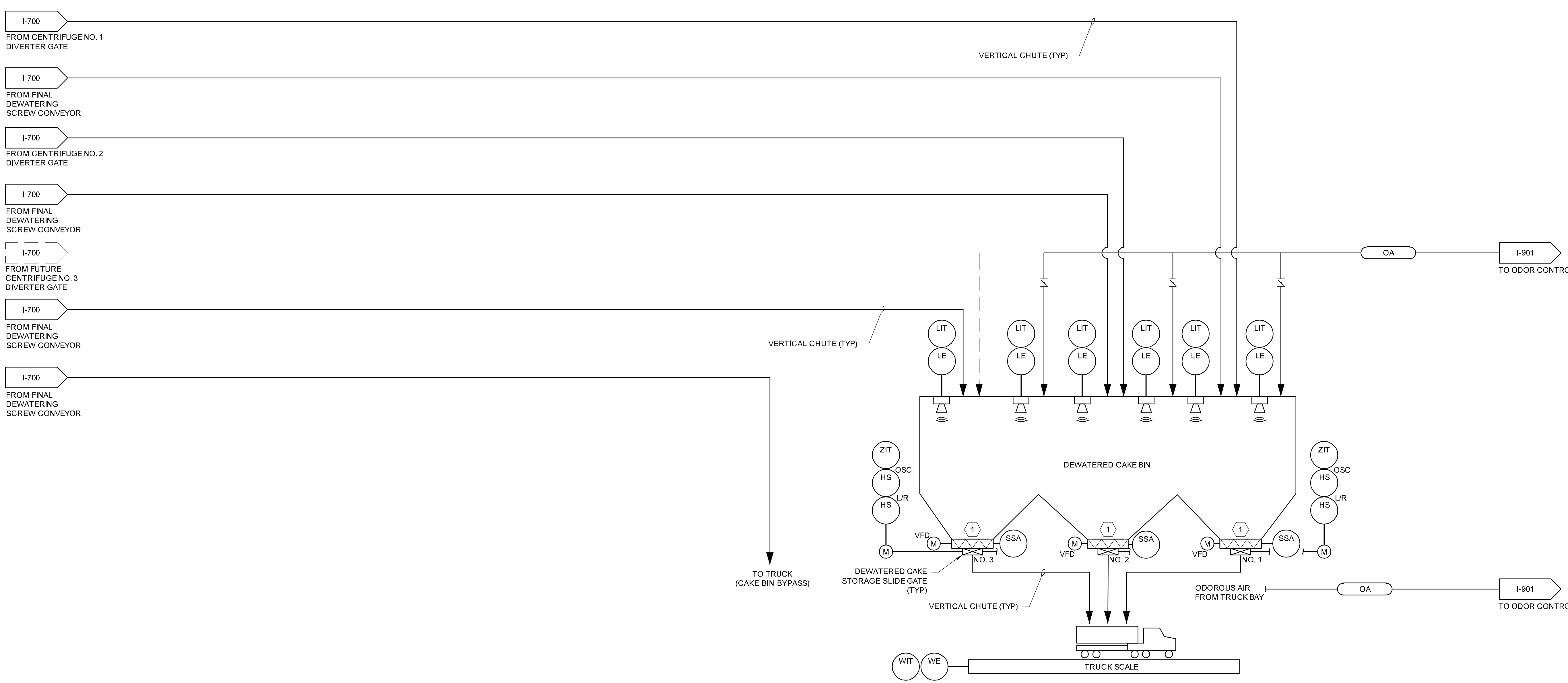
KEY NOTES: #

1. DEWATERED CAKE BIN SCREW CONVEYOR NOS. 1-6.



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FINAL DEWATERING CAKE BIN PROCESS AND INSTRUMENTATION DIAGRAM

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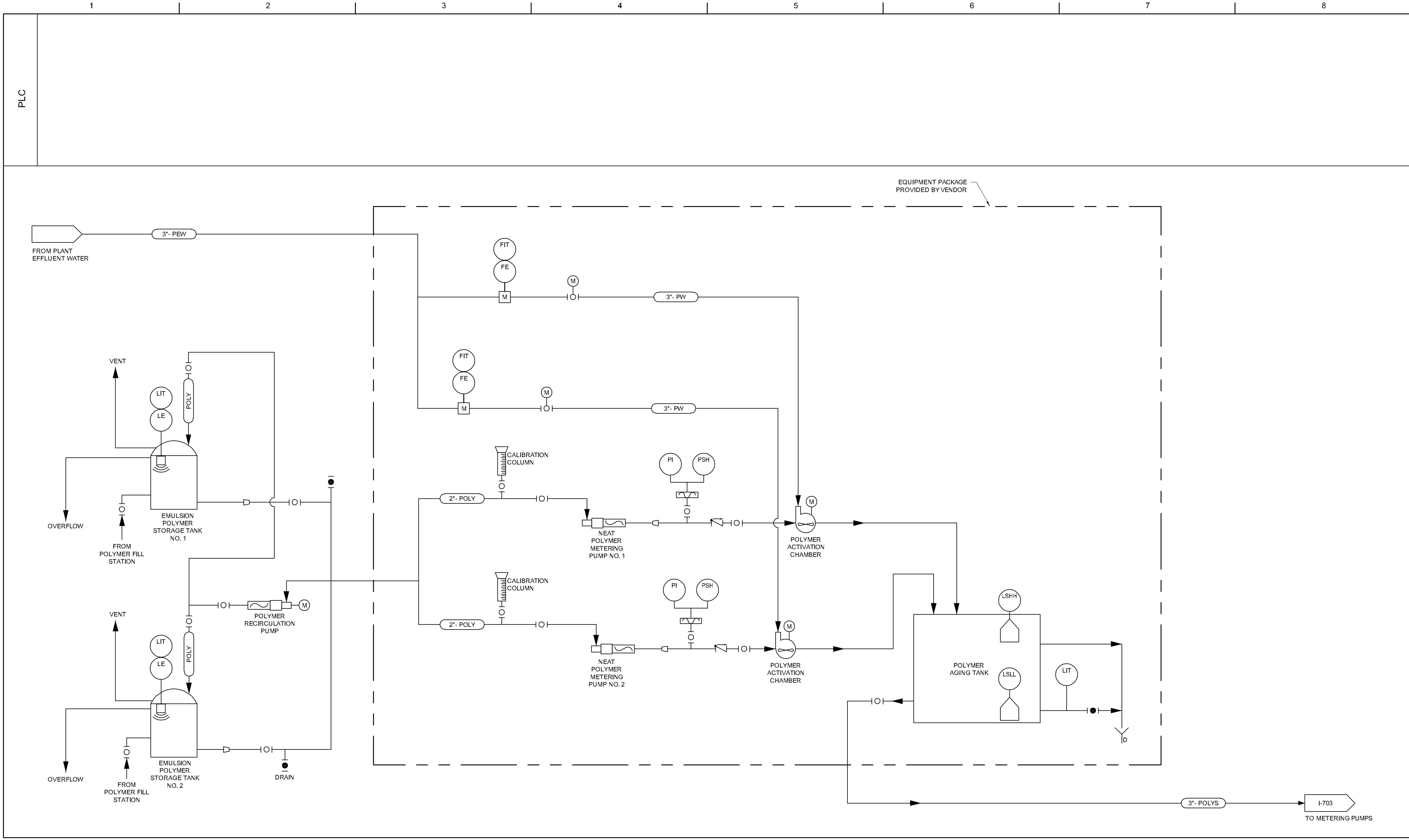

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FINAL DEWATERING POLYMER PROCESS AND INSTRUMENTATION DIAGRAM 1

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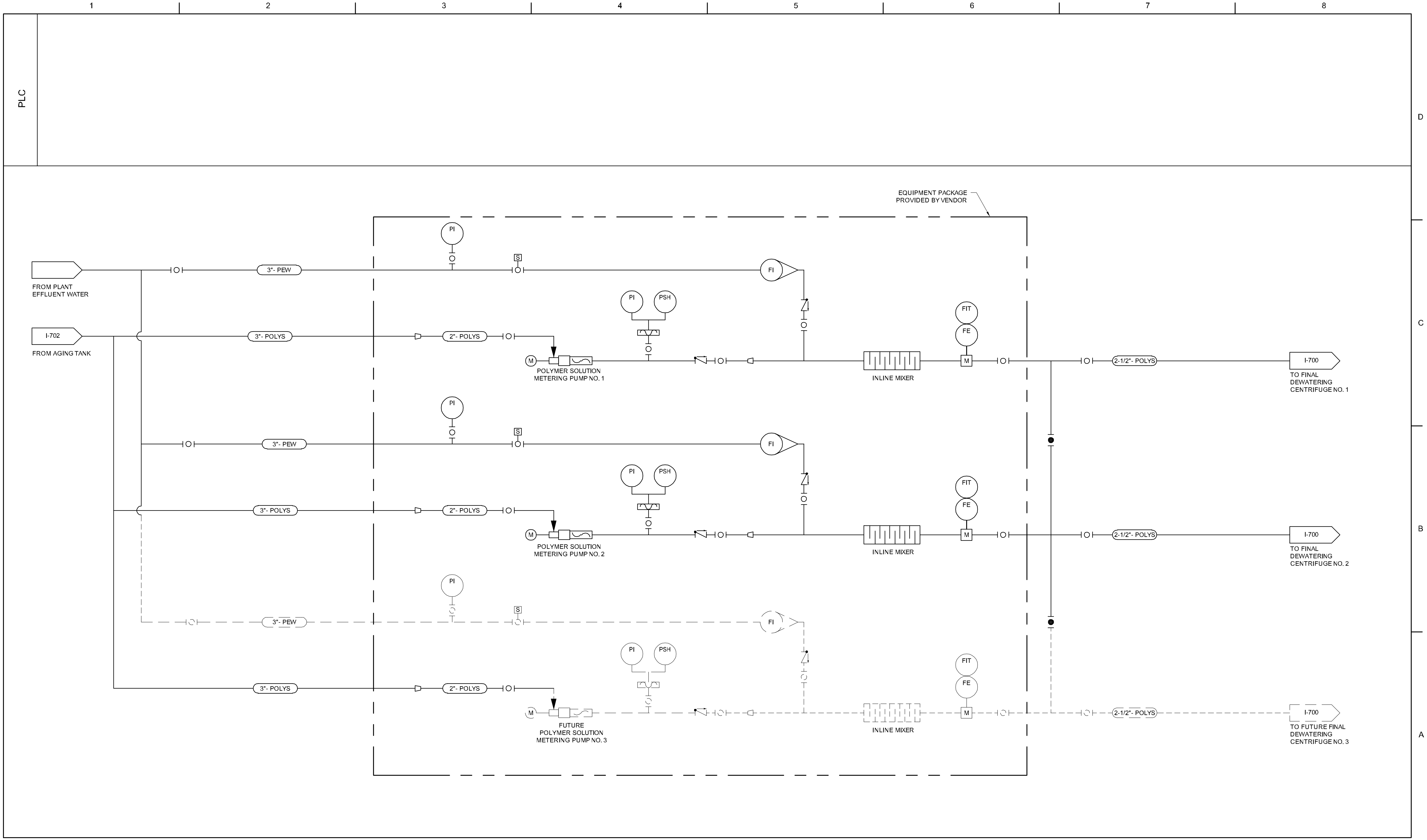

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FINAL DEWATERING POLYMER PROCESS AND INSTRUMENTATION DIAGRAM 2

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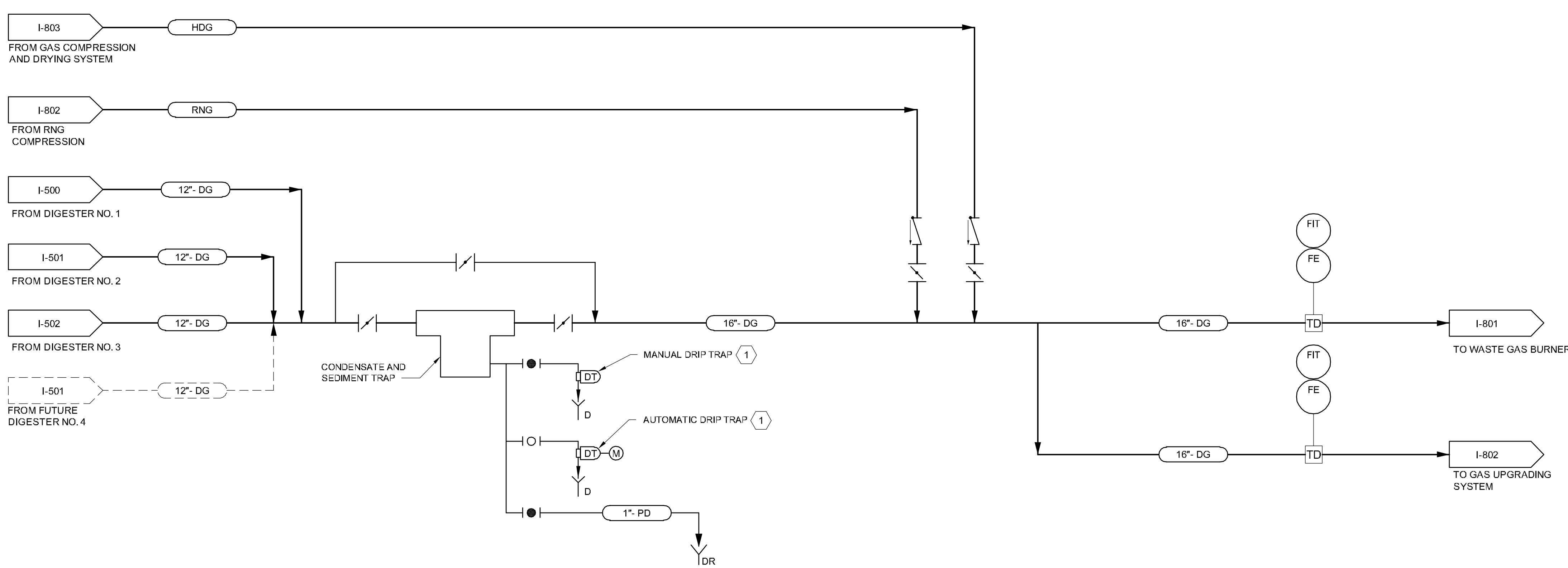
KEY NOTES:

1. DRIP TRAPS REQUIRED AT ALL DIGESTER GAS LOW POINTS.



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DIGESTER GAS DISTRIBUTION PROCESS AND INSTRUMENTATION DIAGRAM

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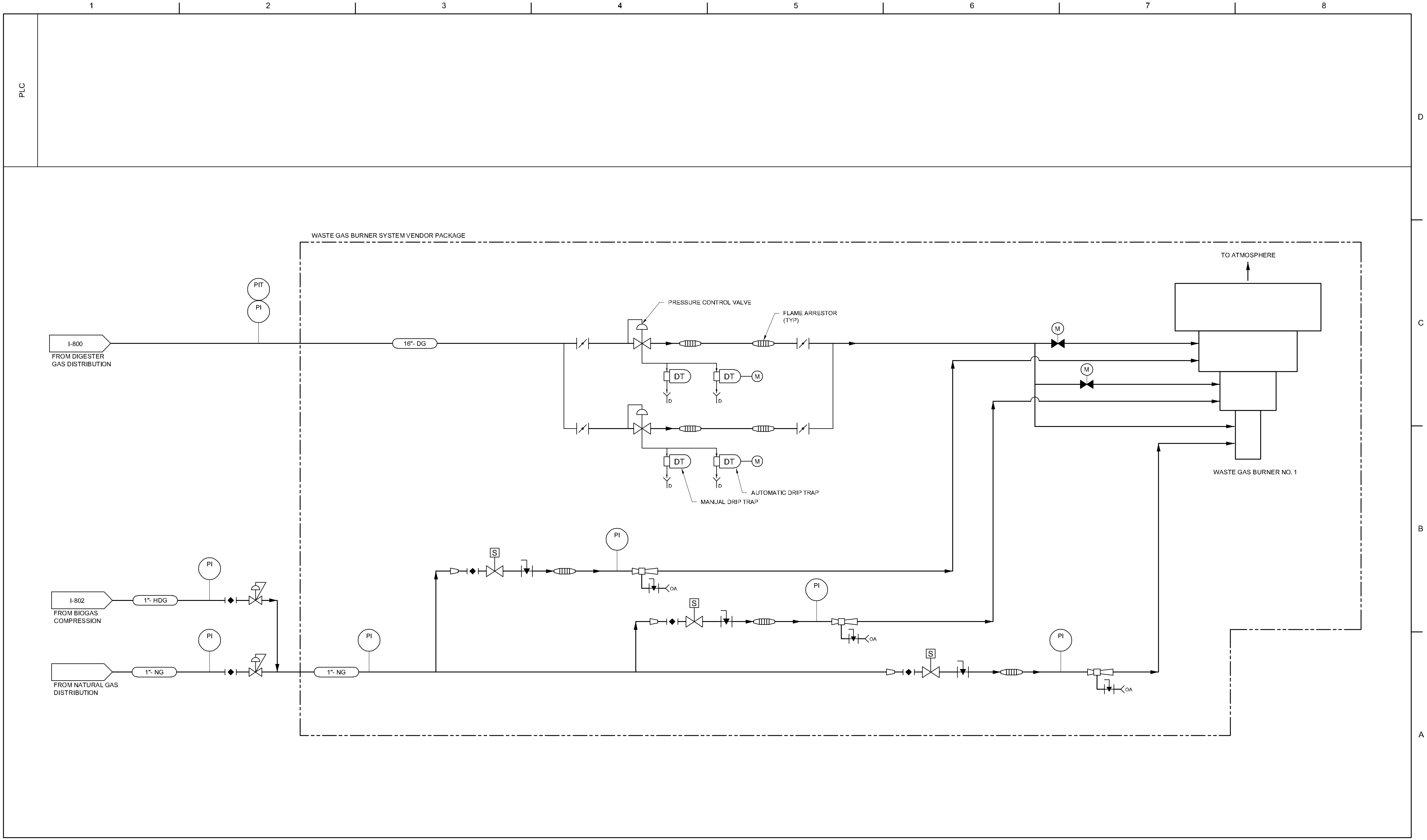

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WASTE GAS BURNER PROCESS AND INSTRUMENTATION DIAGRAM

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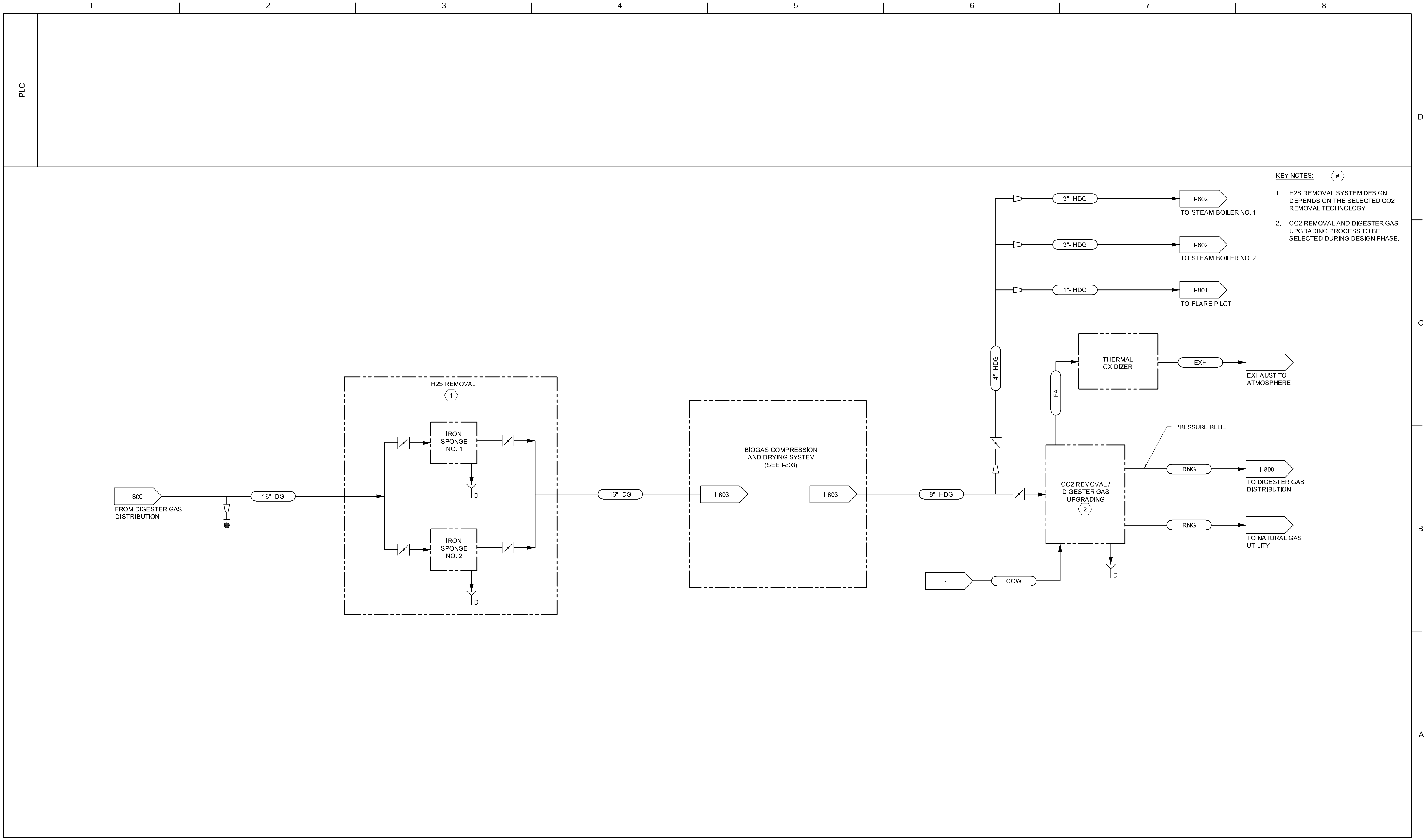

KEY NOTES: #

1. H2S REMOVAL SYSTEM DESIGN DEPENDS ON THE SELECTED CO2 REMOVAL TECHNOLOGY.
2. CO2 REMOVAL AND DIGESTER GAS UPGRADING PROCESS TO BE SELECTED DURING DESIGN PHASE.

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DIGESTER GAS UPGRADING PROCESS AND INSTRUMENTATION DIAGRAM

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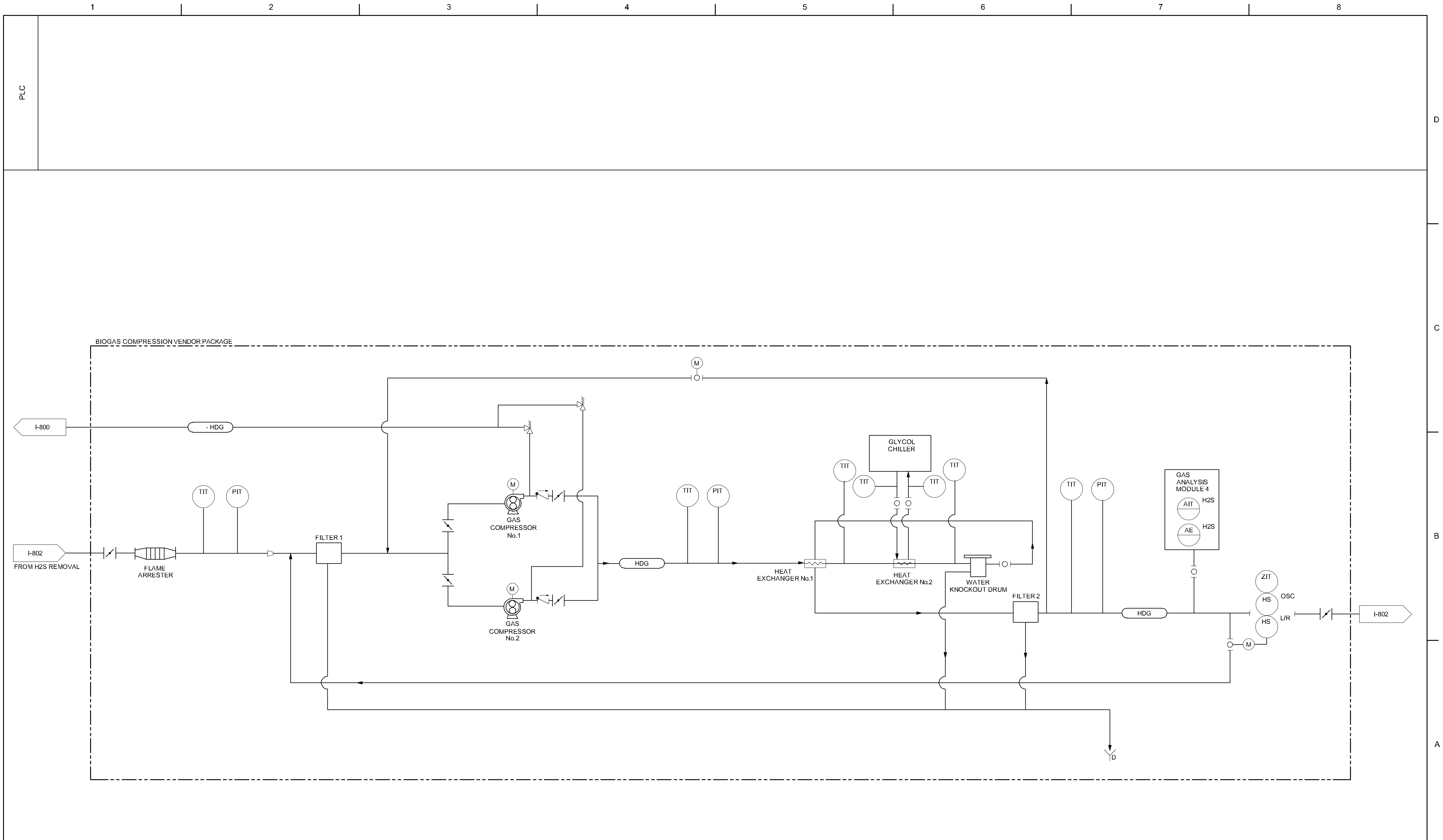

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BIOGAS COMPRESSION
PROCESS AND INSTRUMENTATION DIAGRAM

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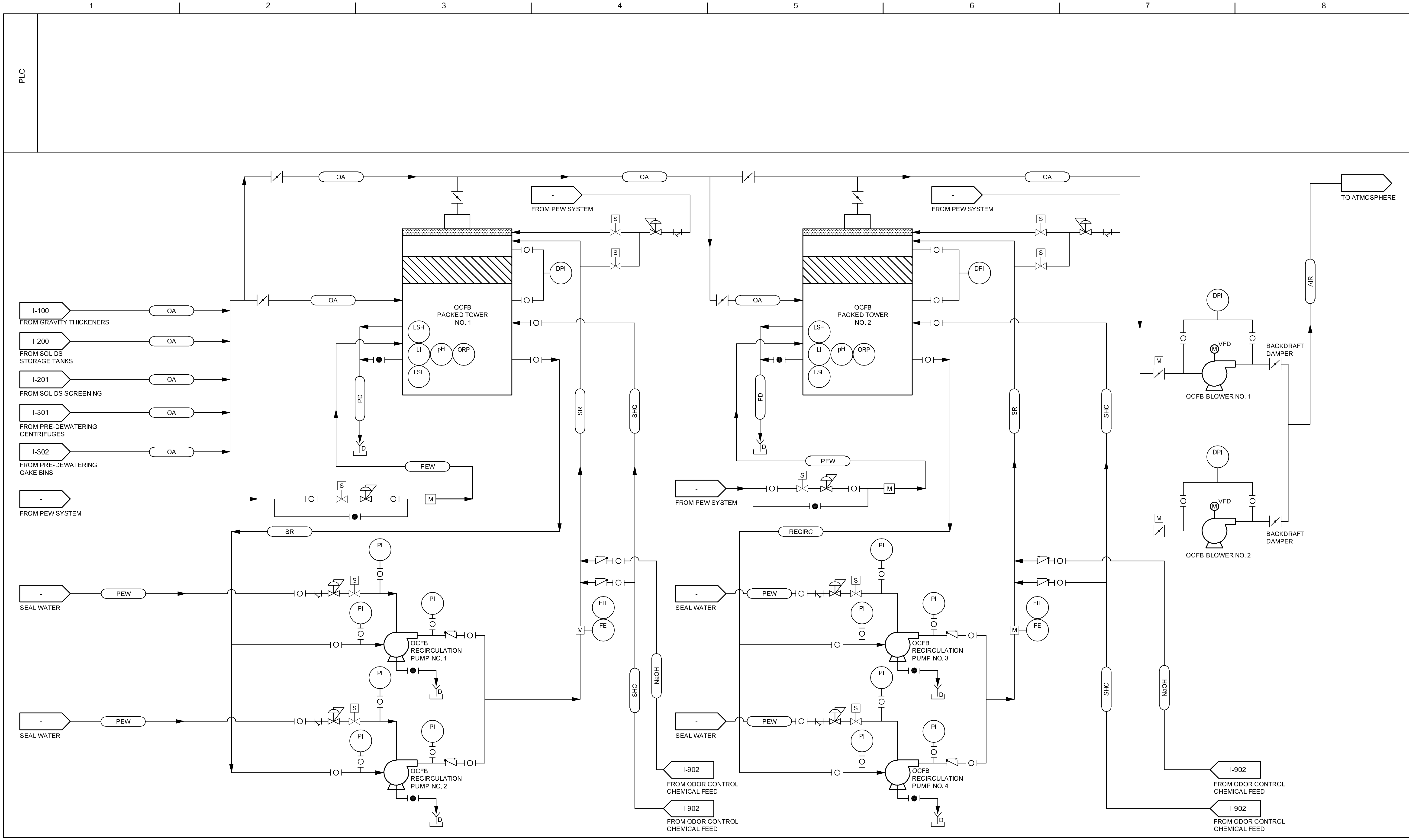

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ARLINGTON COUNTY WPCP RE-GEN

ODOR CONTROL FACILITY B
PROCESS AND INSTRUMENTATION DIAGRAM

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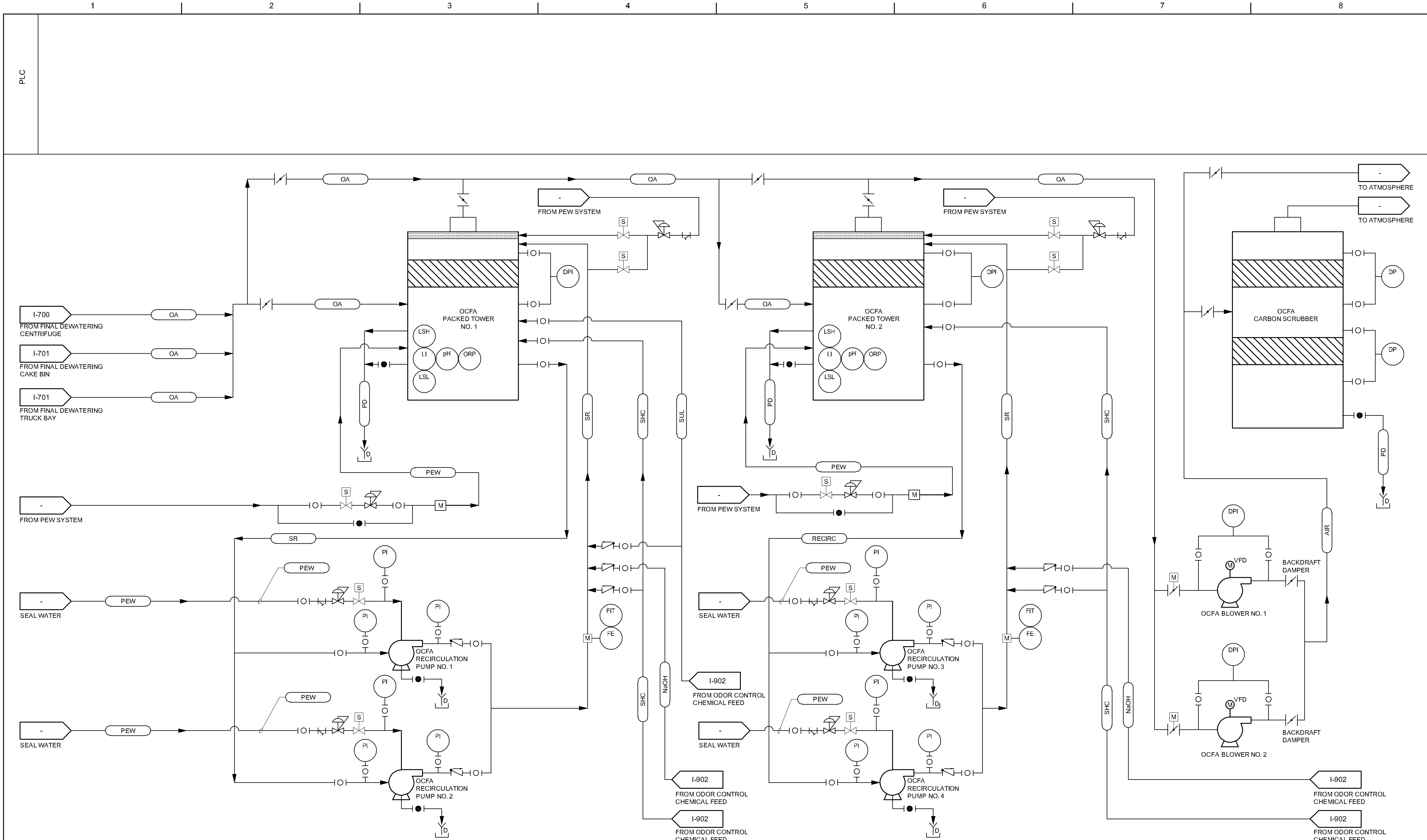

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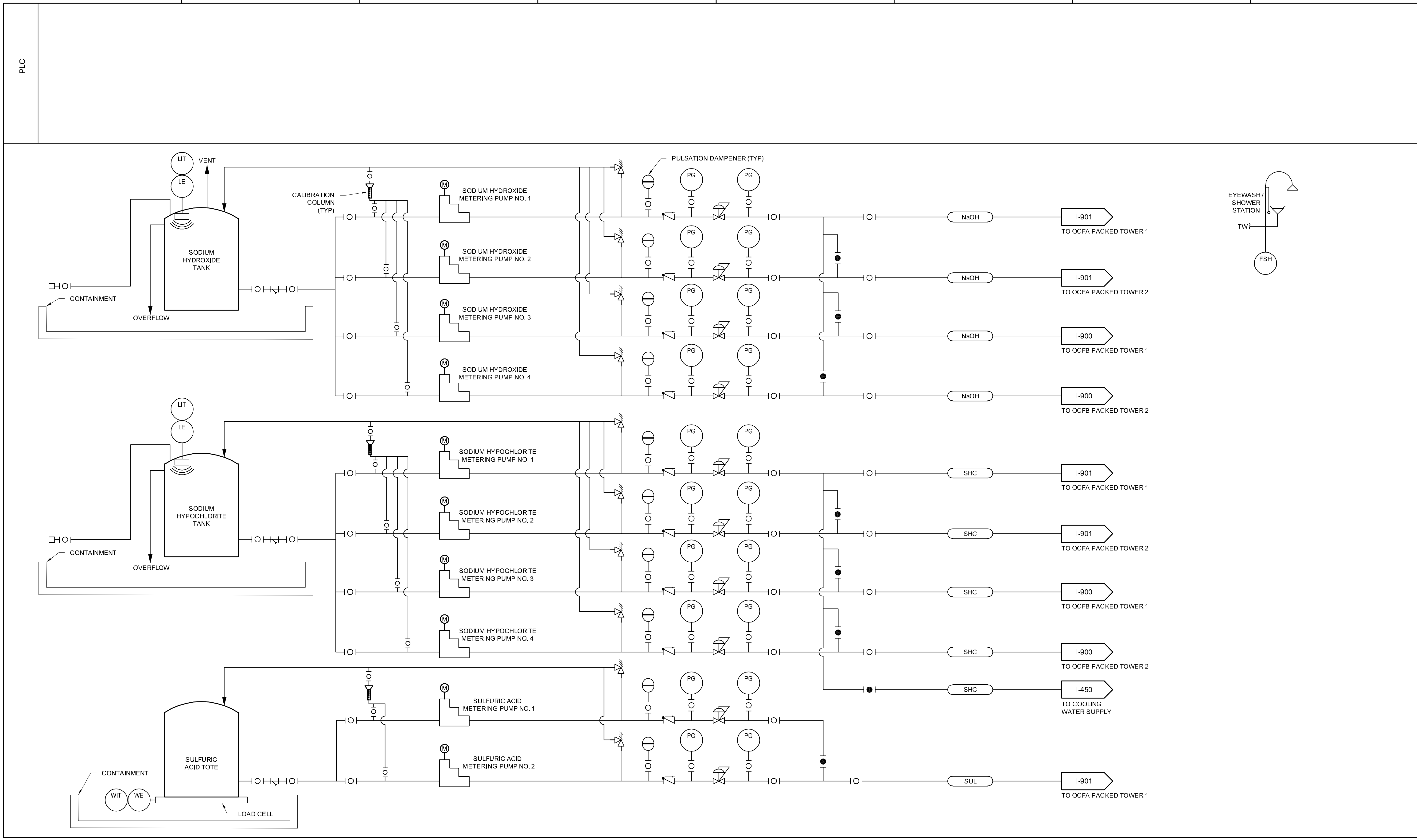

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ARLINGTON COUNTY WPCP RE-GEN

ODOR CONTROL CHEMICAL FEED PROCESS AND INSTRUMENTATION DIAGRAM

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ARLINGTON RE-GEN

FACILITIES PLAN

Volume 3 - Appendices

HDR

February 15, 2023

CONTENTS

Appendix A

Technical Memoranda

Appendix A Contents

Technical Memorandum No. 1

Date:	December 12, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Solids Production and Design Criteria

Contents

Tables

Figures

Attachment

1.0 Introduction

This Technical Memorandum (TM) 1 serves to quantify the current solids production at the Arlington Water Pollution Control Plant (WPCP) and develop projections for future solids loads. Additionally, a solids process model spreadsheet was developed to generate mass balances for the future solids process configuration. This solids process model uses the solids load projections as inputs, along with assumptions for the unit process operations, which will be updated as decisions are made about various unit processes. The model will serve as a tool for evaluating the various unit process options. The WPCP data analysis and load projections are presented first, followed by the solids process model configuration and preliminary results.

2.0 Historical Flows and Loads

Historical WPCP flows and loads were evaluated to serve as a basis for projecting future solids loads. This section describes the approach for data collection and analysis, evaluation of liquid process flows and loads, and evaluation of solids process flows and loads. While the goal of this section is to quantify the solids loads, the liquid process loads were also evaluated to provide a point of reference for solids production and to allow solids production to be defined in terms of flow treated.

2.1 Data Collection

WPCP data for this analysis were exported from the WPCP's historian, Hach Water Information Management Solution (WIMS), in December 2020. Lime delivery data and annual sludge solids discharge monitoring reports were also gathered to provide an additional method of calculating and verifying overall WPCP solids production. The data analysis focused on the 3-year period from December 2017 through November 2020. In the discussion below, the average for a year (e.g., 2020) refers to the period from the previous December through November of that year.

The WPCP data set was reviewed by plotting key parameters, identifying outlier values, and developing mass balances to identify inconsistencies. An example of outlier data was unrealistically high truck scale weights on certain days, which were corrected by identifying the error in hourly data entries and then validated by comparing to sludge discharge monitoring reports. Another example is the reported solids concentration from the dissolved air flotation thickeners (DAFTs). It was found that DAFT solids values were skewed high with many outliers, and therefore would not be reliable for calculating waste activated sludge (WAS) loads. Mass balance calculations were developed to calculate loads across the solids processes using multiple methods. This approach allowed for the selection of the appropriate calculation methods and provided a means of checking overall WPCP solids production.

2.2 WPCP Flow and Influent Loads

The overall WPCP flow was evaluated along with influent biochemical oxygen demand (BOD) and total suspended solids (TSS) loads. The WPCP final effluent flow is the best measurement of WPCP flow, because it is calculated from only two measurements (post-aeration effluent minus plant effluent water used), whereas WPCP influent flow is a calculated value from multiple influent sources and WPCP recycles. WPCP effluent flows are summarized in Table 1 below. The average effluent flow of 23 million gallons per day (mgd) was used to define solids production in terms of flow treated. Flow peaking factors are shown for reference and were not used to specify the WPCP solids loads.

Table 1. WPCP Effluent Flows and Peaking Factors

Parameter	Final Effluent Flow (mgd)			
2018 average	23.9			
2019 average	23.6			
2020 average	21.7			
3-year average	**23.0**			
Parameter	**30-day PF**	**14-day PF**	**7-day PF**	**3-day PF**
2018 peaking factor	1.24	1.34	1.60	2.00
2019 peaking factor	1.20	1.26	1.51	1.94
2020 peaking factor	1.11	1.16	1.24	1.36
Average peaking factor	**1.19**	**1.26**	**1.45**	**1.77**

Primary influent loads and peaking factors (Table 2) were calculated based on influent BOD or TSS measurements and primary effluent flow, with the assumption that the measured primary effluent flow is approximately equal to the primary influent flow, which is not directly measured. Average primary effluent flow was 29 mgd, which is approximately 6 mgd higher than the WPCP effluent flow because of recycles from WPCP effluent water use, backwash, thickening, and dewatering. The primary influent BOD and TSS measurements also include WPCP recycles. A gravity thickener (GT) upset in 2018 that lasted more than a month had a dramatic effect on the load calculations. For this reason, 2018 was excluded from the analysis presented in Table 2, and 2017 data were used instead. The primary influent loads and peaking factors in Table 2 are presented for reference and were not directly used in calculating solids production. Average primary solids capture during 2017–2020 was 68 percent, calculated based on comparing primary influent and effluent TSS values.

Table 2. Primary Influent BOD, TSS Loads and Peaking Factors

Parameter	Primary Influent BOD (lb/d)			Primary Influent TSS (lb-DS/d)		
2017 average	71,100			68,400		
2019 average	65,600			58,100		
2020 average	60,300			56,800		
3-year average	**65,700**			**61,100**		
Parameter	**30-day**	**14-day PF**	**7-day PF**	**30-day PF**	**14-day PF**	**7-day PF**
2017 peaking factor	1.21	1.38	1.48	1.26	1.43	1.64
2019 peaking factor	1.16	1.31	1.45	1.13	1.29	1.56
2020 peaking factor	1.33	1.42	1.60	1.34	1.59	2.02
Average peaking factor	**1.24**	**1.37**	**1.51**	**1.24**	**1.43**	**1.74**

2.3 Solids Production

The overall goals of this analysis were to determine the following:

- The WPCP solids production in terms of dewatered cake hauled (dry tons [DT] per million gallons [MG] of flow treated)
- Primary sludge (PS) or thickened primary sludge (TPS) production
- Primary scum production
- WAS or thickened waste activated sludge (TWAS) production
- Capture rates for thickening and dewatering processes
- Load peaking factors for PS, WAS, and cake (peak 30-day, 14-day, 7-day, and 3-day)

Together these parameters define the solids loads across unit processes. Multiple calculation approaches were evaluated where possible. Data are presented for the selected calculation approach, and some of the alternative approaches are discussed to explain the reasoning for using the selected approach. Figure 1 illustrates the simplified solids process schematic with flow meter locations and total solids (TS) sample collection points identified. The approaches for calculating key solids loads are also shown.

- WAS load was calculated using the total WAS flow and average TS concentration to the DAFT.
- Cake load was calculated using two methods: centrifuge feed load minus centrate load or hauled solids minus lime and water content.
- Thickened PS and primary scum loads were calculated based on an overall mass balance using the cake load, WAS load, and capture rates for thickening and dewatering processes.

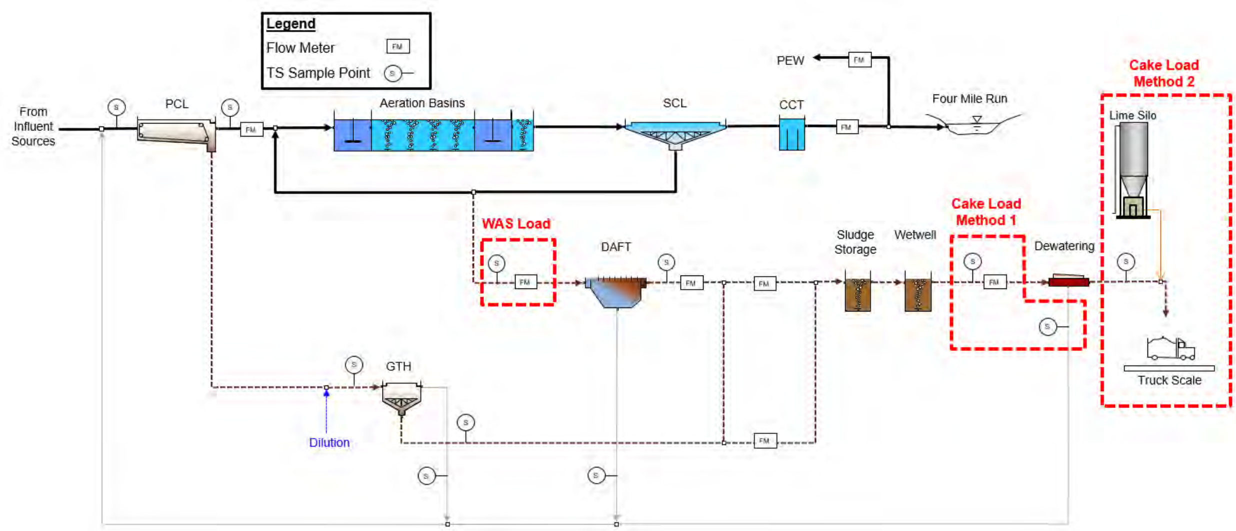

Figure 1. Simplified process schematic and solids load calculation methods

2.3.1 Primary Sludge and Scum

The concentration of the PS is not regularly measured prior to dilution water addition and gravity thickening. WPCP staff collected PS samples for TS analysis on March 9 and April 15, 2021, and PS flow was measured with a strap-on flow meter during the April 15 sampling. Based on these sampling events and analysis of PS runtimes, the typical PS concentration is estimated to be approximately 1.0 percent TS.

Average TPS plus primary scum loads and peaking factors are summarized in Table 3. PS and primary scum were quantified together based the mass balance approaches that were available, and the primary scum component is broken out later based on a separate analysis of primary scum. Loads are presented in terms of thickened sludge to dewatering, rather than un-thickened loads, because of limited flow and concentration data for PS and primary scum. Un-thickened loads can be calculated based on thickening capture rates. TPS plus primary scum loads were calculated based on the centrifuge feed solids load and subtracting the WAS load. Peaking factors were calculated based on the blended sludge solids load and subtracting the WAS load. The TPS load calculation approach using centrifuge feed was deemed to be more accurate for overall solids production because the centrifuge feed solids load was most similar to the WPCP solids production calculated based on hauling records. The approach using the blended sludge load (north and south headers) was deemed more appropriate for peaking factors because this flow is less affected by dewatering operations, whereas the centrifuge feed experiences additional variations because of dewatering schedules. The average TPS plus scum production was approximately 41,900 pounds per day (lb/d). Solids capture at the GT was estimated at 95 percent based on the available data for GT influent TS after dilution and GT overflow TSS.

Table 3. Thickened Primary Sludge and Scum Loads and Peaking Factors

Parameter	Thickened Primary Sludge and Scum (lb-DS/d)			
2018 average	43,300			
2019 average	43,000			
2020 average	39,500			
3-year average	**41,900**			
Parameter	**30-day PF**	**14-day PF**	**7-day PF**	**3-day PF**
2018 peaking factor	1.31	1.44	1.50	1.72
2019 peaking factor	1.43	1.56	1.69	1.84
2020 peaking factor	1.31	1.37	1.41	1.60
Average peaking factor	**1.35**	**1.46**	**1.53**	**1.72**

Alternative calculation methods for TPS and primary scum loads were also evaluated. Average TPS plus scum loads for years without significant GT upsets (2017, 2019, and 2020) were calculated based on primary clarifier influent and effluent TSS along with primary effluent flow, and this method produced a slightly lower estimate of 39,500 lb/d PS (61,100 lb/d primary influent TSS from Table 2 × 68.1 percent primary clarifier capture × 95 percent thickening capture). This approach was not preferred because it cannot be applied during periods when there was a GT upset, and it has larger fluctuations that would lead to unrealistic peaking factors. TPS load was also estimated using the blended sludge flow, subtracting the TWAS flow, and applying the measured TPS solids concentration. That method produced higher results (49,400 lb/d) and was not used because inaccuracies in either the TWAS flow measurement or TPS grab sample solids concentrations could affect the results.

Historically, primary scum has been added to the DAFT. In the near future, scum will be concentrated separately and added to screenings sent to landfill. Given the calculation approach used for this analysis, primary scum and TPS load are quantified together (calculated as centrifuge feed minus WAS). Limited data were available for primary scum, so special sampling was conducted on April 29, 2021. Results for scum percentage TS and percentage VS were highly variable, but typically averaged between 0.5 and 1.0 %TS and 90 percent volatile. The current primary scum production is estimated at 4,800 lb/d based on an average primary scum pump runtime of 16 hours per day, flow of 120 gallons per minute (gpm) when running, and 0.50 percent TS.

2.3.2 Waste Activated Sludge

WAS loads and peaking factors were calculated based on the total WAS flow and WAS concentration (Table 4). Average WAS production was 21,800 lb/d. Average solids capture at the DAFT was over 99.5 percent, based on the average DAFT underflow TSS concentration of 57 milligrams per liter (mg/L) and assuming that no WPCP effluent water is added. With this high capture rate, the WAS load is nearly equal to the TWAS load. As an alternative evaluation approach, the TWAS load was calculated based on TWAS flow and solids concentration. That approach was not reliable and resulted in much higher TWAS loads (28,000 lb/d) because of the TWAS solids values being skewed high even after removing outliers.

The reported TWAS solids concentration averaged 4.1 percent after removing outliers above 9 percent solids. Based on the average TWAS flow rate (57 gpm) and the average WAS load to the DAFT (21,800 lb/d), the TWAS solids concentration is expected to be around 3.2 percent.

Table 4. WAS Loads and Peaking Factors

Parameter	WAS (lb-DS/d)			
2018 average	22,400			
2019 average	22,000			
2020 average	21,100			
3-year average	**21,800**			
Parameter	**30-day PF**	**14-day PF**	**7-day PF**	**3-day PF**
2018 peaking factor	1.21	1.26	1.32	1.47
2019 peaking factor	1.26	1.40	1.45	1.52
2020 peaking factor	1.23	1.42	1.60	1.65
Average peaking factor	**1.23**	**1.36**	**1.46**	**1.55**

2.3.3 Overall Solids Production

Centrifuge feed loads and peaking factors are summarized in Table 5. Average solids load to the centrifuges was 63,700 lb/d. The 3-day peaking factor is influenced by dewatering operation schedules, rather than purely solids generation. Instead, peaking factors for dewatering loads were selected based on a simultaneous peak in TPS and TWAS loads. This results in slightly lower and more realistic 7-day and 3-day peaking factors, while still providing a somewhat conservative estimate of peak solids production.

Table 5. Centrifuge Feed Loads and Peaking Factors

Parameter	Centrifuge Feed Load (lb-DS/d)			
2018 average	65,600			
2019 average	65,000			
2020 average	60,600			
3-year average	**63,700**			
Parameter	**30-day PF**	**14-day PF**	**7-day PF**	**3-day PF**
2018 peaking factor	1.14	1.22	1.37	1.84
2019 peaking factor	1.25	1.35	1.55	1.74
2020 peaking factor	1.41	1.54	1.67	1.96
Average peaking factor[a]	1.27	1.37	1.53	1.85
Peaking factor used[b]	**1.31**	**1.41**	**1.51**	**1.66**

a. Calculated peaking factor is influenced by dewatering operations, particularly the 3-day factor.
b. The selected peaking factor is based on simultaneous peak of TWAS and TPS production.

Dewatered cake production was calculated two ways, as shown in Table 6. The “centrifuge feed minus centrate” approach builds on the data from Table 5, subtracting the centrate solids load calculated using the Hach WIMS data. Average centrifuge solids capture was 95 percent. The “solids hauled minus lime” method is an independent calculation used to corroborate the solids production results. It is based on reported wet tons per day (wtpd) hauled from sludge solids discharge monitoring reports (~97.5 wtpd), subtracting the lime quantity used from delivery records (~4.9 tons/day), and applying the average cake solids concentration from the centrifuges (~31.3 percent). The results from these two methods were quite similar, ranging from 1.26 to 1.31 DT/MG treated. An overall sludge production value of 1.30 DT/MG was selected for developing solids process mass balances. This sludge production is reasonable given the BOD influent to the plant and the use of chemically enhanced primary treatment.

Table 6. Overall Solids Production based on Dewatering Data and Hauling Records

Parameter	Effluent Flow (mgd)	Dewatered Cake (Centrifuge Feed: Centrate)		Dewatered Cake (Solids Hauled – Lime)	
		lb-DS/d	DT/MG	lb-DS/d	DT/MG
2018 average	23.9	60,900	1.28	60,000	1.26
2019 average	23.6	62,400	1.32	60,200	1.28
2020 average	21.7	57,600	1.33	54,100	1.25
3-year average	**23.0**	**60,300**	**1.31**	**58,100**	**1.26**

The solids production factors presented above are summarized in Table 7, along with the method used for developing each factor. These parameters were used to generate a solids mass balance for current conditions, which served as the basis for scaling to future loading conditions.

Table 7. Summary of Solids Production Factors

Parameter	Value				Notes
Dewatered cake production	1.3 DT/MG treated				Based on analysis of centrifuge operating data and hauling records
Capture rates	Centrifuge: 95%, GT: 95%, DAFT: 99.5%				Based on analysis of operating data
TWAS load fraction [TWAS/(TWAS+TPS)]	34.5% of dry solids to dewatering				Based on average WAS load along with overall solids production and capture rates
Parameter	**30-day PF**	**14-day PF**	**7-day PF**	**3-day PF**	**Notes**
PS or TPS peaking factor	1.35	1.46	1.53	1.72	Based on blended sludge load minus WAS load
WAS or TWAS peaking factor	1.23	1.36	1.46	1.55	Based on WAS load to DAFT
Centrifuge feed or cake peaking factor	1.31	1.41	1.51	1.66	Based on simultaneous TWAS and TPS peak

2.3.4 Volatile Solids Fraction

The volatile solids (VS) fraction of the sludge is an important factor for evaluating future anaerobic digestion (AD) and digester gas utilization strategies. Based on the WPCP data, the TPS was 84.2 percent volatile (±5 percent standard deviation) and the TWAS was 72.4 percent volatile (±8 percent standard deviation). Variability in the VS fraction was higher for TWAS than TPS, which could be related to the primary scum added to the DAFT. Using these average values along with the quantities presented above, the mixed sludge or cake is expected to be 80.6 percent volatile by mass balance. WPCP data indicate that blended sludge was 78 percent volatile (±5 percent standard deviation) and dewatered cake was 81.4 percent volatile (±3 percent standard deviation), so this calculated value is reasonable. The primary scum is approximately 90 percent volatile, and by mass balance the TWAS without scum is estimated to be 68.5 percent volatile. Results of a two-week sampling event in December 2021 showed that the WAS was 67.5 percent volatile on average, which supports the calculated value used in this evaluation.

2.4 Solids Production Summary

Current and projected solids loads are summarized in Table 8 below. The values are based on the mass balance analysis presented above. Key calculation inputs and assumptions include the following:

- Overall solids production from the dewatering centrifuges is 1.30 DT/MG treated as currently configured.

- The solids production analysis reflects historical operating conditions including capture rates and the use of ferric chloride for enhanced primary clarification. Solids projections assume that operation of liquid treatment processes is similar in the future.
- Primary scum is included based on the available data and the current practice of sending primary scum to the DAFT and ultimately to dewatering. Peaking factors for scum are assumed to be the same as those for PS. While primary scum is included in the solids loads, it has not been decided whether scum will be included in future THP and anaerobic digestion.
- Current solids capture rates were 95 percent for gravity thickening (PS), 99.5 percent for DAFT (WAS), and 95 percent for centrifuge dewatering.
- Future load projections were evaluated for WPCP flows of 30.8 mgd and 40.0 mgd. The 30.8 mgd WPCP flow condition represents approximately 40 dry tons per day (dtpd) from the centrifuges at current operating conditions and was selected as the design condition for this project during Workshop 2 on March 17, 2021. Based on the most recent Arlington County growth projections (Arlington County Forecast Round 9.1) and assuming linear growth, this condition is expected to be met around year 2051. The 40.0 mgd WPCP flow condition represents the WPCP buildout capacity and the design capacity of the liquid side of the WPCP.

Table 8. Solids Production Summary and Future Projections

Year	Effluent Flow (mgd)	Primary Solids (lb/d)				
		Average	30-day	14-day	7-day	3-day
2020	23.0	38,400	51,800	56,000	59,100	66,000
Design	30.8	51,400	69,400	75,000	79,100	88,400
Buildout	40.0	66,700	90,100	97,400	102,800	114,800
Year	**Effluent Flow (mgd)**	**Primary Scum (lb/d)**				
		Average	**30-day**	**14-day**	**7-day**	**3-day**
2020	23.0	4,800	6,500	7,000	7,400	8,200
Design	30.8	6,400	8,600	9,400	9,900	11,000
Buildout	40.0	8,300	11,200	12,100	12,800	14,300
Year	**Effluent Flow (mgd)**	**WAS (lb/d)**				
		Average	**30-day**	**14-day**	**7-day**	**3-day**
2020	23.0	21,800	26,800	29,700	31,600	33,800
Design	30.8	29,200	36,000	39,800	42,400	45,300
Buildout	40.0	38,000	46,700	51,600	55,000	58,800
Year	**Effluent Flow (mgd)**	**Combined Thickened Solids (lb/d)**				
		Average	**30-day**	**14-day**	**7-day**	**3-day**
2020	23.0	62,900	82,400	89,800	95,000	104,600
Design	30.8	84,300	110,300	120,200	127,200	140,000
Buildout	40.0	109,500	143,300	156,100	165,200	181,900
Year	**Effluent Flow (mgd)**	**Centrifuge Cake (lb/d)**				
		Average	**30-day**	**14-day**	**7-day**	**3-day**
2020	23.0	59,800	78,300	85,200	90,200	99,300
Design	30.8	80,000	104,800	114,200	120,800	133,000
Buildout	40.0	104,000	136,100	148,300	157,000	172,800

3.0 Preliminary Solids Process Model

This section describes the preliminary solids process model, including its background and purpose, solids process model assumptions, and solids process model outputs.

3.1 Background and Purpose

A solids process model was developed using a mass balance approach to determine system operations at steady state. The model includes all major unit processes for the proposed solids handling configuration. Inputs to the model include average solids production quantities and maximum 30-day, 14-day, 7-day, and 3-day peaking factors. These solids quantities are based on the analysis of WPCP data presented in the previous section. Solids quantities are projected to future conditions based on expected increases in WPCP flow and load. The model includes inputs for each unit process, which are currently based on typical industry values and vendor information. Process parameters will be adjusted and updated as necessary as decisions are made regarding equipment selection and process configuration and as additional information is gathered from the thermal hydrolysis process (THP)/AD pilot testing.

The model output is a mass balance at each step in the solids processes. A proposed solids process configuration is illustrated in Figure 2, which is based on THP/AD as recommended by the 2018 Arlington WPCP Solids Master Plan (CDM Smith). Parameters specific to each unit process are included, such as steam demand for THP, sludge cooling requirements, nitrogen (N) released in the AD process, digester gas production, polymer use, and wash water and dilution water requirements.

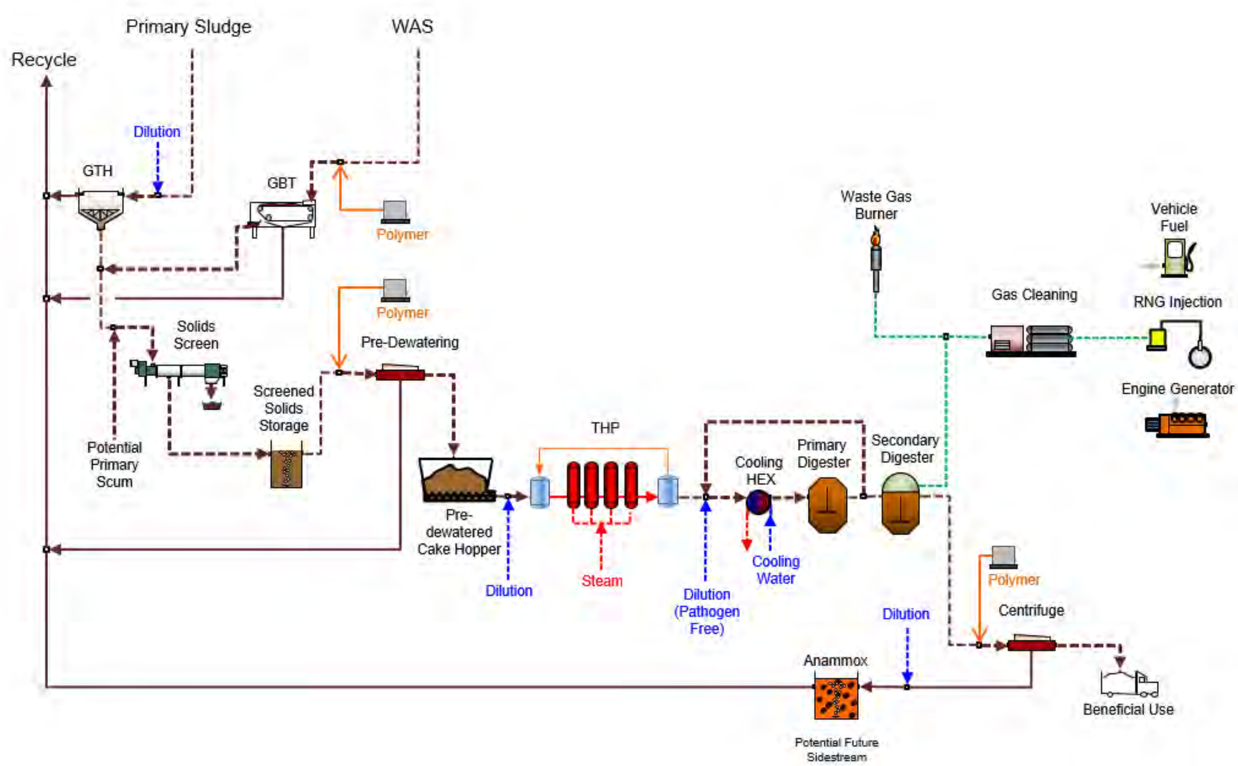

Figure 2. Proposed solids process flow diagram

3.2 Solids Process Model Assumptions

The solids process model was developed starting with the flow and load conditions presented in the previous section. This includes overall sludge production of 1.30 DT/MG treated, stated peaking factors and VS fractions, and similar liquid treatment process operation in the future.

The process model configuration was based on the process flow depicted in Figure 2, and assumptions for process operation listed in Table 9. Many of these parameters will be revised as process decisions are made (e.g., thickening approach, scum/fats, oils, and grease [FOG]) and as additional information is gathered from the WPCP and from the THP/AD pilot testing (e.g., VS destruction, sludge nitrogen content, etc.). Future changes in solids recycle loads relative to current thickening and dewatering operations are reflected in the model as additional primary solids. The process model and mass balance calculations provide a basis for further evaluations and will be updated and expanded as necessary.

Table 9. Process Model Assumptions

Primary Sludge and Thickened Primary Sludge	Value	Source
PS solids concentration	1.0%	Based on analysis of special sampling 3/9/2021 and 4/15/2021
TPS solids concentration	4.0%	Based on analysis of plant data, average was 5%
Solids capture: PS thickening	95%	Based on analysis of plant data for GT influent and overflow
Primary Scum		
Dilute primary scum concentration	0.5%	Average ranged from 0.5% to 1.0% during 2021 special sampling. Scum flow capped at 120 gpm in model and concentration increased accordingly.
WAS and TWAS		
WAS solids concentration	1.0%	Based on analysis of WPCP data, average was 1.08%
Future TWAS solids concentration	5.0%	Typical industry value
Solids capture: Future WAS thickening	98%	Based on historical DAFT capture of >99%
WAS thickening polymer dose (lb active polymer/DT)	5	Typical industry value
Pre-dewatering		
Pre-dewatered solids concentration	25%	High solids not required for pre-dewatering; feasibility to be evaluated further
Pre-dewatering solids capture	95%	Based on current centrifuge dewatering
Dewatering polymer dose (lb active polymer/DT)	10	Based on historical operation at 8 lb/DT
THP/AD		
THP steam demand (ton steam per ton dry solids)	1.0	Typical value for Cambi
Digested sludge recycle ratio to heat exchanger feed	3.5–5.0	Typically set to 3.5:1 recycle ratio at peak 3-day condition
Digester feed solids concentration	9.0%	Typical value for THP
Volatile solids reduction	60%	Typical industry value, supported by pilot results
Sludge nitrogen content (lb-N/lb-VS)	0.045	Based on replicating pilot digester effluent ammonia
Biogas yield (ft^3-biogas/lb-VSd)	15	Typical industry value, supported by pilot results
Biogas higher heating value (Btu/ft^3-biogas)	650	Typical industry value
Biogas lower heating value (Btu/ft^3-biogas)	580	Typical industry value
Post-dewatering		
Post-dewatering solids capture	95%	Typical industry value for centrifuge dewatering
Post-dewatered solids concentration	33%	Estimate; evaluations ongoing
Dewatering polymer dose (lb active polymer/DT)	30	Estimate

3.3 Solids Process Model Outputs

This section presents the modeled flows and loads for each unit process at WPCP flows and loads associated with current conditions (23 mgd annual average effluent flow), selected design year conditions (30.8 mgd), and WPCP buildout (40 mgd).

An overall mass balance process flow diagram for the selected design year annual average conditions is included as Attachment A. While only one operating condition is shown in Attachment A, the tables in this section provide flows, loads, gas production, thermal energy demands, and polymer use for each WPCP flow condition (23.0, 30.8, and 40.0 mgd) and peaking factor (annual average, peak 30-day, 14-day, 7-day, and 3-day). Table 10 through Table 12 include the major process flows and loads for each of these three WPCP flow conditions. Model input parameters included in these tables are italicized. Table 13 through Table 15 show the energy calculations, and Table 16 through Table 18 show the polymer use for each condition.

Table 10. Solids Process Model Flows: 23.0 mgd Flow (2020 Condition)

Parameter	Average	30-day	14-day	7-day	3-day
Primary Solids					
Total solids load (lb-TS/d)	39,924	53,831	58,234	61,434	68,576
Volatile solids load (lb-VS/d)	33,254	44,853	48,518	51,181	57,140
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	478,709	645,460	698,251	736,614	822,251
Flow (gpm)	332	448	485	512	571
Thickened Primary Solids					
Total solids load (lb-TS/d)	37,928	51,140	55,322	58,362	65,147
Volatile solids load (lb-VS/d)	31,592	42,610	46,092	48,622	54,283
Total solids concentration	4.0%	4.0%	4.0%	4.0%	4.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	113,693	153,297	165,835	174,946	195,285
Flow (gpm)	79	106	115	121	136
WAS					
Total solids load (lb-TS/d)	21,826	26,846	29,683	31,648	33,830
Volatile solids load (lb-VS/d)	14,951	18,389	20,333	21,679	23,174
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	68.5%	68.5%	68.5%	68.5%	68.5%
Flow (gpd)	261,702	321,894	355,915	379,468	405,639
Flow (gpm)	182	224	247	264	282
Primary Scum (to Solids Storage Tank with WAS)					
Total solids load (lb-TS/d)	4,784	6,458	6,985	7,367	8,228
Volatile solids load (lb-VS/d)	4,306	5,813	6,286	6,631	7,406
Total solids concentration (lb-TS/lb-sludge)	0.50%	0.50%	0.50%	0.51%	0.57%
Volatile fraction (lb-VS/lb-TS)	90%	90%	90%	90%	90%
Flow (gpd)	114,724	154,878	167,497	172,800	172,800
Flow (gpm)	80	108	116	120	120
Combined Thickened Solids/Pre-dewatering Feed					
Total solids load (lb-TS/d)	64,538	84,444	91,990	97,377	107,206
Volatile solids load (lb-VS/d)	50,848	66,812	72,711	76,932	84,863
Total solids concentration	1.6%	1.6%	1.6%	1.6%	1.7%
Volatile fraction (lb-VS/lb-TS)	78.8%	79.1%	79.0%	79.0%	79.2%

Parameter	Average	30-day	14-day	7-day	3-day
TWAS load fraction (TWAS / (TWAS + TPS + FOG))	33.8%	31.8%	32.3%	32.5%	31.6%
Flow (gpd)	490,120	630,068	689,247	727,214	773,723
Flow (gpm)	340	438	479	505	537
Pre-dewatered Solids					
Total solids load (dtpd)	30.7	40.1	43.7	46.3	50.9
Total solids load (lb-TS/d)	61,311	80,222	87,391	92,508	101,845
Volatile solids load (lb-VS/d)	48,306	63,472	69,076	73,085	80,619
Total solids concentration (lb-TS/lb-sludge)	25.0%	25.0%	25.0%	25.0%	25.0%
Flow (gpd)	29,406	38,476	41,914	44,368	48,847
Flow (gpm)	20	27	29	31	34
Cake mass (wtpd)	123	160	175	185	204
Cake volume (CY/d at 45 lb/ft^3)	202	264	288	305	335
Thermal Hydrolysis Feed Solids with Dilution Water					
Total solids load (lb-TS/d)	61,311	80,222	87,391	92,508	101,845
Volatile solids load (lb-VS/d)	48,306	63,472	69,076	73,085	80,619
Total solids concentration (lb-TS/lb-sludge)	16.5%	16.5%	16.5%	16.5%	16.5%
Flow (gpd)	44,554	58,297	63,506	67,225	74,010
Flow (gpm)	31	40	44	47	51
Thermal Hydrolysis Depressurization Tank Solids with Steam Condensate					
Total solids load (lb-TS/d)	61,311	80,222	87,391	92,508	101,845
Volatile solids load (lb-VS/d)	48,306	63,472	69,076	73,085	80,619
Total solids concentration (lb-TS/lb-sludge)	14.2%	14.2%	14.2%	14.2%	14.2%
Flow (gpd)	51,906	67,916	73,985	78,317	86,222
Flow (gpm)	36	47	51	54	60
Temperature (°F)	221	221	221	221	221
Diluted THP Solids: Depressurization Tank Output and Pathogen-Free Dilution Water					
Total solids load (lb-TS/d)	61,311	80,222	87,391	92,508	101,845
Volatile solids load (lb-VS/d)	48,306	63,472	69,076	73,085	80,619
Total solids concentration (lb-TS/lb-sludge)	9.0%	9.0%	9.0%	9.0%	9.0%
Flow (gpd)	81,683	106,877	116,428	123,246	135,685
Flow (gpm)	57	74	81	86	94
Temperature (°F)	168	168	168	168	168
Digested Solids Recycle: to Cooling Heat Exchanger					
Total solids concentration (lb-TS/lb-sludge)	4.5%	4.5%	4.5%	4.5%	4.5%
Flow (gpd)	408,414	408,395	408,399	474,909	474,899
Flow (gpm)	284	284	284	330	330
Temperature (°F)	98	98	98	98	98
Digester Feed Solids: Diluted THP Sludge with Recycled Digested Sludge					
Total solids concentration (lb-TS/lb-sludge)	5.1%	5.2%	5.2%	5.2%	5.2%
Flow (gpd)	490,097	515,272	524,827	598,155	610,584
Flow (gpm)	340	358	364	415	424
Temperature before HEX (°F)	110	113	114	112	114
Temperature after HEX (°F)	98	98	98	98	98
Digested Solids (to Final Dewatering)					
Total solids load (lb-TS/d)	30,692	39,930	43,557	46,137	50,660
Volatile solids load (lb-VS/d)	17,686	23,180	25,241	26,714	29,434
Total solids concentration (lb-TS/lb-sludge)	4.5%	4.5%	4.5%	4.5%	4.5%
Volatile fraction (lb-VS/lb-TS)	57.6%	58.1%	58.0%	57.9%	58.1%
Flow (gpd)	81,683	106,877	116,428	123,246	135,685
Flow (gpm)	57	74	81	86	94
Ammonia-N concentration (mg/L)	1,996	2,006	2,004	2,003	2,007

Parameter	Average	30-day	14-day	7-day	3-day
Final Dewatering Cake Product					
Total solids load (dtpd)	15	19	21	22	24
Total solids load (lb-TS/d)	29,157	37,934	41,379	43,831	48,127
Volatile solids load (lb-VS/d)	16,802	22,021	23,979	25,379	27,962
Total solids concentration (lb-TS/lb-sludge)	33.0%	33.0%	33.0%	33.0%	33.0%
Cake mass to end use (wtpd)	44	57	63	66	73
Cake volume (CY/d at 45 lb/ft^3)	73	95	103	109	120
Combined Recycles (Thickening, Pre-dewatering, and Final Dewatering)					
Total solids load (lb-TS/d)	6,758	8,910	9,689	10,247	11,322
Flow (mgd)	1.95	2.24	2.35	2.42	2.55
Post-dewatering recycle ammonia load (lb-N/d)	1,274	1,676	1,823	1,929	2,129

Table 11. Solids Process Model Flows: 30.8 mgd Flow (Design Condition)

Parameter	Average	30-day	14-day	7-day	3-day
Primary Solids					
Total solids load (lb-TS/d)	53,464	72,087	77,983	82,268	91,832
Volatile solids load (lb-VS/d)	44,532	60,064	64,972	68,539	76,518
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	641,053	864,356	935,049	986,422	1,101,101
Flow (gpm)	445	600	649	685	765
Thickened Primary Solids					
Total solids load (lb-TS/d)	50,791	68,483	74,084	78,154	87,240
Volatile solids load (lb-VS/d)	42,305	57,061	61,723	65,112	72,692
Total solids concentration	4.0%	4.0%	4.0%	4.0%	4.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	152,250	205,285	222,074	234,275	261,512
Flow (gpm)	106	143	154	163	182
WAS					
Total solids load (lb-TS/d)	29,228	35,950	39,750	42,380	45,303
Volatile solids load (lb-VS/d)	20,021	24,626	27,229	29,031	31,033
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	68.5%	68.5%	68.5%	68.5%	68.5%
Flow (gpd)	350,454	431,058	476,617	508,158	543,203
Flow (gpm)	243	299	331	353	377
Primary Scum (to Solids Storage Tank with WAS)					
Total solids load (lb-TS/d)	6,406	8,649	9,353	9,866	11,019
Volatile solids load (lb-VS/d)	5,766	7,784	8,418	8,879	9,917
Total solids concentration (lb-TS/lb-sludge)	0.50%	0.60%	0.65%	0.68%	0.76%
Volatile fraction (lb-VS/lb-TS)	90%	90%	90%	90%	90%
Flow (gpd)	153,631	172,800	172,800	172,800	172,800
Flow (gpm)	107	120	120	120	120
Combined Thickened Solids /Pre-dewatering Feed					
Total solids load (lb-TS/d)	86,425	113,082	123,187	130,400	143,562
Volatile solids load (lb-VS/d)	68,092	89,470	97,370	103,022	113,642
Total solids concentration	1.6%	1.7%	1.7%	1.7%	1.8%
Volatile fraction (lb-VS/lb-TS)	78.8%	79.1%	79.0%	79.0%	79.2%
TWAS load fraction (TWAS / (TWAS + TPS + FOG))	33.8%	31.8%	32.3%	32.5%	31.6%
Flow (gpd)	656,334	809,142	871,491	915,233	977,515
Flow (gpm)	456	562	605	636	679

Parameter	Average	30-day	14-day	7-day	3-day
Pre-dewatered Solids					
Total solids load (dtpd)	41.1	53.7	58.5	61.9	68.2
Total solids load (lb-TS/d)	82,104	107,428	117,028	123,880	136,384
Volatile solids load (lb-VS/d)	64,688	84,997	92,501	97,870	107,960
Total solids concentration (lb-TS/lb-sludge)	25.0%	25.0%	25.0%	25.0%	25.0%
Flow (gpd)	39,378	51,524	56,128	59,415	65,412
Flow (gpm)	27	36	39	41	45
Cake mass (wtpd)	164	215	234	248	273
Cake volume (CY/d at 45 lb/ft^3)	270	354	385	408	449
Thermal Hydrolysis Feed Solids with Dilution Water					
Total solids load (lb-TS/d)	82,104	107,428	117,028	123,880	136,384
Volatile solids load (lb-VS/d)	64,688	84,997	92,501	97,870	107,960
Total solids concentration (lb-TS/lb-sludge)	16.5%	16.5%	16.5%	16.5%	16.5%
Flow (gpd)	59,664	78,067	85,043	90,023	99,109
Flow (gpm)	41	54	59	63	69
Thermal Hydrolysis Depressurization Tank Solids with Steam Condensate					
Total solids load (lb-TS/d)	82,104	107,428	117,028	123,880	136,384
Volatile solids load (lb-VS/d)	64,688	84,997	92,501	97,870	107,960
Total solids concentration (lb-TS/lb-sludge)	14.2%	14.2%	14.2%	14.2%	14.2%
Flow (gpd)	69,509	90,948	99,075	104,877	115,462
Flow (gpm)	48	63	69	73	80
Temperature (°F)	221	221	221	221	221
Diluted THP Solids: Depressurization Tank Output and Pathogen-Free Dilution Water					
Total solids load (lb-TS/d)	82,104	107,428	117,028	123,880	136,384
Volatile solids load (lb-VS/d)	64,688	84,997	92,501	97,870	107,960
Total solids concentration (lb-TS/lb-sludge)	9.0%	9.0%	9.0%	9.0%	9.0%
Flow (gpd)	109,384	143,122	155,912	165,042	181,700
Flow (gpm)	76	99	108	115	126
Temperature (°F)	168	168	168	168	168
Digested Solids Recycle: to Cooling Heat Exchanger					
Total solids concentration (lb-TS/lb-sludge)	4.5%	4.5%	4.5%	4.5%	4.5%
Flow (gpd)	546,920	546,894	546,900	635,965	635,951
Flow (gpm)	380	380	380	442	442
Temperature (°F)	98	98	98	98	98
Digester Feed Solids: Diluted THP Sludge with Recycled Digested Sludge					
Total solids concentration (lb-TS/lb-sludge)	5.1%	5.2%	5.2%	5.2%	5.2%
Flow (gpd)	656,304	690,016	702,812	801,007	817,652
Flow (gpm)	456	479	488	556	568
Temperature before HEX (°F)	110	113	114	112	114
Temperature after HEX (°F)	98	98	98	98	98
Digested Solids (to Final Dewatering)					
Total solids load (lb-TS/d)	41,100	53,472	58,328	61,784	67,840
Volatile solids load (lb-VS/d)	23,684	31,041	33,802	35,774	39,416
Total solids concentration (lb-TS/lb-sludge)	4.5%	4.5%	4.5%	4.5%	4.5%
Volatile fraction (lb-VS/lb-TS)	57.6%	58.1%	58.0%	57.9%	58.1%
Flow (gpd)	109,384	143,122	155,912	165,042	181,700
Flow (gpm)	76	99	108	115	126
Ammonia-N concentration (mg/L)	1,996	2,006	2,004	2,003	2,007
Final Dewatering Cake Product					
Total solids load (dtpd)	20	25	28	29	32
Total solids load (lb-TS/d)	39,045	50,798	55,412	58,695	64,448

Parameter	Average	30-day	14-day	7-day	3-day
Volatile solids load (lb-VS/d)	22,500	29,489	32,112	33,985	37,445
Total solids concentration (lb-TS/lb-sludge)	33.0%	33.0%	33.0%	33.0%	33.0%
Cake mass to end use (wtpd)	59	77	84	89	98
Cake volume (CY/d at 45 lb/ft^3)	97	127	138	146	161
Combined Recycles (Thickening, Pre-dewatering, and Final Dewatering)					
Total solids load (lb-TS/d)	9,049	11,932	12,975	13,723	15,162
Flow (mgd)	2.27	2.62	2.75	2.84	3.01
Post-dewatering recycle ammonia Load (lb-N/d)	1,706	2,244	2,441	2,583	2,850

Table 12. Solids Process Model Flows: 40 mgd Flow (WPCP Buildout Condition)

Parameter	Average	30-day	14-day	7-day	3-day
Primary Solids					
Total solids load (lb-TS/d)	69,434	93,620	101,277	106,841	119,262
Volatile solids load (lb-VS/d)	57,834	78,005	84,379	89,011	99,374
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	832,537	1,122,540	1,214,350	1,281,068	1,430,002
Flow (gpm)	578	780	843	890	993
Thickened Primary Solids					
Total solids load (lb-TS/d)	65,962	88,939	94,572	94,572	94,572
Volatile solids load (lb-VS/d)	54,942	74,105	78,792	78,789	78,801
Total solids concentration	4.0%	4.0%	4.0%	4.0%	4.0%
Volatile fraction (lb-VS/lb-TS)	83.3%	83.3%	83.3%	83.3%	83.3%
Flow (gpd)	197,727	266,603	283,488	283,488	283,488
Flow (gpm)	137	185	197	197	197
Primary Solids Bypassed around GT to WAS Storage Tank					
Total solids load (lb-TS/d)	-	-	1,728	7,292	19,713
Volatile solids load (lb-VS/d)	-	-	1,439	6,075	16,426
Total solids concentration	-	-	1.00%	1.00%	1.00%
Volatile fraction (lb-VS/lb-TS)	-	-	83.3%	83.3%	83.3%
Flow (gpd)	0	0	20,714	87,432	236,366
Flow (gpm)	0	0	14	61	164
WAS					
Total solids load (lb-TS/d)	37,958	46,689	51,623	55,039	58,835
Volatile solids load (lb-VS/d)	26,001	31,982	35,362	37,702	40,302
Total solids concentration	1.0%	1.0%	1.0%	1.0%	1.0%
Volatile fraction (lb-VS/lb-TS)	68.5%	68.5%	68.5%	68.5%	68.5%
Flow (gpd)	455,134	559,815	618,983	659,945	705,458
Flow (gpm)	316	389	430	458	490
Primary Scum (to Solids Storage Tank with WAS)					
Total solids load (lb-TS/d)	8,320	11,232	12,147	12,813	14,310
Volatile solids load (lb-VS/d)	7,488	10,109	10,932	11,532	12,879
Total solids concentration (lb-TS/lb-sludge)	0.58%	0.78%	0.84%	0.89%	0.99%
Volatile fraction (lb-VS/lb-TS)	90%	90%	90%	90%	90%
Flow (gpd)	172,800	172,800	172,800	172,800	172,800
Flow (gpm)	120	120	120	120	120
Combined Thickened Solids/Pre-dewatering Feed					
Total solids load (lb-TS/d)	112,240	146,859	160,070	169,716	187,430
Volatile solids load (lb-VS/d)	88,432	116,195	126,526	134,098	148,408
Total solids concentration	1.6%	1.8%	1.8%	1.7%	1.6%

Parameter	Average	30-day	14-day	7-day	3-day
Volatile fraction (lb-VS/lb-TS)	78.8%	79.1%	79.0%	79.0%	79.2%
TWAS load fraction (TWAS / (TWAS + TPS + FOG))	33.8%	31.8%	32.6%	33.9%	35.1%
Flow (gpd)	825,662	999,219	1,095,985	1,203,666	1,398,113
Flow (gpm)	573	694	761	836	971
Pre-dewatered Solids					
Total solids load (dtpd)	53.3	69.8	76.0	80.6	89.0
Total solids load (lb-TS/d)	106,628	139,516	152,066	161,230	178,059
Volatile solids load (lb-VS/d)	84,010	110,386	120,200	127,393	140,988
Total solids concentration (lb-TS/lb-sludge)	25.0%	25.0%	25.0%	25.0%	25.0%
Flow (gpd)	51,141	66,914	72,933	77,329	85,400
Flow (gpm)	36	46	51	54	59
Cake mass (wtpd)	213	279	304	322	356
Cake volume (CY/d at 45 lb/ft^3)	351	459	501	531	586
Thermal Hydrolysis Feed Solids with Dilution Water					
Total solids load (lb-TS/d)	106,628	139,516	152,066	161,230	178,059
Volatile solids load (lb-VS/d)	84,010	110,386	120,200	127,393	140,988
Total solids concentration (lb-TS/lb-sludge)	16.5%	16.5%	16.5%	16.5%	16.5%
Flow (gpd)	77,486	101,385	110,505	117,164	129,394
Flow (gpm)	54	70	77	81	90
Thermal Hydrolysis Depressurization Tank Solids with Steam Condensate					
Total solids load (lb-TS/d)	106,628	139,516	152,066	161,230	178,059
Volatile solids load (lb-VS/d)	84,010	110,386	120,200	127,393	140,988
Total solids concentration (lb-TS/lb-sludge)	14.2%	14.2%	14.2%	14.2%	14.2%
Flow (gpd)	90,271	118,114	128,739	136,497	150,744
Flow (gpm)	63	82	89	95	105
Temperature (°F)	221	221	221	221	221
Diluted THP Solids: Depressurization Tank Output and Pathogen-Free Dilution Water					
Total solids load (lb-TS/d)	106,628	139,516	152,066	161,230	178,059
Volatile solids load (lb-VS/d)	84,010	110,386	120,200	127,393	140,988
Total solids concentration (lb-TS/lb-sludge)	9.0%	9.0%	9.0%	9.0%	9.0%
Flow (gpd)	142,057	185,873	202,593	214,802	237,222
Flow (gpm)	99	129	141	149	165
Temperature (°F)	168	168	168	168	168
Digested Solids Recycle: to Cooling Heat Exchanger					
Total solids concentration (lb-TS/lb-sludge)	4.5%	4.5%	4.5%	4.5%	4.5%
Flow (gpd)	710,286	710,252	710,643	827,707	830,277
Flow (gpm)	493	493	494	575	577
Temperature (°F)	98	98	98	98	98
Digester Feed Solids: Diluted THP Sludge with Recycled Digested Solids					
Total solids concentration (lb-TS/lb-sludge)	5.1%	5.2%	5.2%	5.2%	5.2%
Flow (gpd)	852,343	896,125	913,236	1,042,508	1,067,499
Flow (gpm)	592	622	634	724	741
Temperature before HEX (°F)	110	113	114	112	114
Temperature after HEX (°F)	98	98	98	98	98
Digested Solids (to Final Dewatering)					
Total solids load (lb-TS/d)	53,377	69,444	75,792	80,412	88,572
Volatile solids load (lb-VS/d)	30,759	40,313	43,926	46,575	51,501
Total solids concentration (lb-TS/lb-sludge)	4.5%	4.5%	4.5%	4.5%	4.5%
Volatile fraction (lb-VS/lb-TS)	57.6%	58.1%	58.0%	57.9%	58.1%
Flow (gpd)	142,057	185,873	202,593	214,802	237,222
Flow (gpm)	99	129	141	149	165

Parameter	Average	30-day	14-day	7-day	3-day
Ammonia-N concentration (mg/L)	1,996	2,006	2,004	2,003	2,008
Final Dewatering Cake Product					
Total solids load (dtpd)	25	33	36	38	42
Total solids load (lb-TS/d)	50,708	65,972	72,002	76,392	84,143
Volatile solids load (lb-VS/d)	29,221	38,297	41,729	44,246	48,926
Total solids concentration (lb-TS/lb-sludge)	33.0%	33.0%	33.0%	33.0%	33.0%
Cake mass to end use (wtpd)	77	100	109	116	127
Cake volume (CY/d at 45 lb/ft^3)	126	165	180	191	210
Combined Recycles (Thickening, Pre-dewatering, and Final Dewatering)					
Total solids load (lb-TS/d)	11,753	15,496	16,771	17,484	18,778
Flow (mgd)	2.61	3.05	3.22	3.34	3.56
Post-dewatering recycle ammonia load (lb-N/d)	2,215	2,914	3,172	3,362	3,722

Table 13. Energy Calculations: 23 mgd Flow (2020 Condition)

Parameter	Average	30-day	14-day	7-day	3-day
THP Steam Demands					
Steam to THP (ton-steam/d)	31	40	44	46	51
Steam as condensate to sludge (gpd)	7,351	9,619	10,479	11,092	12,212
Sludge Cooling Demands					
Cooling demand (million-Btu/d)	48	63	68	72	79
Cooling demand (million-Btu/hr)	2.0	2.6	2.8	3.0	3.3
Digester Gas Production					
Biogas generated (scfd)	453,158	596,095	648,553	686,112	757,234
Biogas generated (scfm)	315	414	450	476	526
Biogas generated from scum and FOG only (scfm)	38	52	56	59	66
Lower heating value (million-Btu/hr)	11.0	14.4	15.7	16.6	18.3

Table 14. Energy Calculations: 30.8 mgd Flow (Design Condition)

Parameter	Average	30-day	14-day	7-day	3-day
THP Steam Demands					
Steam to THP (ton-steam/d)	41	54	59	62	68
Steam as condensate to sludge (gpd)	9,845	12,881	14,032	14,854	16,353
Sludge Cooling Demands					
Cooling demand (million-Btu/d)	64	84	91	97	106
Cooling demand (million-Btu/hr)	2.7	3.5	3.8	4.0	4.4
Digester Gas Production					
Biogas generated (scfd)	606,837	798,248	868,498	918,793	1,014,036
Biogas generated (scfm)	421	554	603	638	704
Biogas generated from scum and FOG only (scfm)	51	69	75	79	88
Lower heating value (million-Btu/hr)	14.7	19.3	21.0	22.2	24.5

Table 15. Energy Calculations: 40 mgd Flow (WPCP Buildout Condition)

Parameter	Average	30-day	14-day	7-day	3-day
THP Steam Demands					
Steam to THP (ton-steam/d)	53	70	76	81	89
Steam as condensate to sludge (gpd)	12,785	16,729	18,233	19,332	21,350
Sludge Cooling Demands					
Cooling demand (million-Btu/d)	83	109	119	126	139
Cooling demand (million-Btu/hr)	3.5	4.5	4.9	5.2	5.8
Digester Gas Production					
Biogas generated (scfd)	788,101	1,036,686	1,128,534	1,195,835	1,323,951
Biogas generated (scfm)	547	720	784	830	919
Biogas generated from scum and FOG only (scfm)	67	90	97	103	115
Lower heating value (million-Btu/hr)	19.0	25.1	27.3	28.9	32.0

Table 16. Chemical Use: 23 mgd Flow (2020 Condition)

Parameter	Average	30-day	14-day	7-day	3-day
Pre-dewatering polymer use (lb active polymer/d)	323	422	460	487	536
Final dewatering polymer use (lb active polymer/d)	460	599	653	692	760

Table 17. Chemical Use: 30.8 mgd Flow (Design Condition)

Parameter	Average	30-day	14-day	7-day	3-day
Pre-dewatering polymer use (lb active polymer/d)	432	565	616	652	718
Final dewatering polymer use (lb active polymer/d)	617	802	875	927	1,018

Table 18. Chemical Use: 40 mgd Flow (Buildout Condition)

Parameter	Average	30-day	14-day	7-day	3-day
Pre-dewatering polymer use (lb active polymer/d)	561	734	800	849	937
Final dewatering polymer use (lb active polymer/d)	801	1,042	1,137	1,206	1,329

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Solids Process Flow Mass Balance

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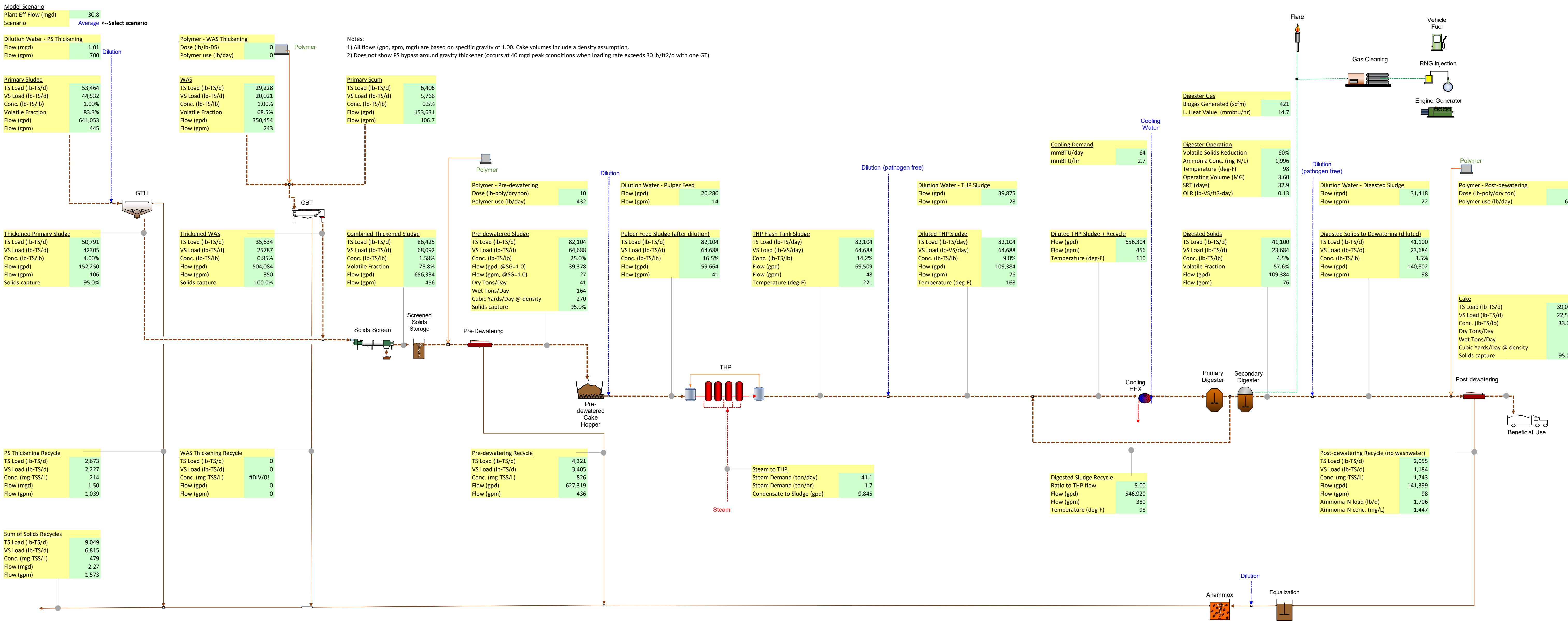
Notes:
1) All flows (gpd, gpm, mgd) are based on specific gravity of 1.00. Cake volumes include a density assumption.
2) Does not show PS bypass around gravity thickener (occurs at 40 mgd peak cconditions when loading rate exceeds 30 lb/ft2/d with one GT)



Model Scenario	
Plant Eff Flow (mgd)	30.8
Scenario	Average <--Select scenario

Dilution Water - PS Thickening	
Flow (mgd)	1.01
Flow (gpm)	700

Polymer - WAS Thickening	
Dose (lb/lb-DS)	0
Polymer use (lb/day)	0

Primary Sludge	
TS Load (lb-TS/d)	53,464
VS Load (lb-TS/d)	44,532
Conc. (lb-TS/lb)	1.00%
Volatile Fraction	83.3%
Flow (gpd)	641,053
Flow (gpm)	445

WAS	
TS Load (lb-TS/d)	29,228
VS Load (lb-TS/d)	20,021
Conc. (lb-TS/lb)	1.00%
Volatile Fraction	68.5%
Flow (gpd)	350,454
Flow (gpm)	243

Primary Scum	
TS Load (lb-TS/d)	6,406
VS Load (lb-TS/d)	5,766
Conc. (lb-TS/lb)	0.5%
Flow (gpd)	153,631
Flow (gpm)	106.7

Thickened Primary Sludge	
TS Load (lb-TS/d)	50,791
VS Load (lb-TS/d)	42305
Conc. (lb-TS/lb)	4.00%
Flow (gpd)	152,250
Flow (gpm)	106
Solids capture	95.0%

Thickened WAS	
TS Load (lb-TS/d)	35,634
VS Load (lb-TS/d)	25787
Conc. (lb-TS/lb)	0.85%
Flow (gpd)	504,084
Flow (gpm)	350
Solids capture	100.0%

Combined Thickened Sludge	
TS Load (lb-TS/d)	86,425
VS Load (lb-TS/d)	68,092
Conc. (lb-TS/lb)	1.58%
Volatile Fraction	78.8%
Flow (gpd)	656,334
Flow (gpm)	456

Polymer - Pre-dewatering	
Dose (lb-poly/dry ton)	10
Polymer use (lb/day)	432

Pre-dewatered Sludge	
TS Load (lb-TS/d)	82,104
VS Load (lb-TS/d)	64,688
Conc. (lb-TS/lb)	25.0%
Flow (gpd, @SG=1.0)	39,378
Flow (gpm, @SG=1.0)	27
Dry Tons/Day	41
Wet Tons/Day	164
Cubic Yards/Day @ density	270
Solids capture	95.0%

Dilution Water - Pulper Feed	
Flow (gpd)	20,286
Flow (gpm)	14

Pulper Feed Sludge (after dilution)	
TS Load (lb-TS/d)	82,104
VS Load (lb-TS/d)	64,688
Conc. (lb-TS/lb)	16.5%
Flow (gpd)	59,664
Flow (gpm)	41

THP Flash Tank Sludge	
TS Load (lb-TS/day)	82,104
VS Load (lb-VS/day)	64,688
Conc. (lb-TS/lb)	14.2%
Flow (gpd)	69,509
Flow (gpm)	48
Temperature (deg-F)	221

Dilution Water - THP Sludge	
Flow (gpd)	39,875
Flow (gpm)	28

Diluted THP Sludge	
TS Load (lb-TS/day)	82,104
VS Load (lb-VS/day)	64,688
Conc. (lb-TS/lb)	9.0%
Flow (gpd)	109,384
Flow (gpm)	76
Temperature (deg-F)	168

Cooling Demand	
mmBTU/day	64
mmBTU/hr	2.7

Diluted THP Sludge + Recycle	
Flow (gpd)	656,304
Flow (gpm)	456
Temperature (deg-F)	110

Digester Gas	
Biogas Generated (scfm)	421
L. Heat Value (mmbtu/hr)	14.7

Digester Operation	
Volatile Solids Reduction	60%
Ammonia Conc. (mg-N/L)	1,996
Temperature (deg-F)	98
Operating Volume (MG)	3.60
SRT (days)	32.9
OLR (lb-VS/ft3-day)	0.13

Digested Solids	
TS Load (lb-TS/d)	41,100
VS Load (lb-TS/d)	23,684
Conc. (lb-TS/lb)	4.5%
Volatile Fraction	57.6%
Flow (gpd)	109,384
Flow (gpm)	76

Dilution Water - Digested Sludge	
Flow (gpd)	31,418
Flow (gpm)	22

Digested Solids to Dewatering (diluted)	
TS Load (lb-TS/d)	41,100
VS Load (lb-TS/d)	23,684
Conc. (lb-TS/lb)	3.5%
Flow (gpd)	140,802
Flow (gpm)	98

Polymer - Post-dewatering	
Dose (lb-poly/dry ton)	30
Polymer use (lb/day)	617

Cake	
TS Load (lb-TS/d)	39,045
VS Load (lb-TS/d)	22,500
Conc. (lb-TS/lb)	33.0%
Dry Tons/Day	20
Wet Tons/Day	59
Cubic Yards/Day @ density	97
Solids capture	95.0%

PS Thickening Recycle	
TS Load (lb-TS/d)	2,673
VS Load (lb-TS/d)	2,227
Conc. (mg-TSS/L)	214
Flow (mgd)	1.50
Flow (gpm)	1,039

WAS Thickening Recycle	
TS Load (lb-TS/d)	0
VS Load (lb-TS/d)	0
Conc. (mg-TSS/L)	#DIV/0!
Flow (gpd)	0
Flow (gpm)	0

Pre-dewatering Recycle	
TS Load (lb-TS/d)	4,321
VS Load (lb-TS/d)	3,405
Conc. (mg-TSS/L)	826
Flow (gpd)	627,319
Flow (gpm)	436

Steam to THP	
Steam Demand (ton/day)	41.1
Steam Demand (ton/hr)	1.7
Condensate to Sludge (gpd)	9,845

Digested Sludge Recycle	
Ratio to THP flow	5.00
Flow (gpd)	546,920
Flow (gpm)	380
Temperature (deg-F)	98

Post-dewatering Recycle (no washwater)	
TS Load (lb-TS/d)	2,055
VS Load (lb-TS/d)	1,184
Conc. (mg-TSS/L)	1,743
Flow (gpd)	141,399
Flow (gpm)	98
Ammonia-N load (lb/d)	1,706
Ammonia-N conc. (mg/L)	1,447

Sum of Solids Recycles	
TS Load (lb-TS/d)	9,049
VS Load (lb-TS/d)	6,815
Conc. (mg-TSS/L)	479
Flow (mgd)	2.27
Flow (gpm)	1,573

Technical Memorandum No. 2

Date:	February 9, 2023
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Condition of Existing Facilities

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Figures

Attachments

1.0 Introduction and Purpose

The purpose of the Arlington Water Pollution Control Plant (WPCP) site visits were to broadly assess the condition of processes being considered for replacement as a part of the new solids handling processes, and to obtain operations and maintenance (O&M) feedback on current facilities. Secondary to the condition assessment is determining whether there are any obvious reasons why the existing processes will not be able to continue to operate reliably for the next 5 years until new processes start up, or whether temporary improvements or early construction packages should be considered.

Each section of the site notes provided below includes an introduction about how the process is used now, a current assessment of operations based on WPCP O&M group comments, and considerations on the future of the process. Where noted, additional detailed evaluations are recommended to be conducted as part of the Biosolids Upgrade project to define specific facilities' repairs or renovations required to incorporate existing facilities into the new solids handling facilities. The site visits took place on January 6 and 7, 2021 and February 10, 2021. All observations represented in this technical memorandum are from those specific dates.

2.0 Overall Plant Considerations

The WPCP was first constructed in the 1930s and has had many major and minor upgrades since its original construction. The site is constrained and phasing of new treatment processes, to be constructed at the current locations of existing treatment processes, has already happened during several WPCP upgrades. A future contractor will likely uncover unknown buried process structures that will need to be investigated before demolition. One example given by WPCP staff was during a previous project the contractor found a concrete slab that could have been part of a process but was later identified as an old sidewalk. That investigation took only one day; others will take longer. This should be considered a normal issue for an 85-year-old treatment plant site. Additional general notes about the WPCP are listed below:

- The WPCP's design capacity is 40 million gallons per day (mgd), but it currently receives an average daily flow of 23 mgd. Normal dry peak hourly flow is 30 mgd, a typical severe storm will often deliver a peak hourly flow of 60 mgd, and superstorm Sandy peak flow was 120 mgd.
- Plant influent flow is the sum of the major sources: two Potomac Interceptors, Four Mile Run Gravity Flow Interceptor, and the Four Mile Run Lift Station.
- Preliminary treatment consists of ½-inch climber-type bar screens and PISTA grit removal. The WPCP has a backup headworks facility with ½-inch flex-rake type (Duperon) bar screens. The existing climber-type screens are scheduled for replacement with ½-inch flex-rake type bar screens (similar to the bypass headworks). The same project will replace scum concentration and screenings handling processes.
- Secondary treatment consists of biological nutrient removal aeration tanks.
- Tertiary treatment is performed using denitrification filters.
- Phosphorus removal is achieved through ferric chloride dose addition at the primary clarifiers and some trimming in the secondary process. Ferric chloride can also be added to the tertiary process, but such addition is used infrequently. Ferric chloride dose is also binding sulfides through the treatment processes, which is improving odor control. The WPCP is beginning early consideration to

converting to an enhanced biological phosphorus removal (EBPR) process in the future, which would change the solids handling characteristics. Any decision to convert the secondary process to EBPR is many years away.
- Total ferric chloride dose is approximately 50 mg/L, with most of the ferric chloride being added to the primary clarifiers.
- Filtered effluent is chlorinated using sodium hypochlorite and then dechlorinated with sodium bisulfite prior to being discharged into Four Mile Run.

3.0 Plant Effluent Water Pumping Station

The current plant effluent water (PEW) pump station was installed as part of the Upgrade and Expansion Phase 7A project. Pump nameplates were not legible. The PEW discharge header supplies two main PEW distribution pipes. The main header has a pressure relief valve on each side, of uncertain condition. The pressure relief valves should be investigated further for replacement. PEW discharge piping at the pump station is insulated and jacketed, so piping materials and condition were not observed during this assessment. O&M reported no specific problems with the process. With normal maintenance the PEW pumps (see Figure 1) should be able to operate long into the future. New solids handling processes will require either more water or a reallocation of the water currently being used, which will change the normal, minimum, and maximum flow and pressure of the WPCP water system. The pumps will need to be assessed for the new operating conditions. Additional notes about the process are provided below:

- There are four vertical-turbine pumps; normally two are in service, not running at maximum speed. All four pumps have a variable-frequency drive (VFD). There appeared to be slight corrosion on the pump baseplates, but repairing and recoating them with protective paint would stop current corrosion and provide adequate protection.
- PEW is chlorinated and dechlorinated before the PEW pump station via sodium bisulfite.
- Staff has observed corrosion and pitting inside PEW pipes that may be microbial in nature. Biogrowth (bisulfite slime) in the WPCP distribution system might be impacting the service life of mechanical seals, solenoid valves, and spray nozzles. The sulfite biogrowth could be creating solids in the WPCP water distribution system, which can directly damage mechanical seals or other mechanical equipment, or stop flow through solenoids that might be supplying cooling/flushing water to mechanical seals. The bacterial biogrowth can appear as a slimy bacterial growth on the inside of pipes because of residual bisulfite after reacting with chlorine.
- Sodium hypochlorite is available in the adjacent Sodium Hypochlorite Facility and can be injected into the discharge of the PEW pumps. The Milton Roy metering pumps already installed are suitable for high discharge pressure if serviceable and needed.
- PEW is normally used for WPCP hoses, process connections, elutriation water in the gravity thickener (GT), maintaining operational readiness of the wet weather filters, and seal water.

The PEW pumps, system capacities, and need for pathogen-free water will be evaluated by the Delivery Team and validated as part of the solids handling project. Assuming the pumps and piping are adequate, it is assumed that any additional rehabilitation of the PEW system will be done through regular rehabilitation projects and not part of the Biosolids Upgrade project.

Figure 1. PEW Pump

Figure 2. Side View of PEW Pump Station

4.0 Waste Activated Solids Pumps

Waste activated solids (WAS) and the east-side return activated solids (RAS) pumps are in the same room of the East Secondary Services Pump Station. This evaluation does not consider the RAS pumps or activated solids process; notes about the RAS and activated solids processes are provided for context. The West Secondary Pump Services Building, which contains the west-side RAS pumps, was not visited.

Three WAS pumps (see Figure 3 and Figure 4) currently pump to the dissolved air flotation thickening (DAFT) process. Normal WAS flow is 80 to 150 gallons per minute (gpm) depending on process needs, which vary by season. The WAS pumps were installed under the Upgrade and Expansion Phase 7B project and are Fairbanks Morse end-suction pumps with mechanical seals. The WAS pumps draw from the discharge of the RAS piping header. O&M reported no specific problems with the WAS pumping process. Note, subsequent to this site visit, issues with the WAS flow meter are being investigated by WPCP staff. No significant issues were observed during the site visit, and it is anticipated that the WAS pumps should be able to operate with normal maintenance for another 5 years. The WAS pumps are anticipated to be replaced with a future Secondary Clarifier Upgrades project. New thickening processes being considered for the Biosolids Upgrades may increase the required pumping head so the future WAS pump sizing will need to be coordinated between projects.

The following are condition assessment notes for the WAS pumps and facility:

- Three clarifiers are not in service, and associated RAS pumps are also locked out. Multiple RAS pumps are permanently out of service (components were removed and installed on other RAS pumps).
- Activated solids mixed liquor suspended solids (MLSS) concentration averages around 3,800 milligrams per liter (mg/L). RAS/WAS concentration is typically 8,000 to 11,000 mg/L, which is considered normal at 2 to 3 times the MLSS concentration.
- WPCP staff can put Clarifier 9 and Aeration Tank 6 in pilot mode to act as a mini separated wastewater treatment plant. They plan to use this mode to test various operating strategies including the Bio-P process. Bio-P allows for more phosphorus removal with less chemical dose.
- WAS pumps have newer Allen-Bradley PowerFlex drives.
- The mechanical seals on the WAS pumps are fine. O&M staff report that the impellers show no signs of wear.

The WAS pump and system capacities required will be confirmed as part of the Biosolids Upgrades. Currently the WAS is pumped to the DAFTs. Once the new site layout is finalized, the WAS pumps will be evaluated to confirm their adequacy for pumping to the new facilities. Sizing will be coordinated with the Secondary Clarifier Upgrades project.

Figure 3. Side View of WAS Pumps

Figure 4. WAS Pump

5.0 Primary Sedimentation

The WPCP has eight rectangular primary sedimentation tanks with chain-and-flight collectors. Typically, five or six trains are in service during normal conditions. During wet weather, or possibly during WPCP shutdowns, additional primary sedimentation tanks can be placed into service for additional storage capacity. Primary sedimentation tanks run with 0 to 3 feet of sludge blanket at the collection (deep) end. Figure 5 depicts the primary solids (PS) piping. The primary clarifiers were last upgraded with Upgrade and Expansion Phase IIB. A separate Primary Clarifier Upgrades project is envisioned for rehabilitation of the primary clarifiers and associated equipment. O&M reported no specific problems with the process but the description of reduced PS pumping capacity in relation to sludge blanket thickness and increase in sludge thickness is noted. Also, the fact that the PS pumps (see Figure 6) are not able operate at full speed without overload indicates a mismatch between original design and current operating conditions.

Based on preliminary observations, thickening solids in the primary sedimentation tanks may be possible with a further evaluation of the chain-and-flight collection mechanism to ensure that it has the additional strength to convey thickened sludge and replacement of the existing screw centrifugal end-suction pumps with progressive-cavity pumps better suited for lower flows of thicker sludge. There is enough room in the pump gallery to accommodate this change if desired. “In-primary” thickening would eliminate the need for GTs or other PS thickening process but increases the risk of chain-and-flight failure because of accumulated thickened PS in the basin. Considering the apparent excess primary sedimentation capacity, this could be considered. *Note subsequent discussions with the County resulted in a recommendation to rehabilitate the GTs and not thicken in the primary clarifiers.*

The following are condition assessment notes for primary sedimentation:

- PS pumps operate on a rotating cycle with one pump running at a time for 10-15 minutes.
- Pumped flow was recorded as between 0.06 and 0.16 mgd depending on PS depth of blanket and number of pumps operating. Based on operating data and pump O&M reviews, HDR questioned these flows and requested verification via measurement of a strap-on flow meter. The verification completed by the County confirmed that actual flows through this pipeline were approximately 400 gpm (0.6 mgd), which is more in line with expected flows. The PS flow meter may be reporting a low number because of grease accumulation on the liner and probes.
- The normal depth of the blanket is less than 1 foot, and ranges from 0 to 3 feet. If it is at 3 feet, then the pump is likely clogged, according to information provided by the Arlington Operations staff consulted.
- PS pumps can send sludge to the primary header drain line which discharges to the preliminary treatment influent. The primary sedimentation tanks also have dedicated end-suction centrifugal pump and piston drain pumps.
- WPCP staff normally run PS pumps at 80 percent speed. Pumps can fail (trips out on overload and VFD reset required) if they are run at 100 percent. The operating range for the pumps is a minimum of 70 percent speed, and a maximum of 85 to 90 percent speed.
- PS pump conduit/feeders are more than 30 years old and require replacement as issues arise.

It is assumed that the PS pumps will be reviewed and upgraded as part of the Primary Clarifier Upgrades and not as part of the Biosolids Upgrades.

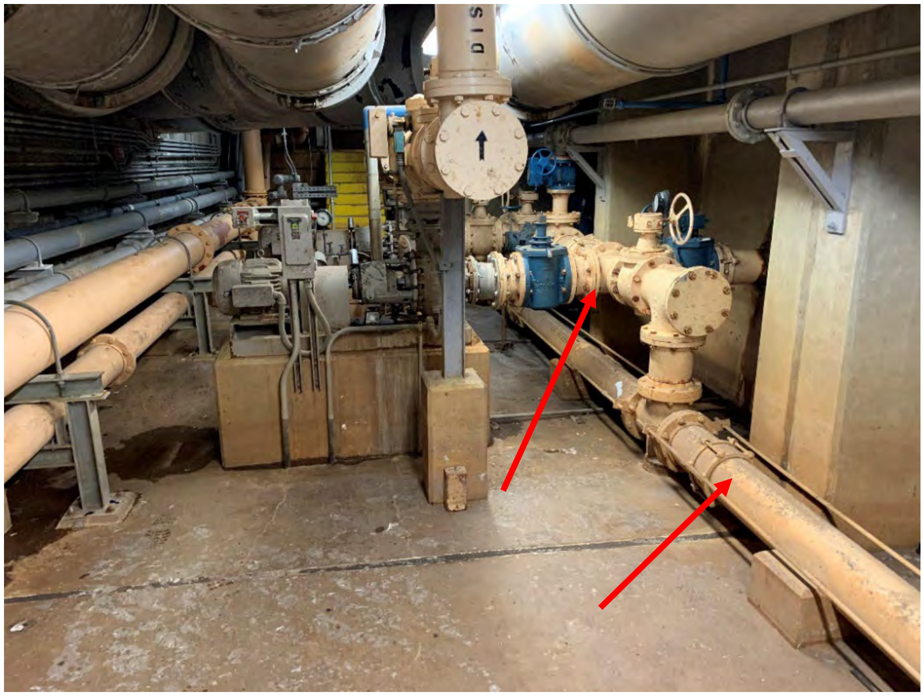

Figure 5. Primary Solids Piping

Figure 6. Primary Solids Pump

6.0 Gravity Thickeners

This section presents a condition assessment of the GTs, including a general evaluation and a structural evaluation.

6.1 General Evaluation

The WPCP has two GTs that typically operate in a duty/standby configuration (see Figure 7). The GTs have flat weirs and receive PS and approximately 700 gpm of elutriation water. The GTs were originally constructed with Contract I and last upgraded under the Upgrades and Expansion Phase IIB project. The thickened solids pumps were replaced in-house by Arlington County in the 2010's.

Some aspects of the primary sedimentation and GT process are not operating or reporting properly. The reported range of PS flow is 0.06 to 0.16 mgd (40 to 110 gpm) with an initial reported solids concentration of 0.5 to 1.5 percent total solids (TS). Based on discussions with operations, this sample includes elutriation water. The underflow of the GTs is typically 70 to 85 gpm of thickened PS with a reported average concentration of approximately 4 percent TS. With the current inlet and outlet solids concentrations, the GT underflow would typically be one-third of the feed flow. Additional information in terms of PS concentration and flows were requested to determine an accurate concentration and mass of PS. Based on this testing, it was confirmed that the average PS flow to the gravity thickeners is approximately 300-400 gpm (0.4 – 0.6 mgd) with a solids concentration of 0.5 to 2.0 percent TS.

O&M reported no specific problems with the process. However, the GT drives and collection mechanism are old and corroded, and leak gear oil. Some evidence was observed of concrete erosion, especially at the inlet channel of each GT, but the amount of exposed aggregate is minor. Electrical conduits are corroded at the entrance to the GT. The mechanical components of this process are near the end of their useful life. Refer to Section 6.2 for the structural condition assessment findings of the GTs.

If gravity thickening of PS is continued as a treatment process, then the process tanks, clarifier drives, electrical equipment, and adjoining support building should be completely rehabilitated, and electrical/ventilation should be brought up to National Fire Protection Association (NFPA) 820 standards, at a minimum. There does not appear to be an impending failure of this process so it can be kept in operation until the rehabilitation can be scheduled, one tank at a time to maintain operations. A full accounting of the feed loads needs to be conducted to assess loading for normal expected performance. WPCP staff should consider replacing the flat weirs with V-notch weirs to allow for reduced hydraulic loading. In discussions with operators, the current method to transition GT influent flow from one GT to the other requires manually pulling/inserting a stop plate. There was a request to add automatically actuated slide gates at the GT influent structure as part of any upgrades.

The following are condition assessment notes for the GTs:

- Typically, one GT is operated for 6 months (or when issues arise with sludge pumps).
- When flow to the GT gets too high, the water level overtops the inlet isolation gate and floods into the out-of-service GT. The condition assessment team was unable to see the condition of the scrapers under the septic water at the bottom of the out-of-service GT.

- GT underflow Seepex progressive-cavity pumps (see Figure 8) are approximately 5 to 6 years old and have not had any significant problems. The pump has required minimal maintenance since installation.
- Sometimes the pumps will not start if they have been out of service for months while the GT is empty. Flushing water supplied to the pump suction and adjusting VFD settings could assist the restart for those pumps that have been out of service for an extended period. WPCP staff could also try bumping the dry pump weekly to rotate the rotor impression on the stator.
- Clarifier depth is around 10 feet. GTs can hold solids for 2 days until 3-foot normal depth of blanket and the typical thickened PS concentration of 3 to 4 percent TS is reached.
- The drive mechanism works, there are no issues with over-torque, the shear pin has never needed replacement, and WPCP staff normally only change the oil.
- Inline pipe shredders (grinders) require periodic normal maintenance to maintain the cutters.
- Each GT had both foul-air fans working (normally 1+1) because of undersized foul-air pipes competing with the Headworks Building going to the odor control unit. Operators indicated that odor is a concern in this area. Overall ventilation (supply and exhaust/odorous air) should be evaluated for the GTs and thickened solids pumping station. In the next 2 years, the WPCP will exhaust foul air from the Preliminary Treatment Building (PTB) into the GTs. This is intended to be a temporary operation until a new odor control system to service the Biosolids Upgrades is constructed.
- There is no indication of copper corrosion in the GT Control Building. Pump control panels were recently replaced. Maintenance indicated that the control room had humidity problems, but new condenser units were installed and these seem to reduce humidity.

Figure 7. Gravity Thickener Center Platform

Figure 8. Gravity Thickener Pump

6.2 Structural Evaluation

GT No. 2 was empty and HDR staff accessed the tank interior via the personnel bridge (walkway). The focus of this visual inspection was not on any mechanism components but rather was limited to the structure and fiberglass roof. Direct inspection of the tank floor was not attempted because of the logistics of gaining access into the confined space. Photo A-1 in Attachment A shows the tank condition, which appears unremarkable. WPCP staff made some effort to superficially clean the wall and launder concrete near the access bridge to better assess the concrete condition (Photos A-2, A-3, and A-4 in Attachment A). This area, as anticipated, has experienced some loss of cement paste, exposing coarse aggregate, and some isolated areas where reinforcing is beginning to appear due to lack of concrete cover. The latter was also evident in other locations around the perimeter (Photos A-5 and A-6). The orange discoloration (Photos A-7, A-8, etc.) is due to staining caused by the addition of ferric chloride as part of the WPCP's wastewater treatment process; this is not harmful to concrete in the concentrations used. Some local "flaking" and discoloration of the wall surface was observed (Photo A-9), but it is anticipated that this is not a serious concern and can be addressed during the rehabilitation process.

The tank is covered by a fiberglass self-supported dome (Photos A-9, A-10, A-11, and A-14), which was a retrofit feature installed soon after the tanks went into operation. From inside, variations of the material's translucence are evident (Photos A-12 and A-13); however, there appeared to be no compromise to the roof's primary odor control function. If the GTs are to be retained and rehabilitated, the tank covers should be replaced with the same project.

The exterior of the tank is a mixture of exposed concrete with infill non-structural brick veneer (Photo A-15). The outboard launder hangs from the concrete wall and is in reasonable condition with one small wet area observed (Photo A-16). The brick has the normal signs of a structure that is more than 50 years old (Photos A-17 and A-18) requiring mortar repointing and masonry crack repair. Some weeping of condensation onto the exterior is affecting the concrete and mortar (Photos A-19 and A-20) especially during freeze/thaw cycles.

There is no reason to expect GT No. 1 to be of significantly different structural condition (see Photos A-21 and A-22).

The interior concrete rehabilitation of the GTs should consist of the following steps:

1. Thorough hydro-cleaning of the tank wall and launder surfaces
2. Preparing exposed reinforcing and applying corrosion inhibitor
3. Protecting such reinforcing with a repair mortar to add protective cover
4. Spray-applying a mortar (fiber reinforced, with silica fume) to replace lost cement paste (approximately ⅜ to ½ inch) over full tank and launder wall surfaces.

The GT integral pump room (below grade) will require some corrosion protection of structural steel embeds (Photo A-24) and addressing the deficiencies in the pipe support systems (Photo A-24). In addition, some of the joints in this room should be investigated further (Photo A-25).

7.0 Dissolved Air Flotation Thickeners

The WPCP has two rectangular DAFTs (see Figure 9). The DAFTs were originally installed under Contract 72-6-S. Normally one is in service and the other one is empty. Operations staff favor one DAFT as the second is known to have leaks. The DAFT process at the WPCP uses a traditional high-pressure recirculation pump, saturation tank fed by reciprocating air compressors, and the pressure break valve. The DAFTs appeared to be operating well; the floated solids looked good and thick and the underflow had a reasonable number of solids.

O&M reported no specific problems with the process. However, the DAFT drives and collection mechanism are old and corroded. The bottom chain and flights do not work, and bottom sludge is not pumped from the process. The polymer makedown system is completely manual, and one batch is made approximately every 12 hours. While some DAFTs require significant attention, this unit is old and likely operating at a consistent feed rate for a long period, so less attention is required. The metal structure and mechanical components of this process are near the end of their useful life. No obvious defect was observed that would prevent operation of this process for the next 5 years.

WPCP staff should consider short-term improvements while waiting for construction of the new thickening process, such as adding an Occupational Safety and Health Administration (OSHA)-required chain guard to the drive motor and bull gear. WPCP staff should also consider operating the float chain and flight at a lower speed for a longer period to reduce stress on the equipment and potentially collect thicker thickened waste activated solids (TWAS) with less solids in the underflow.

The following are condition assessment notes for the DAFTs:

- The DAFT units were manufactured by EIMCO.
- Normal WAS feed is 80 to 150 gpm, with a solids concentration of 8,000 to 11,000 mg/L. Airflow to the saturation tanks is 1.2 standard cubic feet per minute (scfm).
- Recirculation line pressure is 75 to 80 pounds per square inch (psi).

- The float chain and flight is ON for 150 seconds, and then OFF for 750 to 1,000 seconds. The VFD speed of the chain and flight should be decreased and the ON time should be increased or run continually to improve float capture.
- TWAS pumps operate off level (DAFT sludge hopper).
- Possible vivianite mineral formation was observed in the DAFT TWAS pumped pipeline.
- Virginia's pressure limit for the pressure vessel is 100 psi, so circulation tanks for DAFT saturation tanks do not require a pressure vessel permit.
- The dry polymer mix tank (see Figure 10) is mixed by hand, and polymer amounts are eyeballed so the dose is uncertain. Each shift batches its own tank to last 12 hours. Normal polymer pot life is approximately 4 hours after a 30-minute mix time and then the polymer activity starts to degrade, so it is likely that the polymer is overdosed after initial batching to maintain consistent operations later in the batch life. Sometimes the mixing impeller falls off the shaft when the set screw loosens.
- The polymer makeup water does contain disinfection residuals; however, a normal sodium hypochlorite residual of 1 to 3 mg/L will not have a dramatic effect on polymer blending.
- Recirculation pumps start reliably.
- Some input/output (I/O) cards had to be replaced because the relays stopped working.
- Cracking was observed in the southeast corner of the brick veneer (see Figure 11). A structural condition assessment should capture this area. Crack monitors have been installed (by others) thus a procedure has been initiated. Further structural condition assessment was not completed for the DAFT Building, as it is currently unlikely to be in continued use following the Biosolids Upgrades.
- The polymer system/platform is showing significant signs of corrosion. A structural assessment should be completed to determine if modifications/repairs are needed within the next 5 years.

Figure 9. DAFT

Figure 10. DAFT Polymer Mix Tank

Figure 11. Structural Damage at the DAFT

8.0 Solids Storage Tanks

The WPCP has two solids storage tanks (SSTs) and normally only one is in service. The SSTs are some of the oldest structures on the plant, having been constructed with the first plant expansion in 1947. The SSTs were formerly operated as digesters and a part of a larger digester complex with three additional digesters, which were demolished as part of the Upgrades and Expansion Phase 7D project. The SST provides adequate capacity to hold solids for the long weekends when dewatering is not operated. Each SST has a mixer. The tanks have foul-air collection for odor control. The feed and equalization plug valves to the tank are difficult to operate. It is possible that those valves will seize in their current position. The tanks have exceeded their useful life and should be replaced with mixed tanks sized for adequate storage for the new process at a new location. Solids storage piping is depicted in Figure 12. Solids from the storage tanks are pumped in a loop to and from the Dewatering Building, with a control valve used to feed the Dewatering Building wet well.

The following are condition assessment notes for the SSTs:

- The feed and equalization valves between the tanks are not good and tend to seize up, requiring two or three people to open and close.
- Polyvinyl chloride (PVC) lines on mix pumps are not performing well and have previously broken and sprayed solids into the room.
- There is likely lead-based paint in this room (Figure 12).

Figure 12. Solids Storage Piping

9.0 Dewatering Building

The Dewatering Building (DWB) was initially constructed during the Phase IIIA Expansion in the mid-1990s and currently holds the dewatering centrifuges, solids storage hoppers, lime storage and feed system, enclosed truck loadout system, polymer mixing/aging and feed systems, and chemical storage and feed for the odorous air scrubbing system. The floor plans for the four floors of the DWB are shown on Photo A-35 in Attachment A. Dewatering is currently conducted Monday through Friday (sometimes Sunday), with truck loadout late at night during the week to help with potential traffic and odor issues. There are three centrifuges, with space for one additional centrifuge. Normally one centrifuge is needed to keep up with solids production, and during short holiday weeks two centrifuges may be used. Centrifuges, solids conveyors and hoppers, and odor control are described separately below. The DWB appears to be in sound physical condition and, with rehabilitation that will accommodate new processes, should continue to function long into the future; however, DWB support systems (i.e., odor control/heating, ventilation, and air conditioning [HVAC] and electrical) need to be evaluated and upgraded.

The following are condition assessment notes for the DWB:

- Centrifuges were manufactured by Andritz (machine type D7LHP20C-HP), circa 1997, and have approximately 29½-inch bowls.
- WPCP staff is not committed to Andritz and would be open to other centrifuge manufacturers.
- WPCP staff have issues with removing the concrete floor panels up via the hoist, which requires much effort, and odor moves throughout the DWB during this process due to short-circuiting.
- PEW supply pressure around dewatering has been pretty good. It could be an option to reduce PEW system pressure and add booster pumps.
- Hot water for cleaning has created a hazardous fog cloud in the DWB. Staff could keep hot water for polymer, but this is not necessary for the rest of the building.
- Motor control center (MCC) 31A on the first floor (below grade on the west side) was damaged when rainwater leaked in through unsealed penetrations.
- Tanks in the basement of the Bio-Building: polymer and sodium hypochlorite are the active tanks.
- The new design will be for four progressing-cavity pumps to feed the thermal hydrolysis process (THP). These could be accommodated either below the current cake hoppers or in the current lime blending room if the current dewatering space and cake bins are reused. WPCP staff could potentially use fewer hoppers in the new (or rehabilitated) DWB.
- Demolition of the current DWB will require the use of a temporary lime stabilization process. Rehabilitation could be conducted during process operation with addition of new equipment.
- It is very difficult to easily maintain or modify cake conveyors below centrifuges and cake hoppers because of the limited clearance between interconnected equipment as well as accessibility constraints.
- In addition to detailed discipline condition assessment of this structure for potential reuse, a code compliance check should be completed, with building code official consultation.

9.1 Centrifuges in Dewatering Building

Dewatering centrifuges (see Figure 13) are used to separate water from the blended thickened solids. The Andritz centrifuges, installed in the 1990s, are the first model of Andritz centrifuge installed in the United States that had a VFD back drive. The centrifuges are operating at reduced bowl speed and produce a cake solids of over 30 percent TS. Cake solids concentration produced by a dewatering process is as much a function of the feed solids characteristics as it is of machine parameters. The WPCP centrifuges are in the process of receiving upgrades from Andritz and WPCP internal staff consisting of new controls and VFDs along with mechanical rebuild of the machines, especially the gear boxes.

At the time of the site visit, there was concern about the reliability of the current dewatering process. It appears that the wear and tear of the machines plus rebuilding critical components now requires previously defined control parameters to be updated to restore reliability. HDR recommends urgent startup-style site visits from Andritz to restore previous reliability so the centrifuges can be replaced when scheduled as part of the Biosolids Upgrade project. If Andritz is unable to restore reliability, then an early construction package for the sequential replacement of centrifuges could be implemented if the decision is made to keep the current DWB with the next solids handling process. Then the new dewatering centrifuges would operate with the existing processes until the switch to new processes.

Performance of the current dewatering centrifuges in terms of polymer dose and cake solids is very good. Contributing factors to the high cake solids likely include, but are not limited to, high ferric dose, high primary to WAS ratio, polymer conditioning of WAS in the DAFT process, and chemically sequestered phosphorus. The planned pre-dewatering process upstream of THP requires only 16 to 18 percent TS, while the existing centrifuges deliver a higher cake solids concentration. When new dewatering equipment is selected for the new dewatering process, the performance of those machines may need to accommodate very different present and future operating conditions.

The following are condition assessment notes for the centrifuges in the DWB:

- During a recent period of 1 to 2 weeks in 2019, all three centrifuges were not working. WPCP operations had to store solids in process, which created significant process issues.
- Mineral deposits in the centrate split in the conveyor room have restricted centrate flow and caused process problems. Centrate lines are regularly cleaned. Buildup on the pipe walls is likely vivianite mineral, which could be mitigated with a WPCP-wide investigation of mineral cations and ferric dose.
- Centrifuge parts availability has been an issue with Andritz, as well as prompt response to service.
- There is no need to sole-source Andritz during the new centrifuge selection process.
- A fourth centrifuge might be an option for reliability, but HDR would recommend a new centrifuge selection process that begins with installation of a new centrifuge in the fourth open slot as new machines are installed.
- Any new centrifuge would likely require relocating the centrate chute, so there is no benefit to matching the configuration with the existing centrifuges. Any new centrifuge will require adjustment of the solids feed and polymer pipes along with cake and centrate discharge chutes.
- Mechanically, the gear boxes are problematic. The bearings are being eroded internally. Recent experience shows that asking Andritz for help has not been worthwhile.

- Centrifuges are running at only 2,000 revolutions per minute (rpm) instead of the 2,600 rpm on the nameplate. Some solids do not require high G-force for good dewaterability.
- Startup for the centrifuges is inconsistent because it depends on which operator is running the process that week.
- The electrical room will be upgrading centrifuge VFDs. This is probably needed for reliability though it is unfortunate when considering replacement of the entire machine.
- Some VFDs had to be replaced because of failure from power spikes during outages. New centrifuges need VFDs with better VFD protection including basics like line reactors.
- The Moyno feed pumps work well. Every centrifuge can be fed by multiple pumps. Pump VFDs are old and due for replacement.
- Solids loading reliability could be improved. Anything above 150 gpm clogs up the centrifuges; current feed concentration is 3.0 to 3.5 percent solids fed to the centrifuge, resulting in 2,200 to 2,700 pounds per hour mass feed rate.
- The polymer blend system is an automatic tank aging process that occasionally fails and requires a manual feed. The system is difficult to start up if not flushed after shutoff. The quality of polymer can be inconsistent. New dewatering should use emulsion blenders for polymer at the bulk storage tanks. Blend units may require additional controls and specified parameters to account for the height of the centrifuges above the blend units.
- Letting polymer age after blending can save 5 to 10 percent, but the savings often are negated by needing to maintain the polymer age tanks and addition of neat polymer pumps.
- The Moyno dilute polymer pumps work well. Every centrifuge can be fed by multiple pumps. The direct-current drives are about 30 years old. According to conversations with the maintenance staff, Seepex pumps are easier to repair. New polymer blend units would replace the entire existing polymer blending system.

Figure 13. Dewatering Centrifuge

9.2 Conveyors and Cake Hoppers in the Dewatering Building

Shaftless screw conveyors transport cake from the dewatering centrifuges to the cake hoppers. The cake hoppers have live-bottom floors with a pair of shafted conveyors that convey the dewatered cake to the lime blend mill. After lime blending more shaftless screw conveyors convey the cake to the trucks for loading. O&M has improved the process over the years and had no specific complaints about the conveyors. The way the conveyors are situated in the DWB makes it difficult to repair individual components. In general, there are two conveyors for every task, allowing for individual repair or complete rehabilitation of the process. Many of the cake gates are wearing and leak fluid, and occasionally fail to open or close. If the DWB is reused as part of the Biosolids Upgrade project, a complete rehabilitation of the conveyors is required, including liner replacement, and new cake gates (valves), in addition to the replacement of the centrifuges.

The following are condition assessment notes for the conveyors and cake hoppers in the DWB:

- In general, all the conveyors start reliably. The drive motors were previously replaced with greaseless bearing motors for improved maintenance.
- The cake gates sometimes do not close all the way (especially on the first floor). The gates should be replaced before wear makes them inoperable.
- The cake hoppers have a dual screw shafted live-bottom floor. One VFD runs twin screws, but sometimes the operator elects to operate only one screw depending on the needed conveyance rate. Live-bottom floor drive motors can be operated independently, so they should have independent VFDs. Cake hopper live-bottom screws have upgraded gear boxes and shafted screws, but can still overload if the hopper is overfilled.
- Throughout the cake conveyor process, pressure relief panels on the top of the conveyors, with switches that will shut down the cake conveyors, have been disabled by bolting down the lids. This eliminates a nuisance alarm but also a safety device.
- Screw conveyors on the second floor (see Figure 14) have acceptable alignment. Many of the conveyor liners are worn out. There are generally two conveyors for every required task. This is not a simple replacement; if the conveyors are kept the WPCP should accelerate the liner replacement by a specialized contractor with coordinated shutdown.
- Mineral buildup or dried sludge becomes a problem when screws are run and then stopped for a while.
- On the second floor the conveyor gates are likely bad. The conveyors’ gear boxes have been rebuilt and work fairly well. When conveyors are overloaded and sludge leaks out of the conveyor lid, the room can flood with dewatered sludge.

Figure 14. Second-floor Screw Conveyors

9.3 Odor Control in and around Dewatering Building

DWB odor control exists to maintain negative pressure on the solids handling process areas. Over the years foul-airflow control has been adjusted many times. A near-future project will rebalance the foul-airflow control to original design to better assess foul-air control in the DWB process areas. Foul-air treatment is accomplished by multiple chemical scrubbers, including an acid scrubber for ammonia removal and two-stage sodium hypochlorite chemical scrubbers for sulfide removal. The acid scrubber is not currently in use. The bulk sodium hypochlorite and chemical transfer pumps are located in the basement of the Bio-Building. The chemical day tanks and chemical feed pumps are located in the DWB. O&M reported no specific problems with the process other than that it is a nest of piping and very difficult to replace components. In general, this is a difficult technology to operate, but the future possibility of odor generation will likely require reconfiguration. Additional notes about the process are provided below:

- During the visit no excessive odors were observed around the treatment site.
- Fans outside of the Dewatering Building (see Figure 15) are very difficult to access for maintenance with no lifting area.
- Chemical metering pumps, supports, and piping are corroded and in need of replacement.
- Ventilation has been improved but still has issues. Additional balancing was recently completed.
- Possible future conversion to Bio-P will reduce the overall WPCP ferric chloride dose, which could result in more sludge sulfide odors.
- No copper corrosion was observed in the DWB other than on the first floor.
- Some components are near their end of life.
- The odor control system is loud.

Figure 15. Area Where Fan outside the Dewatering Building Is Located

9.4 Dewatering Building Structural Evaluation

This four-story building built in the mid-1990s is a sound structure of reinforced moment frame concrete construction (Photo A-26). Walls are infill concrete masonry with brick veneer on the perimeter; interior partitions are also of concrete masonry, and predominantly non-load-bearing. At the southeast corner the DWB has a low-rise connector to the older Biosolids Processing Building (Bio-Building, built in the late 1970s) (Photos A-28 and A-29). The DWB elevator serves this connector down to the 18-foot elevation (below grade) (Photo A-31). At this level in the connector, the floor was wet with water (Photo A-32), presumably groundwater or rain infiltration. For future consideration, this connector should be preserved (or replaced) to allow full elevator travel.

On the at-grade first floor (level 25 feet), cracking was observed in the concrete ceiling of the MCC room (104) at the west ductwork penetrations (Photo A-35). Cracks were also visible on the floor of the sludge feed pump room (103). Neither of these cracks are considered significant or troublesome. In the truck bays (102), the only minor issue is standing water on the scales causing corrosion of the ferrous floor materials (Photo A-38) and some concrete cracks on scale decks. The conveyors and steel hoppers appeared to be in good condition (Photos A-39 and A-40). The original truck area was extended to the east circa 1999 by approximately 38 feet (Photo A-38).

On the second floor (level 43 feet) no remarkable observations were made. The north/south central corridor is extremely wide but was designed for a lower live load than some of the adjacent process rooms.

On the third floor (level 66 feet), as on the second floor, no remarkable observations were made. It is worth noting that the concrete portions of the solids hoppers are integral to the building's structural system and a cursory look inside revealed good condition for the concrete and steel hopper at the discharge end.

On the fourth floor (level 82.5 feet) the usable area at this centrifuge and control room level is reduced (compared to lower levels) because of the low roof in the southwest quadrant. The structural condition is good, again, with a very wide central corridor. The centrifuge room (Photo A-41) has ample vertical clearance and is serviced by a 7.5-ton bridge crane. The roof structure is of concrete double tees supported by concrete frames with acoustic masonry completing the envelope.

The complete exterior of the DWB is wrapped in a brick veneer (Photos A-42 and A-43). After more than 20 years of exposure, typical maintenance is required for the expansion joint sealants (Photos A-44 and A-45). Additionally, other repairs at weather-impacted areas are required where brick has been damaged by poor drainage (Photo A-46) and joints without flashing but with drainage material (Photo A-47). Wholesale review of brick tuckpointing should be undertaken, correcting mislocated weep joint material (Photo A-46, A-47), along with the other aforementioned repairs.

9.5 Dewatering Building HVAC Evaluation

This section presents an evaluation of the HVAC systems in the DWB. First an overview and general condition is described, followed by more detailed notes on each plan elevation, and concluding with a summary table (Table 1). The rooms referenced in this section refer to the floor plan and room designations in the Upgrade and Expansion – Phase IIIA drawing set.

9.5.1 Overview and General Condition

The DWB was evaluated with respect to the HVAC systems, ductwork, controls, hydronic piping, and plumbing systems. This evaluation was based only on visual inspection of visible pieces of equipment, conversations with WPCP personnel, and the 2019 Dewatering Building Requirement Detail Report (condition assessment) by Arlington County. Any non-visible ductwork, piping, or equipment was not evaluated.

The 2019 condition assessment estimated $1.8 million for HVAC-related replacement costs. Approximately $246,000 of that cost has already been spent to replace assets with the earliest likelihood of failure.

The remaining original equipment shows signs of aging and is nearing the end of its expected service life. However, the equipment is expected to operate for the next 5 years. Future WPCP processes and layout will require the complete redesign of the HVAC and boiler system. During that time all remaining original equipment should be replaced and upgraded based on current code and efficiency requirements. As part of the future solids upgrades, there is an opportunity to use the waste heat for future water or space heating needs.

Most of the ductwork and equipment was observed with only minor defects, with the exception of ductwork and equipment in the lime storage and day bin areas, which were heavily coated with lime. Domestic water piping was observed with normal signs of use and corrosion, and there are no known issues per WPCP personnel. All systems were observed during normal operating conditions.

9.5.2 Plan Elevation 25 Feet

Below are condition assessment notes about the DWB HVAC system, plan elevation 25 feet:

- **MCC room:** The MCC room is cooled via a control room air conditioner (CRAC-1) located in the room and an air-cooled condensing unit (ACC-1) located on the roof. An inline exhaust fan (EF-1) with makeup air through wall louvers provides emergency cooling. The room is mechanically ventilated via a hydronic heating and ventilating unit (HV-1).
- **Sludge feed pumps room:** The sludge feed pumps room is provided with mechanical ventilation. The room is ventilated via the DWB odor control exhaust with makeup air tempering from a hydronic heating and ventilating unit (HV-2). The room is heated with wall-mounted horizontal unit heaters.
- **VFD room:** The VFD room is cooled via a control room air conditioner (CRAC-6) located in the room and an air-cooled condensing unit (ACC-6) located on the roof. An inline exhaust fan (EF-10) with makeup air through wall louvers provides emergency cooling. The room is mechanically ventilated via a hydronic heating and ventilating unit (HV-1).
- **Polymer solution control room:** The polymer solution control room is conditioned with a control room air conditioner (CRAC-2) located in the room and an air-cooled condensing unit (ACC-2) located on the roof. The room is mechanically ventilated via a hydronic heating and ventilating unit (HV-1).
- **Polymer solution feed pumps room:** The polymer solution feed pumps room is provided with mechanical ventilation. The room is ventilated via the DWB odor control exhaust with makeup air tempering from the polymer mixing and aging tank room above via a hydronic heating and ventilating unit (HV-2). The room is heated with a wall-mounted horizontal unit heater.
- **Scrubber recirculation pump, acid storage, and caustic storage pump rooms:** These chemical rooms are provided with mechanical ventilation. The rooms are ventilated via an in-line exhaust fan (EF-2). The rooms are heated with wall-mounted horizontal unit heaters.
- **Truck bay:** The truck bay is provided with mechanical ventilation. The room is ventilated via the DWB odor control exhaust with makeup air tempering from a hydronic heating and ventilating unit (HV-4). The room is heated with wall-mounted horizontal unit heaters.
- **Tool room:** The tool room is provided with mechanical ventilation via a hydronic heating and ventilating unit (HV-4). The room is heated with wall-mounted horizontal unit heaters.
- **HVAC room:** The HVAC room is provided with mechanical ventilation via a hydronic heating and ventilating unit (HV-4). The room is heated with wall-mounted horizontal unit heaters.
- **Corridor:** The corridor is provided with mechanical ventilation via a hydronic heating and ventilating unit (HV-1).
- **Gallery:** The gallery is provided with mechanical ventilation. The room is ventilated via an inline exhaust fan (EF-11) with makeup air tempering from a hydronic heating and ventilating unit (HV-3). The room is heated with wall-mounted horizontal unit heaters.

9.5.3 Plan Elevation 43 Feet

Below are condition assessment notes about the DWB HVAC system, plan elevation 43 feet:

- **Boiler room:** The boiler room is provided with mechanical ventilation. The room is ventilated via a supply fan (SF-1) with relief through wall louvers. Combustion air for the boiler is provided via wall louvers. The room is heated with wall-mounted horizontal unit heaters. Two domestic water heaters located in the room provide domestic hot water to the plumbing fixtures.

- **Switchgear room:** The switchgear room is intended to be cooled with a control room air conditioner (CRAC-3) located in the room and an air-cooled condensing unit (ACC-3) located on the roof. An inline exhaust fan (EF-3) with makeup air through wall louvers is intended to provide emergency cooling. Currently the switchgear room control room air conditioner unit is not operational and is being cooled with the emergency cooling ventilation system. The original air-cooled condensing unit has been removed for future replacement. The room is mechanically ventilated via a hydronic heating and ventilating unit (HV-2).
- **Sludge cake storage bin area:** The sludge cake storage bin area is provided with mechanical ventilation. The room is ventilated via the DWB odor control exhaust with makeup air tempering from a hydronic heating and ventilating unit (HV-2). The room is heated with wall-mounted horizontal unit heaters.
- **Dry polymer hopper room and hoistway:** The dry polymer hopper room and hoistway above are provided with mechanical ventilation. The room is ventilated via a hydronic heating and ventilating unit (HV-2). The room is conditioned with a control room air conditioner (CRAC-7) and an air-cooled condensing unit (ACC-7) located on the roof. The room is heated with wall-mounted horizontal unit heaters.
- **Lime day bin and storage rooms:** The lime day bin and storage area above are provided with mechanical ventilation. The room is ventilated via an inline exhaust fan (EF-19) with makeup air tempering from a hydronic heating and ventilating unit (HV-2). The room is heated with wall-mounted horizontal unit heaters.

9.5.4 Plan Elevation 66 Feet

Below are condition assessment notes about the DWB HVAC system, plan elevation 66 feet:

- **Electrical room:** The electrical room is cooled via a control room air conditioner (CRAC-4) located in the room and an air-cooled condensing unit (ACC-4) located on the roof. An inline exhaust fan (EF-5) with makeup air through wall louvers provides emergency cooling. The room is mechanically ventilated via a hydronic heating and ventilating unit (HV-2).
- **Scrubber room:** The scrubber room is mechanically ventilated. The room is ventilated via a roof-mounted exhaust fan (EF-6) with makeup air tempering from a hydronic heating and ventilating unit (HV-1).
- **Air dryer room:** The air dryer room is mechanically ventilated. The room is ventilated via a roof-mounted exhaust fan (EF-6) with makeup air tempering from a hydronic heating and ventilating unit (HV-1). The room is heated with wall-mounted horizontal unit heaters.
- **Sludge cake room:** The sludge cake room is provided with mechanical ventilation. The room is ventilated via the DWB odor control exhaust with makeup air tempering from a hydronic heating and ventilating unit (HV-2). The room is heated with wall-mounted horizontal unit heaters.
- **Compressor room:** The compressor room is intended to be cooled via an inline exhaust fan (EF-9) with makeup air through wall louvers. The exhaust fan is not operational and the room is not being cooled. The room is mechanically ventilated via a hydronic heating and ventilating unit (HV-2). The room is heated with wall-mounted horizontal unit heaters.

- **Lime transfer blower room:** The lime transfer blower room is cooled via an inline exhaust fan (EF-18) with makeup air through wall louvers. The room is heated with wall-mounted horizontal unit heaters.

9.5.5 Plan Elevation 82.5 Feet

Below are condition assessment notes about the DWB HVAC system, plan elevation 82.5 feet:

- **Centrifuge room:** The centrifuge room is provided with mechanical ventilation. The room is ventilated via roof-mounted exhaust fans (EF-7 and EF-12) with makeup air tempering from a hydronic heating and ventilating unit (HV-1). The room is heated with wall-mounted horizontal unit heaters.
- **Centrifuge control room:** The centrifuge control room is conditioned with a control room air conditioner (CRAC-5) and an air-cooled condensing unit (ACC-5) located on the roof. Operators man this control room 24 hours per day, 7 days per week.

9.5.6 Other Spaces

Below are condition assessment notes about other spaces within the DWB HVAC system:

- **Toilet rooms:** The toilet rooms throughout the DWB are exhausted via ceiling exhaust fans (EF-4 and EF-8) with makeup air from adjacent spaces. The toilet rooms are heated with convector heaters (C-4 and C-9).
- **Janitor rooms:** The janitor rooms throughout the DWB are exhausted via ceiling exhaust fans (EF-15 and EF-16) with makeup air from adjacent spaces. The janitor rooms are heated with a convector heater (C-10).
- **Stairs:** The stairs throughout the DWB are heated with convector heaters (C-1 through C-3, C-5 through C-8, and C-11).

Table 1. Dewatering Building HVAC Evaluation

Asset	Qty.	Type	Installation Year	Condition	Reliability	Comments	Recommendation [a]
Heating and ventilation units (HV-X)	4	Indoor air handler, hydronic	1996	Minor defects only/moderate deterioration	Control panel causes random breakdown.	Intake and coil bypass dampers at all units are not operational.	Replace dampers, damper actuators, and control panel.
Air conditioner (AC-1)	1	Split system	Indoor unit: 1996; outdoor unit: 2020	Indoor unit: moderate deterioration; outdoor unit: new	Unit failure not anticipated.	Air-cooled condensing unit has been replaced within the last year. Indoor unit is original.	None.
Control room air conditioners (CRAC-X) and air-cooled condensing units (ACC-X)	7	Split system	CRAC-3: 1996; CRAC/ACC-1, ACC-2, ACC-4–ACC-7: 2020	CRAC-3: moderate deterioration; CRAC/ACC-1, ACC-2, ACC-4–ACC-7: new	Unit failure not anticipated.	All are new within the last year, except for CRAC-3 (switchgear room), which is original and not operational. CRAC-7 (dry polymer hopper) cycles and locks out, which might shorten its life span.	Replace CRAC-3 and install ACC-3. Downsize CRAC-7/ACC-7.
Exhaust fans (EF-X)	19	Exhaust fans	1996	Minor defects only/moderate deterioration	EF-1–EF-8, EF-10–EF-19: failure not anticipated. EF-9 (compressor room): failed.	Motorized dampers at EF-7 and EF-12 (centrifuge room) are not operational. EF-9 is not operational.	Replace motorized dampers at EF-7 and EF-12. Replace EF-9 if compressor room is to remain in use.
Boiler (HWB-1)	1	Gas-fired boiler	1996	Moderate deterioration	Failure not anticipated.	None.	Replace flue damper and install new burner.
Unit heaters (UH-X)	39	Horizontal unit heaters	1996	Moderate deterioration	Failure not anticipated.	None.	None.
Convectors (C-X)	11	Convector unit heaters	1996	Moderate deterioration	Failure not anticipated.	None.	None.

Asset	Qty.	Type	Installation Year	Condition	Reliability	Comments	Recommendation [a]
Lime storage and day bin area HVAC equipment	N/A	N/A	1996	Moderate deterioration	Failure not anticipated.	Lime buildup on ductwork, exhaust fan, louver, unit heater, and control panel.	Clean on a regular schedule.
Ductwork	N/A	HVAC	1996	Minor defects only/moderate deterioration	Failure not anticipated.	None.	None.
Ductwork [b]	N/A	Odor control	1996	Moderate deterioration	Failure not anticipated.	The odor control exhaust duct serving the polymer solution feed pumps room is unsecure and noisily vibrates above the scrubber recirculation pump room.	Investigate and secure ductwork.
Water heaters	2	Storage tank	Unknown	Minor defects only	Failure not anticipated.	None.	None.
Plumbing piping and fixtures	1	-	1996	Moderate deterioration	Failure not anticipated.	System shows normal aging. No known leaks.	Continue annual testing and replace when needed based on testing.

Equipment tags are based on original drawings.

a. Replacement of equipment is based on replacing equipment in kind. Redesign of space, process, or systems will require evaluation and additional design to meet current NFPA 820 and building codes.

b. The odor control ductwork was not assessed. Only the obvious section of unsecure ductwork was addressed.

9.6 Dewatering Building Electrical Evaluation

The DWB is served from the WPCP 34.5-kilovolt (kV) distribution system. That system is configured as a selective radial system with A and B feeders for redundancy. The voltage is step down to 480 volts (V) at the distribution system (DS)-7 transformers and power is supplied to distribution center (DC)-7 switchgear (see Figure 16), which feeds panels, MCC-31, and MCC-32 in the DWB.

The WPCP-wide distribution system has the capacity to serve any practical expansion of the solids treatment. The capacity at 480 V is limited by the DC-7 1,500-kilovolt-ampere (kVA) transformers. Those transformers will most likely need to be replaced or augmented to serve the existing DWB and new processes.

The main DC-7 switchgear is rated for 4,000 amperes (A) (3,325 kVA) and, like the rest of the distribution equipment, it is reported to be in decent condition. However, it was constructed in 1997 and will be more than 25 years old when new facilities come online. A standard life span for electrical distribution equipment is 30 years, which means switchgear replacement would be planned a short time after the new facilities are in service. In addition, feeder circuit breakers may need to be replaced or reconfigured to match the new processes.

MCC-31 and MCC-32 (A and B) and several panelboards were installed as part of the same project as DC-7 and are about the same age. These MCCs serve process motors throughout the DWB and the need for MCCs is highly dependent on the final use of the DWB. But it is highly likely that new motor starters will be required for the repurposed space.

Given the age of the switchgear and MCC, the estimated reconfiguration that may be required, and for project flexibility, these should be replaced.

10.0WPCP Power Supply

The WPCP has two utility power feeds that form the A and B selective radials that power the seven DS substations. If a utility or WPCP power feeder is out of service, DC 480 V switchgear and MCC will automatically transfer to the other feeder. Transfer is timed to allow the DC to transfer first and then at the MCCs if needed. A standby generation facility (SGF) has three 2,500-kilowatt (kW) generators. The peak WPCP electrical demand is approximately 4,000 kW. The SGF is capable of synchronizing with the utility feeders for closed transition transfer or for peak shaving. When there is a complete utility outage the standby generators automatically start, synchronize with each other, and then energize the main 35 kV WPCP feeders. During the site visit one of the WPCP 34.5 kV switchgears was out of service because of a potential transformer (PT) failure. Without the PT it is not possible to power that switchgear from the generators and some protective functions will be lost. The result is a loss of redundancy. O&M reported no specific problems with the process. Additional notes about the process are provided below:

- The Phase 7A project completed electrical upgrades throughout the WPCP but the DWB was largely excluded.
- Switchgear and MCCs are main-tie-main for maintenance purposes.
    - Some MCCs have auto transfer, but the ones for RAS pumps do not.
    - MCCs powering critical equipment (i.e., chemical feed systems) have automatic transfer controls.

  - Eliminating kirk key systems frequently happens during WPCP upgrades.
    Electrical staff indicated that manual/kirk key systems are still desired for non-critical equipment. This allows a staggered load switchover to avoid electrical dips.

- The WPCP has a split electrical source:

  - The power to the north side of the WPCP is supplied through either DC-1 or DC-7. A main feeder and ductbank connect DC-1 and DC-7 to DC-35 and the generators. This main feeder and ductbank are critical and should not be impacted during the Biosolids Upgrade project.
  - The WPCP has seven DCs.
  - These DCs power various MCCs.
  - The WPCP has four MCCs in the area near RAS.

- Generators switch on automatically for power outages but WPCP maintenance can turn the generators on themselves if necessary.

  - Generators are operated and maintained by contract. Parallel operation or peak shaving is done by agreement with utility.
  - On switchover, most but not all equipment usually auto-restarts. Transfer to backup utility power is 10 to 15 seconds. Transfer to the generator is 45 to 60 seconds.

- Power quality issues: Some process equipment VFDs will trip/shut off because the power is out of operation range, such as losing a phase, etc.
- Arc flash studies have been completed.
- There is no secondary fuse protection on the transformers so sometimes WPCP staff need to suit up completely, but the de-energization of the electrical equipment is mostly not a problem.

Figure 16. DC-7 Switchgear in the Dewatering Building

11.0 WPCP Process Control System

The WPCP process control system (PCS) (see Figure 17) received some upgrades during the Phase 7A project. The PCS uses Rockwell FactoryTalk version 10. The PCS has legacy graphics (no longer supported) with a red is running/open color standard. There is no formal historian. Data gets pivoted into Hach Water Information Management Solution (WIMS) and will eventually get compressed to average values. The next project, likely the Biosolids Upgrade project, should include a formal historian.

WPCP staff has a long-term project to develop PCS high-performance graphics following International Society of Automation (ISA) standards. HDR recommends that a future project include integrator-developed high-performance PCS screens for new processes to eliminate project risk of self-performance. It is also recommended that standards be developed in coordination with the WPCP PCS group.

The WPCP operators still prefer the legacy graphics and trending packages, because that is what they are used to. Operations reported no specific problems. The PCS should be able to operate with normal maintenance into the future. As is the nature with computer systems, the PCS has a shorter service life than most mechanical components of a treatment plant. Additional notes about the PCS are provided below:

- The WPCP has been standardizing on Rockwell Automation, and the PCS human-machine interface (HMI) is FactoryTalk, with Allen-Bradley PowerFlex VFDs and Allen-Bradley programmable logic controllers (PLCs).
- PLC panels around the WPCP had redundant hot-backup PLCs.
- Rockwell is no longer supporting legacy graphics in its next version.
- Red is running/open; green is not running/closed.
- Solid yellow or red is an alarm that has been acknowledged. Blinking yellow or red is an alarm and unacknowledged. Onscreen symbols include:
    - A = automatic
    - M = manual
    - NR = non-remote for either only local control, local control panel (LCP) in local, or lock-out/tag-out (LOTO) situation
- Data can go back to 5 years. Different software was used earlier than that. FactoryTalk Transaction Manager just pulls data. Pivoted data are saved by the engineer and not deleted.
- Control strategies are on SharePoint.

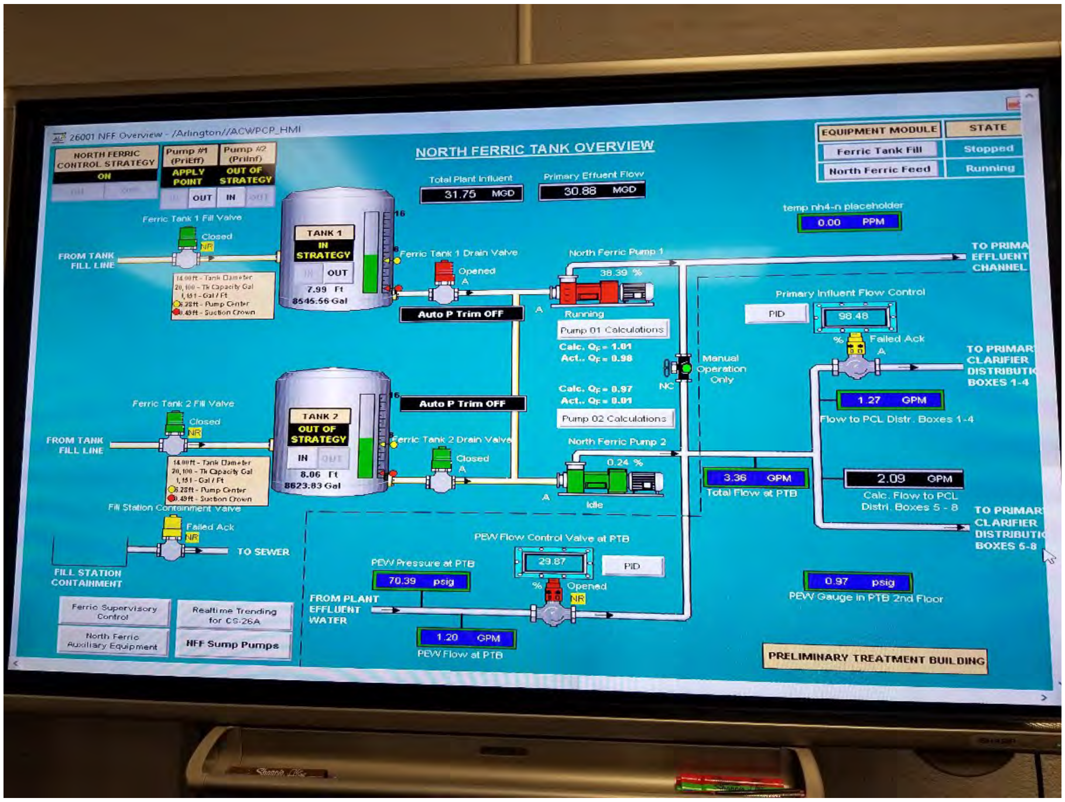

Figure 17. Sample of PCS Screen of the North Ferric Chemical Feed System

Attachment A Structural Photographs

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Gravity Thickener Photographs

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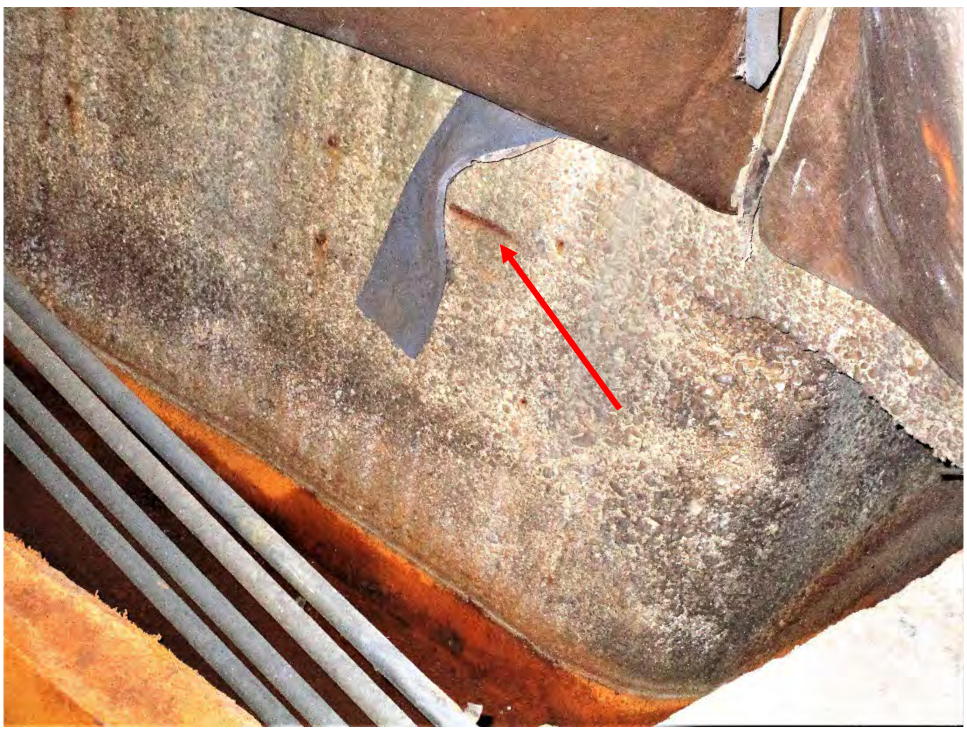
Photo A-1. Mechanical Scraper—To Be Replaced



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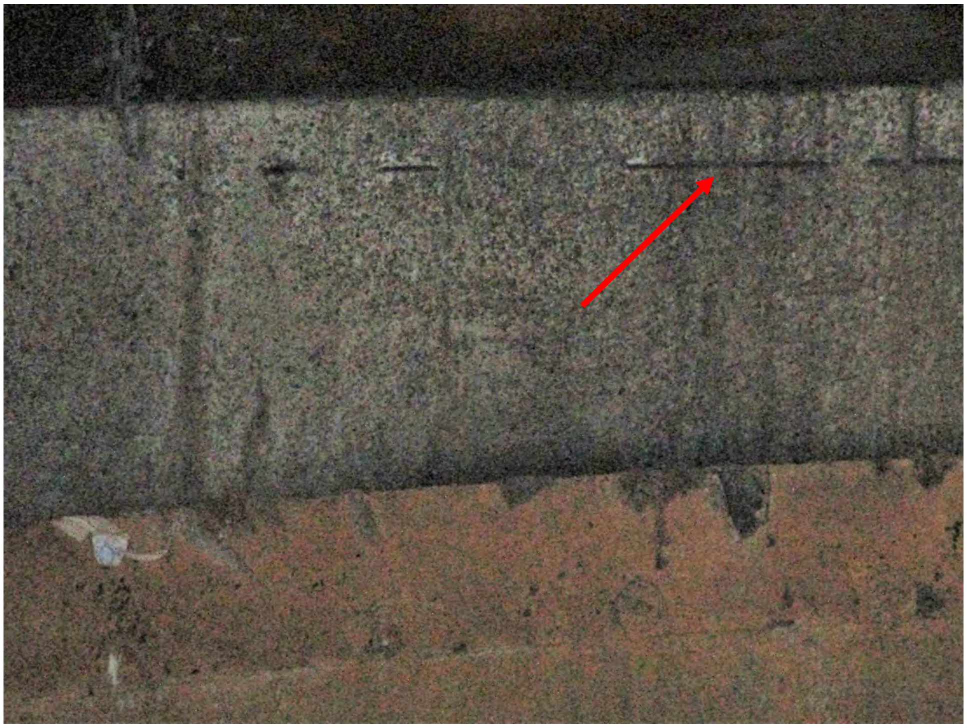

Photo A-6. Reinforcing Exposed

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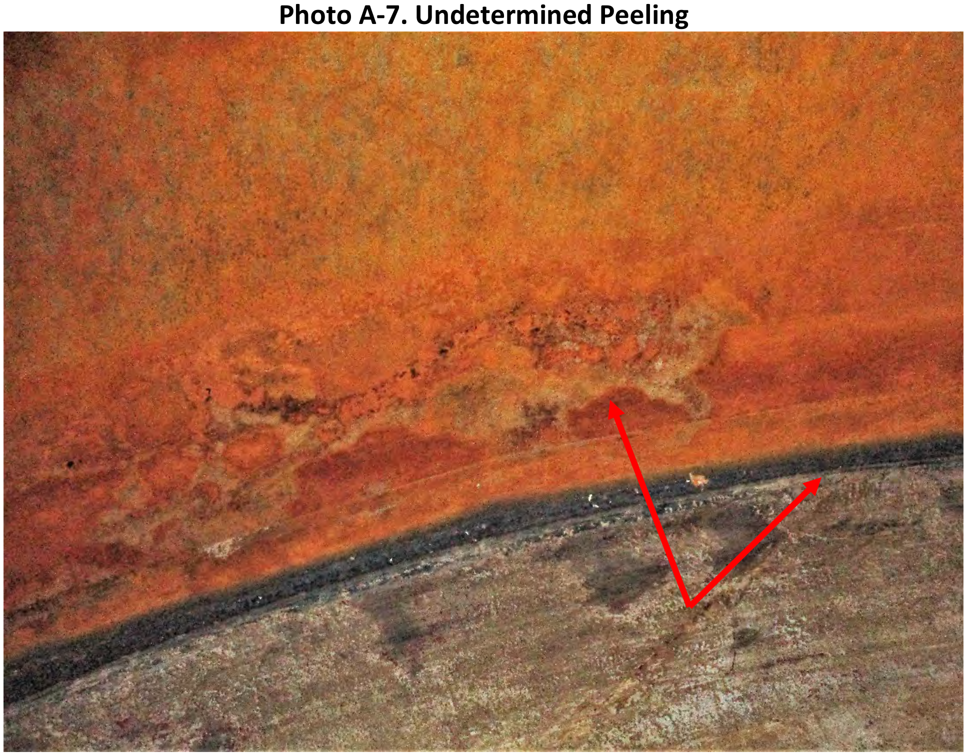

Photo A-8. Substance to Be Investigated

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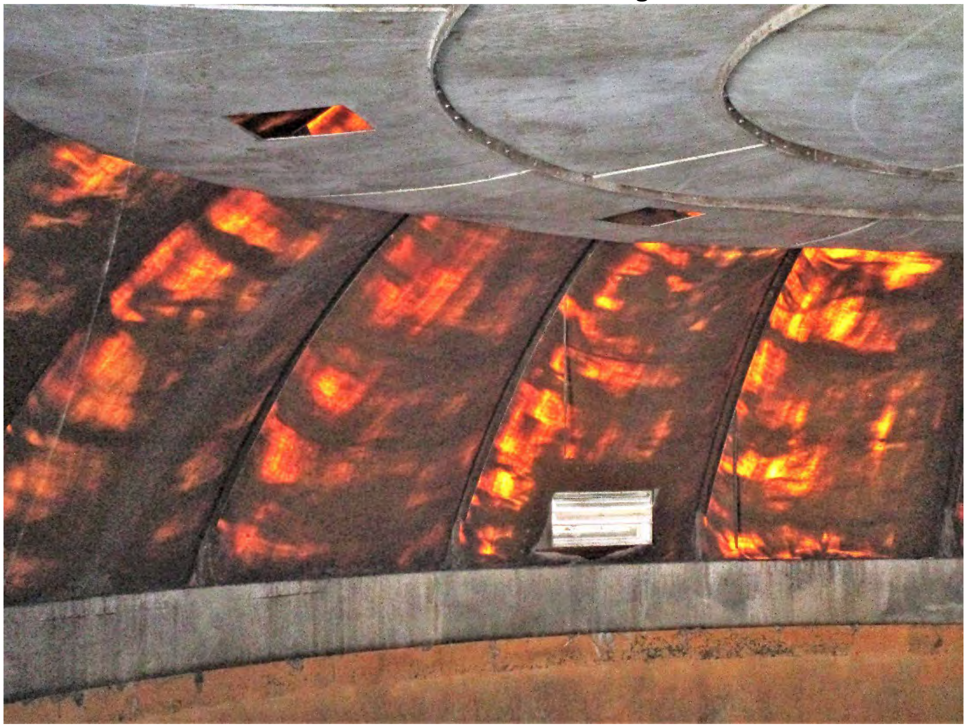

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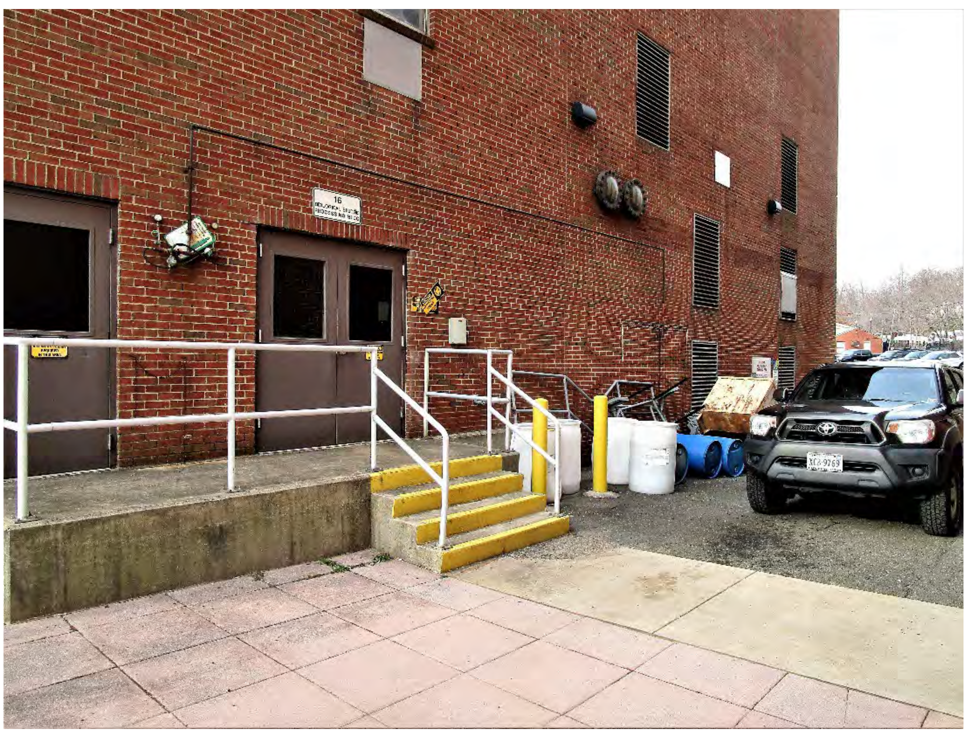

Photo A-29. Bio-Building to Demolish (Photo 2 of 2)

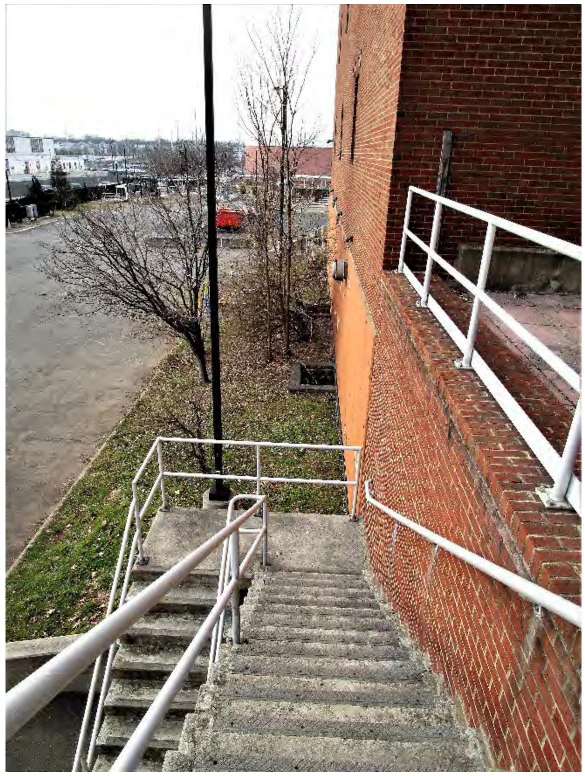

Photo A-30. East Low Link to Save

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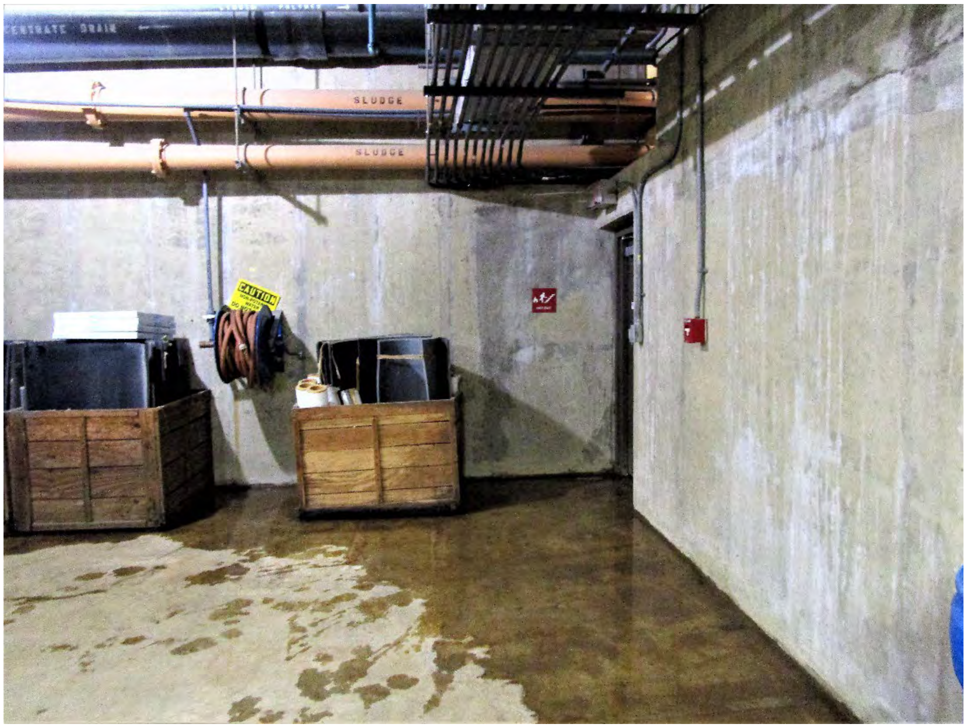


Photo A-32. Water in Link

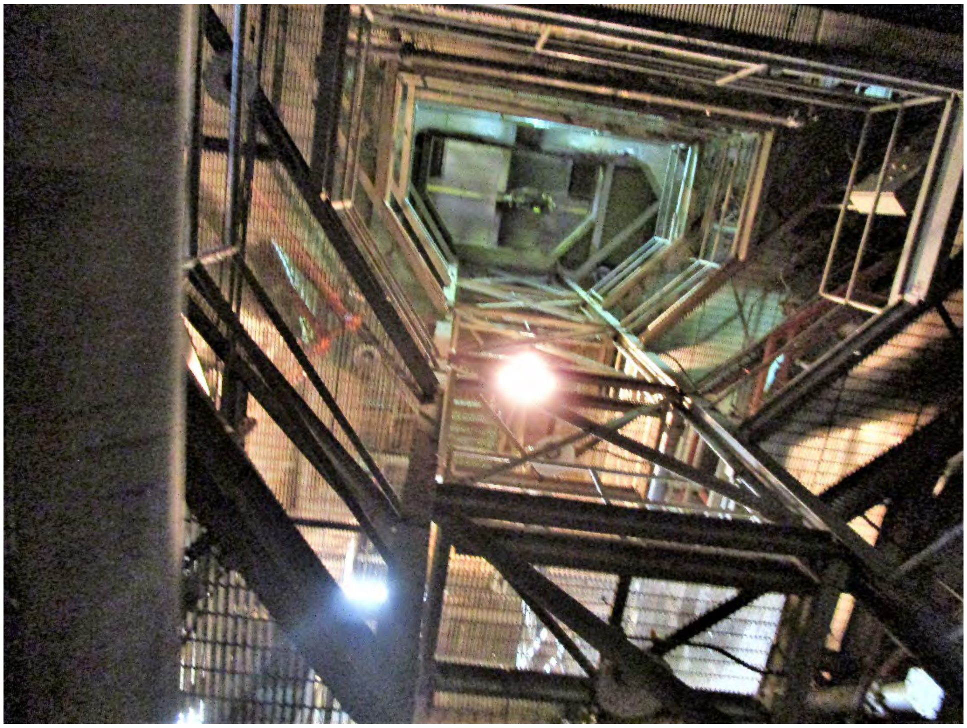


Photo A-33. Incinerator to Demolish

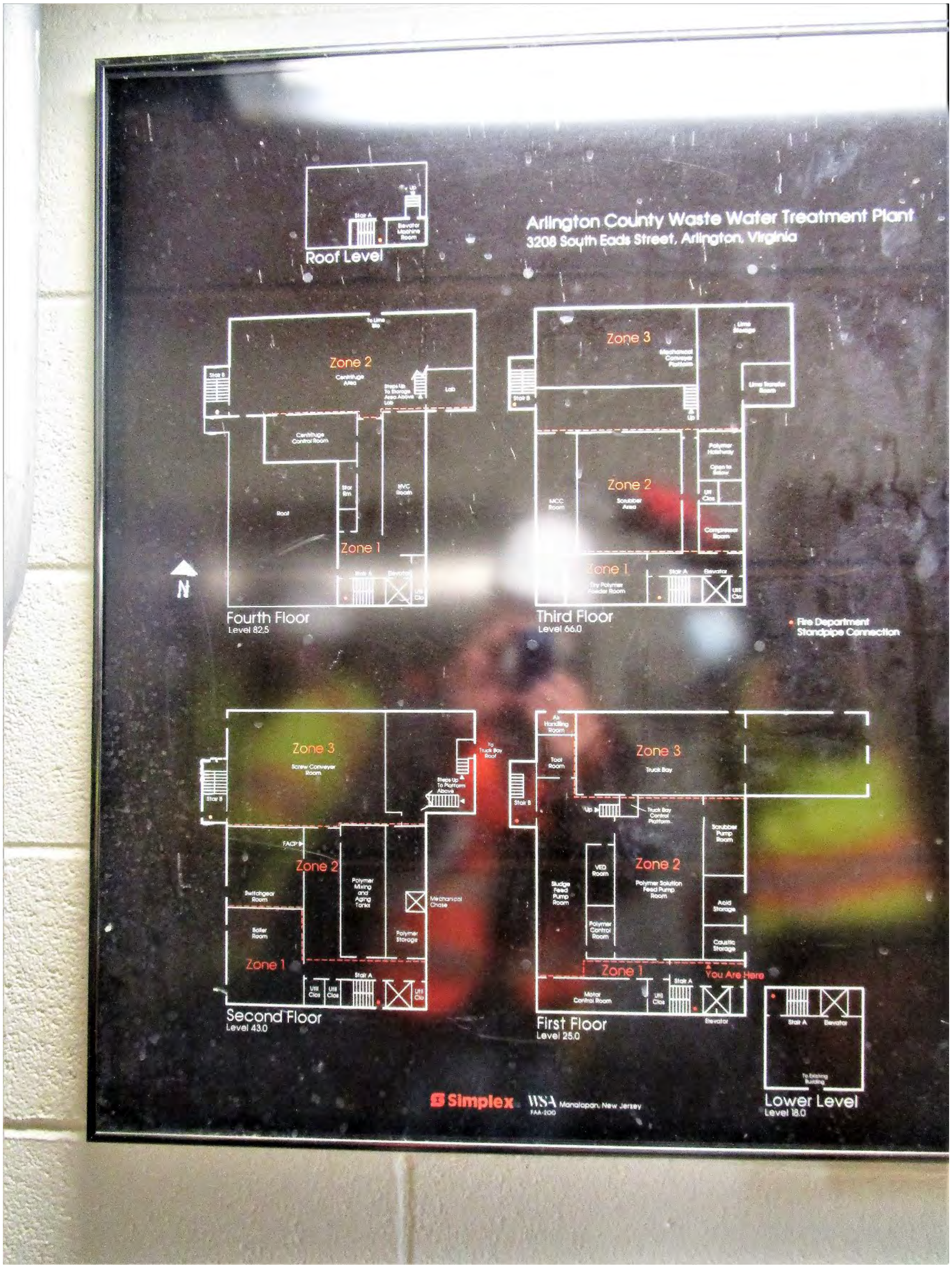
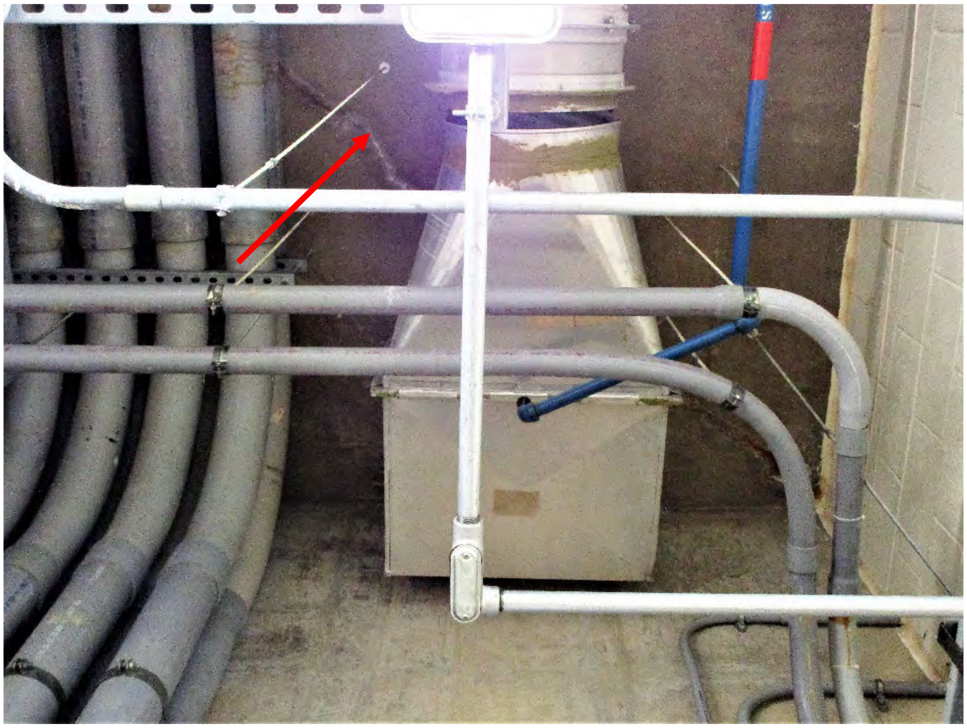


Photo A-34. Floor Map



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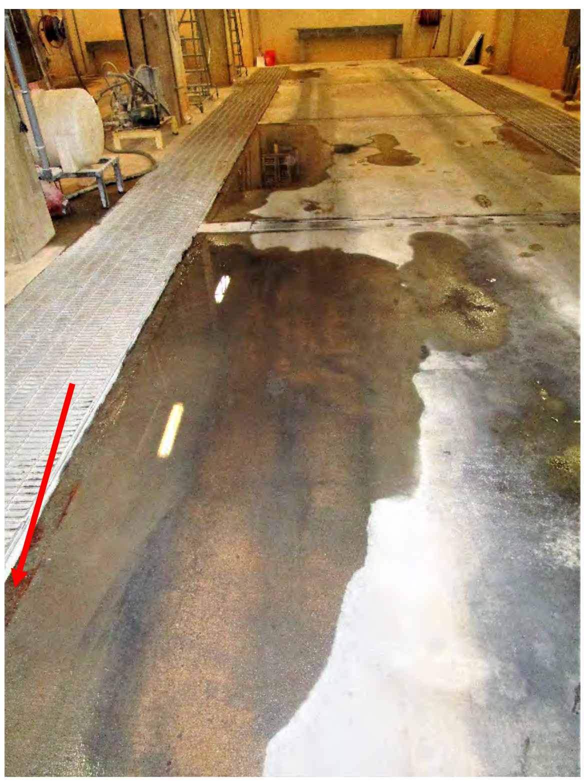

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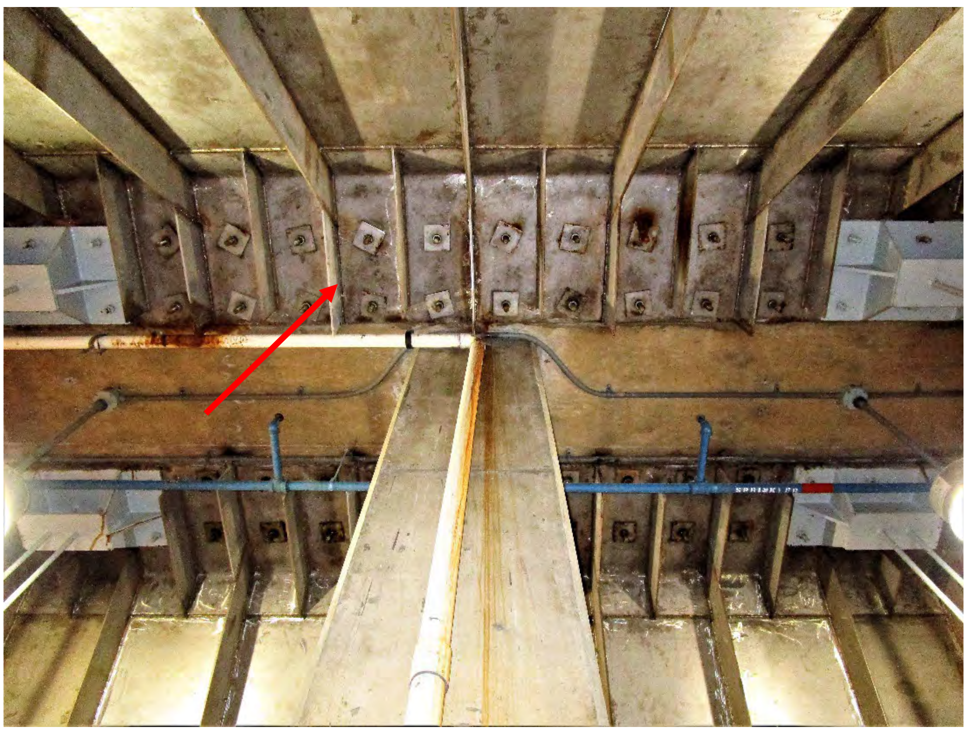

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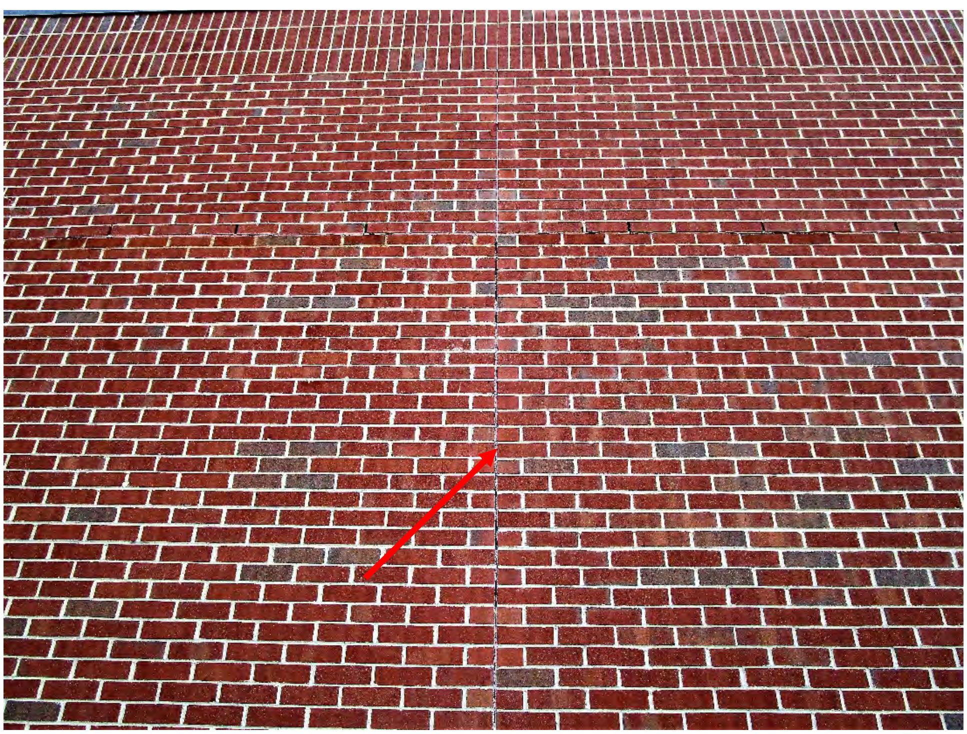

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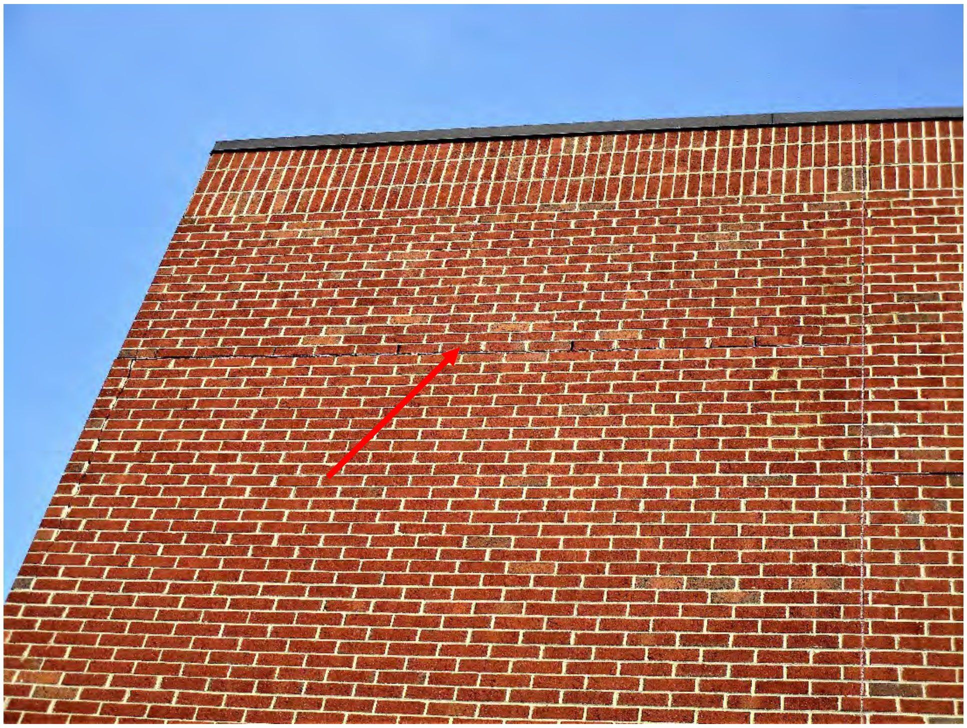
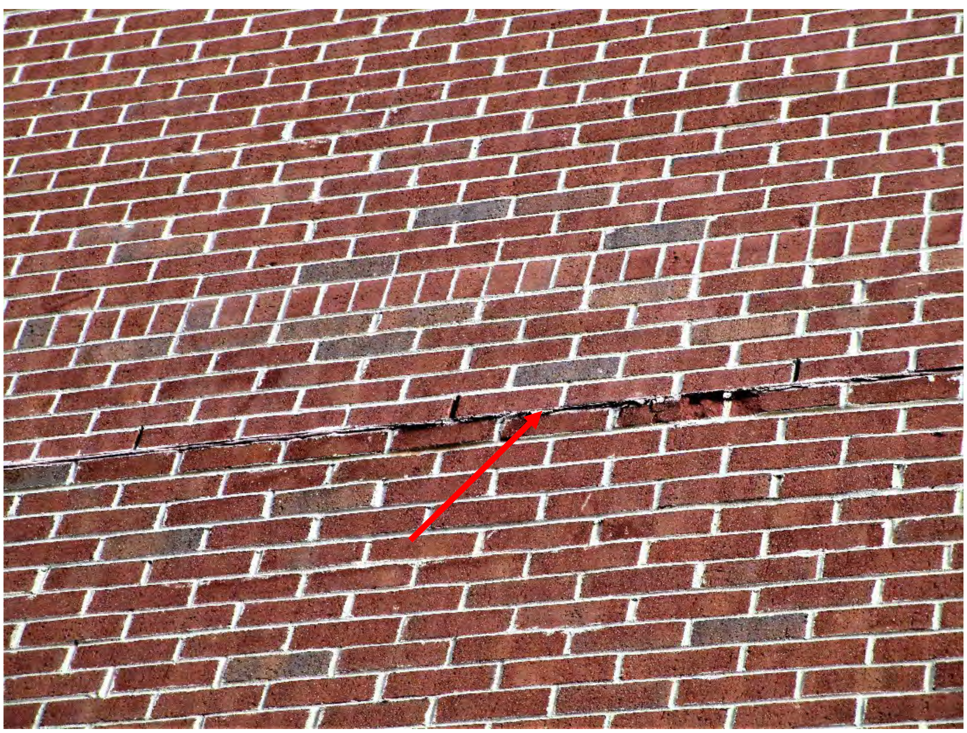


Photo A-45. Brick Joint



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Technical Memorandum No. 3

Date:	July 21,2021
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Biosolids Technology Market Assessment

Contents

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1.0 Introduction

This introductory section presents the background and purpose of the project and describes the evaluation of selected biosolids treatment and handling technologies for the Arlington Water Pollution Control Plant (WPCP).

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington WPCP. Currently solids handling includes primary sludge (PS) and waste activated sludge (WAS) thickening, dewatering, and lime stabilization. The 2018 Solids Master Plan report (Master Plan) for the WPCP recommends replacing the existing lime stabilization process with a thermal hydrolysis process (THP) and anaerobic digestion. The Master Plan arrived at this recommendation following an evaluation of multiple biosolids treatment and handling technologies. The technologies initially screened as part of the Master Plan included:

- **Non-digestion stabilization:** composting and chemical treatment
- **Digestion stabilization:** aerobic digestion, autothermal thermophilic aerobic digestion (ATAD), mesophilic digestion, thermophilic digestion, temperature-phased anaerobic digestion (TPAD)
- **Digestion process enhancements:** thermal hydrolysis, cavitation, thermo-chemical hydrolysis
- **Drying:** solar, direct thermal, indirect thermal
- **Thermal processes:** incineration, wet air oxidation, Anuvia, gasification, pyrolysis, liquid thermal oxidation

The County has requested that certain technologies be further evaluated to identify any technology improvements that should be included for this project and considered for inclusion in the Facilities Plan.

1.2 Evaluation Approach

The following technologies evaluated in the Master Plan were identified through discussions between the County and HDR for additional evaluation because of their current and growing use at wastewater facilities in the United States and their ability to address key project drivers of Class A biosolids end product and energy recovery:

- Solids drying: rotary-drum and belt drying
- Pyrolysis
- Gasification
- THP alternate configurations

This technical memorandum (TM) revisits these solids processing technologies and viable uses for the products they produce based on current market outlets. The remaining technologies that had been screened during the Master Plan were not included in this evaluation because they either do not meet the key project drivers of Class A biosolids end product and energy recovery or the technology maturity had not substantially changed since development of the Master Plan to warrant re-evaluation. The technologies are compared based on their current level of maturity and implementation, scalability to the WPCP, and energy demands. Technology recommendations and planning considerations for the Facilities Plan are provided

2.0 Technology Alternatives

This section presents descriptions of the biosolids treatment and handling technology alternatives considered in this evaluation.

2.1 Solids Drying

Rotary-drum and belt dryers produce dried biosolids through evaporation by bringing dewatered solids into direct contact with heated air. Although it is not necessary to digest solids prior to drying, the odorous nature of dried undigested solids, particularly when the dried solids are rewetted, makes the product undesirable for most non-agricultural end uses. Additionally, digestion produces biogas that can be beneficially used, including as fuel to heat the drying air. When cake solids are dried to greater than 90% solids, both dryer technologies produce a Class A dried biosolids product that has several well-established end-use markets in the United States. In addition to bulk agricultural land application, dried biosolids are used as a solid fuel (primarily in cement kilns); as an ingredient in blended fertilizers; and for turf management, landscaping, and horticulture. Dried biosolids can also be distributed or sold to the general public in bulk or in bags for use as a fertilizer or soil amendment.

2.1.1 Rotary-Drum Drying

Rotary-drum dryers produce a dried, stabilized Class A product by drying dewatered solids through direct contact with heated air in a horizontal, enclosed triple-pass rotating drum. Dewatered solids are blended with recycled dried solids and fed into the rotating drum. Solids are conveyed through the rotating drum in the process air stream, which is heated in a gas-fired furnace. The heated air comes in contact with the solids and evaporates water. The pre-mixing of dewatered and recycled dried solids combined with the rotating action of the drum produce a hard, spherical pellet with a diameter of 3 to 4 millimeters. Dried solids exit the drum and are carried in the process air stream to a cyclone that separates the solids from the process air. Solids are sent to a screen that separates product-size pellets from oversized and undersized material, which are recycled and mixed with dewatered solids. Product-size pellets are then cooled and conveyed to storage. The process air stream passes through a venturi scrubber to removal particulates and water and then continues to an odor control system, typically consisting of a regenerative thermal oxidizer for volatile organic compound and odor (VOC) combustion.

A rotary-drum dryer process at the WPCP would be added following dewatering to dry digested, dewatered solids, as shown in Figure 1.

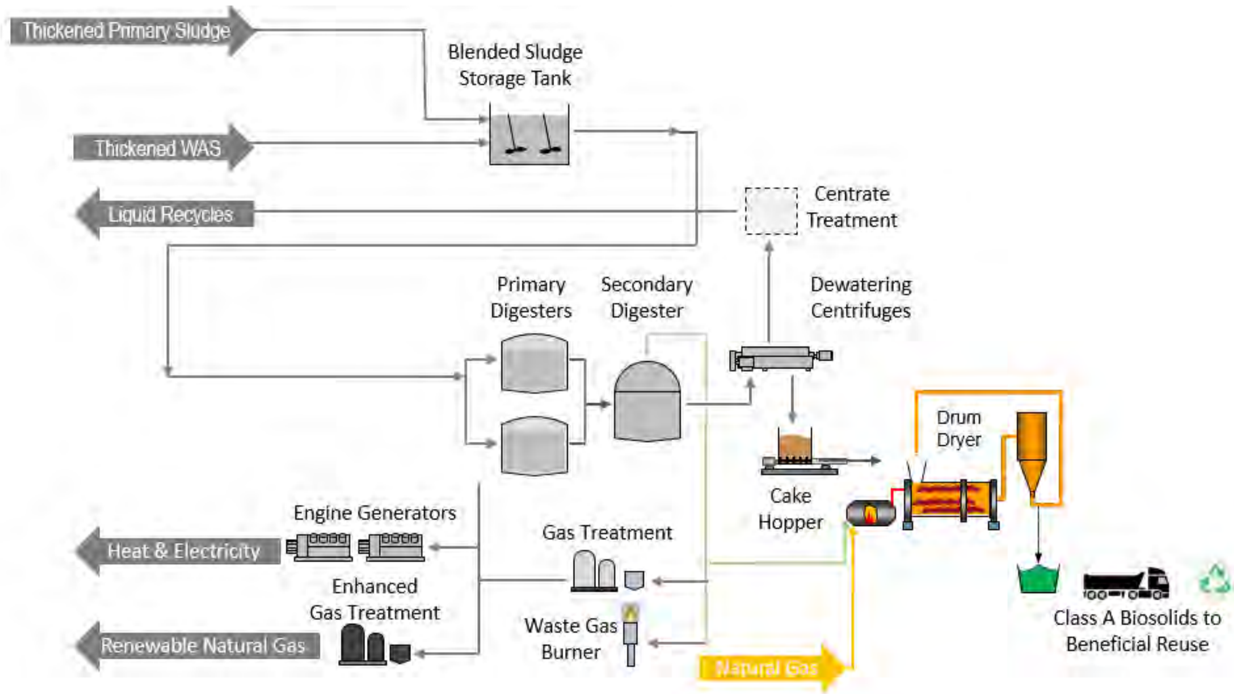


Figure 1. Rotary-Drum Dryer Process Flow Diagram

Rotary-drum drying is considered a process to further reduce pathogens (PFRP) that achieves Class A pathogen reduction by reducing the moisture content of the solids to 10 percent or less and heating the biosolids to at least 80 degrees Celsius (°C) (176 degrees Fahrenheit [°F]). Rotary-drum drying systems operate at a process air temperature of 260°C to 370°C (500°F to 700°F) and typically dry the biosolids to 90 to 95 percent total solids (TS).

Rotary-drum drying is a mature technology with more than 40 years of operating history at wastewater treatment facilities. More than 40 rotary-drum drying installations are operating at wastewater facilities in the United States and on the order of 200 worldwide. Rotary-drum dryers are commonly used at medium to large wastewater facilities of a scale similar to the County's facility.

Table 1 summarizes the benefits and challenges of rotary-drum drying.

Table 1. Rotary-Drum Dryer Benefits and Challenges

Benefits	Challenges
Mature technology in the wastewater industry	Extensive odor and emissions control systems
Class A pathogen reduction	Large energy demands (both natural gas and electricity) and greenhouse gas footprint
Significant biosolids volume reduction	Additional staff required for operations and maintenance (O&M)
Most versatile end product in the biosolids market	Not recommended for implementation with THP
	No per- and polyfluoroalkyl substances (PFAS) destruction
	Relatively high level of mechanical and operational complexity

2.1.2 Belt Drying

Belt drying systems produce a stabilized Class A biosolids product by drying dewatered cake through direct contact with hot air as the dewatered cake is conveyed through a horizontal dryer cabinet on one or more moving belts. Belt drying systems fall into one of two categories:

- **Back-mixing systems (example manufacturers: Andritz, Haarslev):** Similar to the rotary-drum dryer, these types of belt dryers mix dewatered cake and recycled dried material to pre-form a granule that is fed onto the drying belt. Crushing, screening, and recycling of the dried product are integral to the proper performance of the belt dryer.
- **Direct cake feed systems (example manufacturers: Veolia, Haarslev, Huber):** These types of belt dryers pump and extrude dewatered cake, with no back-mixing of dried product, directly onto the drying belts. This type of belt dryer produces a non-uniform product that can range from a mulch-like material to irregularly sized and shaped granules. Post-processing of the dried material (crushing, screening, optional pellet mill) can be provided to produce a more uniform final biosolids product.

Condensers are usually used to separate evaporated water from the process air and recirculate most of the process airflow back to the dryer, reducing the amount of air exhausted to the atmosphere. An odor control system consisting of a wet chemical scrubber or biofilter is typically provided to treat the air exhausted to the atmosphere.

Similar to a rotary-drum dryer, a belt dryer would be added following dewatering to dry digested, dewatered solids, as shown in Figure 2.

Belt drying is also considered a PFRP that achieves Class A pathogen reduction by reducing the moisture content of the solids to 10 percent or less and heating the biosolids to at least 80°C (176°F). Belt drying systems operate at temperatures of 90°C to 150°C (200°F to 300°F) and dry the biosolids to 90 to 95 percent TS.

Belt drying is a mature technology with more than 20 years of operating history, although it is relatively new to the United States. Approximately 15 belt drying installations are in operation at wastewater treatment facilities in the United States, several of which are at a scale similar to the WPCP, and more than 90 worldwide.

Table 2 summarizes the benefits and challenges of belt drying.

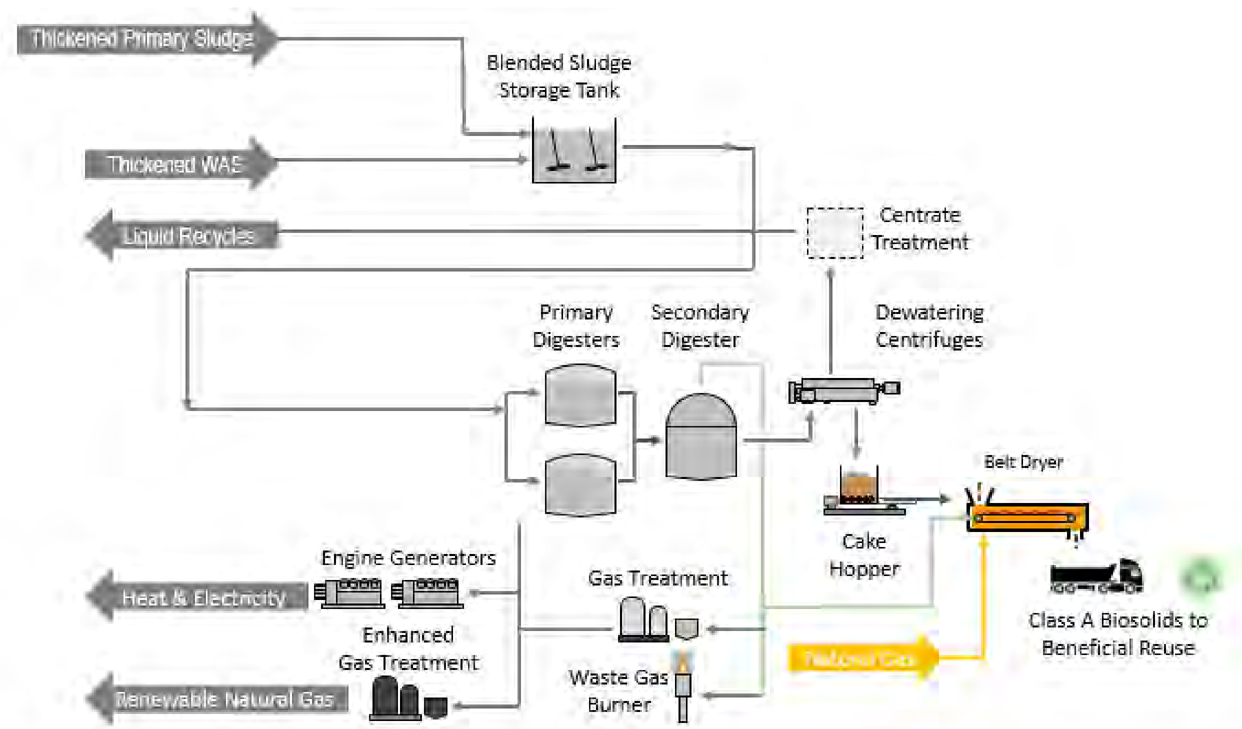


Figure 2. Belt Drying Process Flow Diagram

Table 2. Belt Dryer Benefits and Challenges

Benefits	Challenges
Relatively low operating temperature	Larger footprint compared to drum drying facility
Class A pathogen reduction	Non-uniform product possible without post-processing
Significant biosolids volume reduction	Large energy demands (smaller than drum drying) and greenhouse gas footprint
Versatile end product in the biosolids market	Additional staff required for O&M
Compatible with THP and other add-on processes, based on HDR's recent research	No PFAS destruction
Potential to use waste heat as a heat source	

2.2 Pyrolysis

Pyrolysis thermally decomposes volatile organic material in raw or undigested wastewater solids through the application of heat in the absence of oxygen. Pyrolysis can be implemented either with or without digestion. Dewatered solids are first heat-dried to 70 to 90 percent solids content. The dried solids are conveyed to a self-contained chamber (Figure 3) that breaks down volatile organic material via 350°C to 900°C (660°F to 1,650°F) operating temperatures. The by-products are synthetic gas, or syngas, and biochar. Syngas is typically combusted to provide heat for the pyrolysis reaction and dryer equipment to achieve a near net-zero energy consumption or conditioned to remove impurities and then used to produce heat and electricity through cogeneration. Syngas can also be further processed to produce renewable natural gas (RNG); however, it is likely not cost-effective to do so.

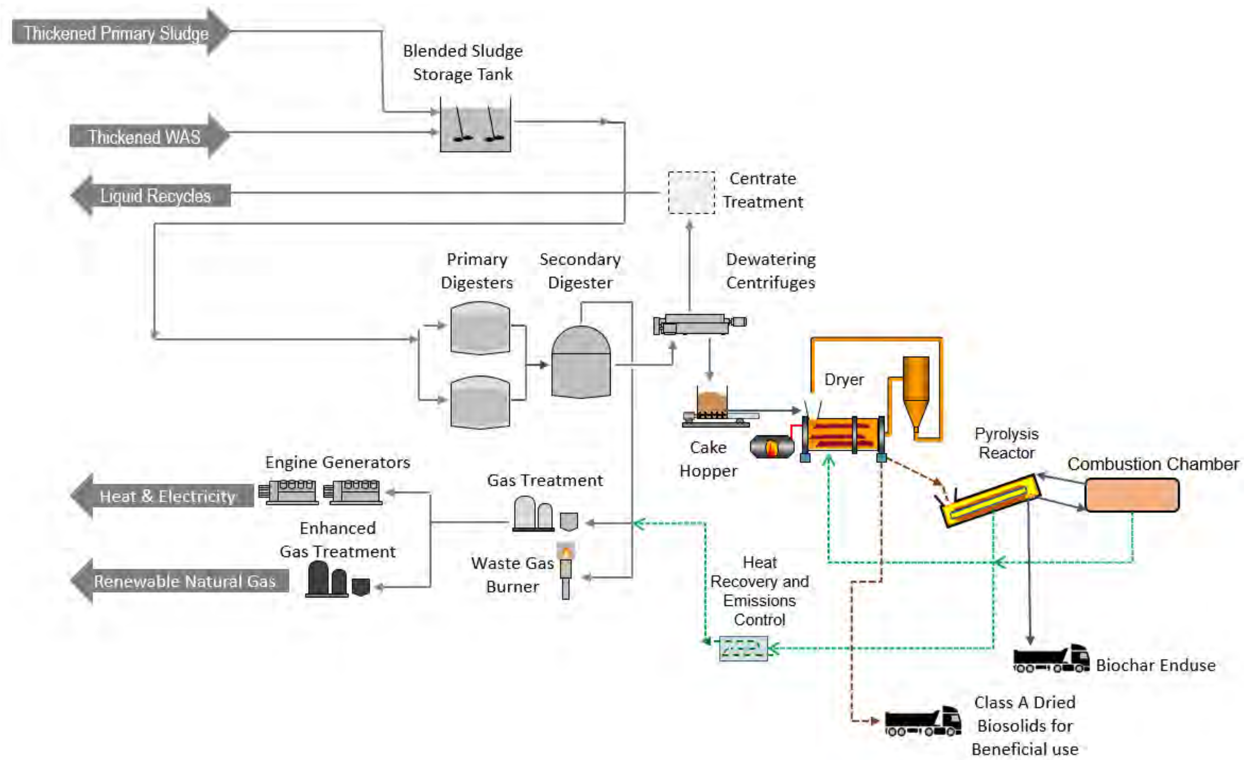


Figure 3. Pyrolysis Process Flow Diagram

Pyrolysis biochar is considered an exceptional quality (EQ) Class A product by significantly reducing the moisture content of the solids to 10 percent or less and heating the biosolids to at least 80°C (176°F) through high heat applications. Though this is considered a biosolids, biochar is a high-carbon, fine-grained product resembling a charcoal product. Biochar from pyrolysis is distinguished by the sequestered carbon emissions and is California Department of Food and Agriculture (CDFA) approved as a safe and renewable product. The pyrolysis technology has the potential to provide end-product diversity in the future as more beneficial uses are identified and accepted for the biochar. However, current management options for biochar are limited to landfilling and use of the material as a filler in manufactured products, typically concrete products. Biochar could also be land-applied to agricultural fields or for land reclamation projects or used as a soil amendment, but these are not currently considered to be viable end-use markets based on the limited history of biosolids pyrolysis in the United States (only a few operating pyrolysis facilities).

Should the pyrolysis system be offline, dried Class A solids can be produced in the dryer.

Pyrolysis is considered an emerging technology for wastewater solids with only two installations at wastewater treatment facilities in the United States. Additional installations processing feedstocks other than municipal biosolids have been in operation for approximately 5 years. Pyrolysis is typically packaged as a modular process with a set capacity and may be best suited for facilities between 0.2 and 20 million gallons per day (mgd) influent flow, smaller than the County's facility.

Table 3 summarizes the benefits and challenges of pyrolysis.

Table 3. Pyrolysis Benefits and Challenges

Benefits	Challenges
Can produce dried Class A biosolids and/or biochar products via the dryer and pyrolysis processes, respectively	Large footprint
Zero to low net energy footprint	Limited application history
Volume reduction	Process and mechanical complexity
Flexibility to adapt to changing market	Multiple new processes for O&M staff
Low odor product	Emissions and greenhouse gas controls required
Potential PFAS destruction (pending ongoing studies)	

2.3 Gasification

Gasification is a thermochemical process that converts dried biosolids into syngas (a low-grade fuel gas), biochar, and ash. Gasification can be implemented either with or without digestion. Dryers process dewatered biosolids (Figure 4) to produce Class A 70 to 90 percent dried biosolids, and the dried biosolids are introduced into a fluidized bed of the gasifier, where air is used as fluidization gas. The gasifier converts biosolids to a low-energy syngas (consisting of hydrogen, methane, and carbon monoxide) and biochar/ash through three main reactions that occur in separate zones within the gasifier reactor:

- **Pyrolysis:** thermal degradation, in the absence of oxygen, of volatile solids (VS) to gaseous products
- **Oxidation:** partial oxidation of the pyrolysis products, which produces heat to drive the pyrolysis and gasification reactions
- **Gasification:** further conversion of biochar to gaseous products

Temperatures inside the gasifier typically range from 480°C (900°F) in the pyrolysis zone to 1,100°C (2,000°F) in the oxidation zone.

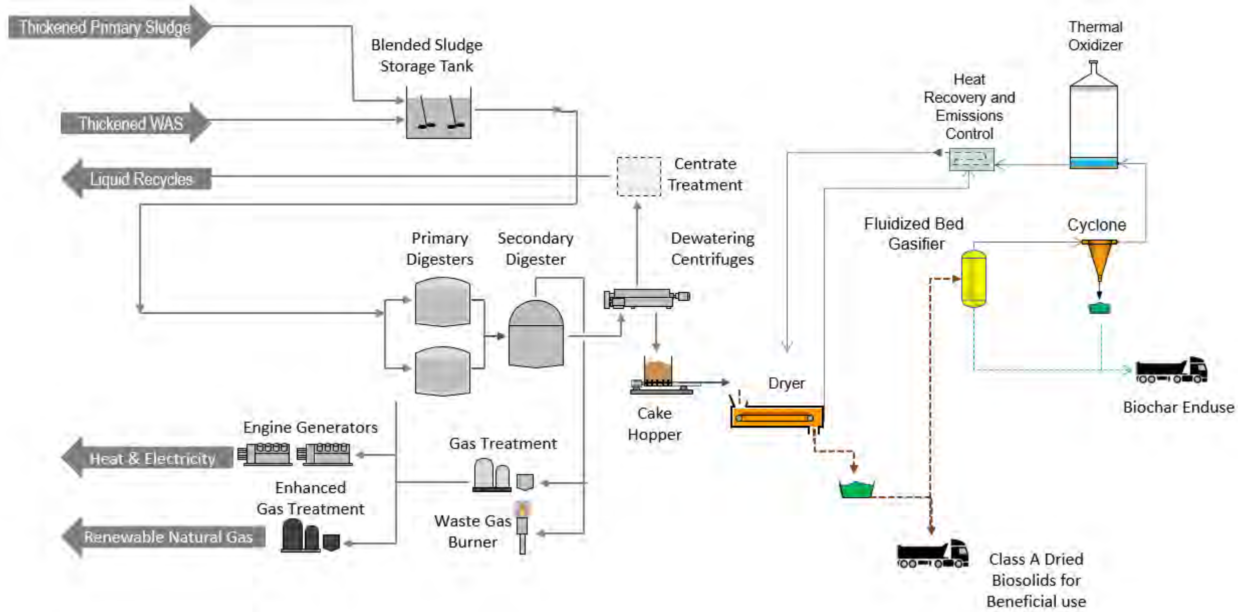


Figure 4. Gasification Process Flow Diagram

Thermal oxidizers and heat exchangers are typically provided to control odors and VOC emissions. Using the heat recovered from the flue gas produced in the thermal oxidizer in the solids drying step can make gasification an energy-neutral process. An emission control system is also provided to treat the air exhausted to the atmosphere. Biochar (unconverted carbon and residual material) is captured in the gasifier cyclone and is produced at the end of the gasification process.

Current management options for gasification biochar and ash produced in the gasification process are limited to landfilling and use of the material as a filler in manufactured products, typically concrete products. Gasification biochar could also be land applied to agricultural fields or for land reclamation projects or used as a soil amendment, but at present these are not considered to be viable end use markets based on the limited history of gasification in the US.

Gasification is considered an established technology in the solid waste field, however in the municipal wastewater market, it is considered an emerging solids technology. There are currently no installations at facilities of similar size to the County's facility. However, one new facility is currently in construction in Linden, New Jersey. This facility, scheduled for startup later in 2021, is reported to have a design capacity of 430 wet tons (92 dry tons) per day. There are also two other proposed facilities in permitting in the United States.

Table 4 provides the benefits and challenges of gasification.

Table 4. Gasification Benefits and Challenges

Benefits	Challenges
Can produce both dried Class A biosolids and biochar	Air Permitting and emissions controls
Flexibility to adapt to changing market	Largest footprint building compared to all technologies
Potential PFAS destruction (pending ongoing studies)	Limited application history
Low odor product	Process and mechanical complexity
Zero to low net energy footprint	

2.4 Thermal Hydrolysis Process Alternate Configurations

THP is a two-stage anaerobic digestion pretreatment process for PS, WAS, or combined PS and WAS comprising high-pressure steam heating of waste or sludge followed by rapid decompression. This combined action sterilizes the sludge and hydrolyzes, or breaks apart, the solids' cellular structure and makes them more biodegradable, which improves VS reduction and gas production in the downstream anaerobic digestion process. Additionally, the viscosity of the thermally hydrolyzed solids (THS) is substantially lower than non-hydrolyzed solids, so that a much higher solids concentration can be efficiently conveyed into and mixed within the digesters.

THP has multiple manufacturers. The system provided by Cambi, the predominant manufacturer for THP installations in North America, includes a pulper, multiple pressurized reactors, and a flash tank. Solids are pre-dewatered and fed to the pulper at 15 to 16 percent TS and pre-conditioned with low-pressure steam. Solids from the pulper and medium-pressure steam are fed to the batch THP reactor, where solids are held for approximately 30 minutes at a temperature of 150°C to 200°C (300°F to 390°F), which provides Class A pathogen reduction, and a pressure of 70 to 120 pounds per square inch (psi). After the holding time, the reactor is depressurized, sending the solids to the flash tank, in which rapid decompression physically lyses, or breaks apart, the cell walls of the solids. Solids leaving the flash tank are then diluted to a solids concentration of 9 to 10 percent using pathogen-free water, cooled to mesophilic anaerobic digester temperatures in cooling heat exchangers, and fed to the anaerobic digesters. The anaerobic digesters continue to operate at 35°C to 38°C (95°F to 100°F). The viscosity of the 9 to 10 percent solids from THP is comparable to thickened solids at 5 percent, allowing conventional digester pumping and mixing equipment to be used. The more readily degradable THP solids typically increase overall VS reduction in the digesters by 15 to 20 percent, with a corresponding increase in digester gas production. THP anaerobic digestion also improves the dewaterability of the digested biosolids; solids can typically be dewatered to 35 percent solids or more using centrifuges. With the increased solids destruction and dewatered cake solids content, the final solids quantity is reduced by two-thirds, substantially reducing costs for beneficial land application and other end uses.

THP is considered an established technology with more than 100 installations at municipal wastewater treatment plants worldwide, and more than 25 years of operation since their first installation. Several of the installations are at treatment facilities of similar scale to the Arlington WPCP.

The current Master Plan recommendation was for conventional THP implementation, where both PS and WAS are dewatered and treated through THP, as shown in Figure 5. Multiple THP configurations are available, as shown in Figure 6. The key benefits and challenges to the alternate THP configurations are summarized in Table 5.

The primary end use for Class A dewatered cake from THP is traditionally bulk agricultural land application. While Class A biosolids could be distributed and marketed for other beneficial uses, the typical 30 to 35 percent dewatered solids are not widely considered a desirable product for other end uses. The Class A cake will likely require additional processing, through air drying (curing) or blending with other materials such as shredded woody waste or sand, to increase the solids content to a 50 to 60 percent range, similar to a compost material, to be suitable for land reclamation, horticultural or soil blending uses, or distribution or sale to the general public for home use.

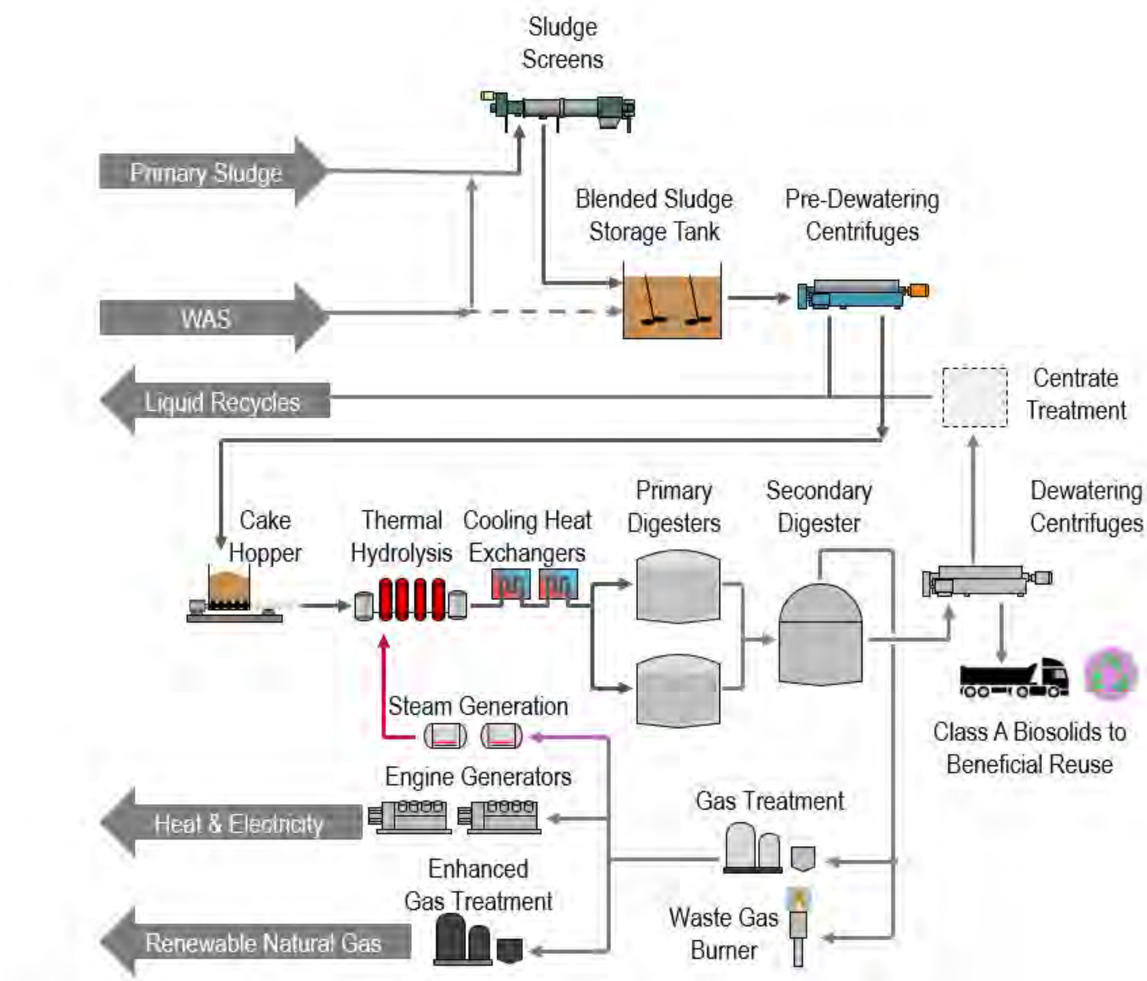


Figure 5. Conventional THP Process Flow Diagram

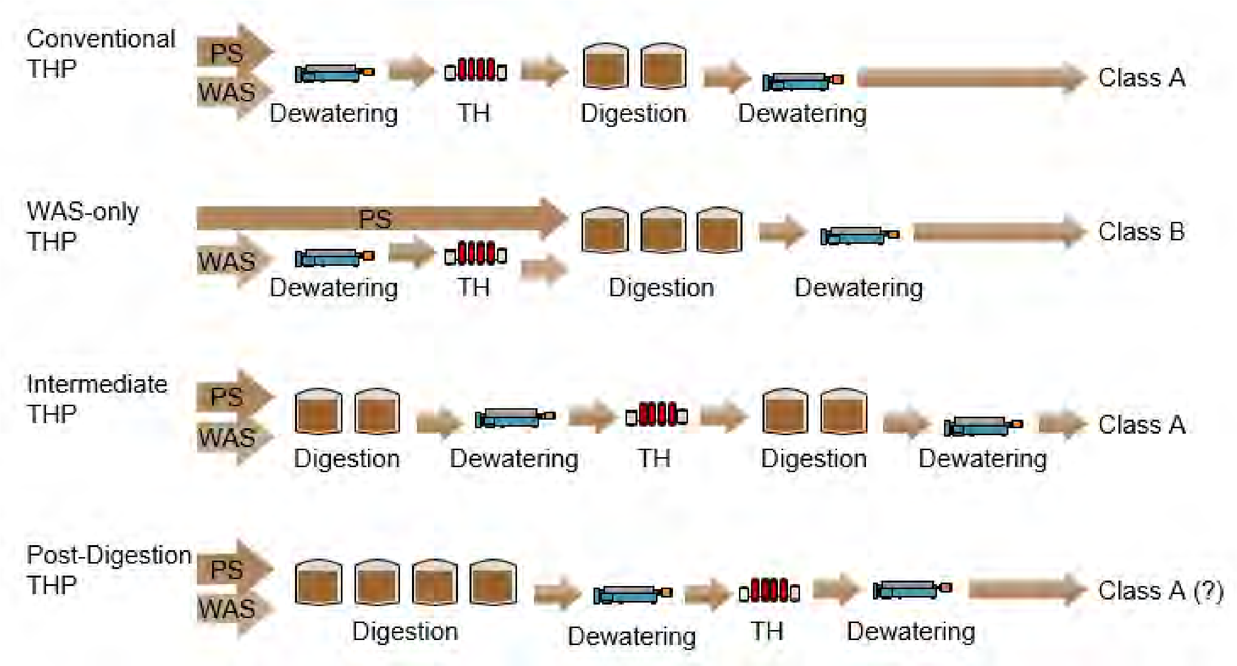


Figure 6. Alternate THP Configurations

Table 5. Alternate Thermal Hydrolysis Configurations Benefits and Challenges

Configuration	Number of Installations	Benefits	Challenges
Conventional THP[a]	63+	• Reduced digester volume (~50%) • Higher cake solids (up to 10% increase) • Class A EQ cake product • Increased VS reduction, biogas (+15%–30%)	• Screening and pre-dewatering • THS cooling • Instrumentation and controls • High-pressure steam
WAS-only THP[b]	5	• Reduced steam demand (~50%) • Smaller pre-dewatering and THP (~40%) • Cooling step may not be needed	• Not a Class A product • Reduced gas yield • Larger digester volume (~60% more than THP, but still ~20% less than anaerobic digestion)
Intermediate THP[b]	5	• Class A EQ cake product • High gas production • Smaller pre-dewatering (~60%) and cooling	• Largest digester volume • THS cooling and recycle • High steam demand
Post-digestion THP[b]	1	• Highest dewaterability • Reduced steam demand and smaller THP • Highest gas production • No cooling	• New technology (only 1 in operation) • Class A not approved • Larger digester volume

Notes:

a. Benefits and challenges for THP digestion are relative to conventional digestion.

b. Benefits and challenges for the alternate THP configurations are relative to conventional THP digestion.

3.0 Biosolids Products and End-Use Options

A key goal for the project is to have Class A biosolids for beneficial use. Class A products have varying end uses, depending on the quality, upstream processing, and market conditions. These factors will be discussed further in TM No. 5, Biosolids Product Market Analysis. For the purposes of comparing the technologies in this TM, Table 6 summarizes the biosolids product current end-use options for the evaluated technologies. THP and drying technologies have the most versatile end product, with the biochar product from pyrolysis and gasification still remaining in emerging markets for beneficial use.

Table 6. Potential Biosolids Product End Uses

Thermal Hydrolysis (Dewatered Cake)	Solids Drying (Granules/Pellets)	Pyrolysis (Biochar)	Gasification (Biochar)
Landfill/ADC	Landfill/ADC	Landfill/ADC	Landfill/ADC
Bulk agriculture	Bulk agriculture	Bulk agriculture	Bulk agriculture
Bulk horticulture	Bulk horticulture	Bulk horticulture	Bulk horticulture
Land reclamation	Land reclamation	Land reclamation	Land reclamation
Fertilizer blending	Fertilizer blending	Fertilizer blending	Fertilizer blending
Soil blending	Soil blending	Soil blending	Soil blending
Energy	Energy	Energy	Energy
Concrete filler	Concrete filler	Concrete filler	Concrete filler

Notes: Alternative daily cover (ADC) is material other than earth used to cover the surface of a landfill at the end of the day.

Legend: COMMON END USE | NEWER MARKET | NO MARKET

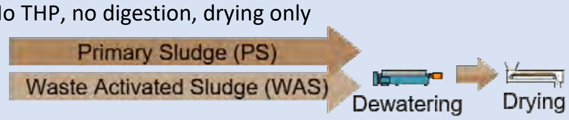
3.1 Thermal Hydrolysis and Drying

The end product from THP is a high-quality Class A cake, when implemented in the conventional arrangement. As shown above, the primary beneficial end use for the Class A dewatered cake is bulk agricultural land application. To retain additional end-use flexibility beyond bulk land application, recent research has been completed on combining THP with drying to produce an even more versatile end product.

The main benefit of implementing THP upstream of drying is a reduction in the energy required for the latter process by up to 40 to 50 percent when compared to conventional anaerobic digestion. Most of the reduction in dryer energy demand is due to the higher solids concentration of the dewatered THS, while the remainder is associated with the improved VS reduction achieved through digesting THS. As a result, implementation of THP can significantly reduce the size of a drying facility. Additionally, the lower evaporation demand of the drier THS cake can increase the efficiency of lower-temperature thermal drying technologies that recover waste heat from processes such as the THP and combined heat and power (CHP) without significantly increasing the footprint for required drying facilities.

Another benefit of implementing THP upstream of drying is the additional flexibility in the dryer design and configuration. If all the solids are processed through THP that already meet the requirements for Class A biosolids, the subsequent dryer process is not required to meet Class A requirements (minimum 80°C [176°F] and 90 percent dried solids). This allows the dryer to be sized and operated to achieve the dryness desired for product quality, based on the end user marketplace, which could be less than 90 percent solids, depending on the desired end use. This provides flexibility in equipment sizing and configuration and potential reductions in drying energy demands. In a conventional digestion-drying configuration, the heat demand for drying equals approximately 75 percent of the energy produced from anaerobic digestion, and therefore approximately 25 percent of the remaining biogas generated can be used for electricity or biomethane production. THP produces 15 to 30 percent more biogas than conventional digestion, and drying energy demand for THP cake is 40 to 50 percent lower than drying after conventional digestion. Therefore, if biogas is used as the primary fuel for the dryers, implementation of THP can result in up to three times more biogas available for other uses such as electricity or biomethane production when compared to conventional digestion followed by thermal drying. Table 7 provides energy and mass balance comparisons of various process configurations.

Table 7. Energy and Mass Balance Comparison of Thermal Hydrolysis and Drying Process Configurations

Process Configuration	Dryer Size & Energy Demand	End Product Hauled, Wet Tons	Biogas Available for electricity or biomethane production after drying and THP demands met	Dried Product Percentage Solids Requirement
No THP, no digestion, drying only 	100%	100%	0%	>90%
Conventional digestion 	70%	60%	100%	>90%
Conventional THP[a] 	40%	55%	300%	N/A[b]
WAS-only THP[a] 	45%	57%	240%	>90%

Notes:

a. Adapted from Barber, W., and Christy, P. (2018). *Combining thermal hydrolysis with drying and downstream thermal processes to optimize energy recovery from sewage sludge*. Residuals and Biosolids Conference (pp. 1188–1211). Phoenix: Water Environment Federation.

b. Conventional THP does not have a product dryness requirement because the cake is already Class A biosolids. However, 90% product solids was used to calculate the hauled wet tons values.

Dryer selection for THP with drying needs to consider the characteristics of the solids from THP. The high temperature and pressure of THP destroys the cell structure of the solids, leading to improved VS destruction, and reduces extracellular polymeric substances (EPS), which can adversely impact dewaterability, resulting in a drier soil-like cake. While the qualities of this Class A cake are beneficial for land application, the different characteristics are less desirable in a dried product.

Of particular focus are energy content, friability, and bulk density of the biosolids as described below:

- **Energy content:** Energy content, or heat value, of biosolids is an important consideration for customers that use biosolids as a fuel substitute, such as cement kilns. Studies have reported that TH can reduce the energy content of biosolids by approximately 10 percent on a dry basis (British thermal units [Btu] per dry ton total suspended solids [TSS]) when compared to conventionally digested biosolids.
- **Friability:** Friability refers to the tendency of a granule to crumble or break when undergoing stress. An end product with high friability is undesirable for most end users, as it can create dust when handled, which can degrade product quality and/or create health and safety risks.
- **Bulk density:** Bulk density is an important criterion for most end users, and the preferable range varies on the end user. Farmers and fertilizer blenders generally prefer a product with high bulk density as it is easier for spreading, while other end users such as soil blenders and cement kilns prefer lower bulk densities.

To confirm the applicability of THP with drying research has been completed on other worldwide installations that have combined THP and thermal drying. The outcome of this work can be found in a 2019 paper, titled *Worthless Dust or Valuable Resource? Drying Thermally Hydrolyzed Solids the Right Way* (S. Spalding and S. Smoot, WEFTEC Conference Proceedings). In summary, it was found that most facilities that hydrolyze all the solids (PS and WAS) use belt dryers, and most drum dryer facilities have a portion of the solids bypass the THP. While there were some anecdotal reports of increased dust and fragility of the dried THS, compared to conventionally digested solids, these risks appeared to be dependent, at least in part, on the process configuration and dryer technology. The research showed that these risks can be minimized by operating THP as a WAS-only configuration, implementing drying technologies that deliver low amounts of mechanical energy (e.g., belt dryers as opposed to drum dryers), or both. There is a greater possibility of degradation because of the shearing of the materials with rotary-drum dryers, when compared to belt dryers.

It has historically been uncommon to couple drying and THP. However, this combination of technologies can open up new end markets that are less affected by seasonal demand (such as soil blenders and cement kilns), thereby increasing end-use reliability. Addition of THP and the resulting improvement in VS reduction, higher biogas production, and enhanced solids dewaterability all can reduce both the capital and operating costs of a dryer. Additionally, if all solids are treated through THP, it is no longer required to achieve 90 percent solids dryness to meet the requirements for Class A biosolids, further reducing dryer size and energy use by 20 to 40 percent, depending on the target end product dryness. Dried products also cost less to transport as compared to dewatered products, further increasing the geographic reach of the County's biosolids program. Further evaluation of the biosolids marketplace would be required to define the design criteria for a dryer to confirm the design dryness and therefore the required equipment.

Overall, the bulk density of dried TH solids is lower than that of conventionally digested solids. The bulk density of dried TH solids varies based on the wastewater characteristics, treatment processes, TH configuration, digester performance, and dryer technology. Results from laboratory testing of the dried TH solids samples are not yet available as this work remains underway. As such, quantifiable differences in bulk density between drying technologies and TH configurations have not been identified at this time. The desired bulk density of the end product and any concerns with the lower bulk density of dried THS would need to be assessed via the evaluation of the biosolids marketplace, including conducting a market survey to determine what characteristics are preferred by potential end users, and then designing and operating the biosolids treatment processes to meet the market's preferences.

It has also been found that TH, and the resulting reduction in VS due to the increased digestibility, does impact the energy content of the final product. The potential reduced energy content for TH-processed biosolids could make dried THS less attracted for use as a supplemental fuel, such as in cement kilns. However, it is likely that chemical addition, such as ferric, is more detrimental to the energy content of the solids than the enhanced VS reduction of TH digestion due to the increased inert solids fraction generated. Pilot or lab testing would quantify the impact of TH on the digested biosolids heating value, and would determine if the dried THS would still be acceptable for this end use.

4.0 Summary and Conclusions

This section presents a summary and conclusions from the thickening evaluation.

4.1 Technology Alternatives

Table 8 summarizes the results of the technology evaluation, including the technologies' maturity in the industry's market.

Table 8. Biosolids Technology Comparison

Parameter	THP	Rotary-Drum Solids Drying	Belt Solids Drying	Pyrolysis	Gasification
Number of installations	100+	200	75	40	3
Years in operation	25	50	20	5	--
Similar plant size installations?	Yes	Yes	Yes	No	No
Energy consumption	$$$	$$$$$	$$$$	$	$
Technological maturity?	Yes	Yes	Yes	No	No

THP and drying are mature and well-established technologies with several dozen online systems, and overall operation history of more than 20 years. Pyrolysis and gasification are considered emerging technologies for municipal biosolids applications. Energy consumption is highest with drying technologies, whereas pyrolysis and gasification are near net-zero energy consumption processes. Similar-sized installations to the WPCP exist for THP and drying technologies, but not for pyrolysis and gasification.

4.2 Conclusions and Recommendations

Based on the analysis presented in this TM, it is recommended that the solids handling improvements replace the existing lime stabilization process with THP and anaerobic digestion, as recommended in the Master Plan for the WPCP.

Anaerobic digestion is an appropriate process for the WPCP's size. Digestion reduces solids output from the WPCP, generates biogas that can be reused, and provides a Class B product should further treatment processes be offline. THP increases digestibility and reduces the size of new digesters required, while creating a versatile, high-quality Class A product.

It is also recommended that the WPCP plan for future upgrades to increase the versatility of beneficial uses of the final end product, to provide greater flexibility and responsiveness to potential future changes in land application regulations and limitations. As a dried product currently has the widest versatility and lower hauling costs than cake, it is recommended that the site plan developed for the Facilities Plan incorporate footprint for future post-processing of the Class A cake product through a belt dryer, if feasible.

It has been shown that belt drying is preferred downstream of THP because of the characteristics of THS. Additionally, the energy required for belt drying can be reduced by using recovered heat from other thermal processes. The footprint for the belt dryer facility will be sized for drying the THS Class A cake, reduced in size to account for the improved VS destruction from THP and the higher solids concentration in the THS cake. However, the footprint will be allocated for a dryer facility to dry the THS to 90 percent TS, as the marketplace demands are not yet known that would have preference for a less-dry product. Additionally, should the pyrolysis or gasification technologies mature to the point where they are considered by the County as potential future add-on processes or as a response to future regulatory drivers, drying is the first step for both. Allocating space on the site now for a future dryer facility can provide many future benefits and the flexibility for the County to continue to evolve and meet changing regulations and market for the beneficial use of high-quality Class A biosolids end products.

Future changes in regulations could result in the need for additional evaluations of appropriate technologies for additional biosolids processing and additional beneficial end uses of the final product. Implementation of the THP and anaerobic digestion and site plan allocation for future post-processing should position the WPCP to be able to respond effectively to future uncertainties.

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Technical Memorandum No. 4

Date:	December 2, 2021
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Thermal Hydrolysis Process Evaluation

Contents

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1.0 Introduction

The purpose of the Arlington County Water Pollution Control Plant (WPCP) Re-Gen project (Project) is well captured in the internal team Project Mission Statement:

> *Upgrade resource recovery facilities to produce Class A biosolids and renewable energy, maximizing sustainability and community acceptance. Collaborate with team members to select and implement processes that are safe, reliable, and financially responsible throughout planning, design, construction, operations and maintenance.*

The following goals and objectives have been established to guide the Project team to fulfill the mission:

- Recover biogas for beneficial use
- Produce a Class A exceptional quality (EQ) end product
- Provide ease of maintenance and repairs
- Keep safety in mind
- Apply proper process selection and configuration
- Use an open, transparent, and collaborative process between all team members
- Promote community acceptance
- Provide a cost-effective program
- Provide an operator-friendly facility
- Promote long-term reliability
- Implement active staff engagement throughout the process
- Ensure that staff are well prepared to operate and maintain the new processes

Thermal hydrolysis (TH) has been selected as the process best able to achieve the above goals and objectives. It produces a Class A EQ biosolids product while minimizing the total quantity of final product produced and maximizing energy recovery from the solids in the form of biogas generated in the anaerobic digesters.

2.0 Background and Purpose

The purpose of this technical memorandum (TM) is to provide an introduction to the thermal hydrolysis process (THP) and compare the process configurations that have been developed by vendors that have frequently competed for municipal biosolids projects in the United States as well as one new to the market.

All TH technologies use steam and pressure to hydrolyze solids. However, these systems vary widely in their process configurations, equipment arrangement, and operational strategies. Additionally, the solids handling facility interfaces upstream and downstream of the THP are different with each technology. Therefore, it is recommended to select the specific THP configuration before proceeding into detailed design.

THP systems manufactured by one manufacturer are currently in use in biosolids projects in the United States. This manufacturer also has the largest number of THP installations worldwide. The second most prominent manufacturer does not have any installations in the U.S but is actively seeking to gain entry to the U.S market. One emerging system has been developed that shows future promise for the U.S.

market. These systems will be evaluated to determine the configuration that is most aligned with the goals, objectives, and requirements of the Project. This TM compares the following THP technologies:

- Cambi™
- Bio Thelys™ by Veolia
- Haarslev Continuous Hydrolysis System (CHS)

Other THP vendor configurations exist overseas, but they have not been proposed for biosolids projects in the United States and have few installations compared to Cambi, Veolia, and Haarslev.

The scope of this evaluation is limited to TH technologies, where steam is used to achieve the temperature and pressure process requirements for cellular hydrolysis. Other methods of cell hydrolysis such as thermo-chemical hydrolysis (example: PONDUS™) and biological hydrolysis (example: Monsal Enzymic Hydrolysis) were analyzed as part of the Solids Master Plan Report in 2018 and determined not to meet the Project goals. Veolia also has a continuous-flow THP process, Exelys™; however, this technology is not being marketed in the United States and is not under consideration for this evaluation.

3.0 Overview of Thermal Hydrolysis

At the Arlington County WPCP, TH will treat primary sludge (PS) and waste activated sludge (WAS) with high pressure and temperature to hydrolyze, or break apart, the solids' cellular structure. TH occurs in two steps: screened and pre-dewatered solids are heated to 150 to 170 degrees Celsius via steam pressure, which is followed by a depressurization step, which assists in cell wall breakage. THP, when in a batch configuration, meets the time and temperature requirements as a process to further reduce pathogens (PFRP), as defined by the U.S. Environmental Protection Agency (EPA). The resulting thermally hydrolyzed solids (THS) are sterile (pathogen-free) and highly digestible by microbes in anaerobic digesters. Additionally, the viscosity of THS is substantially lower than that of non-hydrolyzed solids, so that a higher solids concentration can be efficiently conveyed into and mixed within the digesters.

The ability to load the digesters at a higher rate with more readily digestible solids achieves the goals of solids stabilization in less time with significantly reduced digester volume. The greater digestion and volatile solids destruction increases biogas production and reduces the total digested solids produced by the system. Solids processed through TH dewater more readily, typically resulting in a final dewatered cake being drier by 5 to 10 percentage points compared to conventional anaerobic digestions. The final product is a drier, high-quality, Class A biosolids, with minimal to no offensive odors. By maximizing solids destruction and dewatering, the final wet solids quantity is reduced by two-thirds, substantially reducing costs for beneficial land application and other end uses. The technology is well established abroad, with more than 60 installations internationally since 1995.

3.1 North American Thermal Hydrolysis Installations

The first THP installation in the United States was DC Water's Blue Plains Advanced Wastewater Treatment Plant (WWTP), which was started up and commissioned in 2014 and 2015. Currently, there are four operating THP installations in the United States, with five more in construction. Current and planned THP installations in North America are listed in Table 1.

Table 1. North American THP Project Status

Agency		Project Status	THP System
DC Water, Washington, D.C.	Blue Plains Advanced WWTP	Startup in 2014	4 × Cambi B12 Mark I
Pontiac, Michigan	Clinton River WRRF	Started up in 2018	Cambi B2 Mark II
Medina, Ohio	Holtz WWTP	Started up in 2018	Cambi B2 Mark II
HRSD, Virginia	Atlantic WWTP	Started up in 2020	Cambi B6 Mark II
Trinity River Authority (Dallas, Texas)	Central Regional Wastewater System	In construction; startup in 2021	3 × Cambi B6 Mark II
City of Raleigh, North Carolina	Neuse River RRF Bioenergy Recovery Project	In construction; startup in 2022	Cambi B6 Mark II
WSSC, Maryland	Piscataway WRRF Bioenergy Facility	In construction; startup in 2023	Cambi B6 Mark II 2P/2F
City of Franklin, Tennessee	Franklin WRF	In construction; startup in 2022	Cambi B2 Mark II
San Francisco PUC, California	Southeast WWTP Biosolids Digester Facility	Construction just starting	3 × Cambi B6 Mark II
Kansas City, Missouri	Blue River Biosolids Facility	In design	Cambi B6 Mark II 2P/2F
Charlotte Water, North Carolina	McAlpine Creek Wastewater Management Facility	Preliminary design	2 × Cambi B6 Mark II
City of Calgary, Alberta, Canada	Bonnybrook WWTP	Project currently on hold	2 × Cambi B6 Mark II
Winnipeg, Manitoba, Canada	North End STP	Project currently on hold	3 × Cambi B6 Mark II

To date, all installed and planned THP installations in North America have been supplied by Cambi.

4.0 Thermal Hydrolysis Configurations

This section summarizes TH configurations, including Cambi, Veolia Bio Thelys, and Haarslev CHS.

4.1 Cambi™

The Cambi THP system is a continuous batch process consisting of a pulper tank, reactor vessels, and a flash tank. Screened and pre-dewatered solids are fed to the pulper, which preheats the solids while serving as a buffer tank for the reactor batch cycles. Solids are pumped from the pulper to the reactor, which is then filled with steam to reach the temperature and pressure set point. At the end of the retention time, the pressure is released, rapidly conveying the treated solids to the flash tank where the depressurization completes the cell lysing. Steam is recycled from the flash tank to the pulper to serve as the preheating heat source for the next batch. The solids are pumped from the flash tank and blended with digested solids prior to cooling to mesophilic temperatures in heat exchangers (HEXs) before being fed to the digesters.

A conceptual process flow diagram for Cambi THP is presented in Figure 1.

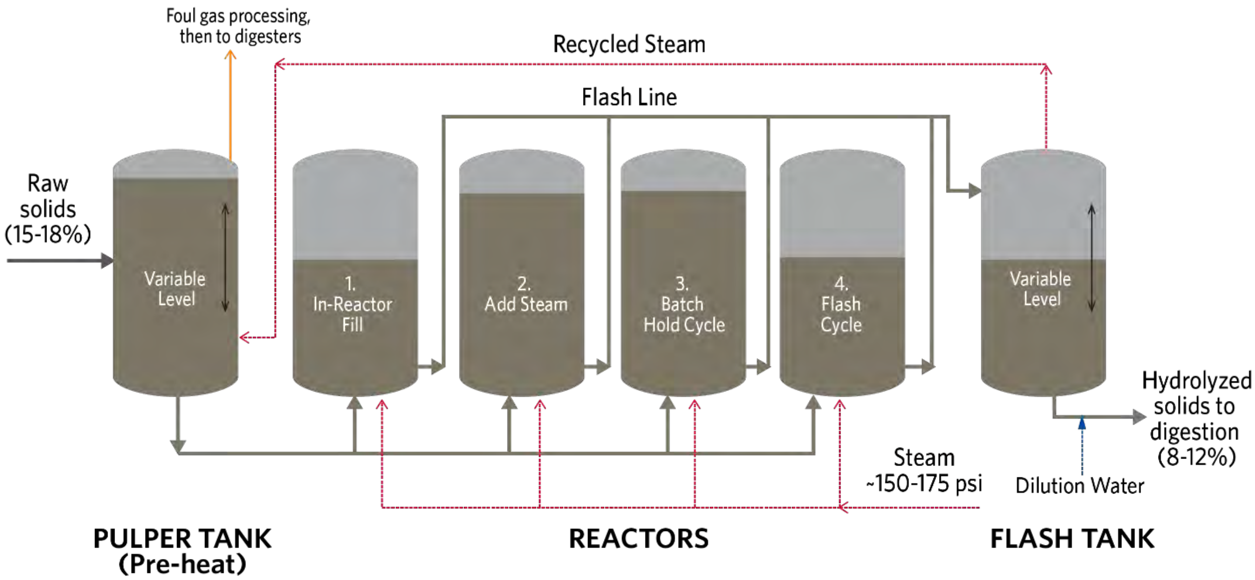

Figure 1. Cambi THP Process Flow Diagram

The Cambi THP has undergone several refinements and evolutions since its first installation in 1995. The most recent was the transition from the Mark I operating system to the new Mark II operating system. This modification was coupled with the transition from 12-cubic-meter reactors (B12) to smaller 6-cubic-meter reactors (B6), and included additional mechanical modifications in the flash tank, removal of the radiation level sensors in the reactor, and simplification of the steam recycle to the pulper, as well as improvements to the foul gas system, as discussed further below. These changes supported process modifications to reduce the duration of the depressurization step by completely and immediately releasing the reactor contents to the flash tank, and immediately sending the steam to the pulper, resulting in a higher throughput of the Cambi THP with reduced steam demand. The complete recycling of steam to the pulper has resulted in a more energy-efficient system. The improvements have also maximized the usage of the reactor volume. The new Mark II generation of Cambi is a standard skid-based system shop fabricated in multiple modules to be assembled on site and has half the footprint of the site-built Mark I systems yet has 80 percent of the solids throughput.

Cambi uses a patented system for the management of the foul gases generated in the THP. Foul gases are sent from the reactors to the flash tank along with the steam, from which they are conveyed to the pulper along with the steam recycle. The foul gases are then cooled using a gas cooler (HEX) before being condensed into the foul-gas tank using an eductor and pathogen-free water. The foul-gas condensate is then sent to the digester feed lines or directly to the digesters, where it is treated within the digestion biological process. The foul-gas system has also evolved in recent years to simplify the system and reduce the risk of odor release and is more effective than the odor control of other THP systems.

Cambi has 63 installations worldwide, with a total installed capacity of 5,600 dry tons per day (dtpd). Of these, 33 are the older Mark I operating system and 30 are the Mark II system, which has a throughput capacity of 92 dtpd. The first Mark II version was placed into service in 2014. There are currently 45 installations with a capacity of 50 dtpd or greater, which are similar in size or larger than the THP proposed for installation at the WPCP.

4.2 Veolia Bio Thelys™

The Bio Thelys process has recently undergone significant modifications from the original version to the new updated process. These process updates are typical of technologies with additional experience. This new Bio Thelys process is being considered in this evaluation. As there is only one Bio Thelys online and operating with the new configuration, an overview of the original version, including operational experience, is provided in this section.

The original Bio Thelys system is a batch system consisting of paired reactors and a buffer tank. Pre-dewatered solids are pumped to a reactor, which retains some hot THS to reduce the "thermal shock" by injecting steam directly into cold solids. Flash steam from the depressurization of the reactor's paired tank increases the temperature in the reactors and further preheats the solids. The reactor is then brought up to pressure using steam injected directly into the reactor through lances and held at the target temperature and pressure. The reactor is then partially depressurized, with flash steam going back to the reactor's paired tank, and the solids sent to the horizontally configured buffer tank using the remaining steam pressure in the reactor. The solids are pumped from the buffer tank and diluted with pathogen-free water prior to cooling to mesophilic temperatures in HEXs before being fed to the digesters. Because of the steam that is carried through to the buffer tank, there is a loss of energy and a higher steam demand. Additionally, the hotter solids result in a larger cooling demand (large HEX and more cooling water) for the original Bio Thelys THS relative to the Cambi Mark II system.

As a result of performance issues experienced at older installations, such as clogging steam lances, reduced throughput with higher steam demand, and foul gas excursions, Veolia has worked to improve and optimize the Bio Thelys process. The company has implemented several modifications in current and future Bio Thelys installations to improve capacity, steam delivery and economy, and operational reliability. The largest change is the transition to a process flow very similar to Cambi, as shown on Figure 2. Screened and pre-dewatered solids are fed to the preheat tank through a dynamic mixer, which preheats the solids while serving as an equalization tank for the reactor batch cycles. Solids are pumped from the preheat tank through another dynamic mixer that combines live steam with the preheated solids and to the reactor to reach a pressure set point. At the end of the retention time, the pressure is released, rapidly conveying the treated solids to the buffer tank where the depressurization completes the cell lysing. Steam is recycled from the buffer tank to the preheating dynamic mixer to serve as the preheating heat source. The solids are pumped from the buffer tank, diluted using pathogen-free water, and cooled to mesophilic temperatures in HEXs before being fed to the digesters. The new version of the Bio Thelys has eliminated the use of steam lances for a dynamic mixer, which has improved the contact between the steam and pre-dewatered solids, allowing a higher pre-dewatered cake concentration (as high as 22 percent), relative to other installed batch processes. This also has eliminated previous issues with clogged steam lances. The steam demand for the updated Bio Thelys is therefore lower than that required for Cambi, attributed primarily to the higher pre-dewatered cake concentration to the system through the dynamic mixer, as well as improved recovery of the flash steam from the buffer tank.

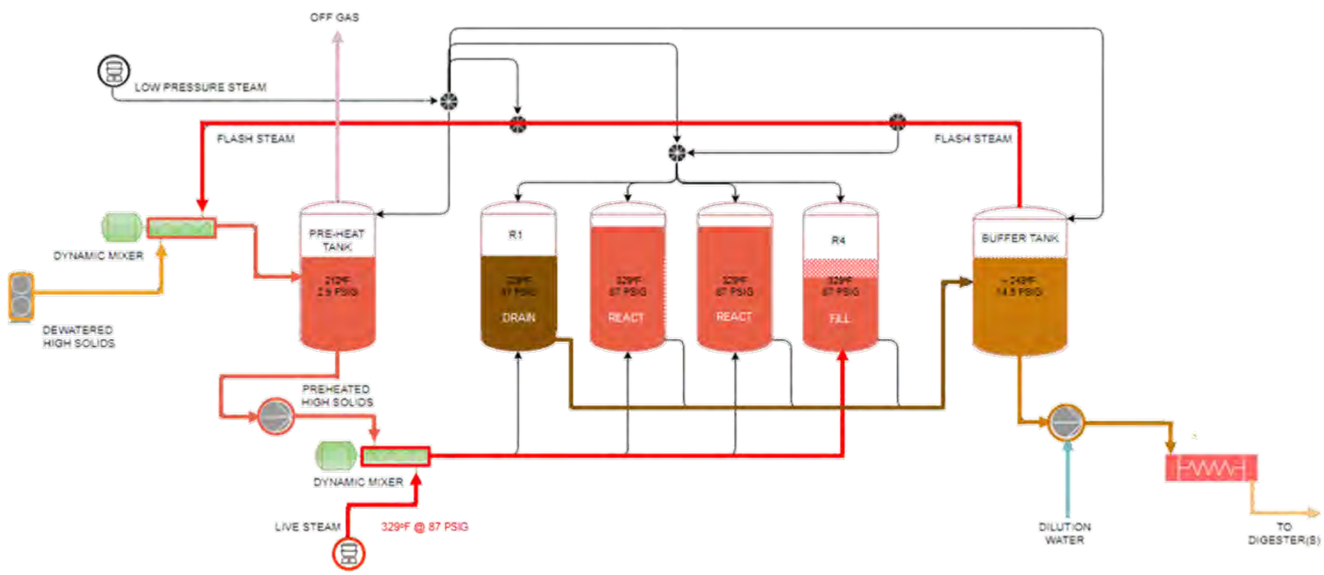

Figure 2. Updated Bio Thelys THP Process Flow Diagram

The foul gases generated in the Bio Thelys THP are cooled to remove condensables from the gas. The remaining gas has been treated in a variety of different methods over time, but is often sent to the digesters. Based on the review of site visit reports and discussions with the plant owners of installations of the older version of Bio Thelys, there were multiple instances of odorous excursions with this system. The new version of Bio Thelys has a similar odor control approach, but it is expected that the incidences of odorous excursions are reduced with the new process flow and larger buffer tanks downstream of the reactors, as well as the steam/gas recycle to the preheat tank.

Veolia has seven operating original Bio Thelys installations worldwide, with a total installed capacity of 89,000 dry tons per year. The two largest installations, in Oxford and Esholt, United Kingdom (UK), with a combined installed capacity of 64,000 dry tons per year, had multiple operational challenges during startup and were not accepted by the client for several years following installation. These systems had multiple issues, including clogged steam lances in the reactors, which were ultimately replaced and multiple foul-gas excursions. These two installations have now been accepted by the owner and are in operation, are the two longest-operating Bio Thelys installations similar in size to the THP proposed for installation at the WPCP.

The first installation of the new version of Bio Thelys is a 56 dtpd facility in Toulouse, France. Because of travel restrictions, the project team has not been able to visit the facility. However, according to Veolia, the facility which started up in 2019 has been operating reliably. Additionally, three other projects with the new Bio Thelys configuration are currently in design and construction in Europe.

4.3 Haarslev CHS

Haarslev CHS is a continuous-flow process, in contrast to the Cambi and Bio Thelys batch processes. Haarslev is newer to the municipal biosolids processing market, but has been well-known in the industrial solids market for more than 30 years, hydrolyzing by-products of factory meat processing operations (feathers and hair). The first installation of CHS on municipal biosolids was started up in 2014 in Grevesmühlen, Germany.

Similar to the newer version of Veolia's Bio Thelys, Haarslev CHS uses a dynamic mixer in the preheater to mix pre-dewatered solids (as high as 22 percent) with steam. The preheated solids are pumped to a small pressurization tank that heats and pressurizes the solids in 90-second batches before being sent to the reactor. The reactor's temperature and pressure are maintained with steam injection while the solids flow in a plug flow to the economizer (similar to the Cambi flash tank) in a continuous process with a minimum 30-minute duration in the reactor. As the solids leave the reactor and go to the economizer, the differential pressure between these two vessels effectively lyses the cells. The cooler is the final step, which operates at a vacuum to cool the temperature of the solids to mesophilic temperatures without requiring a HEX. A conceptual process flow diagram for the Haarslev CHS is shown on Figure 3.

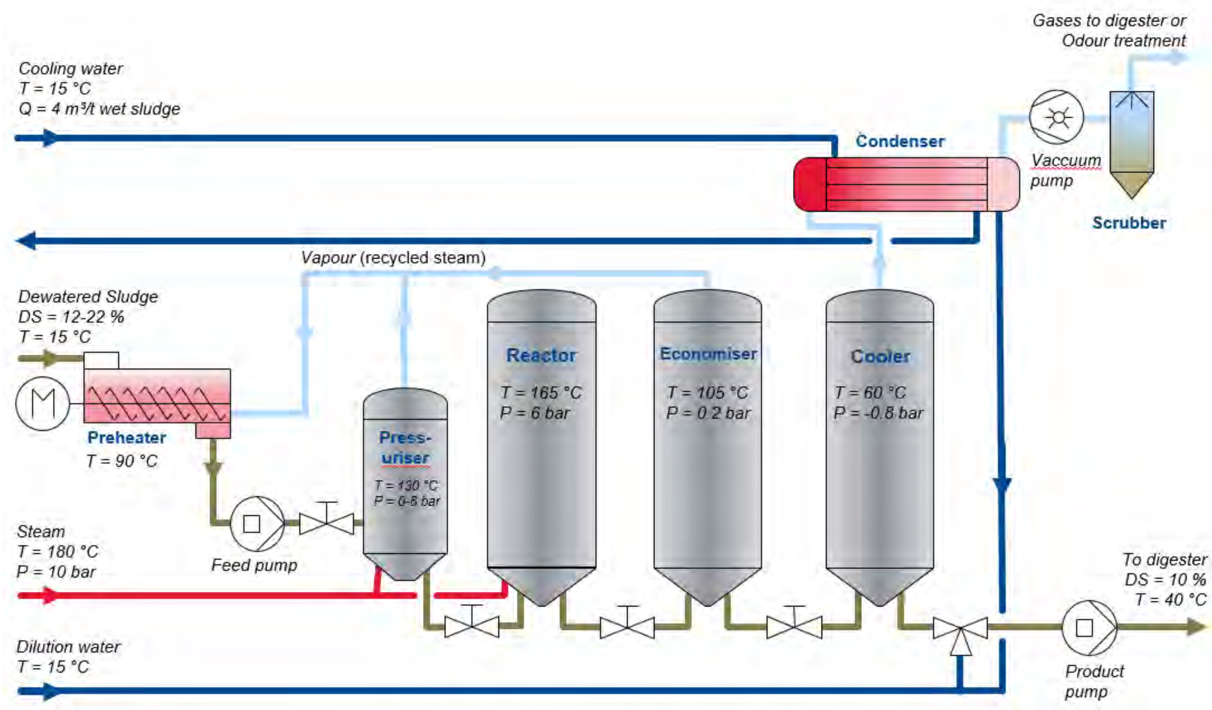

Figure 3. Haarslev CHS Process Flow Diagram

The steam demand for the CHS is lower than that required for Cambi, attributed primarily to the higher pre-dewatered cake concentration to the system through the dynamic mixer.

The continuous-flow configuration of this process does not explicitly meet the Class A time and temperature requirements because short-circuiting of the flow through such systems can occur. To achieve Class A, time and effort would be required to demonstrate and prove a plug flow performance, and pathogen reduction prior to submitting to the Virginia Department of Environmental Quality (VDEQ) for equivalency approval.

Haarslev has four CHS installations worldwide, all in Europe, operating on municipal biosolids with a total installed capacity of 52 dtpd, with the largest single installation at a 24 dtpd capacity in Braunschweig, Germany, or approximately half of the capacity of the THP proposed for installation at the WPCP. Another 24 dtpd installation, currently in construction in Dijon, France, is scheduled to be online by the end of 2021.

5.0 Basis of Evaluation

A list of criteria and requirements has been established as evaluation parameters for comparing the THP vendors and configurations. The criteria include:

- **Proven experience at facilities of comparable size:** The selected THP vendor/ configuration must be able to show significant successful experience with THP systems of comparable size to the Project.
- **Proven reliability:** Arlington is not in a position to help develop or demonstrate an untried or unproven THP configuration. Arlington will select a well-established and highly reliable THP system that has proved these qualities at multiple sites with similar or larger scale.
- **Maximize overall energy efficiency:** A key Project goal is to maximize the biogas for beneficial use and maximize overall energy efficiency. Therefore, the THP system should be able to prove this concept and approach.
- **Process details:** Arlington needs to be assured that the myriad process and technical details are sound and have worked well on previous facilities. Odor control is of particular concern because of close proximity to neighbors at the WPCP.
- **Proven ability to produce Class A biosolids:** The ability to provide Class A biosolids is mandatory. Arlington is not in the position to conduct further research and development to validate Class A compliance or to test out new process features.

6.0 Evaluation

A comparison of the THP technologies per the evaluation criteria identified above is provided in Table 2, and discussed further below.

6.1 Proven Experience at Facilities of Comparable Size

The installation progression of total worldwide TH installed capacities for the evaluated technologies is shown on Figure 4. Based on the installation information provided by the manufacturers included in Table 2, Cambi currently has 63 installations in operation, compared to 7 Bio Thelys and 5 Haarslev installations.

The Mark I and Mark II Cambi generations are shown separately to highlight the shorter operating history of the Mark II system. Since 2014, 30 Mark II systems have been brought online and several more have been ordered by owners. There are currently 18 Mark II installations with capacity greater than 50 million gallons per day (mgd).

The original Veolia Bio Thelys THP has a 17-year operational history; however, the newer version of Veolia Bio Thelys has been in operation for nearly 2 years at one installation, and it is markedly different from the original Bio Thelys. The newer Bio Thelys installation is comparable in size to Arlington County.

The first full-scale installation on municipal wastewater biosolids of the Haarslev CHS continuous-flow THP configuration went into operation in July 2014. The Haarslev CHS does not have any have installations of comparable size to Arlington County.

Table 2. Hydrolysis Technology Installation and Experience Summary

Evaluation Criterion	Unit	Cambi		Veolia		Haarslev
		Mark I	Mark II	Bio Thelys® (old version)	Bio Thelys® (new version)	CHS
Installation and operation experience						
Number of installations	No.	33	30	6	1	5
First installation	Year	1995	2014	2004	1999	2014
Longest operating installation	No. of years	26	7	12	2	7
Total installed capacity	dtpd	4,000	1,600	244	56	53
Largest installation	dtpd	405	242	99	56	26
Number of installations with capacity greater than 50 dtpd	No.	24	18	2	1	0

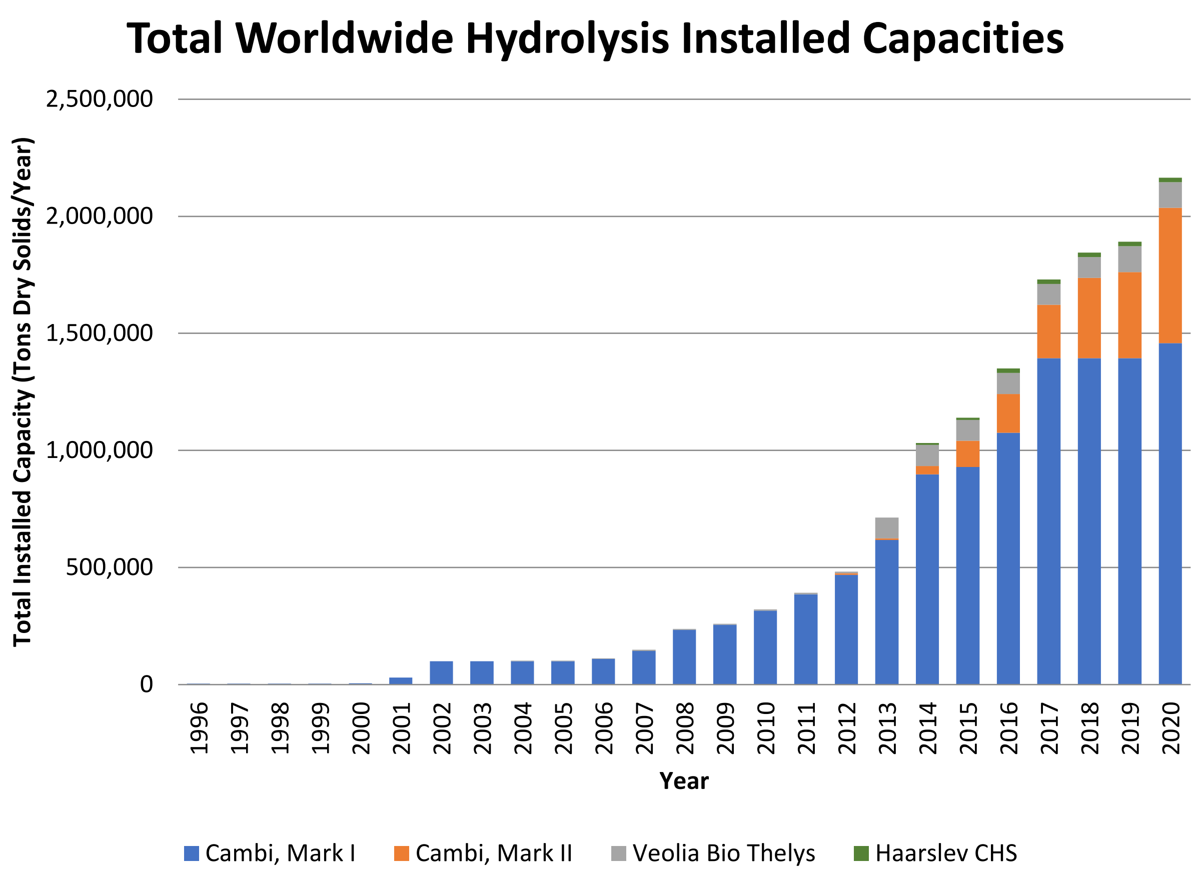

Figure 4. Total Worldwide Thermal Hydrolysis Installed Capacities

6.2 Proven Reliability

Over Cambi's more than 25 years of operational experience, multiple mechanical modifications have been made to the THP to optimize operations and improve reliability and throughput capacity. The Mark II configuration is considered the third generation of the Cambi THP, following multiple installations with lessons learned.

Bio Thelys has a shorter operational experience and had substantial challenges during the startup of its two largest facilities in the United Kingdom. Issues at these facilities included clogging of the steam lances, odor excursions of the foul gas, and high steam demand. Veolia is troubleshooting these systems and has implemented modifications that, in the newer version of Bio Thelys, should mitigate many areas of concern. However, this new configuration has been in service only since 2019 and there are process and equipment risks inherent to being one of the first installations with this new configuration.

From a process, equipment, and operations standpoint, the Haarslev CHS continuous-flow THP is substantially different from the batch-configured processes and there is an anticipated period that will be necessary for Haarslev to refine and optimize this new approach to THP on municipal wastewater biosolids. Haarslev has been operating primarily in the industrial market for the last 30 years.

6.3 Process Details

This section reviews the process details of the THP technologies. Table 3 provides a comparison of some key details of the THP technologies.

Table 3. Hydrolysis Technology Process Comparison

Evaluation Criterion	Unit	Cambi	Veolia	Haarslev
		Mark II	**Bio Thelys®**	**CHS**
Process type: batch or continuous	--	Batch	Batch	Continuous
Pre-dewatered cake feed	Percentage dry solids	16%–18%	Up to 22%	Up to 22%
Steam consumption (average)	kg steam/DT DS	1,000	800	705
Steam/biosolids mixing	--	Lances in reactors	Dynamic mixing	Dynamic mixing
Cooling	--	HEXs	Dilution water and HEXs	Depressurization and dilution water (no HEXs)
Class A final product when fed PS and WAS	--	Yes	Yes	Undetermined

The overall cooling demand of the Cambi Mark II is less than what is required for the Cambi Mark I. The Mark II flashing and improved steam recycle to the pulper and resultant heat recovery results in a lower temperature for the THS leaving the THP with the Mark II system relative to the Mark I system. Steam is injected directly into the reactors using lances for the Cambi Mark II. We are unaware of any recent instances of the Cambi steam lances plugging. The steam lances limit Cambi's pre-dewatered cake to between 16 and 18 percent solids.

The current version of the Bio Thelys and Haarslev CHS use a dynamic mixer to combine the steam, eliminating the need for lances. This allows for a higher pre-dewatered cake (up to 22 percent solids), while the lances limit Cambi's pre-dewatered cake to between 16 and 18 percent solids.

In both the current version of the Bio Thelys and Haarslev CHS, more pathogen-free water is added to the higher-concentration pre-dewatered cake following hydrolysis to achieve the desired digester concentration of 9 to 10 percent. This additional dilution water reduces the temperature of the THS, and thereby the cooling demands. Additionally, this dilution eliminates the need to combine the THS with digested solids prior to the cooling HEXs, as is required with the Cambi THP. Therefore, the cooling HEX equipment size for Veolia's Bio Thelys is significantly smaller than that required by Cambi. The cooler employed by Haarslev uses a vacuum condition in the cooler to reduce the temperature of the THS to mesophilic temperatures, and no downstream cooling HEX is required.

Effective and reliable foul-gas management is critical because of the high intensity and persistence of the odors in the foul-gas stream. Based on the review of the information provided by the manufacturers, as well as firsthand reports from site visits and owner discussions at both Cambi and Bio Thelys installations, Cambi's patented foul-gas handling arrangement has distinct advantages. The Cambi system is a simpler configuration and it has been consistently reliable in preventing the incidence of fugitive odors. The Cambi Mark II version regularly operates without odor release, providing no odor impact even at close range with the THP facilities. Additional operational experience is required to determine the effectiveness of the foul-gas management approach for both the newer Bio Thelys and Haarslev CHS THP systems.

6.4 Maximize Overall Energy Efficiency: Steam Demand

The relative efficiency of the three THP systems was evaluated based on the steam demand of the systems. Cambi has optimized steam demand in the Mark II configuration. Both the current version of the Bio Thelys and Haarslev CHS employ the use of a dynamic mixer to combine the pre-dewatered solids and steam, which results in a better steam economy than Cambi.

6.5 Proven Ability to Produce Class A Biosolids

The Cambi and Bio Thelys batch systems both meet time and temperature requirements for producing Class A biosolids. However, only the Cambi system has been approved by U.S. and state regulators to date.

The Haarslev CHS has a continuous-flow process, rather than batch configuration, and it is anticipated that the efforts to gain approval from VDEQ for Class A equivalency would require time and effort to demonstrate and prove a plug flow performance, and pathogen reduction prior to submitting to the Virginia Department of Environmental Quality (VDEQ) for equivalency approval, as discussed in Section 4.3.

7.0 Summary, Conclusion, and Recommendations

TH is a rapidly evolving technology with many paths being taken by different manufacturers. While all TH technologies use steam and pressure to hydrolyze solids, these systems vary widely in their process configurations, equipment arrangement, and operational strategies. Additionally, the solids handling facility interfaces upstream and downstream of the THP are different with each technology. Therefore, it is recommended to select the specific THP configuration before proceeding into detailed design.

The Haarslev CHS continuous-flow THP configuration has had a very small share of the market, with the first installation on municipal wastewater biosolids in operation since 2014. This process is substantially different from the batch-configured THP systems and there is an anticipated period that will be necessary to develop and prove the process for Class A performance and to confirm operational reliability. In addition, if employed at the Arlington WPCP, it would be the first Haarslev CHS system in the United States.

The Cambi and Bio Thelys batch systems both meet time and temperature requirements for producing Class A biosolids. However, only the Cambi system has obtained regulatory approval in the United States.

The Cambi THP has an advantage in proven and reliable capacity performance with multiple installations similar to the throughput and configuration required for the Arlington WPCP Re-Gen project. The current operating configuration of Cambi also has a proven approach and details for steam efficiency, heat recovery, and odor control. The current version of Bio Thelys has very limited experience, and the older version previously faced challenges with the startup of its largest installations.

The results of vendor selections and evaluations in North America are summarized in Table 4.

Table 4. North American THP Vendor Selections

Agency		Year	THP Selection Process Used	Vendor System Selected
DC Water, Washington, D.C.	Blue Plains Advanced WWTP	2009	Sole source	4 × Cambi B12 Mark I
HRSD, Virginia	Atlantic WWTP	2013	Sole source	Cambi B6 Mark II
City of Franklin, Tennessee	Franklin WRF	2015	Pre-selection competition	Cambi B2 Mark II
Trinity River Authority (Dallas, Texas)	Central Regional Wastewater System	2015	Pre-selection competition	3 × Cambi B6 Mark II
City of Calgary, Alberta, Canada	Bonnybrook WWTP	2016	Pre-selection competition	2 × Cambi B6 Mark II
San Francisco PUC, California	Southeast WWTP Biosolids Digester Facility	2016	Sole source	3 × Cambi B6 Mark II
City of Raleigh, North Carolina	Neuse River RRF Bioenergy Recovery Project	2016	Sole source	Cambi B6 Mark II
WSSC, Maryland	Piscataway WRRF Bioenergy Facility	2018	Sole source	Cambi B6 Mark II 2P/2F
Medina, Ohio	Holtz WWTP	2018	Sole source	Cambi B2 Mark II
Pontiac, Michigan	Clinton River WRRF	2017	Sole source	Cambi B2 Mark II
Winnipeg, Manitoba, Canada	North End STP	2017	Pre-selection competition	3 × Cambi B6 Mark II
Kansas City, Missouri	Blue River Biosolids Facility	2020	Sole source	Cambi B6 Mark II 2P/2F
Charlotte Water, North Carolina	McAlpine Creek Wastewater Management Facility	2021	Pre-selection competition	2 × Cambi B6 Mark II

Because of the differences in technologies and the desire to select the THP configuration before proceeding into detailed design, Arlington County Purchasing has recommended to proceed with a competitive negotiation process to pre-select the THP equipment manufacturer. The evaluation factors will include those provided in Section 6.0 of this memo. The exact mechanism for the competitive negotiation, including evaluation factor scoring and proposal requirements will be developed in conjunction with the WPCB and Arlington County Purchasing.

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Technical Memorandum No. 5

Date:	October 20, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Biosolids Product Market Analysis

Contents

Tables

Appendices

1.0 Background and Purpose

Regulatory and beneficial-use market assessments for various biosolids products, including Class B dewatered cake and Class A exceptional quality (EQ) dewatered cake, dried biosolids, compost, and blended soils, were performed for the 2018 Master Plan report (Master Plan). The purpose of Technical Memorandum (TM) No. 5 is to present updated regulatory and beneficial-use market assessments based on current and emerging regulatory trends and the recent introduction of additional Class A EQ biosolids products from the thermal hydrolysis anaerobic digestion (AD) process in the Mid-Atlantic region. TM No. 5 also presents a recommended outline for a distribution and marketing plan and specific activities to be performed over the next several years to inform that plan. The full distribution and marketing plan will be developed nearer to the time when Class A EQ biosolids will be generated at the Arlington County (County) Water Pollution Control Plant (WPCP).

1.1 Definitions and Description of Biosolids

Biosolids are a resource that is created when wastewater solids are treated to reduce pathogens in accordance with evidence-based regulations established by the U.S. Environmental Protection Agency (EPA). Biosolids generated from the treatment of municipal sewage sludge tend to be rich in nutrients, minerals, micronutrients, and organic matter, which increases crop yields. Additionally, biosolids provide numerous environmental benefits, including enhancing soil microbiology, improving soil structure, and enabling carbon sequestration.

The use of biosolids as a soil amendment also reduces the global environmental impacts of synthetic fertilizers, which include: the consumption of non-renewable resources such as phosphate rock, carbon emissions related to the manufacture of fertilizer using the energy-intensive Haber process, and watershed pollution (the nutrients in synthetic fertilizer are more mobile and water soluble than those in biosolids, increasing the risk of runoff).

Biosolids are considered safe for beneficial use when they have been treated using a process that reduces pathogens. EPA has established Code of Federal Regulations (CFR) Title 40 Part 503, which defines “Class A” and “Class B” standards, which are explained in more detail below.

Solids that have not been treated in accordance with either Class A or B criteria are referred to as “unstabilized solids” and cannot be beneficially reused for any purpose: unstabilized solids must be landfilled, incinerated, or treated on or off site using a Class A or Class B process.

Individual state and local governments can establish additional restrictions above those set by EPA regarding the transport, storage, and distribution of biosolids. State and local regulations can have a significant impact on the availability of biosolids end uses, for example, by capping the allowable amount of biosolids that can be land-applied on farms or prohibiting all land application of biosolids during winter months.

Class B refers to solids that have been treated using a process that significantly reduces pathogens. To protect the public from the risk that some pathogens may escape treatment in a Class B process, federal and state laws set limits on when, where, and how Class B biosolids may be used. These science-based regulations are intended to reduce or minimize exposure to the public and are based on criteria such as application methods, setbacks, access restrictions, and minimum duration between biosolids application and harvesting of crops. Because of these restrictions, Class B biosolids are typically limited to agricultural purposes on farms that grow food not intended for human consumption. In the Mid-Atlantic, the most common Class B products include:

- Lime-stabilized cake
- Anaerobically digested biosolids

Class A refers to solids that have undergone a higher level of treatment to further reduce pathogens, including viruses. The treatment requirements to achieve Class A designation are established by EPA's 40 CFR Part 503 regulations. Class A biosolids face fewer restrictions than Class B biosolids, and can even be sold directly to the public. Hence, there are many potential end-use markets for Class A biosolids. In the Mid-Atlantic, the most common Class A products include:

- Lime-stabilized cake
- Dewatered thermal hydrolysis process (THP) cake
- Cured THP biosolids
- Dried biosolids
- Compost

In addition to the classification, biosolids are often categorized based on the treatment method, post-processing method, and amendments. Some of the more common products in the Mid-Atlantic are defined below:

- **Dewatered cake** refers to biosolids that have been dewatered to 15 to 30 percent solids content (70 to 85 percent water content). Dewatered cake can be either Class A or Class B, depending on the level of treatment prior to dewatering:
  - **Lime-stabilized cake** refers to dewatered solids treated with lime to raise the pH to a level that reduces pathogens. Lime stabilization systems are typically designed to meet Class B requirements, but can also be designed to achieve Class A, with the addition of heat for pasteurization (70 degrees Celsius [°C]/158 degrees Fahrenheit [°F] for 30 minutes). Lime addition increases the weight and volume of end product by 20 to 40 percent, depending on the dose required to meet EPA requirements, satisfy end user preferences, and reduce odors.
  - **Anaerobically digested biosolids** are solids that have been digested in anaerobic conditions. In addition to reducing pathogens, AD reduces the quantity of end product by 35 to 55 percent via the conversion of organic matter into biogas. AD processes are typically designed to meet only Class B requirements, but can also be designed to achieve Class A.
  - **Dewatered THP cake,** for the purposes of this TM, refers to anaerobically digested biosolids that are pretreated in THP. Class A requirements are met by a time-temperature regime (50°C/122°F for 20 minutes) in the THP reactor and volatile solids reduction in the digester. THP enhances the dewaterability of the cake, typically resulting in 25 to 35 percent solids.

- **Dried biosolids** (or "heat dried") refer to solids that have been heated in a dryer after dewatering. Biosolids products with a solids content of 90 percent or greater meet EPA's requirements for Class A. Dewatered THP cake is typically not dried because it already meets Class A requirements, but several facilities in Europe combine the two technologies to reduce hauling costs and/or enhance end product value.

- **Partially dried biosolids** refer to solids that have been dried to a concentration less than 90 percent. Partial drying is uncommon because it requires a lot of energy but does not meet Class A requirements. However, the District of Columbia Water and Sewer Authority (DC Water) and other utilities have experimented with partial heat drying (50 to 70 percent solids) of dewatered THP cake to generate new end products that may be more attractive for certain markets.

- **Cured biosolids** are dewatered biosolids that have been air-dried in unaerated static piles for several days. The curing process reduces odors and increases solids content (generally to 50 to 70 percent). Curing is typically performed only with Class A biosolids.
- **Compost** refers to solids that have been mixed with a bulking agent such as wood chips. Unstabilized solids can be treated to Class A or B with aerobic composting (EPA has specific time and temperature requirements for meeting Class A or B designations), and Class B biosolids can be treated to Class A via composting (e.g., digested Class B solids from Baltimore's Back River Wastewater Treatment Plant [WWTP] are hauled to an off-site composting facility to meet Class A requirements). Composted biosolids can be marketed and sold to landscapers, nurseries, wholesalers, and hardware stores.

  - Note: Class A biosolids can also be blended with a bulking amendment to create a compost-like product. Because the solids are already Class A, it is not necessary to meet any time or temperature requirements; this is the approach DC Water uses to create "Woody Bloom." This *compost-like* material has similar properties and end uses to compost. In this TM, the term "compost" is used to refer to dewatered THP cake that is blended with a bulking agent, not necessarily solids that have been aerobically composted according to a specific time and temperature regime.

- **Soil blends** are biosolids with an amendment such as water treatment residuals or sandy soils to create a product that is more soil-like in appearance. These blends can be marketed as a topsoil or fill material for construction companies and landscapers, or as a daily cover material for landfills (see Section 5.2).

Arlington County is planning to replace the existing lime stabilization process with a Class A THP and AD, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP. This TM evaluates the marketability of the following potential end products:

- Dewatered THP cake
- Dried biosolids
- Cured biosolids
- Compost (dewatered THP cake blended with a bulking agent to create compost-like product)
- Soil blends

2.0 Regional Biosolids Product Market Update

This section presents a review of the current biosolids product market in the Mid-Atlantic region, including a 2018 market assessment review summary, THP biosolids market updates, and a summary of current biosolids markets and products.

2.1 2018 Market Assessment Review

Findings from the Master Plan market assessment for biosolids products in the Mid-Atlantic region are summarized in Table 1.

Table 1. 2018 Market Assessment Summary

Biosolids Product	End-Use Market	Market Maturity
Class B dewatered cake	Bulk agricultural land application, land reclamation	Well-established
Class A dewatered cake	Bulk agricultural land application, wholesale to agricultural market, land reclamation, feedstock for blended products	Well-established and growing
Class A dried	Bulk agricultural land application, wholesale to agricultural market, non-agricultural land application[a], retail sales, fuel, feedstock for blended products	Established bulk, wholesale and retail markets, some effort to enter non-agricultural markets
Class A compost	Bulk agricultural land application, wholesale to agricultural market, land reclamation, non-agricultural land application[a], retail sales, feedstock for blended products	Established wholesale markets, some effort to enter non-agricultural markets
Soil blends	Bulk agricultural land application, wholesale to agricultural market, land reclamation, retail sales, urban land reclamation	Established wholesale market, growing retail market

a. Non-agricultural land application includes use of biosolids as a fertilizer or soil conditioner in horticulture, landscaping, and turf management applications, both commercial and residential.

In general, the 2018 market assessment aligns with current biosolids market conditions in the Mid-Atlantic region. One exception is the fuel market, in which biosolids are used as a substitute for low-grade coal in cement manufacturing. The 2018 market assessment notes that the Lehigh Cement Company plant in Union Bridge, Maryland, receives 14,000 metric tons per year of dried biosolids, and there are plans to increase capacity. However, based on recent discussions with the City of Baltimore, Lehigh Cement apparently has not been accepting biosolids since February 2019 because of reductions in the price of coal and the aging condition of its solids receiving and handling equipment.

As noted in the 2018 market assessment, bulk agricultural land application is still the major beneficial-use outlet for Class A dewatered cake. Class A cake, including THP biosolids, typically must be post-processed to increase the solids content to 50 percent or more or blended with other materials to produce a drier, compost-like product to meet product requirements and preferences of retail, blended soils, and urban land/site reclamation or restoration markets.

2.2 THP Biosolids Product Market Updates

The beneficial use of Class A EQ THP biosolids has evolved and expanded in the Mid-Atlantic region since the 2018 market assessment was completed. Updates to the 2018 market assessment for THP biosolids are summarized as follows.

2.2.1 DC Water

DC Water has been producing Class A EQ THP biosolids at the Blue Plains Advanced WWTP since 2014. At the time the 2018 market assessment was performed, almost all of DC Water's Class A EQ cake was land-applied to farms in Virginia. Since then, DC Water has diversified its beneficial-use program and currently produces a variety of biosolids and blended products serving the bulk agricultural land application, soil blending, and horticultural and landscaping markets.

DC Water produces and markets several types of biosolids products under the brand name Bloom, described as follows (source: https://bloomsoil.com):

- Fresh Bloom is dewatered THP cake, with a solids content of 30 to 35 percent. Fresh Bloom is distributed primarily in bulk for agricultural land application. DC Water also markets Fresh Bloom for soil blending; for example, a local general contractor has used Fresh Bloom as a topsoil amendment on several of its building projects.
- Cured Bloom consists of dewatered biosolids that have been air-dried to approximately 70 percent solids. Cured Bloom is marketed for horticultural and landscaping uses and is available in bulk and bagged form at several retail gardening centers in the metropolitan Washington area.
- Woody Bloom consists of dewatered biosolids blended with shredded or ground hardwood to produce a compost-like material with a solids content of approximately 50 percent. Woody Bloom is marketed in bulk as a general-purpose soil amendment for horticultural and landscaping applications.
- Sandy Bloom consists of dewatered biosolids blended with sand and sawdust. Sandy Bloom can have a solids content of 80 percent or more and is marketed as a top dressing for turf and lawns.

Product analyses of DC Water's products are provided in Appendix B.

DC Water currently produces approximately 150,000 wet tons of Bloom products annually. Bloom is distributed for bulk agricultural land application by third-party contractors and through Blue Drop, a nonprofit entity formed by DC Water to market Bloom and DC Water's technology innovations. In 2020 DC Water reported selling more than 40,000 wet tons of Bloom, compared to slightly less than 10,000 tons in 2017. Approximately 80 percent of Bloom sales in 2017 was direct sale to farms in Maryland with 20 percent to landscapers, soil blenders, and construction companies. From 2018 to 2021, non-agricultural customers accounted for nearly one-third of sales (soil blenders: 17 percent; construction firms: 8 percent; landscapers: 3 percent; nurseries: 2 percent). The remaining 110,000 tons were hauled and land-applied by third-party contractors to farms in Virginia and Pennsylvania. A summary of DC Water's pricing strategy is presented in Table 2.

Table 2. DC Water Pricing Strategy

Product	Approximate Price	Comments
Fresh Bloom, subsidized rate for agricultural customers	$2–$6 per wet ton, including delivery	Price varies based on distance. For some large customers, DC Water also spreads the product for free.
Fresh Bloom, all other customers (e.g., soil blenders, construction)	$5 per wet ton, not including delivery	$3.50 per cubic yard. Most customers have the product delivered. Some customers pick up the product with their own trucks, which is more profitable for DC Water because delivery fees do not fully cover the cost.
Bloom Blends (Sandy and Woody Bloom)	$14–$36 per wet ton	Price varies on order size, product type, and delivery ($5/mile/truck)
Cured Bloom (50 lb bags)	$200+ per wet ton	Suggested retail price: $9.50 per bag ($380 per ton); typically sold to distributors and wholesalers for $5–$6 per bag.

a. Costs compiled from Bloom's website (bloomsoil.com/get-a-quote/) and "Bloom: Lessons in Biosolids Marketing & Sales," an August 2021 webinar presented by James Fotouhi and April Thompson of DC Water and hosted by the Metropolitan Water Reclamation District of Greater Chicago (mwrd.org/sites/default/files/documents/M&R_Seminar_8.27.21.pdf).

2.2.2 Hampton Roads Sanitation District

The Hampton Roads Sanitation District (HRSD) has implemented THP AD at its 54-million-gallon per day (mgd) Atlantic Treatment Plant (ATP) and is projected to produce approximately 39,000 wet tons of Class A biosolids per year (27 dry tons per day [dtpd]) following the closure of another treatment plant and the completion of the flow diversion to ATP. It is currently in the process to work with the Virginia Department of Environmental Quality (VDEQ) to secure a Class A EQ designation for the dewatered cake. HRSD's beneficial-use program will rely almost entirely on bulk agricultural land application by a third-party land application contractor for the near-term future. Based on findings of its 2020 biosolids market study, HRSD may also explore preparing a cured dewatered cake product to market as a soil amendment.

2.2.3 WSSC Water

WSSC Water is currently implementing its Piscataway Bioenergy project, which includes THP AD at the Piscataway WWTP to stabilize approximately 50 dtpd of solids (at startup) from Piscataway and four other WSSC Water resource recovery facilities. The Piscataway THP facility is expected to generate 50,000 to 62,000 wet tons of Class A biosolids per year once it is fully operational in 2024. At startup, WSSC Water will rely almost entirely on bulk agricultural land application by a third-party land application contractor. However, the utility is investigating options for developing cured or upgraded products for additional markets as part of continued biosolids master planning efforts.

2.3 Summary of Current Biosolids Markets and Products

In general, the market for dewatered cake products is limited to bulk agricultural land application.

Non-agricultural markets typically prefer biosolids products that are similar in appearance and consistency to traditional materials, such as compost, fertilizer, potting mix, and soils. Therefore, Class A THP cake may need to be cured, dried, and/or blended with other materials to meet customer expectations in non-agricultural markets.

provides a summary of viable biosolids end-use markets and the types of potential biosolids products (listed at the end of Section 1.1) that may be used or preferred in each market.

Table 3. Biosolids Beneficial-Use Markets and Suitable Products

Market	Market Maturity					Comments
	Cake	Dried	Cured	Compost	Blends	
Bulk agricultural land application	●	●				Established market.
Horticulture, landscaping, and turf management (including retail sales to the general public)		●	◐	●	◐	Emerging market: Markets for dried products and compost are fairly well established (e.g., Milorganite and Orgro). Market for cured cake and soil blends is small but growing (e.g., DC Water).
Commercial soil blending	○	◐	◐		◐	Emerging market: Future investigations are necessary to confirm if soil blenders would consider curing product themselves. Market for cured cake is small but growing (e.g., DC Water). For dried solids, soil blenders may prefer more granular belt-dried than spherical drum-dried biosolids
Site development	○		◐	◐	◐	Emerging market: Cured, compost, or blends are anticipated to be most attractive for this market; however, construction contractors may be willing to use cake at 30%–35% solids for site restoration.
Commercial fertilizer blenders		◐				Emerging market: May be limited to spherical, drum-dried products matching size, shape, or other fertilizer materials.
Biofuel (substitute for low-grade coal at cement kilns)		○				Limited outlet: Local cement kilns have stopped accepting biosolids recently because of current low cost of coal.
Land reclamation (mining, brownfield sites)	○		○	○	○	Limited outlet: Opportunities on a project-by-project basis rather than routine recurring use.

Legend: ● = Established market with strong demand

◐ = Emerging market with potential for strong demand

○ = Potential market

Refer to Section 1.1 for descriptions of products.

- Cake = dewatered THP cake
- Dried = THP cake that has been heat-dried to 90% solids content
- Cured = dewatered THP cake that has been air-dried to 50%–70% solids
- Compost = dewatered THP cake blended with a bulking agent to create a compost-like product
- Blends = dewatered THP cake blended with sandy soils or water treatment residuals to create a soil-like product

3.0 Regulatory and Permitting Update

Regulatory and permitting requirements for beneficial use of biosolids were presented in the Master Plan. Key regulatory and permitting requirements reported in the Master Plan are summarized below for reference:

- Biosolids regulations in most states closely align with the 40 CFR Part 503 biosolids regulations promulgated by the EPA.

- Beneficial use of Class B and Class A EQ biosolids requires a state-issued permit. The permit is typically issued to the generator of the biosolids. For Class B materials, a permit is typically required for each land application field. Utilities that generate Class A biosolids can obtain a "general use" permit that extends to all end users, including any land application fields.

- Bulk agricultural land application of biosolids in Virginia, Maryland, and Pennsylvania typically must be done in accordance with a nutrient management plan (NMP). For sites associated with animal feeding operations or high soil concentrations of phosphorus, Virginia law additionally requires that NMPs be approved by the Virginia Department of Conservation and Recreation (DCR).

- VDEQ has historically viewed "cake-like" Class A EQ biosolids, considered to be anything other than compost or with a solids content of less than 90 percent, as Class B biosolids in its permitting decisions. Many of the site management requirements for Class B cake, including signage and setbacks from the property line, are also required for Class A EQ cake. For example, VDEQ does not require individual permitting and associated public notice for land application sites receiving Class A biosolids from DC Water, but does require the following:
  - 200-foot setback from the property line of a publicly accessible site
  - 400-foot setback from "odor sensitive receptors" (hospitals, schools, churches, etc.)
  - Setbacks must comply with those established in the NMP
  - Setbacks may be extended at VDEQ's discretion, if requested by adjacent property owners
  - Daily notification to VDEQ, including locations and quantities of solids deliveries
  - Notification signage at each site

- Class A EQ biosolids that are distributed and marketed as fertilizers or soil amendments typically must be registered with and have product labeling that has been approved by the relevant state agency. For example, Class A EQ biosolids distributed and marketed in Virginia must be registered with the Virginia Department of Agriculture and Consumer Services (VDACS).
  - DC Water's "Fresh Bloom" product is registered with VDACS as a specialty fertilizer; the Bloom blended products are registered as soil amendments.

- Requirements for storing biosolids vary among the Mid-Atlantic states. Field storage is time limited (on the order of weeks to a month or so) and typically limited to the amount of biosolids to be applied in a single application cycle. A permitted storage facility is typically required for routine storage of larger quantities of bulk biosolids or for extended periods.
  - The requirements for biosolids storage in Virginia are established in Virginia Administrative Code (VAC) Title 9 Section 25-32-550. Virginia storage regulations are the same for Class A and Class B biosolids.

- Localities generally cannot establish stricter requirements than states. However, they can establish stricter requirements for biosolids storage and require additional inspections and monitoring.

This section of TM No. 5 provides updates on recent regulatory activities at the federal level; in the Mid-Atlantic states of Virginia, Maryland, and Pennsylvania; and in North Carolina since the Master Plan regulatory evaluation was completed.

3.1 U.S. Environmental Protection Agency

The 40 CFR Part 503 regulations include pollutant limits for 10 heavy metal pollutants, as well as pathogen reduction and vector attraction reduction requirements. EPA is required to review and identify needed updates to the 503 regulations every 2 years, but to date the reviews have been limited to literature reviews and a targeted data collection survey. EPA has indicated its intent to perform risk assessments for additional pollutants following its 2003 biennial review (targeting barium, beryllium, manganese, silver, fluoranthene, pyrene, 4-chloroaniline, nitrate, and nitrite) and in response to several biosolids program assessments including one in 2002 by the National Research Council and in 2018 by the EPA Office of Inspector General. To date, EPA has made only minor updates and has not added to the list of regulated pollutants in the 503 regulations since they were originally promulgated in the early 1990s.

EPA's most recent major activity on the biosolids front is the assessment of perfluoroalkyl and polyfluoroalkyl substances (PFAS) in biosolids. EPA established a health advisory level of 70 nanograms per liter (ng/L) (parts per trillion [ppt]) for two PFAS compounds in drinking water, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). Measuring the vast number of PFAS compounds created is difficult, so the industry has used the sub-categories of PFOS and PFOA for which toxicology data were available as an industry indicator for PFAS concentrations. An increased focus on the presence of PFAS in biosolids management has been driven by environmental advocacy groups, regulators, and the public. EPA is in the early stages of a risk assessment for PFAS compounds in biosolids, just recently preparing the "problem statement" as the first step in the assessment. EPA expects to complete and issue the risk assessment for public comment by the end of 2022. Once the risk assessment process is completed, EPA will determine if regulatory action at the federal level to address PFAS in biosolids is needed. Regulatory action would likely consist of adding concentration limits for specific PFAS compounds to the 503 regulations.

Note that while EPA is in the early stages of its PFAS risk assessment, several states are beginning to assess the risk associated with PFAS compounds in biosolids. State efforts include sampling and data collection and studies for potential impacts of PFAS compounds on soil and groundwater at biosolids land application sites. The state of Maine also requires sampling for biosolids that are applied to the land, including Class B biosolids, Class A dried biosolids, and Class A composted biosolids, and has established screening-level concentrations for three PFAS compounds (perfluorobutane sulfonate [PFBS], PFOA, and PFOS).

3.2 Virginia

The major regulatory development in Virginia since the Master Plan evaluation has been the first permit for distribution and marketing of Class A EQ dewatered cake and products derived from cake, issued to DC Water for its Bloom biosolids products. The DC Water permit was issued for a 2-year period from

February 2018 through January 2020 and has since been administratively continued. A copy of the permit is provided in 0. Notable provisions of that permit include the following:

- Class A EQ biosolids and products derived from Class A EQ biosolids (Bloom) may be distributed and applied in bulk for application to agricultural and non-agricultural sites, distributed in bulk for blending with other materials, and distributed in bulk or bags for sale and use by the general public.
- DC Water must report monthly to VDEQ the amounts of Class A EQ biosolids and Bloom products distributed in bulk and bagged form. Reporting must include the name and location of the recipient and end user for each transaction in which 1 metric ton or more of Class EQ biosolids or blended Bloom product is distributed.
- Bulk land application of Class A EQ biosolids and Bloom products must be in accordance with an approved NMP.
- DC Water is responsible for ensuring that land application and site management requirements in the Virginia Pollution Abatement regulations are followed for bulk land application of Class A EQ biosolids and Bloom products.

The consensus opinion within the regulated wastewater treatment and biosolids management industry of the initial DC Water distribution and marketing permit, especially the extensive reporting requirements, is that VDEQ is approaching and permitting "cake-like" Class A EQ biosolids and blended products much the same as Class B cake. VDEQ is expected to issue in 2021 notice for public comment on the draft of its first 5-year permit for distribution and marketing of Class A EQ dewatered cake, for the THP biosolids from HRSD's ATP. A draft permit is not yet available for review but is expected to present the template for future distribution and marketing permits for similar Class A EQ cake-like products. It remains to be seen if VDEQ, with 2 years of experience with DC Water's distribution and marketing program, will lessen reporting and other requirements for Class A EQ biosolids in HRSD's and potentially other future distribution and marketing permits.

VDEQ has not announced any planned regulatory action on PFAS compounds in biosolids in lieu of activity at the federal level.

3.3 Maryland

The Maryland Department of Environment (MDE) regulates biosolids management under Sewage Sludge Utilization (SSU) permits. Permits are required for facilities in the state that treat and distribute biosolids and for the land application of Class B biosolids. Class A EQ biosolids from out of state can be distributed and marketed in Maryland under an SSU marketing permit. Mixing and using Class A EQ biosolids blended with other materials such as sand, soil, wood chips, or compost requires written authorization from MDE but not a formal SSU permit. SSU permits are not specifically required for agricultural land application of Class A EQ biosolids, which may be land-applied in accordance with an approved NMP. Maryland does not allow land application of any organic materials, including biosolids, during the winter months (November 2 if east of the Susquehanna River and November 16 if west of the Susquehanna River and continuing through February 28). In addition to NMPs, Maryland has implemented a Phosphorus Management Tool that can limit or prohibit the application of phosphorus-containing fertilizers on farm fields with high levels of phosphorus in the soil and/or high risk of phosphorus entering surface waters in runoff.

In 2016, MDE issued an SSU marketing permit with a 10-year term to DC Water to market Class A EQ biosolids, referred to in the permit as Bloom. The Maryland SSU permit provision requires annual reporting on the amount and disposition of biosolids marketed in the state but does not contain any special requirements for agricultural land application of other beneficial uses of Bloom.

MDE has not announced any planned regulatory action on PFAS compounds in biosolids in lieu of activity at the federal level.

3.4 Pennsylvania

Pennsylvania is in the process of reissuing its general permits for use of Class A EQ biosolids (PAG-07) and Class B biosolids (PAG-08). Notable revisions being proposed include:

- PFOS and PFOA monitoring requirements for biosolids.
- Requiring use of a P-Index to determine allowable land application rates. Similar to Maryland's Phosphorus Management Tool, the P-Index could limit or disallow biosolids application on farm fields with high levels of phosphorus in the soil and/or a high risk of phosphorus entering surface waters in runoff from the field.

3.5 North Carolina

North Carolina regulatory and permitting requirements were not included in the Master Plan evaluation. North Carolina's biosolids regulations align with the Part 503 regulations. North Carolina regulations also include certain management requirements for bulk application of Class A biosolids that are typically reserved for Class B biosolids, including setbacks from surface waters and wells; field storage limits; and prohibitions on applying biosolids on fields that are wet or frozen, are steeply sloped, or where the groundwater level is close to the surface.

There does not appear to be any pending or planned future regulatory activity for biosolids, including for PFAS compounds, in North Carolina.

4.0 Outlook for Beneficial Use of Biosolids in the Mid-Atlantic Region

Bulk agricultural land application has been the dominant market for beneficial use of Class B and Class A EQ biosolids, both dewatered and dried, in the Mid-Atlantic region. However, there has been a declining trend in land application in Virginia, from an average of 220,000 dry tons per year of biosolids applied to 65,000 acres of farmland during the 2008 through 2013 period to approximately 130,000 dry tons per year land-applied to roughly 45,000 acres over the past several years.[1] Part of this decline is likely due to the growth in the horticultural, soil blending, and retail markets as more Class A EQ products have been generated. Part is likely due to a reported shift from Virginia to out-of-state land application of a portion of DC Water's uncured Bloom biosolids during the initial 2-year "trial" distribution and marketing permit. Structural changes in the agricultural market, including the loss of farmland to development, may also account for the reported decline in biosolids land application. While biosolids are land-applied to only a small percentage of agricultural land, less than 1 percent in Virginia, it is assumed that there will be little if any growth, and perhaps a continued decline over time, in the agricultural land

[1] Source: VDEQ 2015. "Biosolids Frequently Asked Questions". Available online at https://www.deq.virginia.gov/home/showpublisheddocument/5564/637552183171470000. Biosolids agricultural land application data and trends for other Mid-Atlantic states are still being compiled and evaluated.

application market for biosolids in the Mid-Atlantic states. The outlook for non-agricultural markets appears good as evidenced by the growth in Class A EQ products generated and used in the non-agricultural markets. However, the following factors and trends that can affect market demands for biosolids should be considered.

4.1 Regulatory Trends

Current and recent regulatory activities and trends can have both positive and negative effects on the beneficial use of biosolids in agricultural and non-agricultural markets. Key activities and trends include the following:

- Winter restrictions on land application of organic materials and biosolids, recently imposed in Maryland, have not appeared on the regulatory agenda in other Mid-Atlantic states. To date, other states in the region appear to have absorbed biosolids diverted out of Maryland during the winter season.
- Phosphorus management tools that may constrain biosolids land application on some farm fields are being implemented in Maryland and Pennsylvania. Virginia has not yet indicated that a P-Index or phosphorus management tool will be developed and implemented in the state. Implementation of a phosphorus management tool may prohibit land application of biosolids on fields that have received repeated applications of manure and poultry litter, especially in the Delmarva Peninsula, with less impact on cropland in the Piedmont.
- PFAS regulatory action will continue to move forward at the federal level and potentially the state level. There is some evidence that regulatory uncertainty over PFAS is negatively affecting the biosolids land application market, and even landfill disposal, with reports of some operators no longer taking biosolids because of concern over potential future liability for PFAS contamination. Regulation of PFAS in biosolids at the federal level, when it occurs, is likely to be based on concentration limits to mirror the regulation of metals and will likely serve as a template for state regulation. This would have a positive impact on biosolids land application by eliminating the current regulatory uncertainty and alleviating fear of potential liability in most cases.

4.2 Farming Trends

Trends in the agricultural sector that may affect land application include the reduction in the number of farms. Business trends that may include larger corporately owned and managed farms, which would tend to be less receptive to using biosolids, appear to be less prevalent in the Mid-Atlantic states than in other parts of the United States, with the possible exception of the poultry and livestock industry.

There has been a documented increase in the number of organic farms in the Mid-Atlantic states. This trend can impact wastewater utilities because United States Department of Agriculture (USDA) regulation 7 CFR 205.105(g) specifically prohibits the application of biosolids on organic fields[2]. The number of organic farms in Virginia has increased from approximately 260 in 2012 to nearly 320 in 2017, as reported in the U.S. Department of Agriculture's most recent comprehensive farm census survey[3].

[2] While USDA regulations categorically prohibit the use of biosolids on organic farms, regardless of level of treatment, raw animal manure can be applied to organic crops, including those intended for human consumption, subject to a minimum 90-day interval between application and harvesting (7 CFR 205.203(c)(1)).

[3] USDA National Agricultural Statistics Service. Results from the 2019 Organic Survey (2017 Census of Agriculture). https://www.nass.usda.gov/Publications/AgCensus/2017/index.php

While conversion from conventional to organic farming would preclude the use of biosolids, the number of organic farms is a small percentage (approximately 1 percent) of the roughly 42,000 farming operations in Virginia. Growth in organic farming is expected to have little if any impact on the land application market.

4.3 Weather and Climate Change

Biosolids land application was severely impacted in Virginia and other Mid-Atlantic states during 2018 by the unusually wet spring and summer. Wet field conditions shut down operations of most land application contractors, which coupled with a lack of storage facilities led to claims of *force majeure* by some contractors. Wetter springs and summers may be a future trend as a result of climate change. This will drive the need for additional biosolids storage, including on-site storage at wastewater treatment plants, and may also be a driver toward the production of drier biosolids to reduce volume and Class A EQ biosolids that can be marketed for non-agricultural uses.

4.4 Public Perception

Negative public perception and opposition to beneficial use of biosolids has typically been tied to odors, dust, truck traffic, and spills related to bulk agricultural land application. A low-odor Class A EQ product and a well-managed land application program can go a long way toward defusing public opposition.

Emerging concerns and growing attention to PFAS have resulted in negative perceptions of biosolids in certain areas of the United States among traditional users such as farmers and landfill operators. The recent report issued by the Sierra Club, *Sludge in the Garden: Toxic PFAS in home fertilizers made from sewage sludge,* has also raised concerns over public acceptance and perceptions in both the agricultural and retail horticultural and landscaping markets. The full impact of PFAS on public perception and acceptance remains to be seen but it does create a risk of diminishing demands for biosolids across multiple market sectors.

4.5 Contract Terms and Pricing

Most producers of Class A EQ biosolids continue to use a third-party contractor to manage some or all of their biosolids distribution. Contract terms and pricing, which can fluctuate significantly over a period of a few years, have not been evaluated in detail for this market assessment TM but should be tracked and evaluated in detail as the County nears completion of the biosolids upgrades at the WPCP. In general, contract pricing for a wet ton of biosolids tends to be lower for Class A EQ biosolids than for Class B biosolids because of the less restrictive permitting requirements. Additionally, the total annual contract cost can be lowered by achieving a higher solids content, resulting in fewer wet tons hauled. Typical contract terms should include provisions that require the third-party contractor to manage up to the facility's entire biosolids distribution but specify an amount that the producer may reserve for direct marketing.

5.0 Potential Opportunities for Arlington County

Bulk agricultural land application will be the major market outlet for the County's Class A EQ biosolids. Other non-agricultural markets can be developed over time. Several local market opportunities are discussed here.

5.1 Enhanced THP Biosolids

Arlington County's Department of Environmental Services Solid Waste Bureau operates a leaf, wood, and yard waste mulch production and marketing program out of the County's Earth Products Yard. These types of mulch materials can be readily blended with Class A EQ dewatered biosolids to produce a compost-like material that can be marketed as a soil amendment similar to DC Water's blended Bloom products. Details on how much blended biosolids-mulch product could be produced, operational capabilities for blending at the Earth Products Yard, distribution options (bulk and/or bagged product), and the overall feasibility of a biosolids blending operation should be discussed with staff at the Earth Products Yard.

5.2 Landfill Daily Cover

VDEQ's landfill operation regulations require covering the active landfill face with 6 inches of compacted soil or other approved cover material at the end of each working day. Intermediate cover of 6 additional inches of soil or approved material is also required when additional waste will not be applied within a 30-day period.

VDEQ has approved using biosolids blended with soil material at a ratio of 1:1 as a daily and intermediate cover material but would not be receptive to using unblended dewatered or dried biosolids as cover material. Using unblended biosolids for cover material would also be an operational issue for landfill operators and equipment, as biosolids tend to become slick when wet.

Landfill operators may be receptive to using blended biosolids and soils for daily cover if the material were available at little to no cost to them. For intermediate cover, landfill operators often have difficulty finding suitable materials that are resistant to erosion and capable of supporting grass or vegetative growth. Biosolids blended with sandy soils would be well-suited for intermediate cover and could potentially be marketed for sale to landfills for this purpose.

5.3 Licensing as a Bloom Product

DC Water continues to expand its direct marketing of Bloom products, recently increasing its annual direct sales and distribution from 40,000 to 100,000 wet tons. To date, most of DC Water's direct sales of Bloom have been in Maryland. Demand for Bloom products may increase in Virginia as both DC Water and VDEQ gain experience in distribution and marketing of the products in the region. Having a local source of Class A EQ biosolids for Bloom products may be an attractive option for DC Water to reduce hauling and distribution costs. Outreach to DC Water to discuss a potential licensing arrangement is recommended at a later date.

6.0 Summary/Conclusions

Bulk agricultural land application is likely to continue to be a major market outlet for biosolids, including Class A EQ dewatered and dried biosolids. Non-agricultural beneficial-use markets require enhanced Class A EQ biosolids, which may include dried biosolids, composted biosolids, or dewatered Class A biosolids that has been "cured" to reduce the moisture content or blended with other materials to produce a compost-like product. It is recommended that the County plan for a diversified biosolids portfolio that includes both dewatered THP biosolids to serve the bulk agricultural land application market and cured and blended THP biosolids products suitable for non-agricultural markets.

6.1 Design Considerations for Future Biosolids Operations

Site constraints and odor considerations at the WPCP make on-site biosolids curing using air drying or blending operations infeasible. Performing these types of post-processing operations at the Earth Products Yard or using a third-party partner such as a soil blender or landscape supply company should be explored further. Curing dewatered THP solids on site using a low-temperature belt dryer is a potential alternative to off-site curing using air drying, with an added benefit of reduced biosolids hauling traffic to and from the WPCP. It should also be noted that while unlikely, there is still some small risk that federal or state regulatory action or heightened public opposition could significantly and negatively impact the feasibility or desirability of applying biosolids to the land for any beneficial use

Should future trends indicate that this worst-case scenario could become a reality, pyrolysis or gasification may become the most viable alternative for biosolids management. A belt drying facility intended for curing THP biosolids could also serve a future pyrolysis or gasification facility should this worst-case scenario occur.

Reserving space on site for a belt drying facility is recommended, and preliminary sizing and space requirements for a belt drying facility should be included in the ongoing site utilization and configuration evaluation. Similarly, it would be informative to evaluate space requirements for a future pyrolysis or gasification process as part of the site utilization analysis.

6.2 Biosolids Distribution and Marketing Plan

The County should develop a detailed distribution and marketing plan as construction of the biosolids facility improvements progresses, prior to startup and commissioning, and closer to the time when actual biosolids product is available to share with potential users. This timing also supports a plan that is based on current market conditions.

The distribution and marketing plan should include the following elements:

- **Biosolids management approach:** evaluate and select the preferred approach from among the following models:
    - **Full-service provider:** A third-party contractor loads, hauls, and applies biosolids, in most cases entirely for bulk agricultural land application. The full-service provider is responsible for identifying and permitting if required at the land application sites. The full-service provider typically does not generate revenue from the sale of biosolids but is paid by the generator to manage its biosolids.

- **Broker:** A third-party entity markets to and secures, sells, and arranges distribution of biosolids to end users, which may include both agricultural and non-agricultural users. The broker may pay the biosolids generator or be paid a fee by the generator, typically at a lower cost than the full-service provided model because the broker is generating revenue from the sale of the biosolids.
- **Direct marketing:** The biosolids generator also manages all marketing and distribution, including marketing to and securing end users and handling sales and distribution of the product. This model typically can provide the most revenue to the biosolids generator but usually requires full-time staff to run the program.
- **Hybrid model:** This model is a combination of direct marketing for some market outlets, typically as product sales, and either a full-service provider or broker for other markets such as bulk agricultural land application. DC Water uses a hybrid model distribution and marketing its Bloom products.

- **Permitting and product registration requirements** for Virginia and potentially Maryland, Pennsylvania, and North Carolina:
  - Distribution and marketing permits
  - Product registration as a fertilizer and soil amendment
- **Targeted non-agricultural end-use market analysis, outreach, and market development:**
  - Surveys and outreach to specific end users to identify targeted quantities, delivery schedules, seasonal/year-round use, and storage capabilities
  - Specific field trials or demonstration projects for targeted markets
- **Product branding:** name, logo, etc.
- **Product type evaluation:** adding post-processing steps to generate products other than dewatered THP cake, such as curing, drying, composting, or blending.
- **End use evaluation:** evaluating potential markets beyond bulk land application.
- **Regional collaboration opportunities,** such as a regional facility for curing, drying, blending, etc.

6.3 Recommended Next Steps

While preparation of a detailed distribution and marketing plan for the County's Class A EQ biosolids is several years away, the County can be taking certain steps and actions now to help inform the plan. These include the following:

- Initiate outreach to Arlington County government agencies (Department of Parks and Recreation, Department of Environmental Services, Department of Transportation, etc.) that may be potential users of blended biosolids products, as an alternative to commercial compost, soil amendments, or fill material.
- Initiate outreach to staff at the Solid Waste Bureau, which manages the Earth Products Yard, to discuss and evaluate the potential for producing blended biosolids products. Conducting a blending trial using a truckload or more of both fresh and cured Bloom procured from DC Water is recommended to help inform the evaluation.
- Identify and make initial contact with landfill operators to learn more about their needs and requirements for daily and intermediate cover and potential interest in alternative cover materials.

- Identify and perform preliminary outreach to specific potential non-agricultural users of biosolids to determine if they use or might be interested in using biosolids, and to identify product requirements and potential demand.
- Initiate outreach to DC Water to discuss the potential for licensing the County's Class A EQ biosolids as a Bloom product.
- Develop a communications strategy for soliciting public perceptions on biosolids and beneficial use of Class A EQ biosolids.
- Develop and implement a PFAS sampling program for WPCP influent, effluent, and biosolids to position the County for a proactive rather than reactive stance on the PFAS in biosolids issue.
- Continue to monitor metals in biosolids.

Appendix A Virginia DEQ Permit for DC Water Bloom

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Street address: 1111 East Main Street, Suite 1400, Richmond, VA 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
www.deq.virginia.gov

Russell W. Baxter
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4000
1-800-592-5482

February 2, 2018

Mr. Chris Peot
Director, Resource Recovery
5000 Overlook Ave., SW
Washington, DC 20032

RE: Issuance of VPA Permit No. VPA04002
DC Water - Bloom

Dear Mr. Peot:

The Virginia Pollution Abatement (VPA) permit for the distribution and marketing of biosolids associated with the above referenced project is enclosed. In accordance with the permit, you are required to submit Monitoring Reports by the fifteenth of each month to:

If submitting hardcopies:
Virginia Department of Environmental Quality
Office of Land Application
PO Box 1105
Richmond, VA 23218

If submitting electronically:
Christina.Wood@deq.virginia.gov
cc: Bryan.Cauthorn@deq.virginia.gov

Electronic submittal is preferred in lieu of hardcopy. The first report for the month ending February 28, 2018 is due by March 15, 2018. DEQ has not developed specific forms for the distribution and marketing reports, so please use your own reporting forms. Please continue to report the biosolids monitoring data in the format that you have been using.

As provided by Rule 2A:2 of the Supreme Court of Virginia, you have thirty days from the date of service (the date you actually received this decision or the date it was mailed to you, whichever occurred first) within which to appeal this decision by filing a notice of appeal in accordance with the Rules of the Supreme Court of Virginia with the Director, Department of Environmental Quality. In the event that this decision is served on you by mail, three days are added to that period. Refer to Part 2A of the Rules of the Supreme Court of Virginia for additional requirement governing appeals from administrative agencies.

Alternatively, any owner under §§ 62.1 - 44.16, 62.1 - 44.17, and 62.1 - 44.19 of the State Water Control Law aggrieved by any action of the State Water Control Board taken without a formal hearing, or by inaction of the Board, may petition in writing a formal hearing of such owner's grievance, provided a petition requesting such hearing is filed with the Board. Said petition must meet the requirements set forth in 9VAC25-230-130(B) of the Board's Procedural Rule No. 1. In cases involving actions of the Board, such petition must be filed within thirty days after notice of such action is mailed to such owner by certified mail.

If you have any questions regarding the permit, please contact me at (804) 840-0681 or anita.tuttle@deq.virginia.gov.

Respectfully,

Christina M Wood

Christina M. Wood
Biosolids Regulation and Guidance Coordinator

Enclosure: Permit No. VPA04002
Fact Sheet

cc: Permit file
Neil Zahradka (via email)

Part I

DISTRIBUTION AND MARKETING OF EXCEPTIONAL QUALITY BIOSOLIDS

During the period beginning with the permit's effective date and lasting until the permit's expiration date, and in accordance with 9VAC25-32-10 *et seq.* and the limitations, conditions and requirements set forth in this permit, the Permittee, District of Columbia Water and Sewer Authority (DC Water), is authorized to market and distribute Exceptional Quality (EQ) biosolids produced at the District of Columbia Advanced Wastewater Treatment Plant at Blue Plains (Blue Plains).

EQ biosolids shall meet an approved Class A pathogen reduction standard, including treatment alternative and indicator organism monitoring, one Vector Attraction Reduction Option, 1 – 8, have monthly average metals concentration below the Pollutant Concentration (PC) and all maximum metals concentrations below the ceiling limits. Exceptional Quality biosolids shall also be monitored annually for organic chemicals.

The DC Water - Blue Plains EQ biosolids, known as "Bloom Products"[(1)], may be marketed and distributed throughout Virginia in the following ways:

1. The sale or giveaway of bulk EQ cake[(2)] biosolids for the purpose of land application on agricultural[(3)] land in accordance with a Nutrient Management Plan (NMP) prepared by a certified nutrient management planner as stipulated in regulations promulgated pursuant to § 10.1-104.2 of the Code of Virginia;

2. The sale or giveaway of bulk EQ cake[(2)] biosolids for the purpose of land application on sites in accordance with a Nutrient Management Plan (NMP) prepared by a certified nutrient management planner as stipulated in regulations promulgated pursuant to § 10.1-104.2 of the Code of Virginia. The use of an application rate greater than the prescribed agronomic rate will be considered the reclamation of disturbed land and shall be managed in accordance with Part I.D.4 of this permit;

3. The sale or giveaway of EQ cake biosolids in a bag or other container[(4)];

4. The sale or giveaway of bulk EQ cake[(2)] biosolids to a facility for the purpose of blending;

5. The sale or giveaway of bulk blended EQ biosolids products for the purpose of land application on turf farms or other agricultural[(3)] land in accordance with a NMP prepared by a certified nutrient management planner as stipulated in regulations promulgated pursuant to § 10.1-104.2 of the Code of Virginia;

6. The sale or giveaway of bulk blended EQ biosolids products for non-agricultural use;

7. The sale or giveaway of blended EQ biosolids products in a bag or other container. [(4)]

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(1) **Bloom Products –** The term "Bloom Products" refers to (i) EQ cake biosolids treated and produced at DC Water - Blue Plains; (ii) Blended EQ biosolids derived from EQ cake biosolids treated and produced at DC Water - Blue Plains that are blended with mulch and other wood products, including ground, shredded or chipped woody waste and other materials that are routinely distributed for the purposes of landscaping such as vegetative compost, mineral products (including sand) and topsoil. Bloom Products may be marketed under various names as registered with the Virginia Department of Agriculture and Consumer Services (VDACS)

(2) **Cake biosolids** – refers to dewatered biosolids with a solids content greater than 15% solids and less than 90% solids and may include digested, lime stabilized, or pasteurized biosolids, etc. Cake biosolids does not include composted biosolids, blended biosolids, or other biosolids products that include bulking agents or other feed stocks.

(3) **Agricultural land -** For the purposes of this permit, refers to land dedicated to **agricultural use** which includes the bona fide production of crops, or animals, or fowl including the production of fruits and vegetables of all kinds; meat, dairy, and poultry products; nuts, tobacco, nursery, and floral products; and the production and harvest of products from silviculture activity.

(4) **Other container** - For the purposes of this permit, "other container" means either an open or a closed receptacle, including, but not limited to, a bucket, box, carton, vehicle or trailer with a load capacity of one metric ton or less.

A. LIMITATIONS AND MONITORING REQUIREMENTS

All biosolids samples shall be collected and analyzed in accordance with Title 40 of the Code of Federal Regulations, Parts 503 and 136. Analyses shall be conducted by a VELAP accredited environmental laboratory.

1. EQ BIOSOLIDS

a. Metals Limitations – EQ cake biosolids, for distribution and marketing and for use in the production of a blended product, and blended EQ biosolids products shall be monitored and limited as specified below. Biosolids shall not be marketed and distributed as a cake or blended product, or used to produce a blended product if:
   1) The monthly average concentration of any pollutant in the biosolids exceeds the Pollutant Concentration (PC) limitation of that pollutant; or
   2) The maximum concentration of any pollutant in a single sample exceeds the ceiling limitation of that pollutant.

PARAMETERS[1]	PC LIMITATIONS	CEILING LIMITATION	MONITORING REQUIREMENTS	
	Monthly Average (mg/kg) [2]	Maximum (mg/kg) [2]	Frequency	Sample Type
Arsenic	41	75	1/Month	Composite
Cadmium	39	85	1/Month	Composite
Copper	1,500	4,300	1/Month	Composite
Lead	300	840	1/Month	Composite
Mercury	17	57	1/Month	Composite
Molybdenum	NL[3]	75	1/Month	Composite
Nickel	420	420	1/Month	Composite
Selenium	100	100	1/Month	Composite
Zinc	2,800	7,500	1/Month	Composite

NL = No Limitation, monitor and report

(1) All parameters are subject to pollutant concentrations (PC) and ceiling limitations. "PC biosolids" contain the parameters identified above at concentrations below the monthly average specified in Part I.A.1.b.
(2) All limits and criteria are expressed on a dry weight basis.
(3) The monthly average concentration is currently under study by USEPA. Research suggests that a monthly average Molybdenum concentration below 40 mg/kg may be appropriate to reduce the risk of copper deficiency in grazing animals.

b. Class A Pathogen Reduction and VAR Requirements – EQ cake biosolids shall be treated and monitored to meet Class A Pathogen Reduction and VAR standards prior to sale or giveaway in bulk, bag or other container for the purpose of land application or blending, and prior to use in a blended product. Biosolids shall be monitored and limited in accordance with the treatment option identified below:

TREATMENT OPTION: CLASS A PATHOGEN REDUCTION ALTERNATIVE 1	MONITORING REQUIREMENT
a) Either the density of fecal coliform in the biosolids shall be less than 1,000 Most Probable Number per gram of total solids (dry weight basis), or the density of Salmonella sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the biosolids is used or disposed; at the time the biosolids is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 9VAC25-32-356 B, C, E or F.	1/Month (1)(2)
b) The temperature of the sewage sludge that is used or disposed shall me maintained at a specific value for a period of time in accordance with 9VAC25-32-710.A.3.b. (1) When the percent solids of the sewage sludge is 7.0% or higher, the temperature of the sewage sludge shall be 50°C or higher; the time period shall be 20 minutes or longer; and the temperature and time period shall be determined using equation (1), except when small particles of sewage sludge are heated by either warmed gases or an immiscible liquid. EQUATION (1) $D = 131{,}700{,}000/10^{0.1400t}$ D = time in days t = temperature in degrees Celsius (2 When the percent solids of the sewage sludge is 7.0% or higher and small particles of sewage sludge are heated by either warmed gases or an immiscible liquid, the temperature of the sewage sludge shall be 50°C or higher; the time period shall be 15 seconds or longer; and the temperature and time period shall be determined using equation (1). (3) When the percent solids of the sewage sludge is less than 7.0% and the time period is at least 15 seconds, but less than 30 minutes, the temperature and time period shall be determined using equation (1). (4) When the percent solids of the sewage sludge is less than 7.0%; the temperature of the sewage sludge is 50°C or higher; and the time period is 30 minutes or longer, the temperature and time period shall be determined using equation (2). EQUATION (2) $D = 50{,}070{,}000/10^{0.1400t}$ D = time in days t = temperature in degrees Celsius	(1)(2)
VECTOR ATTRACTION REDUCTION TREATMENT STANDARD OPTION 1	MONITORING REQUIREMENT
38% Reduction of volatile solids by digestion (9VAC25-32-720.B.1).	1/Month (1)(2)

(1) Between sampling events, operating records shall demonstrate that the wastewater treatment plant (WWTP) is operating at a performance level known to meet pathogen reduction and VAR standards.
(2) Process monitoring shall be sufficient to demonstrate compliance with Pathogen Reduction Alternative 1 and VAR Option1 requirements.

c. Nutrient Characteristics – All EQ cake biosolids and blended EQ biosolids products shall be monitored and limited as specified below prior to distribution and marketing:

PARAMETERS	LIMITATIONS		MONITORING	
	Monthly Average	Minimum and Maximum	Frequency	Sample Type
Percent Solids (%)	NL	NA	1/Month	Composite
Volatile Solids (%)	NL	NA	1/Month	Composite
Total Kjeldahl Nitrogen (mg/kg)[(1)]	NL	NA	1/Month	Composite
Ammonium Nitrogen (mg/kg) [(1)]	NL	NA	1/Month	Composite
Nitrate Nitrogen (mg/kg) [(1)]	NL	NA	1/Month	Composite
Total Phosphorus (mg/kg) [(1)]	NL	NA	1/Month	Composite
Total Potassium (mg/kg) [(1)]	NL	NA	1/Month	Composite
pH (s.u.)	NA	NL	1/Month	Composite
Alkalinity as $CaCO_3$ (mg/kg) [(1)]	NL	NA	1/Month	Composite

NL = No Limitation, monitor and report
NA = Not Applicable

[(1)] Expressed on a dry weight basis

d. EQ Biosolids Characteristics – All EQ cake biosolids and blended EQ biosolids products shall be monitored and limited as specified below prior to distribution and marketing:

PARAMETERS	LIMITATIONS		MONITORING REQUIREMENTS	
	Monthly Average (1) (mg.kg)	Minimum and Maximum (1) (mg/kg)	Frequency	Sample Type
Polychlorinated biphenols (PCBs)	NL	NL	Annually	Composite
Aldrin/dieldrin (total)	NL	NL	Annually	Composite
Benzo (a) pyrene	NL	NL	Annually	Composite
Chlordane	NL	NL	Annually	Composite
4 4’ DDT/DDE/DDD (total) (2)	NL	NL	Annually	Composite
Dimethyl nitrosamine	NL	NL	Annually	Composite
Heptachlor	NL	NL	Annually	Composite
Hexachlorobenzene	NL	NL	Annually	Composite
Hexachlorobutadiene	NL	NL	Annually	Composite
Lindane	NL	NL	Annually	Composite
Toxaphene	NL	NL	Annually	Composite
Trichloroethylene	NL	NL	Annually	Composite
Aluminum	NL	NL	Annually	Composite
Boron, water soluble	NL	NL	Annually	Composite
Calcium	NL	NL	Annually	Composite
Chorides	NL	NL	Annually	Composite
Manganese	NL	NL	Annually	Composite
Total Sulfur	NL	NL	Annually	Composite

NL = No Limit, monitor and report

(1) All parameters are expressed on a dry weight basis.
(2) 4 4’ DDT = 2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane
4 4’ DDE = 1,1-Bis (p-chlorophenyl)-2,2—dichloroethylene;
4 4’ DDD = 1,1-Bis (p-chlorophenyl)--2,2--dichloroethane

B. REPORTING REQUIREMENTS

1. Monthly Reporting – The permittee shall submit biosolids monitoring data and a monthly distribution report to the Department of Environmental Quality (DEQ) - Office of Land Application (OLAP) by the 15th day of each month (as evidenced by the transmission date or postmark), for monitoring and land application activities that occurred in the previous calendar month. When the report is submitted electronically, the sender must include the attestation statement in Part I.B.1.d. which states that the transmitted documents are being submitted under his/her signature.

   If no EQ cake biosolids or blended EQ biosolids products are produced or distributed under this permit during a calendar month, a report shall be submitted stating that no EQ cake biosolids or blended EQ biosolids products were produced and/or distributed. All reports shall include the name of the permittee and the DEQ permit number.

   a. Biosolids Monitoring Data – The following data shall be submitted with the monthly report for all biosolids land applied during the previous month:
      1) The results of the monitoring specified in:
         (a) Part I.A.1.b. Metals Limitations for:
            i. EQ cake biosolids – for sale or giveaway and used in blending:
            ii. Blended EQ biosolids products;
         (b) Part I.A.1.c. Class A Pathogen Reduction and Vector Attraction Reduction – for cake biosolids for sale or giveaway and used in blending:
            i. Indicator organism monitoring;
            ii. CambiTHP ™ process control time and temperature data for pathogen reduction;
            iii. Digester volatile solids reduction for VAR;
         (c) Part I.A.1.d. Nutrient Characteristics for:
            i. EQ cake biosolids for sale or giveaway;
            ii. Blended EQ biosolids;
         (d) Part I.A.1.e. EQ Biosolids Characteristics for:
            i. EQ cake biosolids for sale or giveaway and used in blending;
            ii. Blended EQ biosolids;
      2) Monitoring required by Part I.B.1.a.1) shall be submitted in the format provided in the Biosolids Monitoring Report. Supporting documentation, including laboratory chain of custody forms and certificates of analyses, shall be included in the report;
      3) Monthly average shall be reported as the average of the results of all samples collected within a calendar month and analyzed using an approved method, in accordance with Part II.C. of this permit. For monitoring periods which include multiple months, if one sample is collected during the monitoring period, that result shall be reported as the monthly average. If samples are collected in different months during the monitoring period, each monthly average shall be calculated for each month samples were collected in the monitoring period and the highest monthly average reported. Individual results and calculations shall be submitted with the report; and
      4) The maximum concentration shall be reported as the highest single result from all samples collected and analyzed during a monitoring period.
      5) The following certification statement:
         "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

b. Monthly Distribution Report – The monthly distribution report shall include the following information for the month:
   1) Monthly Production:
      (a) Total amount of EQ cake biosolids produced, in dry tons and wet tons;
      (b) Total amount of EQ cake biosolids distributed, in wet tons;
      (c) The total amount of EQ cake biosolids used in the blended product, in wet tons;
      (d) The total amount of blended EQ biosolids product produced, in wet tons;
      (e) The total amount of blended EQ biosolids product distributed, in wet tons.
   2) For EQ cake biosolids and blended EQ biosolids product distributed in a bag or other container in Virginia include:
      (a) The total amount of EQ cake biosolids or blended EQ biosolids products bagged, in wet tons;
      (b) The amount of EQ cake biosolids or blended EQ biosolids products distributed in bags, in wet tons;
      (c) When bagged EQ cake biosolids or blended EQ biosolids products are distributed in amounts greater than 1 metric ton in a single transaction, for each such transaction include:
         i. The amount of bagged EQ cake biosolids or blended EQ biosolids products distributed, in wet tons;
         ii. The name of the recipient;
         iii. The name of the business that will use the biosolids products, if applicable; and
         iv. The date of each transaction.
      (d) The amount of EQ cake biosolids or blended EQ biosolids products distributed in other containers, in wet tons;
   3) For EQ cake biosolids distributed in bulk to permitted blending facilities in Virginia, include:
      (a) Total amount of EQ cake biosolids distributed in bulk to permitted blending facilities, in wet tons;
      (b) The amount of EQ cake biosolids distributed in bulk for blending, by transaction, in wet tons;
      (c) The name of the permitted blending facility receiving the EQ cake biosolids;
      (d) The blending facility's Virginia Pollution Abatement permit number authorizing blending, marketing and distribution of EQ biosolids products; and
      (e) The date of each transaction;
   4) For blended EQ biosolids product distributed in bulk for use in Virginia include:
      (a) The amount of blended EQ biosolids product distributed in bulk, by transaction;
      (b) The name of the recipient of bulk blended EQ biosolids product;
      (c) The name of the business that will use the biosolids products, if applicable; and
      (d) The date of each transaction;
   5) For EQ cake biosolids and blended EQ biosolids products distributed in bulk for the purpose of land application in Virginia, include:
      (a) Total amount of EQ cake biosolids distributed in bulk for land application at agricultural operations, including turf farms, in dry tons and wet tons;
      (b) The amount of EQ cake biosolids distributed in bulk for land application at non-agricultural sites, by transaction, in dry tons and wet tons;
      (c) The amount of blended EQ biosolids products distributed in bulk for land application at agricultural sites, by transaction, in wet tons;
      (d) The name of the recipient of bulk EQ cake biosolids or blended EQ biosolids products;
      (e) The name of the agricultural operations where the bulk EQ cake biosolids or blended EQ biosolids products were applied;
      (f) The address of the agricultural operation where the bulk EQ cake biosolids or blended EQ biosolids products were applied, as identified on the Nutrient Management Plan;
      (g) The latitude and longitude of the delivery location, in decimal degrees; and
      (h) The date of each transaction.

(i) For EQ cake biosolids, provide a presentation of the calculation of the total fee; and
(j) A summary list of the total amount of biosolids applied and the calculated fee broken down by County, presented in alphabetical order by county.

6) The name of a responsible official or authorized representative of the permittee and a statement signed and dated by that responsible official or authorized representative, indicating that the information submitted has been verified by that responsible official or authorized representative as correctly reported, in accordance with the Part II.K.

7) Electronic Submittal Attestation Statement – When submitting a report via email, the following statement shall be included in the email.
"I, representative official's or authorized representative's name, hereby declare that I am submitting the attached documents under my signature for the purposes of compliance with the reporting requirements of VPA Permit number VPA04002. With the transmission of this email, I attest that the above statement is true and valid to the best of my knowledge."

2. Biosolids Land Application Fee – The permittee shall remit to the DEQ a fee of $3.75 per dry ton of Exceptional Quality cake biosolids distributed in bulk for land application in the Commonwealth of Virginia.

Billing and payment procedures are as follows:

1) Upon reviewing the Monthly Distribution Report in Part I.B.1.b.5., DEQ will bill the permittee for the fee that is due. Payment is due 30 days after receipt of the bill from DEQ;

2) The permittee shall collect this fee from the facilities that generated the biosolids that were applied; and

3) A check or money order shall be made payable to the "Treasurer of Virginia", and mailed with the invoice to:

Department of Environmental Quality
Receipts Control
P.O. Box 1104
Richmond, VA 23218

Failure to submit payment by the due date may result in the permit being revoked or approved sources being reclassified as unapproved. This permit shall not be reissued, administratively continued or modified without full payment of any past due fee.

3. Annual Report – The permittee shall submit an Annual Report not later than February 19th of each year to the DEQ - OLAP. The report shall be for the previous calendar year's activity. If no EQ cake biosolids were generated or distributed under this permit during a calendar year, a report shall be submitted stating that no EQ cake biosolids were generated or distributed. The report shall include at minimum:

   a. The annual total amount of EQ cake biosolids produced, in dry tons and wet tons;

   b. The annual total amount of EQ cake biosolids and blended EQ biosolids products distributed in Virginia, in dry tons and wet tons;

   c. The annual total amount of EQ cake biosolids distributed in bulk for land application in Virginia, in dry tons and wet tons;

   d. The annual total amount of blended EQ biosolids products distributed in bulk for land application in Virginia, in wet tons;

   e. The annual total amount of EQ cake biosolids distributed in bulk to permitted blending facilities in Virginia, in wet tons;

   f. The annual total amount of EQ cake biosolids and blended EQ biosolids products bagged, in wet tons;

   g. The annual total amount of EQ cake biosolids and blended EQ biosolids products distributed in bags in Virginia, in wet tons;

   h. The annual total amount of EQ cake biosolids and blended EQ biosolids products distributed in other containers in Virginia, in wet tons;

   i. The results of the EQ Biosolids Characteristics monitoring data required by Part I.A.1.e.;

   j. Any biosolids monitoring data required by Part I.A. that were not submitted during the reporting calendar year; and

   k. The annual report shall be certified and signed in accordance with Part II.K.

C. RECORD KEEPING REQUIREMENTS

1. Records Retention – The permittee shall retain records of EQ cake biosolids and blended EQ biosolids products production, marketing and distribution activities for a period of at least five years from the date of the sample, measurement, report or application, unless otherwise specified in this permit. This period of retention may be extended by request of the Board at any time. Records to be retained include:

    a. Monitoring information required in Part I.A.;

    b. Reports required in Part I.B.;

    c. Records required below in Part I.C.2.;

    d. Records required below in Part I.E.; and

    e. Site Operator Notification and Information as required in Part I.E.6.;

2. Exceptional Quality Biosolids Record Keeping – Records shall include:

    a. The following certification statement:
    "I certify, under penalty of law, that the information that will be used to determine compliance with the Class A pathogen requirements in 9VAC25-32-675 A and the vector attraction reduction requirement in (insert one of the vector attraction reduction requirements in 9VAC25-32-685 B 1 through B 8) was prepared under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate this information. I am aware that there are significant penalties for false certification including the possibility of fine and imprisonment.";

    b. A description of how the Class A pathogen requirements in 9VAC25-32-675 A are met; and

    c. A description of how one of the vector attraction reduction requirements in 9VAC25-32-685 B 1 through B 8 is met.

D. BIOSOLIDS MANAGEMENT PLAN (BSMP)

1. BSMP – The BSMP and all of its components are an enforceable part of the permit. The permittee shall implement and maintain a BSMP which shall consist of the following components:

    a. The materials developed and submitted at the time of permit application or permit modification in accordance with 9VAC25-32-60.F.;

    b. The Operations and Maintenance (O&M) Manual;

    c. The Odor Control Plan; and

    d. Reclamation plan for mined and disturbed land.

    Any proposed changes in biosolids production, marketing or distribution practices or procedures followed by the permittee, as represented in the documents required by Part I.D.1.a. – c., shall be documented and submitted to DEQ-OLAP within 90 days of the effective date of the changes.

2. O&M Manual Requirement – An O&M Manual shall be submitted to DEQ-OLAP within 90 days of the effective date of this permit. The permittee shall conduct all biosolids production, marketing or distribution practices activities in accordance with the O&M Manual. The O&M Manual shall include at a minimum:

   a. A copy of this permit;

   b. Procedures for making the blended EQ biosolids products as registered or licensed by VDACS;

   c. Procedures for a Virginia Certified Land Applicator to provide oversight, as described in Part I.E.5, of the farm sites where EQ cake biosolids or blended EQ biosolids are delivered and land applied, including procedures for:

      1) Confirming presence of the NMP upon delivery of EQ cake biosolids or blended EQ biosolids at the agricultural site where the biosolids will be applied;
      2) Reviewing site management requirements with the farm operator;
      3) Sign posting or evaluation of adequate sign placement at the farm site; and
      4) Evaluation of appropriate staging location and on-site storage facility at the farm site.

   d. Schedules and record keeping instructions for a Virginia Certified Land Applicator assigned to oversight on the farm sites where EQ cake biosolids or blended EQ biosolids are delivered and land applied;

   e. Sampling schedules for:
      1) Required monitoring, including a list of required minimum tests; and
      2) Operational control testing;

   f. Sample collection, preservation, and analysis procedures, including selection of sample locations, and laboratories and methods used;

   g. Instructions for recording and reporting of all monitoring activities; and

   h. Spill response, remediation, and reporting procedures for offsite spills, including telephone numbers for immediate reporting to the DEQ - OLAP; and

3. Odor Control Plan (OCP) Requirement – The generating facility's OCP shall include at a minimum:
   a. Methods used to minimize odor in producing biosolids;

   b. Methods used to identify malodorous biosolids before delivery to the land applier (at the generating facility);

   c. Methods used to identify and abate malodorous biosolids if delivered to the field, prior to land application; and

   d. Methods used to abate malodor from biosolids if land applied.

4. Reclamation of Mined and Disturbed Land – EQ biosolids may be land applied at greater than agronomic rates on sites that have been mined or disturbed, as identified in an approved Reclamation Plan for the purpose of mineral sands mine soil reconstruction; construction site top soil replenishment, or other such soil restoration at disturbed sites in accordance with 9VAC25-32-300 et seq., this permit and the Reclamation Plan.

   a. Prior to delivery of EQ biosolids to a reclamation site, the permittee shall submit the following:
      1) Reclamation Plan for the reclamation activity:
         A Reclamation Plan developed with the assistance of the Department of Crop and Soil Environmental Sciences of the Virginia Polytechnic Institute and State University for all sites and VDMME for mined sites, that includes at minimum:
         (a) A site map showing area included in the field, including any setbacks that are required;
         (b) The Soil Reconstruction Protocol(s) to be used at the site;
         (c) EQ biosolids rate(s) of application;
         (d) Soil analysis results;
         (e) Crop to be planted following application, including information on the seeding mixture and a seeding schedule; and
         (f) Other practices as required by the Reclamation Plan; and
      2) Approved NMP for agricultural activity or turf maintenance following reclamation or release from VDMME for mined sites.

   b. The following conditions also apply to reclamation activities on mined and disturbed land:
      1) The EQ biosolids application rate shall be limited by the most restrictive cumulative trace element loading in accordance with the table below:

PARAMETER	LIMITATIONS		MONITORING REQUIREMENTS	
	Maximum CPLR[1]		Frequency	Sample Type
	(kg/ha)[2][3]	(lb/A)[2][3]		
Arsenic	41	36	Each Application	Calculated
Cadmium	39	35	Each Application	Calculated
Copper	1,500	1,340	Each Application	Calculated
Lead	300	270	Each Application	Calculated
Mercury	17	16	Each Application	Calculated
Molybdenum	NL[4]	NL[4]	Each Application	Calculated
Nickel	420	375	Each Application	Calculated
Selenium	100	89	Each Application	Calculated
Zinc	2,800	2,500	Each Application	Calculated
Aluminum[5]	4,570	4,113	Each Application	Calculated

(1) The CPLR is the maximum cumulative application of trace elements that can be applied to soils used for crop production. The maximum cumulative application rate is limited for all ranges of cation exchange capacity due to soil background pH in Virginia of less than 6.5 s.u. and lack of regulatory controls of soil pH adjustment after biosolids application ceases.
(2) All limits and criteria are expressed on a dry weight basis in kg/ha and lb/A.
(3) No person shall apply bulk biosolids subject to the CPLRs identified above to agricultural land, forest, a public contact site, or a reclamation site if any of the CPLRs identified above has been reached.
(4) The maximum cumulative application is currently under study by USEPA. Research suggests that for Molybdenum a cumulative pollutant loading rate below 40 kg/ha may be appropriate to reduce the risk of copper deficiency in grazing animals.

(5) All sites that receive WTP residuals containing aluminum are subject to the tracking of aluminum loading, regardless of concentration of aluminum in the residuals.

2) If the cadmium concentration of the EQ biosolids is greater than 21 mg/kg, post application soil pH shall maintained at 6.0 or greater during the first year after the initial application.
3) The site shall be revegetated with grass and legumes in accordance with the Reclamation Plan.

c. After a reclaimed site has been released from its permit conditions with the Virginia Department of Mines, Mineral and Energy, or any local government bond obligation, EQ biosolids may not be applied at reclamation rates. The site must be managed in accordance with the approved nutrient management plan.

E. DISTRIBUTION AND MARKETING

1. DISTRIBUTION AND MARKETING OF EQ CAKE BIOSOLIDS AND BLENDED EQ BIOSOLIDS

a. Under the authority of this permit:
1) EQ cake biosolids produced at DC Water - Blue Plains may be marketed and distributed in Virginia in bulk, bag or other container;
2) EQ cake biosolids produced at DC Water - Blue Plains may be distributed in bulk to facilities for blending,; and
3) Blended EQ biosolids products derived from EQ cake biosolids produced at DC Water - Blue Plains may be marketed and distributed in Virginia in bulk, bag or other container.

b. Prior to the distribution and marketing of any EQ cake biosolids or blended EQ biosolids products, the biosolids product must be registered with the Virginia Department of Agriculture and Consumer Services in accordance with the provisions of § 3.2-3607 of the Code of Virginia. A copy of the registration shall be submitted to the DEQ OLAP.

The permittee shall maintain the VDACS registration for the duration of this permit.

c. Product Labeling – A label shall be affixed to a bag or other container in which biosolids is sold or given away, or an information sheet shall be provided to the person who receives the biosolids. The label or information sheet provided to users of marketed or distributed biosolids shall include the following:
1) The name and address of the preparer of the biosolids;
2) The nutrient content;
3) A statement that application of the exceptional quality biosolids to the land is prohibited except in accordance with the instructions on the label or information sheet; and
4) Other information in accordance with regulations promulgated under § 3.2-3601 of the Code of Virginia and with the labeling provisions of § 3.2-3611 of the Code of Virginia.

2. DISTRIBUTION OF EQ CAKE OR BLENDED EQ BIOSOLIDS IN BAGS OR OTHER CONTAINERS

   a. EQ cake biosolids and blended EQ biosolids products may be sold or given away in bag or other containers for resale or direct use.

   b. The permittee shall document the following information for the sale or giveaway of bagged EQ biosolids – cake or blended:
      1) The amount of EQ cake biosolids and blended EQ biosolids bagged;
      2) The amount of EQ cake biosolids and blended EQ biosolids sold or given away in bags; and
      3) The amount of EQ cake biosolids and blended EQ biosolids sold or given away in other containers.

   c. The permittee shall document the following information for the sale or giveaway of bagged EQ biosolids – cake or blended – in amounts greater than 1 metric ton:
      1) Name of recipient;
      2) Name of business that will land apply or resell the biosolids, if applicable;
      3) Amount distributed, in wet tons; and
      4) The date of the transaction.

3. DISTRIBUTION OF EQ CAKE BIOSOLIDS FOR THE PURPOSE OF BLENDING

   a. EQ cake biosolids produced at DC Water – Blue Plains may be sold or given away in bulk to a facility that will blend the EQ biosolids in accordance with a valid VDACS license and registration.

   b. The permittee shall document the following information for the sale or giveaway of EQ cake biosolids in bulk to a blending facility:
      1) Total amount of EQ cake biosolids distributed in bulk to permitted blending facilities, in wet tons;
      2) The name of the blending facility receiving the EQ cake biosolids;
      3) The amount of EQ cake biosolids distributed in bulk for blending, by transaction, in wet tons; and
      4) The date of each transaction.

   c. Notice and Necessary Information - The permittee shall provide to the operator of the blending facility that receives EQ cake biosolids notification and information. The notification shall include at minimum:

      1) A statement that biosolids land applied meet
         (a) Class A pathogen reduction; and
         (b) VAR requirements 1 through 8; and
      2) A statement that metals concentrations in the biosolids were below the pollution concentration and the ceiling limit;
      3) The concentration of Nitrogen and Phosphorus in lbs/wet ton.

4. BULK DISTRIBUTION OF BLENDED EQ BIOSOLIDS PRODUCTS FOR USE AT NON-AGRICULTURAL SITES

   a. Blended EQ biosolids products may be sold or given away in bulk for non-agricultural use in Virginia.

   b. The permittee shall document the following information for the sale or giveaway of bulk blended EQ biosolids products in amounts greater than 1 metric ton:
      1) Name of recipient;
      2) Name of business that will use the blended EQ biosolids, if applicable;
      3) Amount of blended EQ biosolids products distributed, in wet tons; and
      4) The date of the transaction.

   c. Notice and Necessary Information - The permittee shall provide to the recipient of the biosolids notification and information. The notification shall include at minimum:

      1) A statement that biosolids land applied meet
         (a) Class A pathogen reduction;
         (b) VAR requirements 1 through 8; and
      2) A statement that metals concentrations in the biosolids were below the pollution concentration and the ceiling limit;
      3) The concentration of Nitrogen and Phosphorus in lbs/wet ton.

5. BULK DISTRIBUTION OF EQ CAKE BIOSOLIDS FOR LAND APPLICATION AT AGRICULTURAL AND NON-AGRICULTURAL SITES AND BLENDED EQ BIOSOLIDS FOR LAND APPLICATION AT AGRICULTURAL SITES

   The following conditions apply to EQ cake biosolids and blended EQ biosolids products that are marketed or distributed in bulk for the purpose of land application at agricultural operations, including turf farms, in Virginia, and EQ cake biosolids marketed or distributed in bulk for the purpose of land application:

   a. If EQ cake biosolids are land applied at a site that is authorized to receive biosolids under a VPA or VPDES permit, the biosolids shall be land applied under the authority and conditions of the VPA or VPDES permit; and the site will be managed as such.

   b. The permittee shall have on site prior to the start of land application, a certified land applier. While on-site the land applier shall:
      1) Ensure proper staging of the biosolids;
      2) Inspect the on-site storage pad, as applicable;
      3) Post the signs at appropriate locations, or ensure that the signs have been posted at appropriate locations;
      4) Verify the presence of the NMP on site; and
      5) Discuss site specific staging requirements, on-site storage requirements and setbacks with the recipient or operations manager.

   c. Nutrient Management Plan
      1) Bulk quantities of EQ cake biosolids or blended EQ biosolids products shall be land applied in accordance with a NMP prepared by a certified nutrient management planner as stipulated in regulations promulgated pursuant to § 10.1-104.2 of the Code of Virginia.
      2) The NMP shall be developed prior to delivery of bulk EQ cake biosolids or blended EQ Biosolids to the farm site.
         (a) If the NMP is prepared by the permit holder:

i. When EQ cake biosolids or blended EQ biosolids products are bulk applied by the permit holder, the permit holder shall provide a copy of the NMP to the farm operator of the site and the Department of Conservation and Recreation (DCR) within 30 days after bulk land application at the site has commenced; or

ii. When EQ cake biosolids or blended EQ biosolids products are bulk applied by the recipient, the permit holder shall provide a copy of the NMP to the farm operator of the site at the time of delivery of EQ cake biosolids or blended EQ biosolids products to the recipient. The permit holder shall provide a copy of the NMP to DCR within 30 days after bulk land application at the site has commenced.

(b) If the NMP is prepared by the recipient of EQ cake biosolids or blended EQ biosolids products:

i. When EQ cake biosolids or blended EQ biosolids products are bulk applied by the permit holder, the permit holder shall obtain a copy of the NMP from the recipient prior to bulk land application at the site. The permit holder shall provide a copy of the NMP to DCR within 30 days after bulk land application at the site has commenced; or

ii. When EQ cake biosolids or blended EQ biosolids products are bulk applied by the recipient, the permit holder shall obtain a copy of the NMP from the recipient at the time of delivery of EQ cake biosolids or blended EQ biosolids products to the recipient. The permit holder shall provide a copy of the NMP to DCR within 30 days after bulk land application at the site has commenced.

3) After submittal of the NMP to DCR, the permittee is not required to maintain a copy of the NMP.
4) The amount of bulk EQ cake biosolids or blended EQ Biosolids distributed shall not exceed the amount required to meet the application rate established in the NMP.
5) The permittee shall instruct the recipient that the NMP must be onsite during the application of biosolids.
6) Site specific application rates shall not exceed the rates established in the NMP.

d. The permittee shall maintain records of the transaction, including:
1) The amount of EQ cake biosolids distributed, in dry tons and wet tons;
2) The amount of blended EQ biosolids products distributed, in wet tons;
3) The name of the recipient;
4) The name of the farm where the biosolids will be applied;
5) The latitude and longitude, in decimal degrees, of the delivery location;
6) The address of the farm as identified on the NMP; and
7) The date of the transaction.

e. Site Management
1) EQ cake biosolids or blended EQ biosolids shall not be land applied in the setbacks established in the NMP;
2) EQ cake biosolids or blended EQ biosolids shall not be applied in the setbacks from property lines and occupied dwellings that have been extended due to health concerns;
3) EQ cake biosolids or blended EQ biosolids shall not be applied within 200 feet from the property line of a publicly accessible site, or 400 feet from an odor sensitive receptor, such as a hospital, school or church, etc;
4) Upon delivery to an agricultural site, biosolids that will be land applied within 7 days must be staged in accordance with the staging requirements in Part I.G. below.
5) Biosolids may be stored up to 45 days from the day of delivery on an agricultural site in accordance with the on-site storage requirements in Part I.H. below.

f. Daily Notification – The permittee shall provide to DEQ-OLAP written notification each day bulk EQ cake biosolids or bulk blended EQ biosolids are distributed for land application at an agricultural site. This notification shall include:

1) Deliveries pre-scheduled for the day, including
   (a) Name of the recipient;
   (b) Name of the farm where biosolids will be delivered, as identified on the NMP;
   (c) The amount of EQ cake biosolids, or blended EQ biosolids ordered for delivery, in wet tons; and
   (d) Latitude and longitude, in decimal degrees, of the delivery location.
2) Unscheduled deliveries that occurred on the previous day, including
   (a) Name of the recipient;
   (b) Name of the farm where biosolids will be delivered, as identified on the NMP;
   (c) The amount of EQ cake biosolids, or blended EQ biosolids delivered, in wet tons; and
   (d) Latitude and longitude, in decimal degrees, of the delivery location.

g. Sign Posting
1) Upon delivery of bulk EQ cake biosolids, the permittee shall provide to the recipient a minimum of 2 signs for each field indicated in the nutrient management plan to receive EQ cake biosolids. The permittee shall instruct the recipient to post signs at the site so that they are visible and legible from the public right-of-way in both directions of travel, and conform to the specifications herein.

   Alternatively, the permittee may have a Certified Land Applicator who oversees delivery of biosolids to the site post the signs at the site in accordance with the specifications herein.

   (a) Signs shall be posted at or near the intersection of the public right-of-way and the main site access road or driveway to the site used by the biosolids transport vehicles.
   (b) If the field is located adjacent to a public right-of-way, at least one sign shall be posted along each public road frontage beside the field to which biosolids are to be land applied.
   (c) Signs shall remain in place until application has been completed at the site. From the time of posting until the land application has been completed, the farm operator shall make a good faith effort to repair any sign that has been damaged so as to render any of its required information illegible or replace any sign that has been removed from a land application site.
2) Signs shall be made of weather-resistant materials and shall be sturdily mounted so as to be capable of remaining in place and legible throughout the period that the sign is required at the site. Signs required by this section shall be temporary, nonilluminated, and four square feet or more in area, and contain at least the following information:
   (a) A statement that Exceptional Quality biosolids are being land-applied at the site;
   (b) The name of the permitted product;
   (c) The telephone number of an individual designated by the permittee to respond to inquiries; and
   (d) Contact information for DEQ, including a telephone number for inquiries.

h. Notice and Necessary Information - The permittee shall provide to the operator of the site that receives biosolids notification and information. The notification shall include at minimum:

1) A statement that biosolids land applied meet
   (a) Class A pathogen reduction; and
   (b) VAR requirements 1 through 8;
2) A statement that metals concentrations in the biosolids applied to the site were below the pollution concentration and the ceiling limit; and
3) The concentration of Nitrogen and Phosphorus in lbs/wet ton.

F. TRANSPORT

1. Transport routes should follow primary highways, shall avoid residential areas when possible, and shall comply with all Virginia Department of Transportation requirements and standards.

2. Transport vehicles shall be sufficiently sealed to prevent leakage and spillage of biosolids. For biosolids with a solids content of less than 15%, totally closed watertight transport vehicles with rigid tops shall be used to prevent spillage unless adequate justification is provided to DEQ-OLAP demonstrating that such controls are unnecessary prior to transport. DEQ-OLAP may also require certain dewatered biosolids exceeding 15% solids content to be handled as liquid Biosolids.

3. The permittee shall take appropriate steps to prevent drag-out and track-out of dirt and debris or biosolids from land application sites onto public roads. Where material is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly as soon as practicable, but no later than the end of each day.

4. The permittee shall be responsible for the prompt cleanup and removal of biosolids spilled during transport. The operations manual shall include a plan for the prevention of spills during transport and for the cleanup and removal of spills. The permit holder shall ensure that its personnel, subcontractors or the drivers of vehicles transporting biosolids for land application shall be properly trained in procedures for spill removal and cleanup.

5. The permittee shall promptly report offsite spills to DEQ-OLAP, the chief executive officer or designee for the local government jurisdiction in which the spill occurred, and the owner of the facility generating the biosolids. The report shall be made verbally as soon as possible, but no later than 24 hours after the discovery of the spill. After business hours, notification may be provided by voicemail, facsimile or email.

6. A written report, which shall include a description of measures taken in response to the spill, shall be submitted by the permittee to DEQ, the chief executive officer or designee for the local government and the owner of the facility generating the biosolids within five working days of the spill. The report may be sent by first class mail, facsimile or email, or it may be hand delivered.

G. STAGING

Biosolids may be staged in preparation for commencing land application or during an ongoing application at agricultural sites. Biosolids shall be staged within the land application area of the field identified in the NMP or an adjacent field. Staging is not considered storage and shall not take the place of storage.

a. Staging of biosolids shall not commence unless the field meets the requirements for land application in accordance with Part IX of 9VAC25-32-303 and field conditions are favorable for land application.

b. Biosolids may be staged for up to seven days, including the first day biosolids are offloaded onto the staging area, with the following exceptions:

   1) In areas of Karst topography;
   2) In areas identified in the U.S. Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS) soil survey as frequently flooded; or
   3) At sites that have on-site storage.

c. If staged biosolids cannot be spread by the end of the seventh day of staging, the permittee shall ensure the following actions are taken:

1) Biosolids shall be covered to prevent contact with precipitation;
2) DEQ-OLAP shall be notified in writing within 24-hours of determining that the biosolids will not be spread by the end of day seven, and no later than the close of business on day seven. Notification shall include the biosolids source(s) and amounts, location of the site, and reason for staging biosolids longer than seven days; and
3) Biosolids which have been staged for greater than seven days shall be spread or removed from the field as soon as field conditions that prohibit access to the field by loaders and spreaders no longer exist.

d. Staging shall be limited to the amount of biosolids specified in the NMP to be applied at the intended field.

e. Biosolids will be staged within the land application area of the field in which the biosolids will be applied or in a field adjacent to the subject field, in a location selected to prevent runoff to waterways and drainage ditches.

f. Biosolids shall not be staged in the setback areas identified in the NMP.

g. Biosolids shall not be staged overnight within 400 feet of an occupied dwelling unless the setback is reduced or waived with the written consent of the dwelling occupant and landowner.

h. Biosolids shall not be staged overnight within 200 feet of a property line unless the setback is reduced or waived with the written consent of the landowner.

i. Management practices, as described in the BSMP, shall be utilized as appropriate to prevent pollution of state waters by staged biosolids.

j. The certified land applier will instruct the farm operator to inspect the staged biosolids daily and after precipitation events of 0.1 inches or greater to ensure that runoff controls are in good working order. Observed excessive slumping, erosion, or movement of biosolids is to be corrected within 24 hours of observation. Any ponding at the site is to be eliminated and any malodor shall be addressed in accordance with the OCP.

k. Staged biosolids shall be managed so as to prevent adverse impacts to water quality or public health.

H. ON-SITE STORAGE

a. Biosolids may be stored for up to 45 days on a constructed surface at a location preapproved by DEQ-OLAP. These stored biosolids shall be applied only to sites under the operational control of the same owner or operator of the agricultural site where the on-site storage is located.

b. Operational requirements for on-site storage include the following:

1) The permittee shall notify DEQ-OLAP on the day of delivery whenever it is necessary to implement on-site storage. Notification shall include the amount of biosolids and the location of biosolids to be stored;
2) Storage shall be limited to the amount of biosolids specified in the NMP to be applied at sites under the operational control of the same owner or operator of the site where the on-site storage is located;
3) If malodors related to the stored biosolids are verified by DEQ-OLAP at any occupied dwelling on surrounding property(ies), the malodor shall be corrected, in accordance with the OCP, within 48 hours following DEQ's notification to the permittee, or the biosolids must be removed from the storage site;
4) All biosolids stored on the on-site storage pad shall be land applied by the 45th day, including the first day of on-site storage;
5) Best management practices shall be utilized as appropriate to prevent contact of the biosolids with storm water run on or runoff;
6) The certified land applier shall instruct the farm operator to inspect the stored biosolids at least every seven days and after precipitation events of 0.1 inch or greater to ensure that runoff controls are in good working order;
7) Observed excessive slumping, erosion, or movement of biosolids is to be corrected within 24 hours of observation. Any ponding or malodor at the storage site is to be corrected in accordance with the OCP; and
8) Storage of biosolids shall be managed so as to prevent adverse impacts to water quality or public health.

c. Construction requirements for on-site storage include the following:
1) Existing on-site storage shall comply with the requirements of this section as of September 1, 2014;
2) An on-site storage "pad" shall be constructed within a site approved for land application;
3) On-site storage shall be located to provide minimum visibility of the biosolids from adjacent properties;
4) The surface shall be constructed with sufficient strength to support operational equipment and with a maximum permeability of 10^{-7} cm/sec; and
5) In areas of Karst topography and environmentally sensitive sites, on-site storage may be prohibited or require additional restrictions.

I. OTHER SPECIAL CONDITIONS

1. Threatened and Endangered Species Protection – No person shall apply biosolids to the land if it is likely to adversely affect a threatened or endangered species listed in 4VAC15-20-130 and § 4 of the Endangered Species Act (16 USC § 1533) or if the land application is likely to adversely affect its designated critical habitat.

2. The Board will modify or, alternatively, revoke and reissue this permit as appropriate and necessary to incorporate changes to any applicable standard or requirement for the use or disposal of biosolids promulgated under Section 405(d) of the Clean Water Act, the State Water Control Law, or 9VAC 25-32-10, *et seq.*, of the Virginia Pollutant Abatement Permit Regulation.

3. All pollutant management activities covered under this permit shall maintain no point source discharge of pollutants to surface waters except in the case of a storm event greater than the 25-year, 24-hour storm. The operation of the facilities of the owner permitted herein shall not contravene the Water Quality Standards, as adopted and amended by the Board, or any provision of the Water Control Law.

4. Any and all product, materials, industrial wastes, and/or other wastes resulting from the purchase, sale, mining, extraction, transport, preparation, and/or storage of raw or intermediate materials, final product, by-product or wastes, shall be handled, disposed of, and/or stored in such a manner so as not to permit a discharge of such product, materials, industrial wastes, and/or other wastes to State waters, except as expressly authorized.

CONDITIONS APPLICABLE TO ALL VPA PERMITS

A. MONITORING.

1. Samples and measurements taken as required by this permit shall be representative of the monitored activity.
2. Monitoring shall be conducted according to procedures listed under Title 40 Code of Federal Regulations Part 136, unless other procedures have been specified in this permit.
3. The permittee shall periodically calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals that will insure accuracy of measurements.
4. Samples taken as required by this permit shall be analyzed in accordance with 1VAC30-45, Certification for Noncommercial Environmental Laboratories, or 1VAC30-46, Accreditation for Commercial Environmental Laboratories except for the following:
   a. Field sample testing and measurements performed at the site where the sample is taken, are not subject to the requirements of 1VAC30-45 or 1VAC30-46; and
   b. Tests, analyses, measurements or monitoring, using protocols established pursuant to §10.1-104.2 to determine soil fertility, animal manure nutrient content, or plant tissue nutrient uptake for the purposes of nutrient management.

B. RECORDS.

1. Records of monitoring information shall include:
   a. The date, exact place, and time of sampling or measurements;
   b. The name of the individual(s) who performed the sampling or measurements;
   c. The date(s) and time(s) analyses were performed;
   d. The name of the individual(s) who performed the analyses;
   e. The analytical techniques or methods used, with supporting information such as observations, readings, calculations and bench data; and
   f. The results of such analyses.
2. The permittee shall retain records:
   a. Of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years or in the case of activities regulated under Part IX of the Virginia Pollution Abatement Permit Regulation (9VAC25-32-10 et seq.), at least five years from the date of the sample, measurement, report or application. This period of retention may be extended by request of the Board at any time.
   b. Records related to biosolids data and information specified in agreements between generator, owner, agents, landowners and farmers shall be described and maintained for a minimum period of five years or the duration of the permit or subsequent revisions if longer than five years.

C. REPORTING MONITORING RESULTS.

1. The permittee shall submit the results of the monitoring required by this permit as specified in Part I.B. of this permit.
2. Monitoring results shall be reported on forms provided or specified by the Department.
3. If the permittee monitors any pollutant specifically addressed by this permit, at a sampling location specified in this permit, more frequently than required by this permit using test procedures approved under Title 40 of the Code of Federal Regulations Part 136 or using other test procedures approved by the U.S. Environmental Protection Agency or using procedures specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted on the reporting form specified by the Department
4. If the permittee monitors any pollutant that is not required to be monitored by this permit, at a sampling location specified in this permit, and uses test procedures approved under Title 40 of the Code of Federal Regulations Part 136 or using other test procedures approved by the U.S. Environmental Protection

Agency, or using procedures specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted on the reporting form specified by the Department.

5. Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

D. DUTY TO PROVIDE INFORMATION.

1. The permittee shall furnish to the Department, within a reasonable time, any information which the Board may request to determine whether cause exists for modifying, revoking and reissuing, terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Department, upon request, copies of records required to be kept by the permittee.
2. Plans, specifications, maps, conceptual reports and other relevant information shall be submitted as requested by the Board prior to commencing construction.

E. COMPLIANCE SCHEDULE REPORTS.

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.

F. UNAUTHORIZED DISCHARGES.

Except in compliance with this permit, or another permit issued by the Board, it shall be unlawful for any person to:

1. Discharge into state waters sewage, industrial wastes, other wastes, or any noxious or deleterious substances; or
2. Otherwise alter the physical, chemical or biological properties of such state waters and make them detrimental to the public health, or to animal or aquatic life, or to the use of such waters for domestic or industrial consumption, or for recreation, or for other uses.

G. REPORTS OF UNAUTHORIZED DISCHARGES.

Any permittee who discharges or causes or allows a discharge of sewage, industrial waste, other wastes or any noxious or deleterious substance into or upon state waters in violation of Part II F; or who discharges or causes or allows a discharge that may reasonably be expected to enter state waters in violation of Part II F, shall notify the Department of the discharge immediately upon discovery of the discharge, but in no case later than 24 hours after said discovery. A written report of the unauthorized discharge shall be submitted to the Department, within five days of discovery of the discharge. The written report shall contain:

1. A description of the nature and location of the discharge;
2. The cause of the discharge;
3. The date on which the discharge occurred;
4. The length of time that the discharge continued;
5. The volume of the discharge;
6. If the discharge is continuing, how long it is expected to continue;
7. If the discharge is continuing, what the expected total volume of the discharge will be; and
8. Any steps planned or taken to reduce, eliminate and prevent a recurrence of the present discharge or any future discharges not authorized by this permit.

Discharges reportable to the Department under the immediate reporting requirements of other regulations are exempted from this requirement.

H. REPORTS OF UNUSUAL OR EXTRAORDINARY DISCHARGES.

If any unusual or extraordinary discharge including a bypass or upset should occur from a treatment works and the discharge enters or could be expected to enter state waters, the permittee shall promptly notify, in no case later than 24 hours, the Department by telephone after the discovery of the discharge. This notification shall provide all available details of the incident, including any adverse effects on aquatic life and the known number of fish killed. The permittee shall reduce the report to writing and shall submit it to the Department within five days of discovery of the discharge in accordance with Part II I 2. Unusual and extraordinary discharges include but are not limited to any discharge resulting from:

1. Unusual spillage of materials resulting directly or indirectly from processing operations;
2. Breakdown of processing or accessory equipment;
3. Failure or taking out of service some or all of the treatment works; and
4. Flooding or other acts of nature.

I. REPORTS OF NONCOMPLIANCE.

The permittee shall report any noncompliance which may adversely affect state waters or may endanger public health.

1. An oral report shall be provided within 24 hours from the time the permittee becomes aware of the circumstances. The following shall be included as information which shall be reported within 24 hours under this paragraph:
   a. Any unanticipated bypass; and
   b. Any upset which causes a discharge to surface waters.
2. A written report shall be submitted within 5 days and shall contain:
   a. A description of the noncompliance and its cause;
   b. The period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and
   c. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

3. The Board may waive the written report on a case-by-case basis for reports of noncompliance under Part II I if the oral report has been received within 24 hours and no adverse impact on state waters has been reported.
4. The permittee shall report all instances of noncompliance not reported under Parts II I 1 or 2, in writing, at the time the next monitoring reports are submitted. The reports shall contain the information listed in Part II I 2.

NOTE: The immediate (within 24 hours) reports required in Parts II G , H and I may be made to the Department's Central Office at (804) 698-4000 (voice) or (804) 698-4032 (fax), or online at http://www.deq.virginia.gov/programs/pollutionresponsepreparedness/makingareport.aspx. For reports outside normal working hours, leave a message and this shall fulfill the immediate reporting requirement. For emergencies, the Virginia Department of Emergency Services Management maintains a 24 hour telephone service at 1-800-468-8892.

J. NOTICE OF PLANNED CHANGES.

1. The permittee shall give notice to the Department as soon as possible of any planned physical alterations or additions to the design or operation of the pollutant management activity.
2. The permittee shall give at least 10 days advance notice to the Department of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

K. SIGNATORY REQUIREMENTS.

1. Applications. All permit applications shall be signed as follows:
   a. For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (i) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;
   b. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or
   c. For a municipality, state, federal, or other public agency: By either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a public agency includes: (i) The chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency.
2. Reports, etc. All reports required by permits, and other information requested by the Board shall be signed by a person described in Part II K 1, or by a duly authorized representative of that person. A person is a duly authorized representative only if:
   a. The authorization is made in writing by a person described in Part II K 1;
   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.); and
   c. The written authorization is submitted to the Department.
3. Changes to authorization. If an authorization under Part II K 2 is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Part II K 2 shall be submitted to the Department prior to or together with any reports, or information to be signed by an authorized representative.
4. Certification. Any person signing a document under Parts II K 1 or 2 shall make the following certification:

   "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

L. DUTY TO COMPLY.

The permittee shall comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the State Water Control Law. Permit noncompliance is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. Compliance with a permit during its term constitutes compliance, for purposes of enforcement, with the State Water Control Law.

M. DUTY TO REAPPLY.

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee shall apply for and obtain a new permit. All permittees with a currently effective permit shall submit a new application at least 180 days before the expiration date of the existing permit, unless permission for a later date has been granted by the Board. The Board shall not grant permission for applications to be submitted later than the expiration date of the existing permit.

N. EFFECT OF A PERMIT.
This permit does not convey any property rights in either real or personal property or any exclusive privileges, nor does it authorize any injury to private property or invasion of personal rights, or any infringement of federal, state or local law or regulations.

O. STATE LAW.
Nothing in this permit shall be construed to preclude the institution of any legal action under, or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any other state law or regulation or under authority preserved by Section 510 of the Clean Water Act. Except as provided in permit conditions on "bypassing" (Part II U), and "upset" (Part II V) nothing in this permit shall be construed to relieve the permittee from civil and criminal penalties for noncompliance.

P. OIL AND HAZARDOUS SUBSTANCE LIABILITY.
Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Sections 62.1-44.34:14 through 62.1-44.34:23 of the State Water Control Law.

Q. PROPER OPERATION AND MAINTENANCE.
The permittee shall be responsible for the proper operation and maintenance of all treatment works, systems and controls which are installed or used to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective plant performance, adequate funding, adequate staffing, and adequate laboratory and process controls, including appropriate quality assurance procedures.

R. DISPOSAL OF SOLIDS OR SLUDGES.
Solids, sludges or other pollutants removed in the course of treatment or management of pollutants shall be disposed of in a manner so as to prevent any pollutant from such materials from entering state waters.

S. DUTY TO MITIGATE.
The permittee shall take all reasonable steps to minimize or prevent any pollutant management activity in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

T. NEED TO HALT OR REDUCE ACTIVITY NOT A DEFENSE.
It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

U. BYPASS.
1. Prohibition - Bypass means intentional diversion of waste streams from any portion of a treatment works. A bypass of the treatment works is prohibited except as provided herein.
2. Anticipated Bypass - If the permittee knows in advance of the need for a bypass, he shall notify the Department promptly at least 10 days prior to the bypass. After considering its adverse effects the Board may approve an anticipated bypass if:
   a. The bypass will be unavoidable to prevent loss of human life, personal injury, or severe property damage ("Severe Property Damage" means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production); and
   b. There are no feasible alternatives to bypass such as the use of auxiliary treatment facilities, retention of untreated waste, or maintenance during normal periods of equipment downtime. However, if bypass occurs during normal periods of equipment downtime or preventive maintenance and in the exercise of reasonable engineering judgment the permittee could have installed adequate backup equipment to prevent such bypass, this exclusion shall not apply as a defense.

3. Unplanned Bypass - If an unplanned bypass occurs, the permittee shall notify the Department as soon as possible, but in no case later than 24 hours, and shall take steps to halt the bypass as early as possible. This notification will be a condition for defense to an enforcement action that an unplanned bypass met the conditions in paragraphs U 2 a and b and in light of the information reasonably available to the permittee at the time of the bypass.

V. UPSET.

A permittee may claim an upset as an affirmative defense to an action brought for noncompliance. In any enforcement proceedings a permittee shall have the burden of proof to establish the occurrence of any upset. In order to establish an affirmative defense of upset, the permittee shall present properly signed, contemporaneous operating logs or other relevant evidence that shows:

1. That an upset occurred and that the cause can be identified;
2. That the permitted facility was at the time being operated efficiently and in compliance with proper operation and maintenance procedures;
3. That the 24-hour reporting requirements to the Department were met; and
4. That the permittee took all reasonable steps to minimize or correct any adverse impact on state waters resulting from noncompliance with the permit.

W. INSPECTION AND ENTRY.

Upon presentation of credentials, any duly authorized agent of the Board may, at reasonable times and under reasonable circumstances:

1. Enter upon any permittee's property, public or private and have access to records required by this permit;
2. Have access to, inspect and copy any records that must be kept as part of permit conditions;
3. Inspect any facility's equipment (including monitoring and control equipment) practices or operations regulated or required under the permit; and
4. Sample or monitor any substances or parameters at any locations for the purpose of assuring permit compliance or as otherwise authorized by the State Water Control Law.

For purposes of this section, the time for inspection shall be deemed reasonable during regular business hours, and whenever the facility is involved in managing pollutants. Nothing contained herein shall make an inspection unreasonable during an emergency.

X. PERMIT ACTIONS.

Permits may be modified, revoked and reissued, or terminated for cause upon the request of the permittee or interested persons, or upon the Board's initiative, to reflect the requirements of any changes in the statutes or regulations. If a permittee files a request for a permit modification, revocation, or termination, or files a notification of planned changes, or anticipated noncompliance, the permit terms and conditions shall remain effective until the request is acted upon by the Board. This provision shall not be used to extend the expiration date of the effective VPA permit.

Y. TRANSFER OF PERMITS.

1. Permits are not transferable to any person except after notice to the Department. The Board may require modification or revocation and reissuance of the permit to change the name of the permittee and to incorporate such other requirements as may be necessary. Except as provided in Part II Y 2, a permit may be transferred by the permittee to a new owner or operator only if the permit has been modified to reflect the transfer or has been revoked and reissued to the new owner or operator.
2. As an alternative to transfers under Part II Y 1, this permit shall be automatically transferred to a new permittee if:
    a. The current permittee notifies the Department at least 30 days in advance of the proposed transfer of the title to the facility or property;
    b. The notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit responsibility, coverage, and liability between them; and

c. The Board does not, within the 30-day time period, notify the existing permittee and the proposed new permittee of its intent to modify or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in Part II.Y.2.b.

Z. SEVERABILITY.

The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

Appendix B Product Analyses for DC Water Biosolids

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188
www.compostlab.com

"Fresh Bloom" Soil Analysis

Account #: 9060695-1/3-8679
Group: Jun19C #46
Reporting Date: July 8, 2019

DC Water & Sewer Authority
5000 Overlook Avenue, SW
Washington, DC 20032
Attn: James Fotouhi

Date Received: 19 Jun. 19
Sample Identification: BLM-Fresh
Sample ID #: 9060695 - 1/3

Nutrients	Dry wt.	As Rcvd.	units
Total Nitrogen:	4.8	1.4	%
Ammonia (NH_4-N):	4100	1200	mg/kg
Nitrate (NO_3-N):	< 1.0	< 0.3	mg/kg
Org. Nitrogen (Org.-N):	4.4	1.3	%
Phosphorus (as P_2O_5):	6.8	2.0	%
Phosphorus (P):	30000	8600	mg/kg
Potassium (as K_2O):	0.11	0.033	%
Potassium (K):	950	270	mg/kg
Calcium (Ca):	2.4	0.68	%
Magnesium (Mg):	0.32	0.092	%
Sulfate (SO_4-S):	460	130	mg/kg
Boron (Total B):	5.0	1.4	mg/kg
Moisture:	0	71.3	%
Sodium (Na):	0.042	0.012	%
Chloride (Cl):	0.048	0.014	%
pH Value:	NA	8.43	unit
Bulk Density :	14	50	lb/cu ft
Carbonates ($CaCO_3$):	28	8.0	lb/ton
Conductivity (EC5):	4.7	NA	mmhos/cm
Organic Matter:	63.6	18.3	%
Organic Carbon:	33.0	9.6	%
Ash:	36.4	10.4	%
C/N Ratio	7.0	7.0	ratio
AgIndex	> 10	> 10	ratio

Stability Indicator:	
CO2 Evolution	Respirometery
mg CO_2-C/g OM/day	6.5
mg CO_2-C/g TS/day	4.1
Stability Rating	*moderately unstable*

Maturity Indicator: Cucumber Bioassay	
Compost:Vermiculite (v:v)	1:2
Emergence (%)	93
Seedling Vigor (%)	68
Description of Plants	*stunted*

Pathogens	Results	Units	Rating
Fecal Coliform	< 7.5	MPN/g	*pass*
Salmonella	< 3	MPN/4g	*pass*

Date Tested: 19 Jun. 19

Physical Contaminants**	% by weight
Total Plastic	< 0.1
Film Plastic	< 0.1
Glass	< 0.1
Metal	< 0.1
Sharps	ND
Total	< 0.5

Metals	Dry wt.	EPA Limit	units
Aluminum (Al):	4000	-	mg/kg
Arsenic (As):	4.4	41	mg/kg
Cadmium (Cd):	1.2	39	mg/kg
Chromium (Cr):	64	-	mg/kg
Cobalt (Co)	7.6	-	mg/kg
Copper (Cu):	440	1500	mg/kg
Iron (Fe):	87000	-	mg/kg
Lead (Pb):	33	300	mg/kg
Manganese (Mn):	530	-	mg/kg
Mercury (Hg):	< 1.0	17	mg/kg
Molybdenum (Mo):	13	75	mg/kg
Nickel (Ni):	26	420	mg/kg
Selenium (Se):	4.1	100	mg/kg
Zinc (Zn):	780	2800	mg/kg

Size Distribution	
MM	% by weight
> 50	0.0
25 to 50	0.0
16 to 25	8.4
9.5 to 16	35.3
6.3 to 9.5	17.5
4.0 to 6.3	12.8
2.0 to 4.0	14.0
< 2.0	12.0

**Greater than 4mm in size (Sharps greater than 2mm)

Analyst: Assaf Sadeh

*Sample was received and handled in accordance with TMECC procedures.

Account No.:
9060695 - 1/3 - 8679
Group: Jun19C No. 46

Date Received 19 Jun. 19
Sample i.d. BLM-Fresh
Sample I.d. No. 1/3 9060695

INTERPRETATION: "Fresh Bloom" Soil Analysis Page one of three

Is Your Compost Stable?

Respiration Rate Biodegradation Rate of Your Pile
6.5 mg CO2-C/ g OM/day
++++++++++++++++++++++++++
< Stable >|<Moderately Unstable>|< Unstable >|< High For Mulch

Is Your Compost Mature?

AmmoniaN/NitrateN ratio
37000 Ratio
+++
VeryMature>|< Mature >|< Immature

Ammonia N ppm
4100 mg/kg dry wt.
++
VeryMature>|< Mature >|< Immature

Nitrate N ppm
< 1.0 mg/kg dry wt.
+
< Immature >|< Mature

pH value
8.43 units
++
< Immature >|< Mature >|< Immature

Cucumber Emergence
93.3 percent
+++
< Immature >|< Mature

Is Your Compost Safe Regarding Health?

Fecal Coliform
< 1000 MPN/g dry wt.
+++++++
< Safe >|< High Fecal Coliform

Salmonella
Less than 3 /4g dry wt.
+++++++
<Safe (none detected) >|< High Salmonella Count(> 3 per 4 grams)

Metals US EPA 503
Pass dry wt.
+++++++++
<All Metals Pass >|< One or more Metals Fail

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P2O5+K2O)
11.7 Percent dry wt.
++
<Low >|< Average >|< High Nutrient Content

AgIndex (Nutrients / Sodium and Chloride Salts) ((N+P2O5+K2O) / (Na + Cl))
15 Ratio
+++
Na & Cl >|< Nutrient and Sodium and Chloride Provider >|< Nutrient Provider

Plant Available Nitrogen (PAN) Estimated release for first season
5 lbs/ton wet wt.
+++++++++++++++++++
Low Nitrogen Provider>|< Average Nitrogen Provider >|<High Nitrogen Provider

C/N Ratio
7.0 Ratio
+++++++++++++
< Nitrogen Release >|< N-Neutral >|< N-Demand>|< High Nitrogen Demand

Soluble Available Nutrients & Salts (EC5 w/w dw)
4.7 mmhos/cm dry wt.
+++++++++++++++++++++++++
SloRelease>|< Average Nutrient Release Rate >|<High Available Nutrients

Lime Content (CaCO3)
28 Lbs/ton dry wt.
++
< Low >|< Average >|< High Lime Content (as CaCO3)

What are the physical properties of your compost?

Percent Ash
36.4 Percent dry wt.
+++++++++++++++++++++++++++++
< High Organic Matter >|< Average >|< High Ash Content

Sieve Size % > 6.3 MM (0.25")
61.1 Percent dry wt.
++
All Uses >|< Size May Restrict Uses for Potting mix and Golf Courses

Account No.:		Date Received	19 Jun. 19	
9060695 - 1/3 - 8679		Sample i.d.	BLM-Fresh	
Group:	Jun19C No. 46	Sample I.d. No.	1/3	9060695

INTERPRETATION: "Fresh Bloom" Soil Analysis

Is Your Compost Stable?

Respiration Rate

6.5 Moderate-selected use mg CO_2-C/g OM/day

The respiration rate is a measurement of the biodegradation rate of the organic matter in the sample (as received). The respiration rate is determined by measuring the rate at which CO_2 is released under optimized moisture and temperature conditions.

Is Your Compost Mature?

AmmoniaN:NitrateN ratio

37000 immature

Ammonia N ppm

4100 immature

Nitrate N ppm

< 1.0 immature

pH value

8.43 immature

Composting to stabilize carbon can occur at such a rapid rate that sometimes phytotoxins remain in the compost and must be neutralized before using in high concentrations or in high-end uses. This step is called curing. Typically ammonia is in excess with the break-down of organic materials resulting in an increase in pH. This combination results in a loss of volatile ammonia (it smells). Once this toxic ammonia has been reduced and the pH drops, the microbes convert the ammonia to nitrates. A low ammonia + high nitrate score is indicative of a mature compost, however there are many exceptions. For example, a compost with a low pH (<7) will retain ammonia, while a compost with high lime content can lose ammonia before the organic fraction becomes stable. Composts must first be stable before curing indicators apply.

Cucumber Bioassay

93.3 Percent Cucumbers are chosen for this test because they are salt tolerant and very sensitive to ammonia and organic acid toxicity. Therefore, we can germinate seeds in high concentrations of compost to measure phytotoxic effects without soluble salts being the limiting factor. Values above 80% for both percent emergence and vigor are indicative of a well-cured compost. Exceptions include very high salts that affect the cucumbers, excessive concentrations of nitrates and other nutrients that will be in range when formulated to make a growing media.

Is Your Compost Safe Regarding Health?

Fecal Coliform

< 1000 / g dry wt. Fecal coliforms can survive in both aerobic and anaerobic conditions and is common in all initial compost piles. Most human pathogens occur from fecal matter and all fecal matter is loaded in fecal coliforms. Therefore fecal coliforms are used as an indicator to determine if the chosen method for pathogen reduction (heat for compost) has met the requirements of sufficient temperature, time and mixing. If the fecal coliforms are reduced to below 1000 per gram dry wt. it is assumed all others pathogens are eliminated. Potential problems are that fecal coliform can regrow during the curing phase or during shipping. This is because the conditions are now more favorable for growth than during the composting process.

Salmonella Bacteria

Less than 3 3 / 4g dry wt. Salmonella is not only another indicator organism but also a toxic microbe. It has been used in the case of biosolids industry to determine adequate pathogen reduction.

Metals

Pass The ten heavy metals listed in the EPA 503 regulations are chosen to determine if compost can be applied to ag land and handled without toxic effects. Most high concentrations of heavy metals are derived from woodwaste feedstock such as chrome-arsenic treated or lead painted demolition wood. Biosolids are rarely a problem.

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P_2O_5+K_2O)

11.7 High nutrient content

This value is the sum of the primary nutrients Nitrogen, Phosphorus and Potassium. Reported units are consistent with those found on fertilizer formulations. A sum greater than 5 is indicative of a compost with high nutrient content, and best used to supply nutrients to a receiving soil. A sum below 2 indicates low nutrient content, and is best-used to improve soil structure via the addition of organic matter. Most compost falls between 2 and 5.

Account No.:		Date Received	19 Jun. 19	
9060695 - 1/3 - 8679		Sample i.d.	BLM-Fresh	
Group:	Jun19C No. 46	Sample I.d. No.	1/3	9060695

INTERPRETATION: "Fresh Bloom" Soil Analysis

AgIndex (Nutrients/Na+Cl)
15 High nutrient ratio Composts with low AgIndex values have high concentrations of sodium and/or chloride compared to nutrients. Repeated use of a compost with a low AgIndex (< 2) may result in sodium and/or chloride acting as the limiting factor compared to nutrients, governing application rates. These composts may be used on well-draining soils and/or with salt-tolerant plants. Additional nutrients form another source may be needed if the application rate is limited by sodium or chloride. If the AgIndex is above 10, nutrients optimal for plant growth will be available without concern of sodium and/or chloride toxicity. Composts with an AgIndex of above 10 are good for increasing nutrient levels for all soils. Most composts score between 2 and 10. Concentrations of nutrients, sodium, and chloride in the receiving soil should be considered when determining compost application rates. The AgIndex is a product of feedstock quality. Feedstock from dairy manure, marine waste, industrial wastes, and halophytic plants are likely to produce a finished compost with a low AgIndex.

Plant Available Nitrogen (lbs/ton)
5 Low N Provider Plant Available Nitrogen (PAN) is calculated by estimating the release rate of Nitrogen from the organic fraction of the compost. This estimate is based on the respiration rate, ammonia, and nitrate values. Despite the PAN value of the compost, additional sources of Nitrogen may be needed during he growing season to offset the Nitrogen demand of the microbes present in the compost. With ample nutrients these microbes can further breakdown organic matter in the compost and release bound Nitrogen. Nitrogen demand based on a high C/N ratio is not considered in the PAN calculation because additional Nitrogen should always be supplemented to the receiving soil when composts with a high C/N ratio are applied.

C/N Ratio
7.0 Indicates maturity As a guiding principal, a C/N ratio below 14 indicates maturity and above 14 indicates immaturity, however, there are many exceptions. Large woodchips (>6.3mm), bark, and redwood are slow to breakdown and therefore can result in a relatively stable product while the C/N ratio value is high. Additionally, some composts with chicken manure and/or green grass feedstocks can start with a C/N ratio below 15 and are very unstable. A C/N ratio below 10 supplies Nitrogen, while a ratio above 20 can deplete Nitrogen from the soil. The rate at which Nitrogen will be released or used by the microbes is indicated by the respiration rate. If the respiration rate is too high the transfer of Nitrogen will not be controlable.

Soluble Nutrients & Salts (EC5 w/w dw - mmhos/cm)
4.7 Average salts This value refers to all soluble ions including nutrients, sodium, chloride and some soluble organic compounds. The concentration of salts will change due to the release of salts from the organic matter as it degrades, volatilization of ammonia, decomposition of soluble organics, and conversion of molecular structure. High salts + high AgIndex is indicative of a compost high in readily available nutrients. The application rate of these composts should be limited by the optimum nutrient value based on soil analysis of the receiving soil. High Salts + low AgIndex is indicative of a compost low in nutrients with high concentrations of sodium and/or chloride. Limit the application rate according to the toxicity level of thesodium and/or chloride. Low salts indicates that the compost can be applied without risking salt toxicity, is likely a good source of organic matter, and that nutrients will release slowly over time.

Lime Content (lbs. per ton)
28 High lime content Compost high in lime or carbonates are often those produced from chicken manure (layers) ash materials, and lime products. These are excellent products to use on a receiving soil where lime has been recommended by soil analysis to raise the pH. Composts with a high lime content should be closely considered for pH requirements when formulating potting mixes.

Physical Properties

Percent Ash
36.4 Average ash content Ash is the non-organic fraction of a compost. Most composts contain approximately 50% ash (dry weight basis). Compost can be high in ash content for many reasons including: excess minerilzation(old compost), contamination with soil base material during turning, poor quality feedstock, and soil or mineral products added. Finding the source and reducing high ash content is often the fastest means to increasing nutrient quality of a compost.

Particle Size % > 6.3 MM (0.25")
61.1 May restrict use Large particles may restrict use for potting soils, golf course topdressings, seed-starter mixes, and where a fine size distribution is required. Composts with large particles can still be used as excellent additions to field soils, shrub mixes and mulches.

Appendix:			
Plant Available Nitrogen (PAN) calculations:		Estimated available nutrients for use when calculating application rates	
PAN = (X * (organic N)) + ((NH4-N) + (NO3-N))			lbs/ton (As Rcvd.)
X value =	If RR < 2 then X = 0.1		
	If RR =2.1 to 5 then X = 0.2	Plant Available Nitrogen (PAN)	5.0
	If RR =5.1 to 10 then X = 0.3	Ammonia (NH4-N)	2.40
	If RR > 10 then X = 0.4	Nitrate (NO3-N)	0.00
Note: If C/N ratio > 15 additional N should be applied.		Available Phosphorus (P2O5*0.64)	25.0
RR = Respiration rate		Available Potassium (K2O)	0.7

ANALYTICAL CHEMISTS
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"Cured Bloom" Soil Analysis

Account #: 9050879-1/2-8679
Group: May19E #8
Reporting Date: June 8, 2019

DC Water & Sewer Authority
5000 Overlook Avenue, SW
Washington, DC 20032
Attn: James Fotouhi

Date Received: 30 May. 19
Sample Identification: BLM-Wnd1-BF-89d-flip+8
Sample ID #: 9050879 - 1/2

Nutrients	Dry wt.	As Rcvd.	units
Total Nitrogen:	3.9	2.8	%
Ammonia (NH_4-N):	350	250	mg/kg
Nitrate (NO_3-N):	360	260	mg/kg
Org. Nitrogen (Org.-N):	3.8	2.7	%
Phosphorus (as P_2O_5):	8.2	5.9	%
Phosphorus (P):	36000	26000	mg/kg
Potassium (as K_2O):	0.11	0.080	%
Potassium (K):	930	670	mg/kg
Calcium (Ca):	3.1	2.2	%
Magnesium (Mg):	0.39	0.28	%
Sulfate (SO_4-S):	1300	910	mg/kg
Boron (Total B):	12	8.3	mg/kg
Moisture:	0	28.1	%
Sodium (Na):	0.042	0.030	%
Chloride (Cl):	0.018	0.013	%
pH Value:	NA	6.11	unit
Bulk Density :	35	49	lb/cu ft
Carbonates ($CaCO_3$):	9.0	6.4	lb/ton
Conductivity (EC5):	3.3	NA	mmhos/cm
Organic Matter:	52.5	37.8	%
Organic Carbon:	28.0	20.0	%
Ash:	47.5	34.1	%
C/N Ratio	7.3	7.3	ratio
AgIndex	> 10	> 10	ratio

Stability Indicator:	
CO2 Evolution	Respirometery
mg CO_2-C/g OM/day	2.8
mg CO_2-C/g TS/day	1.4
Stability Rating	*stable*

Maturity Indicator: Cucumber Bioassay	
Compost:Vermiculite (v:v)	1:2
Emergence (%)	93
Seedling Vigor (%)	88
Description of Plants	*healthy*

Pathogens	Results	Units	Rating
Fecal Coliform	25	MPN/g	*pass*
Salmonella	< 3	MPN/4g	*pass*

Date Tested: 30 May. 19

Physical Contaminants**	% by weight
Total Plastic	< 0.1
Film Plastic	< 0.1
Glass	< 0.1
Metal	< 0.1
Sharps	ND
Total	< 0.5

Metals	Dry wt.	EPA Limit	units
Aluminum (Al):	5100	-	mg/kg
Arsenic (As):	6.5	41	mg/kg
Cadmium (Cd):	1.6	39	mg/kg
Chromium (Cr):	78	-	mg/kg
Cobalt (Co)	6.8	-	mg/kg
Copper (Cu):	450	1500	mg/kg
Iron (Fe):	100000	-	mg/kg
Lead (Pb):	33	300	mg/kg
Manganese (Mn):	600	-	mg/kg
Mercury (Hg):	< 1.0	17	mg/kg
Molybdenum (Mo):	15	75	mg/kg
Nickel (Ni):	28	420	mg/kg
Selenium (Se):	4.6	100	mg/kg
Zinc (Zn):	790	2800	mg/kg

Size Distribution	
MM	% by weight
> 50	0.0
25 to 50	0.0
16 to 25	2.9
9.5 to 16	6.9
6.3 to 9.5	10.3
4.0 to 6.3	25.0
2.0 to 4.0	27.3
< 2.0	27.6

**Greater than 4mm in size (Sharps greater than 2mm)

Analyst: Assaf Sadeh

*Sample was received and handled in accordance with TMECC procedures.

Account No.: Date Received 30 May. 19
9050879 - 1/2 - 8679 Sample i.d. BLM-Wnd1-BF-89d-flip+8
Group: May19E No. 8 Sample I.d. No. 1/2 9050879

INTERPRETATION: "Cured Bloom" Soil Analysis Page one of three

Is Your Compost Stable?

Respiration Rate Biodegradation Rate of Your Pile
2.8 mg CO2-C/ g OM/day

+++++++++++

< Stable >|<Moderately Unstable>|< Unstable >|< High For Mulch

Is Your Compost Mature?

AmmoniaN/NitrateN ratio
0.97 Ratio

+++++++++++++++++++

VeryMature>|< Mature >|< Immature

Ammonia N ppm
350 mg/kg dry wt.

+++++++++++++++++++++++++++++++++++++++

VeryMature>|< Mature >|< Immature

Nitrate N ppm
360 mg/kg dry wt.

++

< Immature >|< Mature

pH value
6.11 units

++

< Immature >|< Mature >|< Immature

Cucumber Emergence
93.3 percent

+++

< Immature >|< Mature

Is Your Compost Safe Regarding Health?

Fecal Coliform
< 1000 MPN/g dry wt.

+++++++

< Safe >|< High Fecal Coliform

Salmonella
Less than 3 /4g dry wt.

+++++++

<Safe (none detected) >|< High Salmonella Count(> 3 per 4 grams)

Metals US EPA 503
Pass dry wt.

+++++++++

<All Metals Pass >|< One or more Metals Fail

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P2O5+K2O)
12.2 Percent dry wt.

++

<Low >|< Average >|< High Nutrient Content

AgIndex (Nutrients / Sodium and Chloride Salts) ((N+P2O5+K2O) / (Na + Cl))
15 Ratio

+++

Na & Cl >|< Nutrient and Sodium and Chloride Provider >|< Nutrient Provider

Plant Available Nitrogen (PAN) Estimated release for first season
7 lbs/ton wet wt.

+++++++++++++++++++++++++

Low Nitrogen Provider>|< Average Nitrogen Provider >|<High Nitrogen Provider

C/N Ratio
7.3 Ratio

++++++++++++++

< Nitrogen Release >|< N-Neutral >|< N-Demand>|< High Nitrogen Demand

Soluble Available Nutrients & Salts (EC5 w/w dw)
3.3 mmhos/cm dry wt.

+++++++++++++++++

SloRelease>|< Average Nutrient Release Rate >|<High Available Nutrients

Lime Content (CaCO3)
9.0 Lbs/ton dry wt.

++++++++++++++

< Low >|< Average >|< High Lime Content (as CaCO3)

What are the physical properties of your compost?

Percent Ash
47.5 Percent dry wt.

+++++++++++++++++++++++++++++++++++++

< High Organic Matter >|< Average >|< High Ash Content

Sieve Size % > 6.3 MM (0.25")
20.2 Percent dry wt.

++

All Uses >|< Size May Restrict Uses for Potting mix and Golf Courses

Account No.:		Date Received	30 May. 19
9050879 - 1/2 - 8679		Sample i.d.	BLM-Wnd1-BF-89d-flip+8
Group:	May19E No. 8	Sample I.d. No.	1/2 9050879

INTERPRETATION: "Cured Bloom" Soil Analysis

Is Your Compost Stable?

Respiration Rate

2.8 Low: Good for all uses mg CO2-C/g OM/day

The respiration rate is a measurement of the biodegradation rate of the organic matter in the sample (as received). The respiration rate is determined by measuring the rate at which CO2 is released under optimized moisture and temperature conditions.

Is Your Compost Mature?

AmmoniaN:NitrateN ratio

0.97 mature

Ammonia N ppm

350 mature

Nitrate N ppm

360 mature

pH value

6.11 immature

Composting to stabilize carbon can occur at such a rapid rate that sometimes phytotoxins remain in the compost and must be neutralized before using in high concentrations or in high-end uses. This step is called curing. Typically ammonia is in excess with the break-down of organic materials resulting in an increase in pH. This combination results in a loss of volatile ammonia (it smells). Once this toxic ammonia has been reduced and the pH drops, the microbes convert the ammonia to nitrates. A low ammonia + high nitrate score is indicative of a mature compost, however there are many exceptions. For example, a compost with a low pH (<7) will retain ammonia, while a compost with high lime content can lose ammonia before the organic fraction becomes stable. Composts must first be stable before curing indicators apply.

Cucumber Bioassay

93.3 Percent

Cucumbers are chosen for this test because they are salt tolerant and very sensitive to ammonia and organic acid toxicity. Therefore, we can germinate seeds in high concentrations of compost to measure phytotoxic effects without soluble salts being the limiting factor. Values above 80% for both percent emergence and vigor are indicative of a well-cured compost. Exceptions include very high salts that affect the cucumbers, excessive concentrations of nitrates and other nutrients that will be in range when formulated to make a growing media.

Is Your Compost Safe Regarding Health?

Fecal Coliform

< 1000 / g dry wt.

Fecal coliforms can survive in both aerobic and anaerobic conditions and is common in all initial compost piles. Most human pathogens occur from fecal matter and all fecal matter is loaded in fecal coliforms. Therefore fecal coliforms are used as an indicator to determine if the chosen method for pathogen reduction (heat for compost) has met the requirements of sufficient temperature, time and mixing. If the fecal coliforms are reduced to below 1000 per gram dry wt. it is assumed all others pathogens are eliminated. Potential problems are that fecal coliform can regrow during the curing phase or during shipping. This is because the conditions are now more favorable for growth than during the composting process.

Salmonella Bacteria

Less than 3 3 / 4g dry wt.

Salmonella is not only another indicator organism but also a toxic microbe. It has been used in the case of biosolids industry to determine adequate pathogen reduction.

Metals

Pass

The ten heavy metals listed in the EPA 503 regulations are chosen to determine if compost can be applied to ag land and handled without toxic effects. Most high concentrations of heavy metals are derived from woodwaste feedstock such as chrome-arsenic treated or lead painted demolition wood. Biosolids are rarely a problem.

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P2O5+K2O)

12.2 High nutrient content

This value is the sum of the primary nutrients Nitrogen, Phosphorus and Potassium. Reported units are consistent with those found on fertilizer formulations. A sum greater than 5 is indicative of a compost with high nutrient content, and best used to supply nutrients to a receiving soil. A sum below 2 indicates low nutrient content, and is best-used to improve soil structure via the addition of organic matter. Most compost falls between 2 and 5.

Account No.:		Date Received	30 May. 19
9050879 - 1/2 - 8679		Sample i.d.	BLM-Wnd1-BF-89d-flip+8
Group:	May19E No. 8	Sample I.d. No.	1/2 9050879

INTERPRETATION: "Cured Bloom" Soil Analysis

AgIndex (Nutrients/Na+Cl)
15 High nutrient ratio Composts with low AgIndex values have high concentrations of sodium and/or chloride compared to nutrients. Repeated use of a compost with a low AgIndex (< 2) may result in sodium and/or chloride acting as the limiting factor compared to nutrients, governing application rates. These composts may be used on well-draining soils and/or with salt-tolerant plants. Additional nutrients form another source may be needed if the application rate is limited by sodium or chloride. If the AgIndex is above 10, nutrients optimal for plant growth will be available without concern of sodium and/or chloride toxicity. Composts with an AgIndex of above 10 are good for increasing nutrient levels for all soils. Most composts score between 2 and 10. Concentrations of nutrients, sodium, and chloride in the receiving soil should be considered when determining compost application rates. The AgIndex is a product of feedstock quality. Feedstock from dairy manure, marine waste, industrial wastes, and halophytic plants are likely to produce a finished compost with a low AgIndex.

Plant Available Nitrogen (lbs/ton)
7 Average N Provider Plant Available Nitrogen (PAN) is calculated by estimating the release rate of Nitrogen from the organic fraction of the compost. This estimate is based on the respiration rate, ammonia, and nitrate values. Despite the PAN value of the compost, additional sources of Nitrogen may be needed during he growing season to offset the Nitrogen demand of the microbes present in the compost. With ample nutrients these microbes can further breakdown organic matter in the compost and release bound Nitrogen. Nitrogen demand based on a high C/N ratio is not considered in the PAN calculation because additional Nitrogen should always be supplemented to the receiving soil when composts with a high C/N ratio are applied.

C/N Ratio
7.3 Indicates maturity As a guiding principal, a C/N ratio below 14 indicates maturity and above 14 indicates immaturity, however, there are many exceptions. Large woodchips (>6.3mm), bark, and redwood are slow to breakdown and therefore can result in a relatively stable product while the C/N ratio value is high. Additionally, some composts with chicken manure and/or green grass feedstocks can start with a C/N ratio below 15 and are very unstable. A C/N ratio below 10 supplies Nitrogen, while a ratio above 20 can deplete Nitrogen from the soil. The rate at which Nitrogen will be released or used by the microbes is indicated by the respiration rate. If the respiration rate is too high the transfer of Nitrogen will not be controlable.

Soluble Nutrients & Salts (EC5 w/w dw - mmhos/cm)
3.3 Average salts This value refers to all soluble ions including nutrients, sodium, chloride and some soluble organic compounds. The concentration of salts will change due to the release of salts from the organic matter as it degrades, volatilization of ammonia, decomposition of soluble organics, and conversion of molecular structure. High salts + high AgIndex is indicative of a compost high in readily available nutrients. The application rate of these composts should be limited by the optimum nutrient value based on soil analysis of the receiving soil. High Salts + low AgIndex is indicative of a compost low in nutrients with high concentrations of sodium and/or chloride. Limit the application rate according to the toxicity level of thesodium and/or chloride. Low salts indicates that the compost can be applied without risking salt toxicity, is likely a good source of organic matter, and that nutrients will release slowly over time.

Lime Content (lbs. per ton)
9.0 Average lime content Compost high in lime or carbonates are often those produced from chicken manure (layers) ash materials, and lime products. These are excellent products to use on a receiving soil where lime has been recommended by soil analysis to raise the pH. Composts with a high lime content should be closely considered for pH requirements when formulating potting mixes.

Physical Properties

Percent Ash
47.5 Average ash content Ash is the non-organic fraction of a compost. Most composts contain approximately 50% ash (dry weight basis). Compost can be high in ash content for many reasons including: excess minerilzation(old compost), contamination with soil base material during turning, poor quality feedstock, and soil or mineral products added. Finding the source and reducing high ash content is often the fastest means to increasing nutrient quality of a compost.

Particle Size % > 6.3 MM (0.25")
20.2 May restrict use Large particles may restrict use for potting soils, golf course topdressings, seed-starter mixes, and where a fine size distribution is required. Composts with large particles can still be used as excellent additions to field soils, shrub mixes and mulches.

Appendix:			
Plant Available Nitrogen (PAN) calculations:		Estimated available nutrients for use when calculating application rates	
PAN = (X * (organic N)) + ((NH4-N) + (NO3-N))			lbs/ton (As Rcvd.)
X value =	If RR < 2 then X = 0.1		
	If RR =2.1 to 5 then X = 0.2	Plant Available Nitrogen (PAN)	6.5
	If RR =5.1 to 10 then X = 0.3	Ammonia (NH4-N)	0.50
	If RR > 10 then X = 0.4	Nitrate (NO3-N)	0.52
Note: If C/N ratio > 15 additional N should be applied.		Available Phosphorus (P2O5*0.64)	75.6
RR = Respiration rate		Available Potassium (K2O)	1.6

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California
SOIL CONTROL LAB
42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188
www.compostlab.com

"Woody Blend" Soil Analysis

Account #: 9010135-1/2-8679
Group: Jan19B #16
Reporting Date: January 24, 2019

DC Water & Sewer Authority
5000 Overlook Avenue, SW
Washington, DC 20032
Attn: Bill Brower

Date Received: 08 Jan. 19
Sample Identification: FBLM: Fines (GCM) 3:7 V-1
Sample ID #: 9010135 - 1/2

Nutrients	Dry wt.	As Rcvd.	units
Total Nitrogen:	2.1	1.0	%
Ammonia (NH_4-N):	2300	1100	mg/kg
Nitrate (NO_3-N):	53	26	mg/kg
Org. Nitrogen (Org.-N):	1.9	0.92	%
Phosphorus (as P_2O_5):	2.3	1.1	%
Phosphorus (P):	10000	4900	mg/kg
Potassium (as K_2O):	0.30	0.15	%
Potassium (K):	2500	1200	mg/kg
Calcium (Ca):	1.9	0.91	%
Magnesium (Mg):	0.34	0.16	%
Sulfate (SO_4-S):	1900	910	mg/kg
Boron (Total B):	9.3	4.5	mg/kg
Moisture:	0	51.8	%
Sodium (Na):	0.028	0.013	%
Chloride (Cl):	0.026	0.013	%
pH Value:	NA	7.94	unit
Bulk Density :	17	36	lb/cu ft
Carbonates ($CaCO_3$):	15	7.3	lb/ton
Conductivity (EC5):	5.3	NA	mmhos/cm
Organic Matter:	60.9	29.3	%
Organic Carbon:	29.0	14.0	%
Ash:	39.1	18.8	%
C/N Ratio	14	14	ratio
AgIndex	> 10	> 10	ratio

Stability Indicator:		
CO2 Evolution	Respirometery	
mg CO_2-C/g OM/day	3.0	
mg CO_2-C/g TS/day	1.8	
Stability Rating	*stable*	

Maturity Indicator: Cucumber Bioassay	
Compost:Vermiculite (v:v)	1:2
Emergence (%)	100
Seedling Vigor (%)	51
Description of Plants	*stunted*

Pathogens	Results	Units	Rating
Fecal Coliform	9.3	MPN/g	*pass*
Salmonella	< 3	MPN/4g	*pass*

Date Tested: 08 Jan. 19

Physical Contaminants**	% by weight
Total Plastic	< 0.1
Film Plastic	< 0.1
Glass	< 0.1
Metal	< 0.1
Sharps	ND
Total	< 0.5

Metals	Dry wt.	EPA Limit	units
Aluminum (Al):	5800	-	mg/kg
Arsenic (As):	3.9	41	mg/kg
Cadmium (Cd):	< 1.0	39	mg/kg
Chromium (Cr):	45	-	mg/kg
Cobalt (Co)	6.4	-	mg/kg
Copper (Cu):	180	1500	mg/kg
Iron (Fe):	36000	-	mg/kg
Lead (Pb):	20	300	mg/kg
Manganese (Mn):	380	-	mg/kg
Mercury (Hg):	< 1.0	17	mg/kg
Molybdenum (Mo):	6.8	75	mg/kg
Nickel (Ni):	23	420	mg/kg
Selenium (Se):	1.9	100	mg/kg
Zinc (Zn):	320	2800	mg/kg

Size Distribution	
MM	% by weight
> 50	0.0
25 to 50	0.0
16 to 25	0.0
9.5 to 16	0.0
6.3 to 9.5	3.0
4.0 to 6.3	6.9
2.0 to 4.0	18.8
< 2.0	71.4

**Greater than 4mm in size (Sharps greater than 2mm)

Analyst: Assaf Sadeh

*Sample was received and handled in accordance with TMECC procedures.

Account No.: Date Received 08 Jan. 19
9010135 - 1/2 - 8679 Sample i.d. FBLM: Fines (GCM) 3:7 V-1
Group: Jan19B No. 16 Sample I.d. No. 1/2 9010135

INTERPRETATION: "Woody Blend" Soil Analysis

Is Your Compost Stable?

Respiration Rate Biodegradation Rate of Your Pile
3.0 mg CO2-C/ g OM/day
+++++++++++
< Stable >|<Moderately Unstable>|< Unstable >|< High For Mulch

Is Your Compost Mature?

AmmoniaN/NitrateN ratio
43 Ratio
++
VeryMature>|< Mature >|< Immature

Ammonia N ppm
2300 mg/kg dry wt.
++
VeryMature>|< Mature >|< Immature

Nitrate N ppm
53 mg/kg dry wt.
+++
< Immature >|< Mature

pH value
7.94 units
++
< Immature >|< Mature >|< Immature

Cucumber Emergence
100.0 percent
+++
< Immature >|< Mature

Is Your Compost Safe Regarding Health?

Fecal Coliform
< 1000 MPN/g dry wt.
+++++++
< Safe >|< High Fecal Coliform

Salmonella
Less than 3 /4g dry wt.
+++++++
<Safe (none detected) >|< High Salmonella Count(> 3 per 4 grams)

Metals US EPA 503
Pass dry wt.
+++++++++
<All Metals Pass >|< One or more Metals Fail

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P2O5+K2O)
4.7 Percent dry wt.
++++++++++++++++++++++++++++++++++++
<Low >|< Average >|< High Nutrient Content

AgIndex (Nutrients / Sodium and Chloride Salts) ((N+P2O5+K2O) / (Na + Cl))
15 Ratio
+++
Na & Cl >|< Nutrient and Sodium and Chloride Provider >|< Nutrient Provider

Plant Available Nitrogen (PAN) Estimated release for first season
4 lbs/ton wet wt.
+++++++++++++++
Low Nitrogen Provider>|< Average Nitrogen Provider >|<High Nitrogen Provider

C/N Ratio
14 Ratio
+++++++++++++++++++++++++++
< Nitrogen Release >|< N-Neutral >|< N-Demand>|< High Nitrogen Demand

Soluble Available Nutrients & Salts (EC5 w/w dw)
5.3 mmhos/cm dry wt.
+++++++++++++++++++++++++++
SloRelease>|< Average Nutrient Release Rate >|<High Available Nutrients

Lime Content (CaCO3)
15 Lbs/ton dry wt.
++++++++++++++++++++++++
< Low >|< Average >|< High Lime Content (as CaCO3)

What are the physical properties of your compost?

Percent Ash
39.1 Percent dry wt.
++++++++++++++++++++++++++++++
< High Organic Matter >|< Average >|< High Ash Content

Sieve Size % > 6.3 MM (0.25")
3.0 Percent dry wt.
+++++++++++++++++++++++
All Uses >|< Size May Restrict Uses for Potting mix and Golf Courses

Account No.:		Date Received	08 Jan. 19	
9010135 - 1/2 - 8679		Sample i.d.	FBLM: Fines (GCM) 3:7 V-1	
Group:	Jan19B No. 16	Sample I.d. No.	1/2	9010135

INTERPRETATION: "Woody Blend" Soil Analysis

Is Your Compost Stable?

Respiration Rate

3.0 Low: Good for all uses mg CO2-C/g OM/day

The respiration rate is a measurement of the biodegradation rate of the organic matter in the sample (as received). The respiration rate is determined by measuring the rate at which CO2 is released under optimized moisture and temperature conditions.

Is Your Compost Mature?

AmmoniaN:NitrateN ratio	
43	immature
Ammonia N ppm	
2300	immature
Nitrate N ppm	
53	mature
pH value	
7.94	mature

Composting to stabilize carbon can occur at such a rapid rate that sometimes phytotoxins remain in the compost and must be neutralized before using in high concentrations or in high-end uses. This step is called curing. Typically ammonia is in excess with the break-down of organic materials resulting in an increase in pH. This combination results in a loss of volatile ammonia (it smells). Once this toxic ammonia has been reduced and the pH drops, the microbes convert the ammonia to nitrates. A low ammonia + high nitrate score is indicative of a mature compost, however there are many exceptions. For example, a compost with a low pH (<7) will retain ammonia, while a compost with high lime content can lose ammonia before the organic fraction becomes stable. Composts must first be stable before curing indicators apply.

Cucumber Bioassay

100.0 Percent

Cucumbers are chosen for this test because they are salt tolerant and very sensitive to ammonia and organic acid toxicity. Therefore, we can germinate seeds in high concentrations of compost to measure phytotoxic effects without soluble salts being the limiting factor. Values above 80% for both percent emergence and vigor are indicative of a well-cured compost. Exceptions include very high salts that affect the cucumbers, excessive concentrations of nitrates and other nutrients that will be in range when formulated to make a growing media.

Is Your Compost Safe Regarding Health?

Fecal Coliform

< 1000 / g dry wt.

Fecal coliforms can survive in both aerobic and anaerobic conditions and is common in all initial compost piles. Most human pathogens occur from fecal matter and all fecal matter is loaded in fecal coliforms. Therefore fecal coliforms are used as an indicator to determine if the chosen method for pathogen reduction (heat for compost) has met the requirements of sufficient temperature, time and mixing. If the fecal coliforms are reduced to below 1000 per gram dry wt. it is assumed all others pathogens are eliminated. Potential problems are that fecal coliform can regrow during the curing phase or during shipping. This is because the conditions are now more favorable for growth than during the composting process.

Salmonella Bacteria

Less than 3 3 / 4g dry wt.

Salmonella is not only another indicator organism but also a toxic microbe. It has been used in the case of biosolids industry to determine adequate pathogen reduction.

Metals

Pass

The ten heavy metals listed in the EPA 503 regulations are chosen to determine if compost can be applied to ag land and handled without toxic effects. Most high concentrations of heavy metals are derived from woodwaste feedstock such as chrome-arsenic treated or lead painted demolition wood. Biosolids are rarely a problem.

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P2O5+K2O)

4.7 Average nutrient content

This value is the sum of the primary nutrients Nitrogen, Phosphorus and Potassium. Reported units are consistent with those found on fertilizer formulations. A sum greater than 5 is indicative of a compost with high nutrient content, and best used to supply nutrients to a receiving soil. A sum below 2 indicates low nutrient content, and is best-used to improve soil structure via the addition of organic matter. Most compost falls between 2 and 5.

Account No.:		Date Received	08 Jan. 19
9010135 - 1/2 - 8679		Sample i.d.	FBLM: Fines (GCM) 3:7 V-1
Group:	Jan19B No. 16	Sample I.d. No.	1/2 9010135

INTERPRETATION: "Woody Blend" Soil Analysis

AgIndex (Nutrients/Na+Cl)

15 High nutrient ratio Composts with low AgIndex values have high concentrations of sodium and/or chloride compared to nutrients. Repeated use of a compost with a low AgIndex (< 2) may result in sodium and/or chloride acting as the limiting factor compared to nutrients, governing application rates. These composts may be used on well-draining soils and/or with salt-tolerant plants. Additional nutrients form another source may be needed if the application rate is limited by sodium or chloride. If the AgIndex is above 10, nutrients optimal for plant growth will be available without concern of sodium and/or chloride toxicity. Composts with an AgIndex of above 10 are good for increasing nutrient levels for all soils. Most composts score between 2 and 10. Concentrations of nutrients, sodium, and chloride in the receiving soil should be considered when determining compost application rates. The AgIndex is a product of feedstock quality. Feedstock from dairy manure, marine waste, industrial wastes, and halophytic plants are likely to produce a finished compost with a low AgIndex.

Plant Available Nitrogen (lbs/ton)

4 Low N Provider Plant Available Nitrogen (PAN) is calculated by estimating the release rate of Nitrogen from the organic fraction of the compost. This estimate is based on the respiration rate, ammonia, and nitrate values. Despite the PAN value of the compost, additional sources of Nitrogen may be needed during he growing season to offset the Nitrogen demand of the microbes present in the compost. With ample nutrients these microbes can further breakdown organic matter in the compost and release bound Nitrogen. Nitrogen demand based on a high C/N ratio is not considered in the PAN calculation because additional Nitrogen should always be supplemented to the receiving soil when composts with a high C/N ratio are applied.

C/N Ratio

14 Indicates maturity As a guiding principal, a C/N ratio below 14 indicates maturity and above 14 indicates immaturity, however, there are many exceptions. Large woodchips (>6.3mm), bark, and redwood are slow to breakdown and therefore can result in a relatively stable product while the C/N ratio value is high. Additionally, some composts with chicken manure and/or green grass feedstocks can start with a C/N ratio below 15 and are very unstable. A C/N ratio below 10 supplies Nitrogen, while a ratio above 20 can deplete Nitrogen from the soil. The rate at which Nitrogen will be released or used by the microbes is indicated by the respiration rate. If the respiration rate is too high the transfer of Nitrogen will not be controlable.

Soluble Nutrients & Salts (EC5 w/w dw - mmhos/cm)

5.3 Average salts This value refers to all soluble ions including nutrients, sodium, chloride and some soluble organic compounds. The concentration of salts will change due to the release of salts from the organic matter as it degrades, volatilization of ammonia, decomposition of soluble organics, and conversion of molecular structure. High salts + high AgIndex is indicative of a compost high in readily available nutrients. The application rate of these composts should be limited by the optimum nutrient value based on soil analysis of the receiving soil. High Salts + low AgIndex is indicative of a compost low in nutrients with high concentrations of sodium and/or chloride. Limit the application rate according to the toxicity level of thesodium and/or chloride. Low salts indicates that the compost can be applied without risking salt toxicity, is likely a good source of organic matter, and that nutrients will release slowly over time.

Lime Content (lbs. per ton)

15 Average lime content Compost high in lime or carbonates are often those produced from chicken manure (layers) ash materials, and lime products. These are excellent products to use on a receiving soil where lime has been recommended by soil analysis to raise the pH. Composts with a high lime content should be closely considered for pH requirements when formulating potting mixes.

Physical Properties

Percent Ash

39.1 Average ash content Ash is the non-organic fraction of a compost. Most composts contain approximately 50% ash (dry weight basis). Compost can be high in ash content for many reasons including: excess minerilzation(old compost), contamination with soil base material during turning, poor quality feedstock, and soil or mineral products added. Finding the source and reducing high ash content is often the fastest means to increasing nutrient quality of a compost.

Particle Size % > 6.3 MM (0.25")

3.0 May restrict use Large particles may restrict use for potting soils, golf course topdressings, seed-starter mixes, and where a fine size distribution is required. Composts with large particles can still be used as excellent additions to field soils, shrub mixes and mulches.

Appendix:			
Plant Available Nitrogen (PAN) calculations:		Estimated available nutrients for use when calculating application rates	
PAN = (X * (organic N)) + ((NH4-N) + (NO3-N))			lbs/ton (As Rcvd.)
X value =	If RR < 2 then X = 0.1		
	If RR =2.1 to 5 then X = 0.2	Plant Available Nitrogen (PAN)	4.0
	If RR =5.1 to 10 then X = 0.3	Ammonia (NH4-N)	2.20
	If RR > 10 then X = 0.4	Nitrate (NO3-N)	0.05
Note: If C/N ratio > 15 additional N should be applied.		Available Phosphorus (P2O5*0.64)	14.3
RR = Respiration rate		Available Potassium (K2O)	2.9

BLOOM GOOD SOIL,® BETTER EARTH.

"Sandy Blend"

Sand-Sawdust Bloom Blend - Nutrient Analysis

Date Received: 02 Jun. 16
Sample Identification: Blend
bs:s:sd -70d flip+6
Sample ID #: 6060088 - 2/3

Nutrients	Dry wt.	As Rcvd.	units
Total Nitrogen:	1.6	1.4As	%
Ammonia (NH4-N):	1700	1400	mg/kg
Nitrate (NO3-N):	54	46	mg/kg
Org. Nitrogen (Org.-N):	1.4	1.2	%
Phosphorus (as P2O5):	3.3	2.7	%
Phosphorus (P):	14000	12000	mg/kg
Potassium (as K2O):	0.18	0.15	%
Potassium (K):	1500	1200	mg/kg
Calcium (Ca):	1.2	1.0	%
Magnesium (Mg):	0.20	0.16	%
Sulfate (SO4-S):	1900	1600	mg/kg
Boron (Total B):	9.7	8.2	mg/kg
Moisture:	0	16.1	%
Sodium (Na):	0.040	0.033	%
Chloride (Cl):	0.05	0.042	%
pH Value:	NA	6.67	unit
Bulk Density :	30	35	lb/cu ft
Carbonates (CaCO3):	5.4	4.5	lb/ton
Conductivity (EC5):	4.0	NA	mmhos/cm
Organic Matter:	34.02	28.52795	%
Organic Carbon:	14	12	%
Ash:	65.98	55.32846	%
C/N Ratio	8.7	8.7	ratio
AgIndex	>10	>10	ratio

Metals	Dry wt.	EPA Limit	units
Aluminum (Al):	2600	-	mg/kg
Arsenic (As):	4.0	41	mg/kg
Cadmium (Cd):	<1.0	39	mg/kg
Chromium (Cr):	25	1200	mg/kg
Cobalt (Co)	4.3	-	mg/kg
Copper (Cu):	160	1500	mg/kg
Iron (Fe):	42000	-	mg/kg
Lead (Pb):	18	300	mg/kg
Manganese (Mn):	170	-	mg/kg
Mercury (Hg):	<1.0	17	mg/kg
Molybdenum (Mo):	5.0	75	mg/kg
Nickel (Ni):	13	420	mg/kg
Selenium (Se):	1.9	36	mg/kg
Zinc (Zn):	310	2800	mg/kg

Stability Indicator:

CO2 Evolution	Respirometery	Biologically Available C
mg CO2-C/g OM/day	3.4	3.4
mg CO2-C/g TS/day	1.1	1.0
Stability Rating	stable	stable

Maturity Indicator: Cucumber Bioassay

Compost:Vermiculite(v:v)	1.2
Emergence (%)	100
Seedling Vigor (%)	119.2308
Description of Plants	healthy

Pathogens	Results	Units	Rating
Fecal Coliform	<7.5	MPN/g	pass
Salmonella	<3	MPN/g	pass

Date Tested: 02 Jun. 16

Inerts	% by weight
Plastic	<0.5
Glass	<0.5
Metal	<0.5
Sharps	ND

Maturity Indicator: Cucumber Bioassay

MM	% by weight
>50	0
25 to 50	0
16 to 25	0
9.5 to 16	0
6.3 to 9.5	0.076407
4.0 to 6.3	2.026028
2.0 to 4.0	16.309 28
<2.0	81.58829

Technical Memorandum No. 6

Date:	October 20, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Thickening Evaluation

Contents

Tables

Figures

Executive Summary

The Arlington County (County) Water Pollution Control Plant (WPCP) Solids Master Plan report's (March 2018) (Master Plan) preferred alternative eliminated thickening of primary solids (PS) and waste activated solids (WAS). The purpose of this thickening evaluation is to validate the Master Plan's preferred alternative of no thickening, and to compare potential thickening configurations and technologies. The following thickening technologies were included in this evaluation:

- Gravity thickeners (GTs): currently used for PS thickening
- Dissolved air flotation thickeners (DAFTs): currently used for WAS thickening
- Gravity-belt thickeners (GBTs)
- Rotary-drum thickeners (RDTs)
- Thickening centrifuges

The following eight alternatives were originally identified for inclusion in this thickening evaluation:

- **Alternative 1:** no thickening
- **Alternative 2:** GTs for PS and DAFTs for WAS
- **Alternative 3:** GTs for PS and GBTs for WAS
- **Alternative 4:** GTs for PS and RDTs for WAS
- **Alternative 5:** GTs for PS and thickening centrifuges for WAS
- **Alternative 6:** co-thickening (PS and WAS) with GTs
- **Alternative 7:** un-thickened (UT) PS and GBT or RDT thickening for WAS
- **Alternative 8:** co-thickening (PS and WAS) with GBTs or RDTs

Solids loading projections used for the evaluation are based on the 30.8-million-gallon per day (mgd) (approximately year 2052, refer to Technical Memorandum (TM) No. 1, *Solids Production and Design Criteria* for design criteria) design condition. Thickening, solids screening, solids storage, and pre-dewatering facilities were preliminarily sized based on the 30.8 mgd, peak 3-day solids loading projections. It is assumed for Alternatives 2 through 6 that the existing GTs would be used, following concrete rehabilitation and replacement of the internal mechanical equipment. A condition assessment was performed on the existing GTs and it was determined that the mechanical components are at the end of their useful life and should all be replaced. However, the GT tanks are structurally sound but require some concrete rehabilitation, including concrete repairs and a new domed cover.

Preliminary thickening and pre-dewatering facility layouts were prepared and used as a basis for preparing conceptual capital costs. A workshop was held on March 17, 2021, to review the initial thickening evaluation during which Alternatives 2, 5, 6, and 8 were eliminated from further evaluation. The County requested that new Alternatives 7A and 8A be added to the evaluation, as variations on Alternatives 7 and 8, respectively. Alternative 7A includes gravity thickening of PS and no thickening of WAS (plan for future thickening). Alternative 8A includes separate mechanical thickening of PS and WAS located in the same facility. Alternatives 1, 3, 4, 7, 7A, and 8A were retained for further evaluation.

Following the initial alternatives screening and elimination, operation and maintenance (O&M) costs were prepared for the remaining alternatives. A summary of the shortlisted alternatives is provided in Table 1 below.

Based on the analyses, Alternative 7A (GT/no WAS thickening) appears to provide the best overall value to Arlington County, balancing operational flexibility, proven performance, lower energy profile, and ability to fit within the site constraints. Space will be allocated for future GBTs or RDTs. Alternative 7A is recommended over Alternative 1 because of the reduced storage and odor control requirements and greater flexibility in site utilization. Figure 1 provides the process flow diagram (PFD) for the recommended thickening alternative.

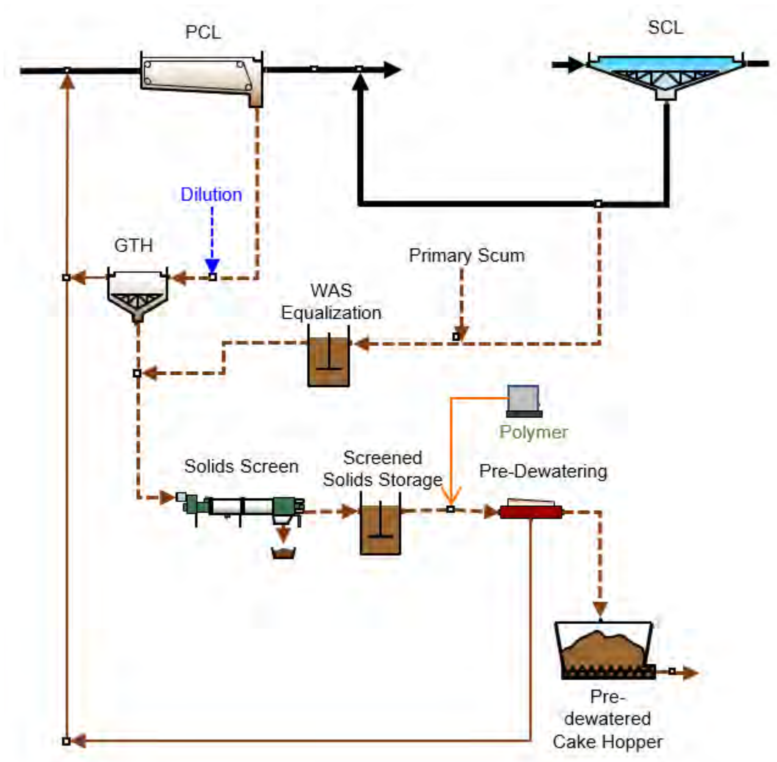

Figure 1. Alternative 7A Process Flow Diagram

Table 1. Summary of Shortlisted Alternatives

Parameter	Alt. 1: No Thickening	Alt. 3: GT/GBT	Alt. 4: GT/RDT	Alt. 7: Un-thickened PS/TWAS	Alt. 7A: GT/ Un-thickened WAS	Alt. 8A: Separate GBT/RDT
Site impacts	• Requires most solids storage volume (can consider reusing GTs) • Largest pre-dewatering facility footprint	• Provides one of the most compact layouts • Smallest pre-dewatering facility footprint	• Provides the most compact layout • Smallest pre-dewatering facility footprint	• Large volume of storage required for un-thickened PS • Larger pre-dewatering facility footprint	• Additional WAS storage required upstream of screening • More storage than Alternative 3 or 4	• Additional PS storage required upstream of thickening • Smallest pre-dewatering facility footprint
Operability	• Fewer unit processes to operate • Limited flexibility (with 1 day of solids storage) • 24/7 solids screening and pre-dewatering is required	• GTs are a familiar process to WPCP staff and have performed well • GBTs require periodic operator attention, but do not require constant care	• GTs are a familiar process to WPCP staff and have performed well • RDTs require even less operator attention than GBTs	• Limited flexibility because of un-thickened PS • GBT/RDT requires periodic operator attention	• GTs are a familiar process to WPCP staff and have performed well • Un-thickened WAS eliminates a unit process	• GBT/RDT for PS thickening would require more operator attention because of PS solids concentration variability • Potentially two types of polymer required for PS and WAS
Maintenance	• No thickening maintenance • Largest number of solids screens, mixing, and pre-dewatering units requiring additional attention	• GT maintenance is relatively low • GBT maintenance can be done in-house	• RDT maintenance is relatively low • RDT maintenance can be done in-house	• GBT/RDT maintenance similar to Alts. 3 and 4 • Larger number of solids screens, mixing, and pre-dewatering units requiring additional attention	• GT maintenance is relatively low • No maintenance for WAS as it will remain un-thickened	• GBT or RDT maintenance can be performed in-house, but will be greater than Alts. 3 and 4 because of more thickening units needed for PS and WAS
Energy	• No thickening energy required • High energy demands for multiple storage tanks	• Low energy demand for thickening • Lowest energy demand for pre-dewatering	• Low energy demand for thickening • Lowest energy demand for pre-dewatering	• Lowest energy demand for thickening WAS only • Higher energy demand for pre-dewatering	• Lowest energy demand for thickening • Slightly higher energy demand for pre-dewatering	• Higher energy demand for mechanical thickening of PS and WAS

Parameter	Alt. 1: No Thickening	Alt. 3: GT/GBT	Alt. 4: GT/RDT	Alt. 7: Un-thickened PS/TWAS	Alt. 7A: GT/ Un-thickened WAS	Alt. 8A: Separate GBT/RDT
	• Highest energy demand for pre-dewatering					• Lowest energy demand for pre-dewatering
Downstream process impacts	• Requires the most screening and pre-dewatering capacity	• Minimizes screening and pre-dewatering	• Minimizes screening and pre-dewatering	• Greater screening and pre-dewatering capacity	• Slightly larger screening but pre-dewatering capacity same as other thickening options	• Minimizes screening and pre-dewatering
Odors	• Significant odor control needed for storage volume	• GTs are covered, and GBTs can be enclosed to reduce odors	• GTs are covered and RDTs are enclosed	• Significant odor control needed for large PS storage volume	• GTs and SSTs are covered	• Local odor issues associated with GBTs especially for thickening PS; RDTs are enclosed
Conceptual capital cost	$31.1M	$32.1M	$32.6M	$31.7M	$28.8M	$37.7M
O&M present value	$12.0M	$15.1M	$15.9M	$14.1M	$13.3M	$18.4M
Net present value	$43.3M	$47.1M	$48.5M	$45.8M	$42.1M	$56.1M

1.0 Introduction

This introductory section presents the background and purpose of the project and describes the evaluation approach applied to the thickening system at the Arlington Water Pollution Control Plant (WPCP).

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington WPCP. Currently solids handling includes primary solids (PS) and waste activated solids (WAS) thickening, dewatering, and lime stabilization. Planned improvements will replace the existing lime stabilization process with a thermal hydrolysis process (THP) and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The Master Plan included a recommendation to eliminate solids thickening to send un-thickened (UT) solids directly to new solids screening and pre-dewatering facilities upstream of the THP system. Eliminating the thickening process may reduce operations and maintenance (O&M) demands but will also impact sizing and operations of the downstream solids storage, screening, and pre-dewatering processes. The purpose of this thickening evaluation is to further assess and compare thickening alternatives with the no-thickening approach, including impacts to downstream solids handling processes. The results of this evaluation will inform and validate a final decision on eliminating or providing PS and WAS thickening that will be included in the Facilities Plan.

1.2 Evaluation Approach

A suite of alternatives using various thickening technologies, including the existing gravity thickeners (GTs) and dissolved air flotation thickeners (DAFTs), as well as other mechanical thickening processes, was developed for separate and co-thickening of PS and WAS. Conceptual process sizing, configurations, site layouts, and conceptual costs for thickening facilities as well as downstream solids storage, screening, and pre-dewatering were prepared for each alternative. Alternatives were presented and reviewed at a March 17, 2021, project workshop with the County. Workshop participants screened and selected a short list of preferred alternatives. Shortlisted alternatives were further evaluated and compared based on conceptual O&M cost estimates and non-cost considerations including impacts to downstream solids handling processes, site layout and space requirements, and odors. Selected shortlisted alternatives will be considered further in forthcoming evaluations of site utilization and other facility improvements.

2.0 Summary of Existing Facilities and Processing

This section presents a summary of the major process mechanical equipment/systems of the existing thickening facilities at Arlington WPCP, including an overview of existing solids handling and a description of solids thickening and storage.

2.1 Overview of Existing Solids Handling

A process flow diagram (PFD) for existing solids handling at the WPCP is shown in Figure 2. Solids are thickened using GTs for PS and DAFTs for WAS. Thickened solids are blended in solids storage tanks (SSTs) and dewatered using centrifuges. Lime is added to the dewatered solids to achieve Class B pathogen and vector attraction reduction. Stabilized biosolids are hauled off site for beneficial use through bulk land application.

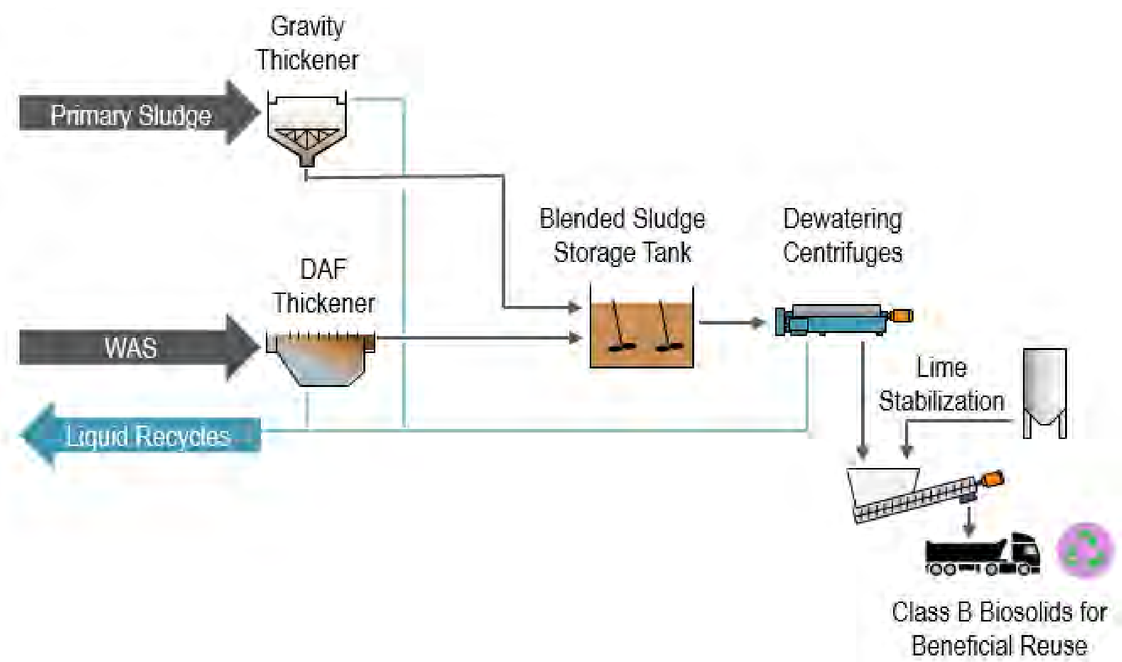

Figure 2. Existing PS and WAS Process Flow Diagram

2.2 Solids Thickening and Storage

PS are pumped from the primary clarifiers to GTs 1 and 2 at an average of 1.0 percent solids, prior to the addition of elutriation water. As documented in TM No. 1, the percent solids data are based on recent special samples as the daily measurements of PS are taken at a location that includes elutriation water. Typically, one of two GTs is in operation. PS are thickened to an average of 4 percent solids. Thickened PS are pumped to the solids storage tanks for storage and blending with thickened waste activated solids (TWAS) prior to dewatering. Refer to Table 2 for the existing GT characteristics.

Table 2. Existing Gravity Thickener Characteristics

Characteristic	Value	Unit
Number of units	2 (1 operating, 1 standby)	
GT diameter	65	ft
Surface area, ea.	3,300	ft^2
Side water depth (SWD)	10	ft
Volume, ea.	0.25	MG
Tank material	Concrete	

WAS is collected from the secondary clarifiers and pumped to DAFTs 1 and 2 at an average of 1.1 percent solids. Typically, one DAFT unit is in operation for WAS thickening. WAS is thickened to an average of 4 percent solids. TWAS is pumped to the solids storage tanks for storage and blending with thickened PS prior to dewatering. See Table 3 for the existing DAFT characteristics.

Table 3. Existing DAFT Characteristics

Characteristic	Value	Unit
Number of units	2 (1 operating, 1 standby)	
Length	50	ft
Width	12	ft
Height	10.75	ft
Surface area, ea.	600	ft^2

The WPCP has two existing solids storage tanks. Gravity thickened PS and DAFT TWAS are pumped to one of two storage tanks, prior to dewatering. Characteristics for the existing solids storage tanks are summarized in Table 4.

Table 4. Existing Solids Storage Tanks Characteristics

Characteristic	Value	Unit
Number of tanks	2 (1 operating, 1 standby)	
Diameter	53	ft
Side water depth	25.5	ft
Volume, each	0.42	MG
Total volume	0.84	MG
Storage duration at current (2020) peak 3-day solids loading	2.5	Days

3.0 Design Criteria

This section presents the major process mechanical design criteria for the thickening system at the Arlington WPCP, including solids loading; thickening technologies; and solids screening, storage, and pre-dewatering requirements. Design criteria for ancillary equipment/systems (i.e., solids pumping, polymer, etc.) and other disciplines will be developed and documented in the Facilities Plan.

3.1 Solids Loading

Thickening alternatives were evaluated based on projected PS and WAS loadings documented in TM No. 1. The following design loading conditions were considered in the thickening evaluation:

- **30.8 million gallons per day (mgd):** design condition
- **40.0 mgd:** projected buildout loading

Peak 3-day solids loadings at the 30.8 mgd and 40.0 mgd design conditions were used to develop preliminary process equipment selections and facility concepts. A summary of the solids loading projections used for the design conditions is provided in Table 5. Startup/minimum conditions were not considered for this evaluation but will be considered in the Facilities Plan.

PS and WAS have an average solids concentration of 1.4 percent and 1.1 percent, respectively. The average PS:WAS ratio is 70:30.

Table 5. Summary of Solids Loading Design Criteria

Design Condition: 30.8 mgd	Flow (gpm)	Solids Concentration	Solids Loading (lb-DS/hr)
PS (3-day)	770	1.0%	3,900
WAS (3-day)	340	1.1%	1,900
Total	1,110	1.0%	5,800
Design Condition: 40.0 mgd	**Flow (gpm)**	**Solids Concentration**	**Solids Loading (lb-DS/hr)**
PS (3-day)	1,000	1.0%	5,000
WAS (3-day)	450	1.1%	2,500
Total	1,450	1.0%	7,500

3.2 Thickening Technologies

The thickening evaluation considered multiple thickening technologies for separate and co-thickening of PS and WAS. Thickening technologies considered include the existing GTs and DAFTs, as well as gravity-belt thickeners (GBTs), rotary-drum thickeners (RDT), and thickening centrifuges. Preliminary process sizing and alternative evaluations were based on the technology-specific design criteria presented in the following sections.

3.2.1 Gravity Thickeners

Continued use of the existing GTs was evaluated both for separate thickening of PS as well as co-thickening of PS and WAS. Design criteria used for the GTs are summarized in Table 6. Rehabilitation and improvements to the GT complex are required to extend the service life of the existing facilities. Refer to TM No. 2, *Condition of Existing Facilities*, for a condition assessment of the existing facility and recommended improvements including concrete repairs and complete replacement of the tank covers and mechanical equipment internal to the tanks. Conceptual costs for structural and major process mechanical rehabilitation have been developed and included in the capital cost estimate for those alternatives that include gravity thickening.

Table 6. Gravity Thickener Design Criteria

Parameter	Value	Unit
PS (maximum loading)	30 (4,150)	lb/ft^2-d (lb/hr)
WAS (maximum loading)	8	lb/ft^2-d
PS and WAS (maximum loading)	14	lb/ft^2-d
Thickened PS concentration	4.0	Percent
Co-thickened PS and WAS concentration	3.0	Percent

3.2.2 Dissolved Air Flotation Thickeners

The two existing DAFT units were included in this evaluation for WAS thickening. DAFT design criteria are summarized in Table 7. For the purposes of this evaluation, the maximum solids loading for the DAFTs assumes polymer addition as they currently operate. Although DAFT units require high levels of energy and maintenance, they were included in the evaluation as the WPCP currently uses this technology.

Table 7. DAFT Design Criteria

Parameter	Value	Unit
Hydraulic loading	1,200	gpm
Maximum solids loading (no polymer addition)	600	lb-DS/hr
Maximum solids loading (with polymer addition)	1,200	lb-DS/hr
Typical polymer dosages	0–5	lb/DT
TWAS concentration	4.0	Percent

Based on the solids design criteria included in TM No. 1, the existing DAFT units are likely exceeding recommended loading rates during peak 3-day loadings. Operations has been able to accommodate these flows previously, but it is expected to become more difficult as flows increase.

3.2.3 Gravity-Belt Thickeners

GBTs are a proven technology for mechanical thickening and provide a competitive balance of thickening performance per footprint, operational cost, and power usage. Typically, polymer is injected into the solids stream and mixed upstream of the GBTs. The solids/polymer slurry is fed into a feedbox for a consistent distribution across the belt. The belt conveys the solids through stationary plows that furrow the slurry to promote water/solids separation. The belt discharges the thickened solids into a hopper, which is connected to a pump. Filtrate is collected in drain pans and flows by gravity to the process drain system. A spraywater system, including a booster pump and spray header, is used to clean the belt on the bottom side of the GBT as it returns to the feedbox. A schematic of the GBT process is shown on Figure 3.

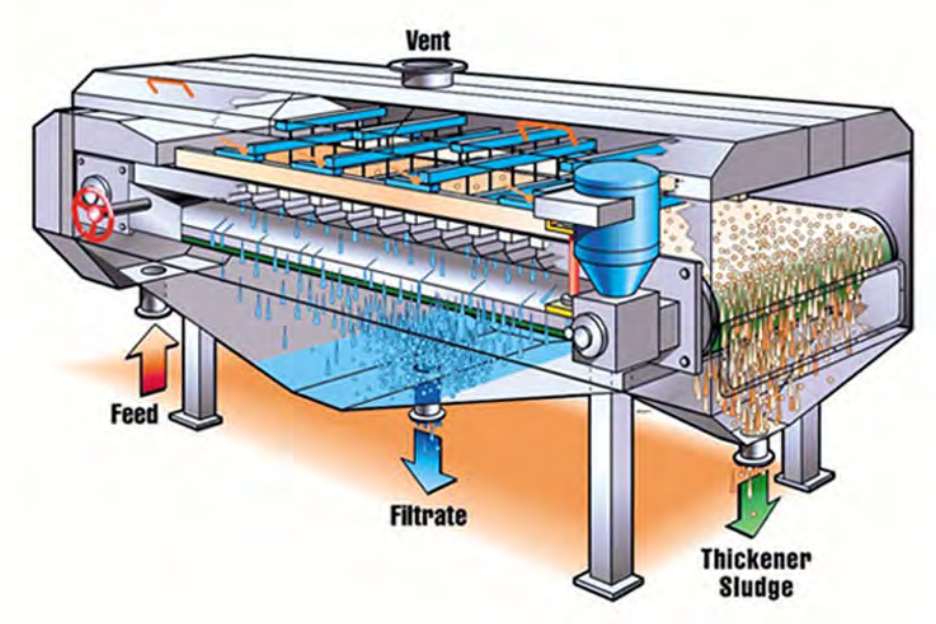

Image credit: BDP Industries.

Figure 3. GBT Schematic

GBTs can be open to allow for easy observation of the thickening process; however, this can lead to local odor issues as the solids are exposed to the atmosphere, especially for co-thickened solids. GBTs can be covered to contain odors but covers can hinder the ability to easily observe the thickening process. GBTs are typically located indoors and off-site odors can be managed through ventilation and odor treatment. An image of an enclosed GBT is shown on Figure 4, and an open GBT is shown on Figure 5. Typical GBT design criteria used for this evaluation are summarized in Table 8.

Figure 4. Enclosed GBT

Figure 5. Open GBT

Table 8. GBT Design Criteria

Parameter	Value	Unit
Belt width	2.0	Meters
Hydraulic loading	400	gpm
Solids loading	2,000	lb-DS/hr
Typical polymer dosages	6–10	lb/DT
GBT thickened solids concentration	5.0	Percent

3.2.4 Rotary-Drum Thickeners

RDTs are another proven mechanical thickening technology and offer similar performance to GBTs. Polymer is added and mixed with the solids feed in a flocculation tank upstream of the RDT. A schematic of an RDT is shown on Figure 6.

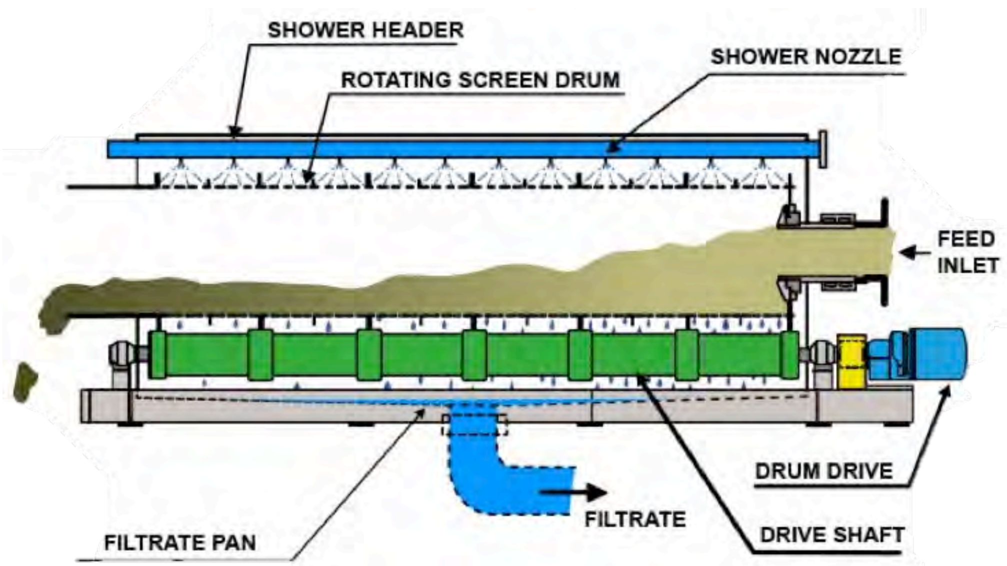

Figure 6. RDT Schematic

An image of an RDT, with floc tank, is shown on Figure 7. Solids are fed into a rotating cylindrical screen fitted with a screw and flights to furrow and convey solids forward. Water is drained through the screen into a filtrate drain. Solids are discharged into a hopper at the downstream end of the RDT. A spraywater system is used to constantly clean the screen. Typical RDT design criteria used for this evaluation are summarized in

Table 9.

Figure 7. RDT and Floc Tank

Table 9. RDT Design Criteria

Parameter	Value	Unit
Hydraulic loading	350	gpm
Solids loading	1,800	lb-DS/hr
Typical polymer dosages	5-15	lb/DT
RDT thickened solids concentration	5.0	Percent

3.2.5 Thickening Centrifuges

Thickening centrifuges were included in this evaluation for mechanical thickening. WPCP staff are familiar with centrifuge operation and maintenance because centrifuges are currently used for dewatering. Thickening centrifuges have the same operation principle as a dewatering centrifuge. The main difference between thickening centrifuges and dewatering centrifuges is how they are controlled, and the instrumentation used to monitor and produce a consistent thickened solids or dewatered cake concentration. Dewatering centrifuges typically monitor torque to control the bowl/scroll speed(s). However, in a thickening centrifuge, torque is not significant as the scroll is conveying a much more liquid slurry through the bowl. Instrumentation is needed to monitor feed solids and/or thickened solids concentrations, which is used to adjust the differential speed. Some manufacturers offer an automatically adjustable pond (depth of liquid within the centrifuge) varying system that adjust while the centrifuge is operating to allow the pond depth to increase or decrease, depending on feed solids concentration and/or thickened solids concentration. Typical design criteria used in the evaluation of centrifuge thickening for WAS are listed in Table 10.

Table 10. Thickening Centrifuge Design Criteria

Parameter	Value	Unit
Bowl diameter	29	Inch (nominal)
Hydraulic loading	400	gpm
Solids loading	4,000	lb-DS/hr
TWAS concentration	Up to 10	Percent
Typical polymer dosages	10–15	lb/DT

3.3 Solids Screening, Storage, and Pre-Dewatering

Solids thickening directly and significantly impacts the size and configuration of the solids screening, storage, and pre-dewatering facilities located downstream. These technologies, facilities, and site impacts will be evaluated in detail, separately from this thickening evaluation. However, conceptual sizing and layouts are included in the thickening evaluation to assess and compare how each thickening alternative impacts these downstream process facilities. Table 11 provides the criteria used in this thickening evaluation. It is assumed these facilities will operate 24 hours per day, 7 days per week.

Table 11. Solids Screening, Storage, and Pre-Dewatering Criteria

Parameter	Solids Screening	Solids Storage	Pre-Dewatering
Configuration/type	Inline	Circular	Centrifuge
Size	5 mm (perforations)	60 ft diameter/20 ft SWD 0.42 MG volume	29 in. bowl (nominal)
Manufacturer/model	Huber/SP290	N/A	GEA/CF8000
Hydraulic loading	370 gpm at 1.3%	1 day of storage at 30.8 mgd, peak 3-day	500 gpm
Solids loading	6.0% maximum	N/A	4,000 lb-DS/hr

Following the selection of approach for thickening, these other systems, including screening, thickened solids storage, and pre-dewatering will be refined and optimized. The solids storage tanks used for the thickening evaluation assumes a common size and construction for each alternative. For some alternatives, the required volume in order to store 24 hours of solids at the peak 3-day design condition results in only one storage tank at this common size. Ultimately, the conceptual design for liquid (un-thickened and thickened) solids storage will be refined, including tank volume, construction, mixing and odor control, as required, and a minimum of two solids storage tanks will be provided in the Facilities Plan, providing both the required liquid solids storage as well as the redundancy needed for operational flexibility of this unit process.

4.0 Thickening Alternatives

Eight thickening alternatives were developed and presented at the March 17, 2021, workshop. Two additional alternatives (7A and 8A) were added to the evaluation through discussions with the County at workshops. Table 12 summarizes each alternative and provides a brief description of the process flow. In each alternative discussion, the total number of thickening units, solids screens, pre-dewatering units, and liquid solids storage tanks needed for both the 30.8 mgd and 40.0 mgd design conditions are listed.

Table 12. Thickening Alternatives Evaluated

Alternative	Thickening Technologies	General Process Flow
1	No thickening	PS/WAS → storage → solids screens → storage → pre-dewatering
2	GT/DAFT	PS → GTs WAS → DAFTs → solids screens → storage → pre-dewatering
3	GT/GBT	PS → GTs WAS → GBTs → solids screens → storage → pre-dewatering
4	GT/RDT	PS → GTs WAS → RDTs → solids screens → storage → pre-dewatering
5	GT/centrifuge	PS → GTs WAS → centrifuges → solids screens → storage → pre-dewatering
6	Co-thickening (GT)	PS + WAS → GTs → solids screens → storage → pre-dewatering
7	Un-thickened PS/GBT or RDT	PS → storage WAS → GBTs or RDTs → solids screens → storage → pre-dewatering
7A	GT/Un-thickened WAS	PS → GTs WAS → storage → solids screens → storage → pre-dewatering
8	Co-thickening (GBT or RDT)	PS → storage WAS → → GBTs or RDTs → solids screens → storage → pre-dewatering
8A	Separate thickening (GBT or RDT)	PS → storage → GBTs or RDTs WAS → GBTs or RDTs → solids screens → storage → pre-dewatering

4.1 Conceptual Design and Capital Cost Development

Conceptual process configurations, equipment sizing, and building and site layouts were developed for each thickening alternative. Preliminary design criteria were distributed to various manufacturers for thickening, solids screening, and pre-dewatering equipment to obtain preliminary equipment quotes and equipment dimensions and layout drawings. Based on the preliminary design criteria, equipment layout drawings and building footprint/dimensions were established as a basis for estimating facility costs. The building footprint included the process equipment needed to meet the 30.8 mgd, peak 3-day solids loading; space for adding additional equipment in the future to meet the 40.0 mgd, peak 3-day solids loading; and space for various support facilities including polymer storage and feed, electrical and control room spaces, and bridge cranes to allow for equipment removal.

4.1.1 Conceptual Pre-Dewatering Building Layouts

A conceptual pre-dewatering building layout was prepared for each alternative to determine the approximate footprint of the facility as a basis for conceptual cost preparation and site layout considerations. The pre-dewatering building layout assumes that the solids screens and pre-dewatering equipment will be located in the same building. For the purposes of this evaluation, the pre-dewatering building layout includes solids screens and pre-dewatering centrifuges for the 30.8 mgd, peak 3-day solids projections, and includes space for future expansion of solids screens and pre-dewatering centrifuges as needed to meet the 40.0 mgd, peak 3-day solids projections. Electrical and control room spaces, polymer area, and space needed for equipment maintenance/removal have been considered in the conceptual pre-dewatering building layouts.

4.1.2 General Site Layouts

General site layout figures are provided for each alternative. The intent of these site figures is to show approximate site space required by the alternative and assumes that new buildings/structures are provided for the new thickening, solids screening, storage, and pre-dewatering facilities, except for the GTs and DAFTs (where applicable). Site layout(s) will be further developed in the site utilization evaluation.

4.1.3 Conceptual Capital Costs

Conceptual capital and construction costs were prepared for each alternative based on preliminary equipment quotes from vendors; cost per square foot (ft^2) for buildings; and general percentages for ancillary facilities, site work, contingencies, and general contractor costs shown in Table 13. Demolition costs were included for the alternatives where the existing thickening facilities were not used (GT, DAFT, or both). GT rehabilitation costs were included for the alternatives that included gravity thickening. The rehabilitation costs include concrete repair, replacement of major process mechanical equipment, and replacement of the covers.

Table 13. General Percentage Adders to Base Cost for Conceptual Cost Development

Parameter	Percentage
Sitework	15%
Electrical	20%
Instrumentation and controls	8%
Large and specialty pipe	5%
Geotechnical (piles)	7%
Project contingency	20%
Contractor mobilization/staging	5%
Contractor bonds/insurance	3%
Contractor overhead and profit	15%

The conceptual cost is only a rough order of magnitude to use for relative comparisons between the various alternatives. The conceptual costs presented herein are not for budgeting purposes. Opinions of probable construction costs (OPCCs) will be prepared as part of the Facilities Plan, separate from this thickening evaluation.

4.2 Thickening Alternative Descriptions

This section presents descriptions of the thickening alternatives under consideration.

4.2.1 Alternative 1: No Thickening

Alternative 1 would eliminate thickening in its entirety, as recommended in the Master Plan. A PFD of Alternative 1 is shown on Figure 8. As PS is pumped intermittently from the primary clarifiers, a small approximately 8-hour PS buffer tank is recommended upstream of the solids screens. Although existing operations could be altered to pump continuously, this would require modifications to the existing pumping systems, which are beyond the scope of this analysis. The buffer tank provides additional benefit of decoupling operation of the existing primary clarifiers from the screens and pre-dewatering units, reducing the chance for process upset. For purposes of this evaluation, it is assumed that one 60-foot-diameter storage tank (420,000 gallons) would be provided for storing un-thickened solids. This equates to just over 6 hours of storage at the 3-day peak design condition (just over 12 hours at average design conditions). The existing GT tanks could be retrofit to store primary solids upstream of screening, requiring new covers and mixing systems for PS storage. The two existing GTs would provide approximately as much storage as one new solids storage tank. For purposes of this evaluation, only the new solids storage tank was priced.

WAS would be pumped to the solids storage tanks to be combined with the PS. Additional combined storage of PS and WAS is required before pre-dewatering, for a total storage of 24 hours for peak 3-day load at 30.8 mgd. Screening and dewatering un-thickened PS and WAS has a significant impact on the hydraulic loading and sizing for these facilities and for the required screened solids storage prior to pre-dewatering. Table 14 summarizes the solids flows and the number of solids screens, pre-dewatering centrifuges, and storage tanks needed for 30.8 mgd and 40.0 mgd solids loading projections. Figure 9 shows a general layout of the pre-dewatering facility and the solids storage tanks required for this alternative. Figure 10 shows a conceptual layout of the pre-dewatering building for this alternative.

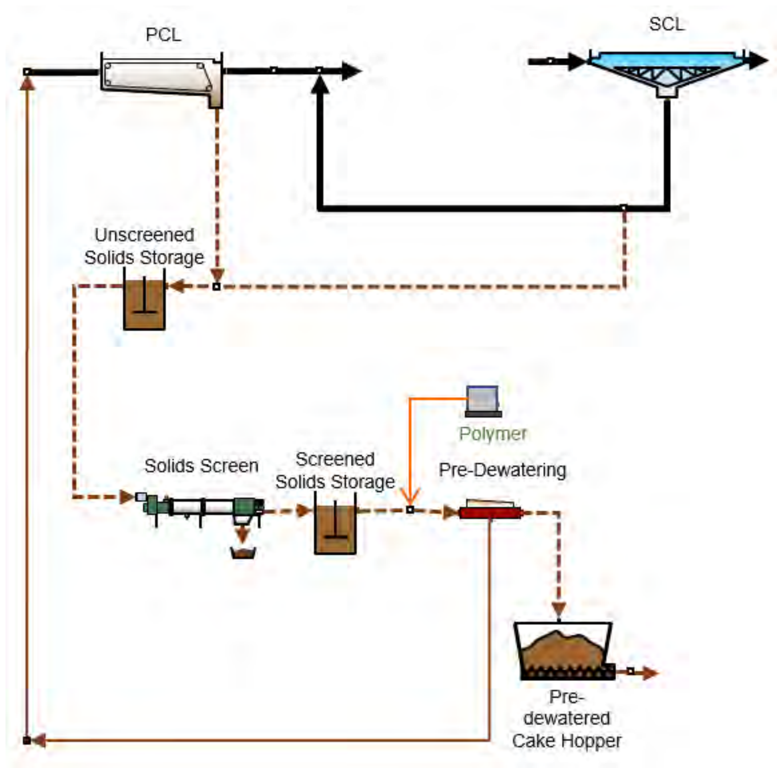

Figure 8. Alternative 1 Process Flow Diagram

Table 14. Alternative 1 Design Criteria

Parameter	30.8 mgd	40.0 mgd
PS/WAS concentration	1.03%	1.03%
PS/WAS flow to screens (gpm)	1,120	1,450
Number of solids screens (duty/standby)	3/1	4/1
Number of pre-dewatering centrifuges (duty/standby)	3/1	3/1
Liquid solids storage tanks (duty/standby)	4/0[a]	
Conceptual capital cost	$31M	

Notes:

a. Includes 1 tank for un-thickened PS (8 hr storage).

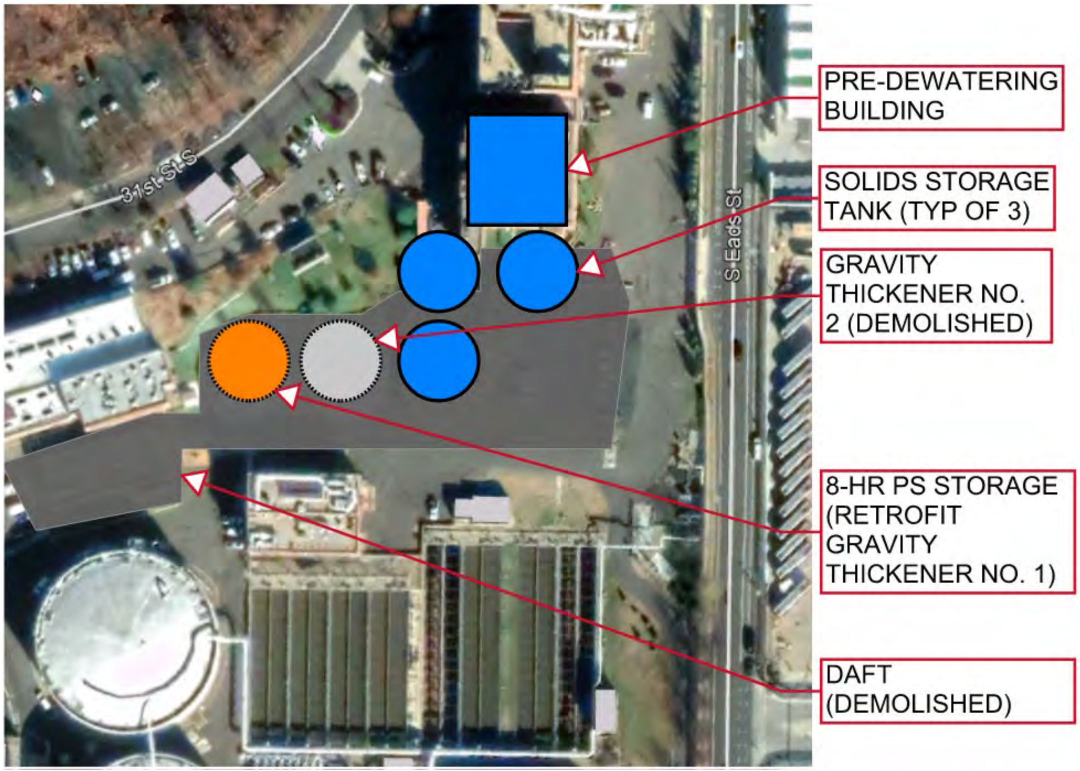

Figure 9. Alternative 1 General Site Layout

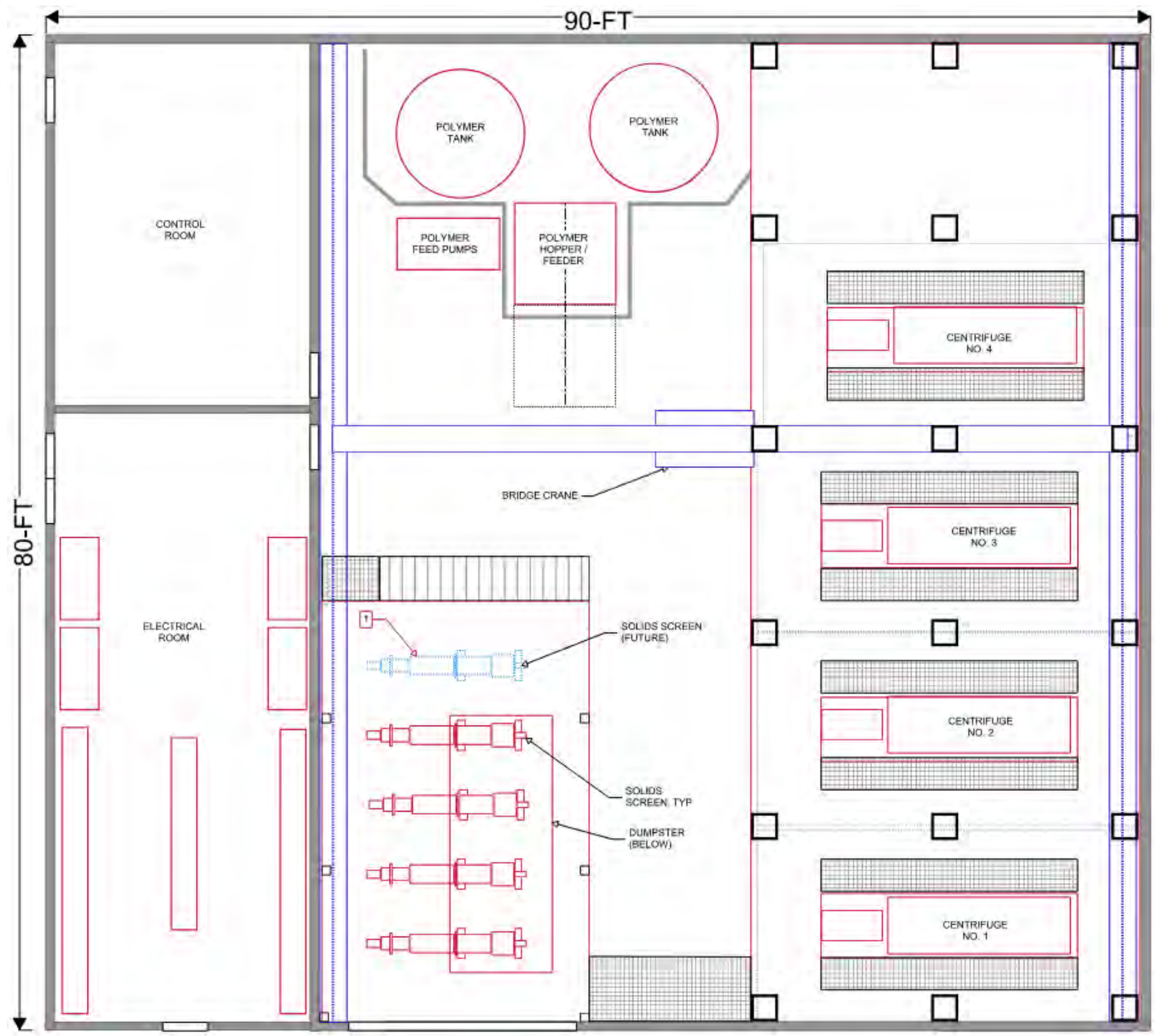

Figure 10. Conceptual Pre-dewatering Building Layout

The County requested that the existing GT tanks be considered for storage in lieu of constructing new storage. The volume of one existing GT tank is approximately half that of the new storage tank used for this evaluation. Therefore, using two GT tanks would reduce the number of new storage tanks by one. The conceptual cost difference between installing three new storage tanks versus installing two new storage tanks and using the two existing GT tanks is not expected to be significant. While cost savings would be realized from eliminating one new storage tank, the existing GTs would require concrete rehabilitation and would need to be converted to storage tanks, which would include replacement covers as well as mixing equipment. Additionally, this alternative requires a buffer tank for PS storage prior to the solids screens. One GT would provide approximately 8 hours of PS storage, or a new tank would need to be constructed.

The advantages and disadvantages of this alternative are listed in Table 15.

Table 15. Alternative 1 Advantages and Disadvantages

Advantages	Disadvantages
Eliminates thickening process and associated O&M costs, including polymer and plant effluent water	Site constrictions during construction and maintenance of plant operations considerations are more significant because of the volume of storage required for un-thickened solids and an 8-hour PS storage/buffer tank upstream of solids screening.
Lower conceptual capital and O&M costs	Higher volume of storage for un-thickened solids results in increased volume of odorous air to treat from storage tank headspace, although similar to GTs.
	Additional solids screening and pre-dewatering equipment units are required to process un-thickened solids.
	Screening and pre-dewatering facility footprint increased to accommodate additional solids screening and pre-dewatering equipment units.

4.2.2 Alternative 2: Gravity Thickeners (PS)/Dissolved Air Flotation Thickeners (WAS)

Alternative 2 would be similar to the current solids thickening processes at the WPCP as shown on the PFD on Figure 11. The GT would require structural repairs, major process mechanical equipment improvements, and replacement of the covers, as well as connection to a new or upgraded odor control station. Table 16 presents design criteria for Alternative 2, Figure 12 provides a general site layout for Alternative 2, and Figure 13 shows a conceptual layout of the pre-dewatering building for this alternative and all subsequent alternatives that include thickening.

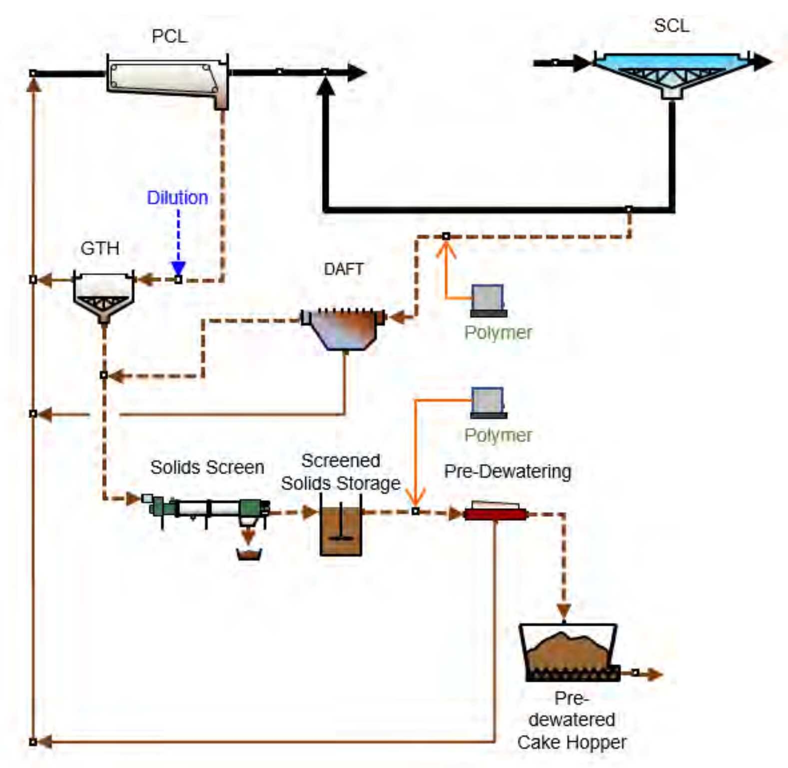

Figure 11. Alternative 2 Process Flow Diagram

Table 16. Alternative 2 Design Criteria

Parameter	30.8 mgd	40.0 mgd
Thickened PS/TWAS concentration	4.0%	4.0%
Number of GTs (duty/standby)	1/1	1/1 [a]
Number of DAFT (duty/standby)	2/1	3/1
PS/WAS flow to screens (gpm)	290	370
Number of solids screens (duty/standby)	2/1	2/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	2/1
Liquid solids storage tanks	1	
Conceptual cost	$44M	

Notes:

a. At 40 mgd, peak 3-day solids projections, GT maximum loading is exceeded. There is sufficient time to evaluate GT performance at higher loading rates. Options for future consideration (post-2050) include: proofing performance with higher loading rates, operating both GTs during peak loading events, building a third GT in the future, or bypassing a portion of un-thickened PS (estimated at less than 20%) if only one GT is available and it is unable to perform at higher loading rates.

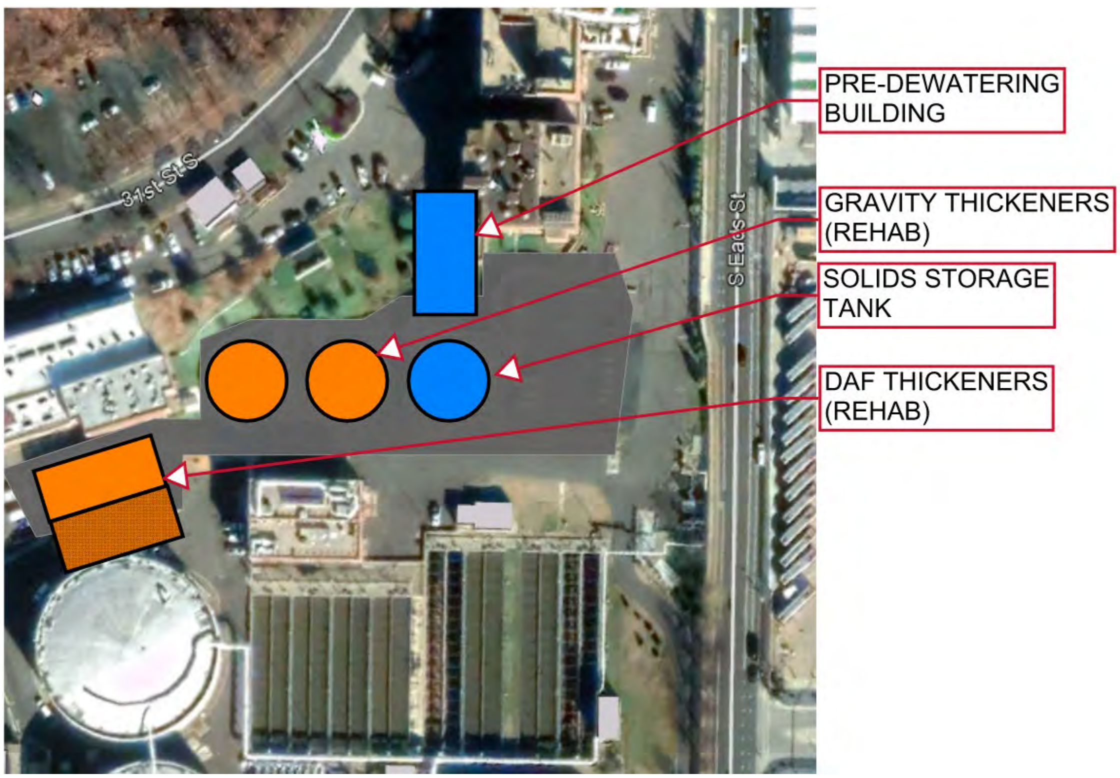

Figure 12. Alternative 2 General Site Layout

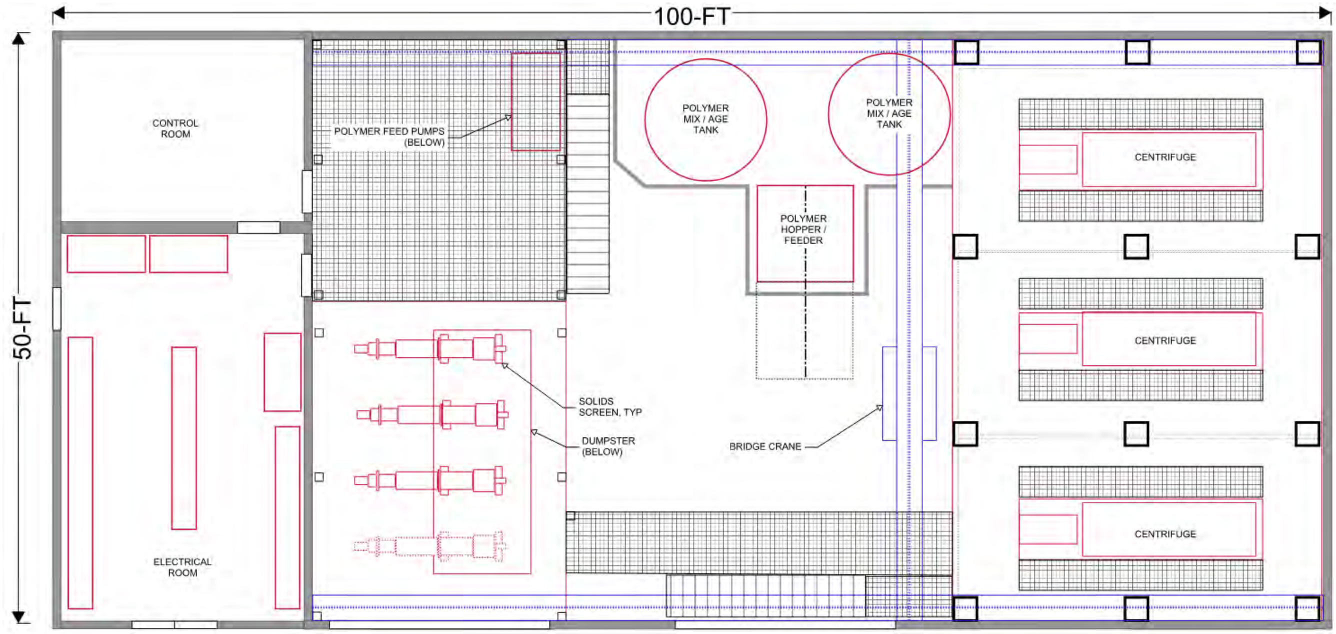

Figure 13. Conceptual Pre-dewatering Building Layout

During the March 17, 2021, workshop, Alternative 2 was eliminated from consideration as there is not sufficient site space for the DAFT facility to be expanded as required to meet future flows. Additionally, the conceptual cost is much higher than that of other alternatives and the DAFTs are high-energy, mechanically intensive units.

4.2.3 Alternative 3: Gravity Thickeners (PS)/Gravity-Belt Thickeners (WAS)

Alternative 3 would include gravity thickening of PS and mechanical thickening of WAS using a GBT and is shown in the PFD on Figure 14. GT rehabilitation would be required, as described for Alternative 2. For the purposes of this evaluation, a new facility to house the GBTs ancillary equipment, including polymer, was considered. The GBTs offer a small footprint per thickening performance compared to the existing DAFT process and are responsive to operator adjustment to control thickening operations.

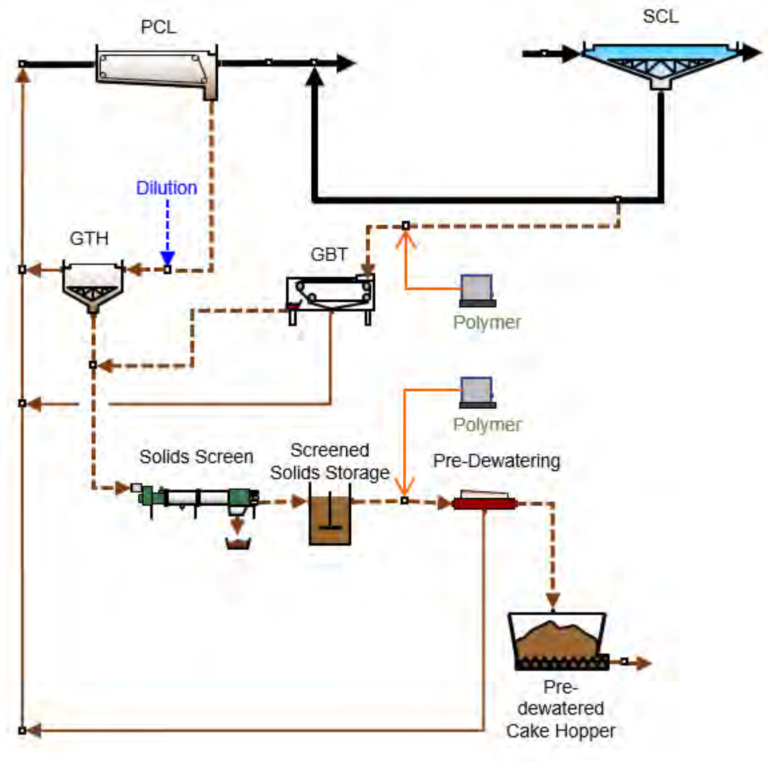

Figure 14. Alternative 3 Process Flow Diagram

This alternative would provide benefits to the overall site impacts. Solids storage and the pre-dewatering equipment/facility quantities and layouts would be minimized. Additionally, the DAFT building can be demolished, providing additional space on site for other uses. The conceptual cost for this alternative is on the lower end of the alternative costs. Table 17 presents design criteria for Alternative 3. The site layout provided in Figure 15 shows a separate GBT building for WAS thickening and a new pre-dewatering building. A conceptual layout of a GBT facility is shown in Figure 16. The pre-dewatering equipment and building layout for this option would be similar to the one shown for Alternative 2.

Table 17. Alternative 3 Design Criteria

Parameter	30.8 mgd	40.0 mgd
Thickened PS/TWAS concentration	4.28%	4.28%
Number of GTs (duty/standby)	1/1	1/1 [a]
Number of GBTs (duty/standby)	1/1	2/1
PS/WAS flow to screens (gpm)	270	350
Number of solids screens (duty/standby)	2/1	2/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	2/1
Liquid solids storage tanks	1	
Conceptual cost	$32M	

Notes:

a. At 40 mgd, peak 3-day solids projections, GT maximum loading is exceeded. There is sufficient time to evaluate GT performance at higher loading rates. Options for future consideration (post-2050) include: proofing performance with higher loading rates, operating both GTs during peak loading events, building a third GT in the future, or bypassing a portion of un-thickened PS (estimated at less than 20%) if only one GT is available and it is unable to perform at higher loading rates.

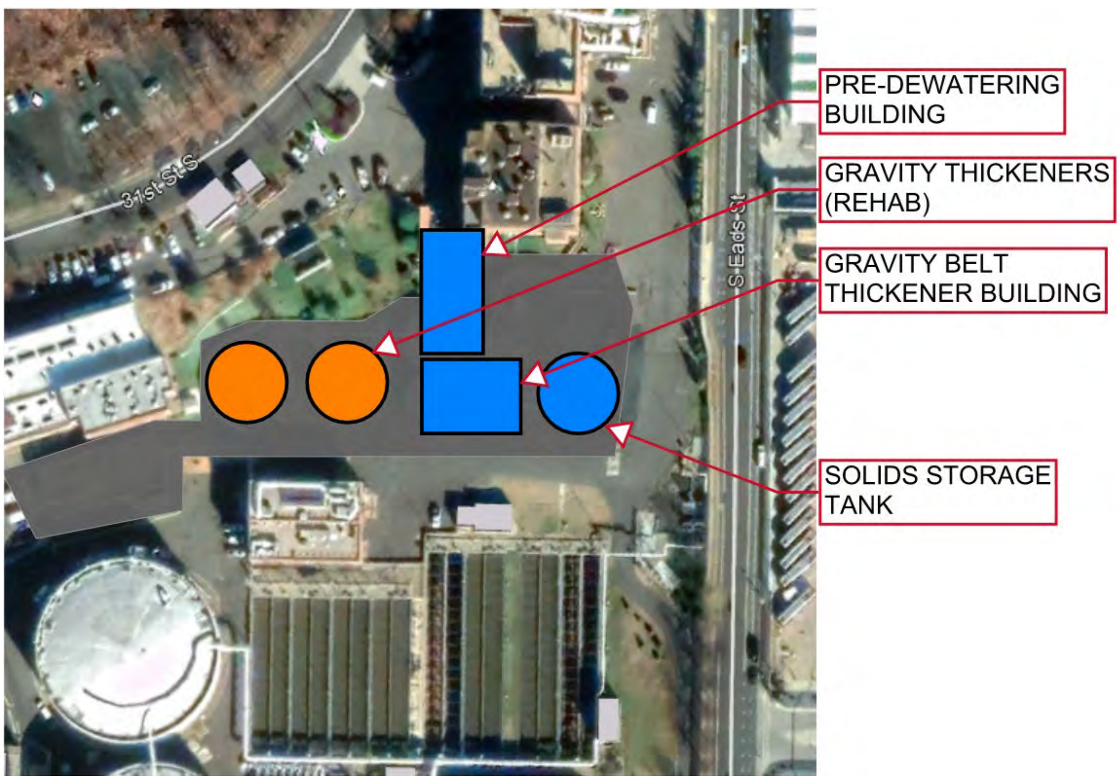

Figure 15. Alternative 3 General Site Layout

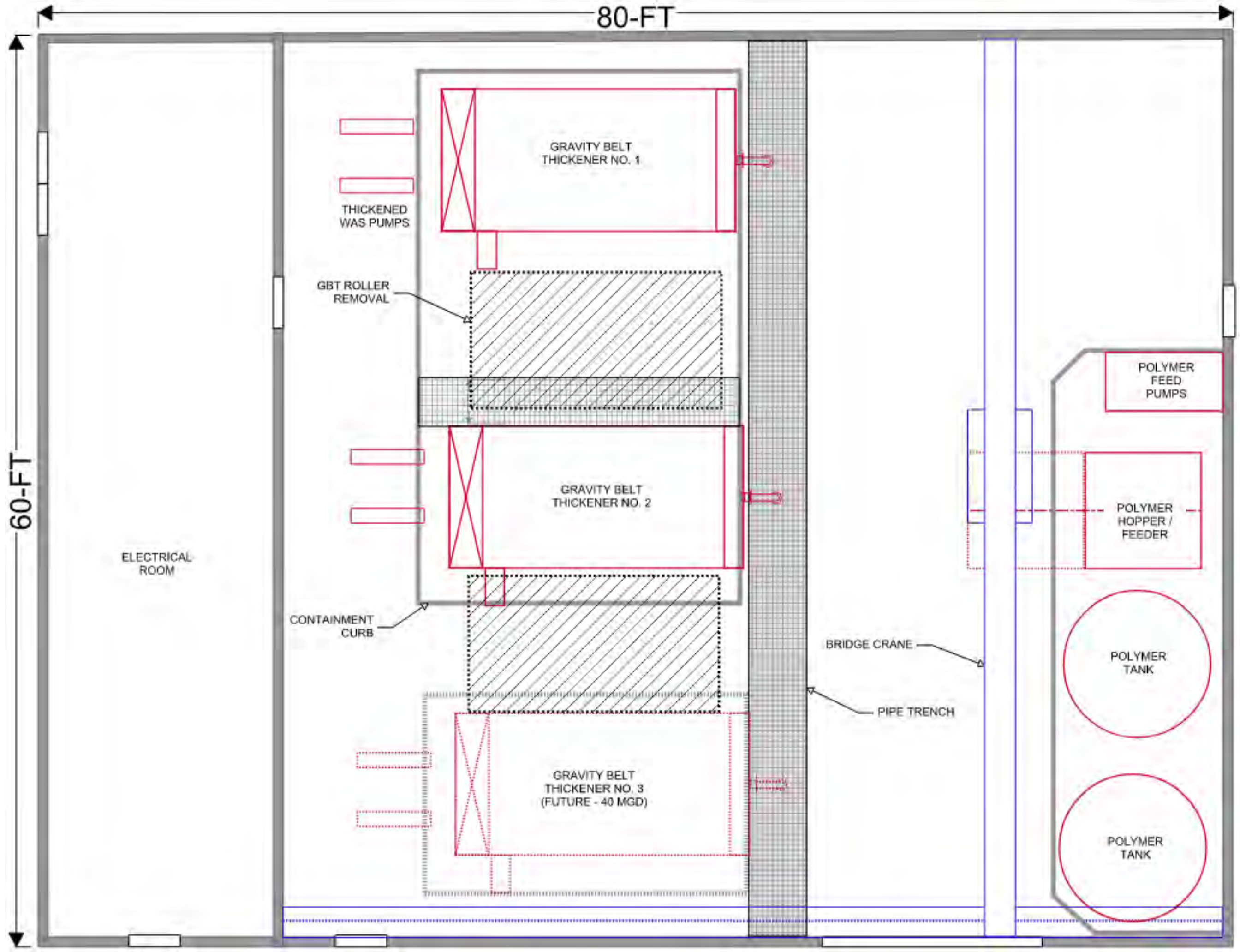

Figure 16. Alternative 3 GBT Building Layout

The advantages and disadvantages of this alternative are listed in Table 18.

Table 18. Alternative 3 Advantages and Disadvantages

Advantages	Disadvantages
GBTs offer high thickening performance per square foot, minimizing WAS thickening footprint.	GBT technology is new to the WPCP staff.
GTs provide a "buffer" for PS upstreaming of solids screens, no separate PS storage/buffer tank is necessary.	GBTs can have local odor issues if not enclosed, especially for co-thickened solids. Some enclosures reduce operation observation and access for maintenance.
Lower conceptual capital and O&M costs.	GT loading is exceeded at 40.0 mgd, peak 3-day solids projections. Mitigation measures may be required beyond 2050.
GTs and GBTs both have relatively low energy requirements.	Flushing of PS lines to GTs needs to be considered.
GBTs for WAS thickening is a common and effective practice.	Belt changes after 2 years of operation.
GBT operations and maintenance is less significant/intensive than other thickening technologies (thickening centrifuges and DAFTs).	Potential roller replacements required.
Open GBTs as well as many enclosures permit operator observation of thickening process, allowing for fine-tuning processes.	
Thickening PS/WAS upstream of solids screens, solids storage, and pre-dewatering reduces equipment quantities and facility footprint on constrained site.	

4.2.4 Alternative 4: Gravity Thickeners/Rotary-Drum Thickeners

Alternative 4 would include gravity thickening for PS and RDTs for WAS. A PFD for Alternative 4 is shown on Figure 17. A new facility was assumed for the RDTs. RDTs have a slightly lower solids throughput (approximately 10 percent lower) than GBTs. Table 19 presents design criteria for Alternative 4. Figure 18 provides the site plan with a new RDT facility and a new pre-dewatering building similar to that shown for Alternative 2. Figure 19 shows an RDT building layout for Alternative 4. Conceptual cost for this alternative is comparative to Alternative 3 (GT/GBTs).

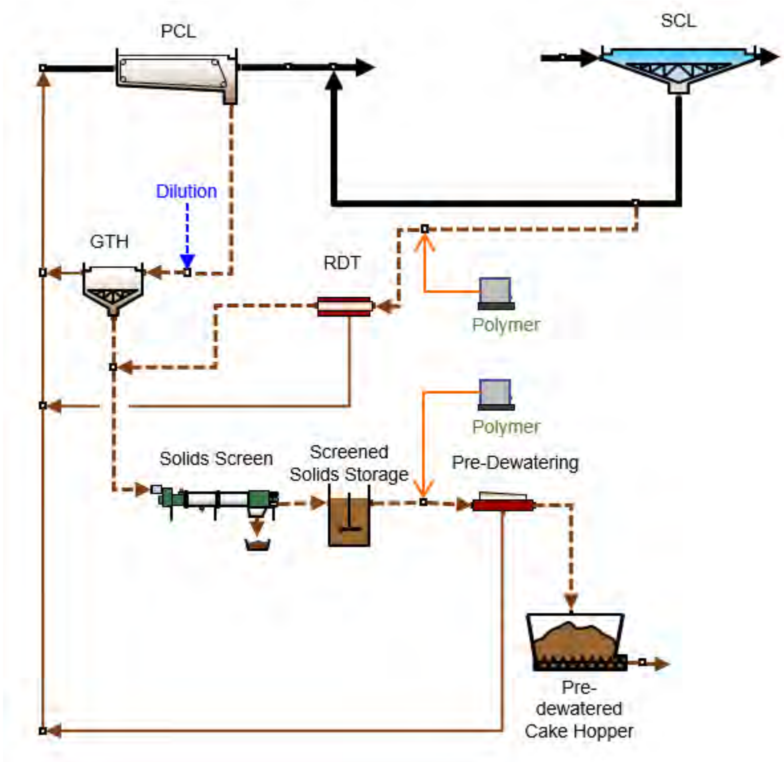

Figure 17. Alternative 4 Process Flow Diagram

Table 19. Alternative 4 Design Criteria

Parameter	30.8 mgd	40.0 mgd
Thickened PS/TWAS concentration	4.23%	4.23%
Number of GTs (duty/standby)	1/1	1/1 [a]
Number of RDTs (duty/standby)	2/1	2/1
PS/WAS flow to screens (gpm)	270	350
Number of solids screens (duty/standby)	2/1	2/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	2/1
Liquid solids storage tanks	1	
Conceptual cost	$33M	

Notes:

a. At 40 mgd, peak 3-day solids projections, GT maximum loading is exceeded. There is sufficient time to evaluate GT performance at higher loading rates. Options for future consideration (post-2050) include: proofing performance with higher loading rates, operating both GTs during peak loading events, building a third GT in the future, or bypassing a portion of un-thickened PS (estimated at less than 20%) if only one GT is available and it is unable to perform at higher loading rates.

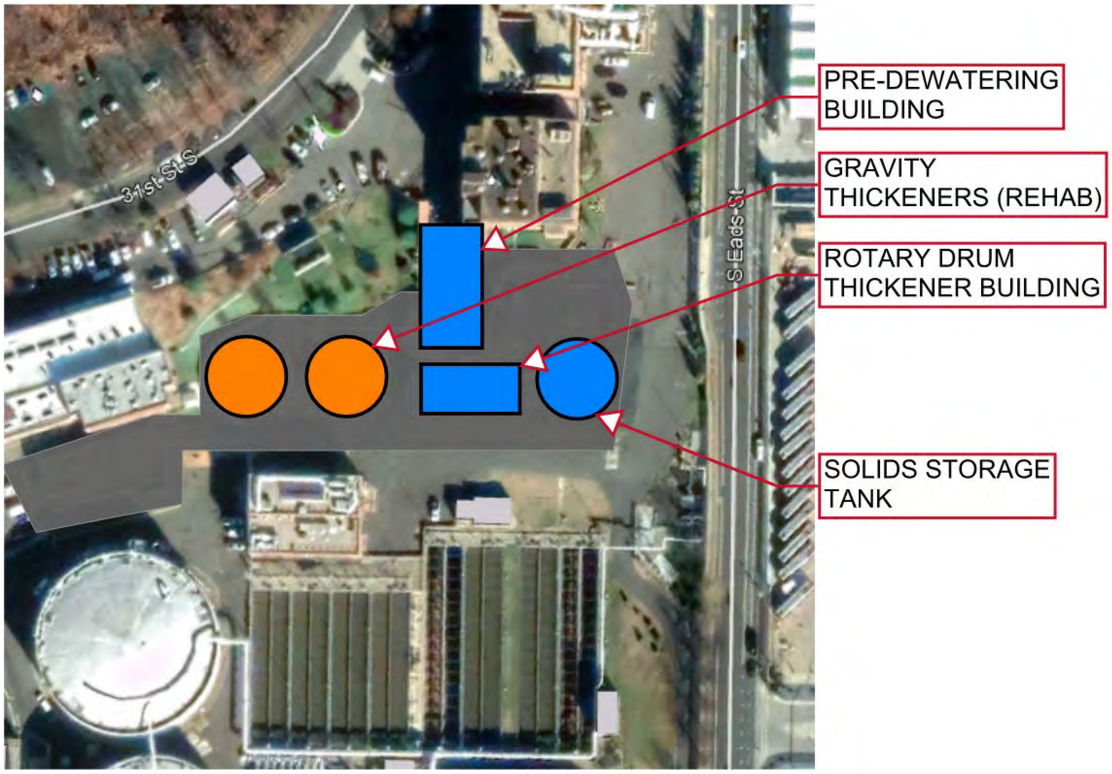

Figure 18. Alternative 4 General Site Layout

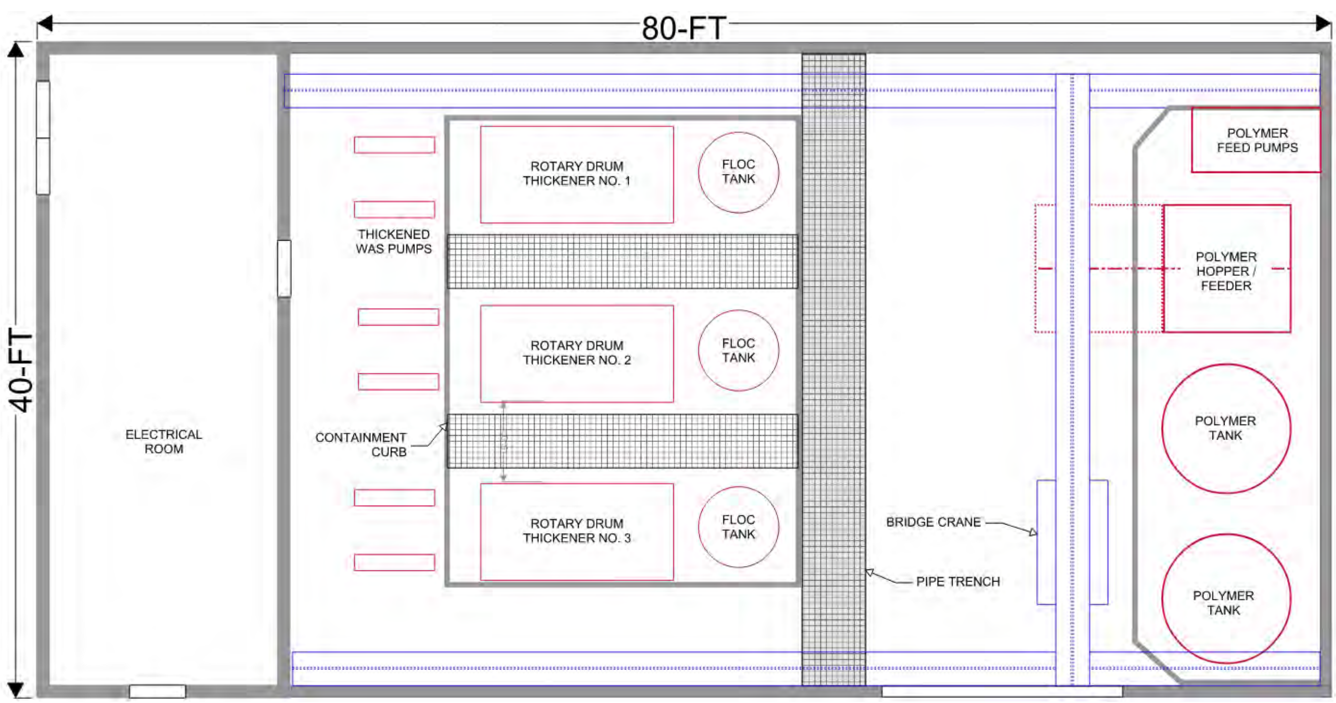

Figure 19. Alternative 4 RDT Building Layout

The advantages and disadvantages of this alternative are listed in Table 20.

Table 20. Alternative 4 Advantages and Disadvantages

Advantages	Disadvantages
RDTs offer high thickening performance per square foot, minimizing WAS thickening footprint.	RDT technology is new to the WPCP staff.
GTs provide a "buffer" for PS upstreaming of solids screens, no separate PS storage/buffer tank is necessary.	RDT solids thickening capacity is typically lower, requiring more units, and can require more polymer than GBTs.
Lower conceptual capital and O&M costs.	RDTs are enclosed, observation of thickening process is not available.
GTs and RDTs both have relatively low energy requirements.	RDTs offer less operator control for adjustments in thickening process and preventing "over-thickening" can be difficult.
RDTs for WAS thickening is a common and effective practice.	GT loading is exceeded at 40.0 mgd, peak 3-day solids projections. Mitigation measures may be required beyond 2050.
RDTs are enclosed, minimizing local odor issues.	
RDT operations and maintenance is less significant/intensive than other thickening technologies (thickening centrifuges and DAFTs).	
Thickening PS/WAS upstream of solids screens, solids storage and pre-dewatering reduces equipment quantities and facility footprint on constrained site.	
Minimal wear components and maintenance.	

4.2.5 Alternative 5: Gravity Thickeners/Centrifuges

Alternative 5 would include gravity thickening for PS and WAS thickening using thickening centrifuges. A PFD of Alternative 5 is shown on Figure 20. Blending centrifuge TWAS with gravity-thickened PS would result in a thickened PS/TWAS concentration of approximately 4.7 percent as indicated in Table 21. Figure 21 below shows a site layout and Figure 22 shows a preliminary centrifuge thickening building layout for Alternative 5.

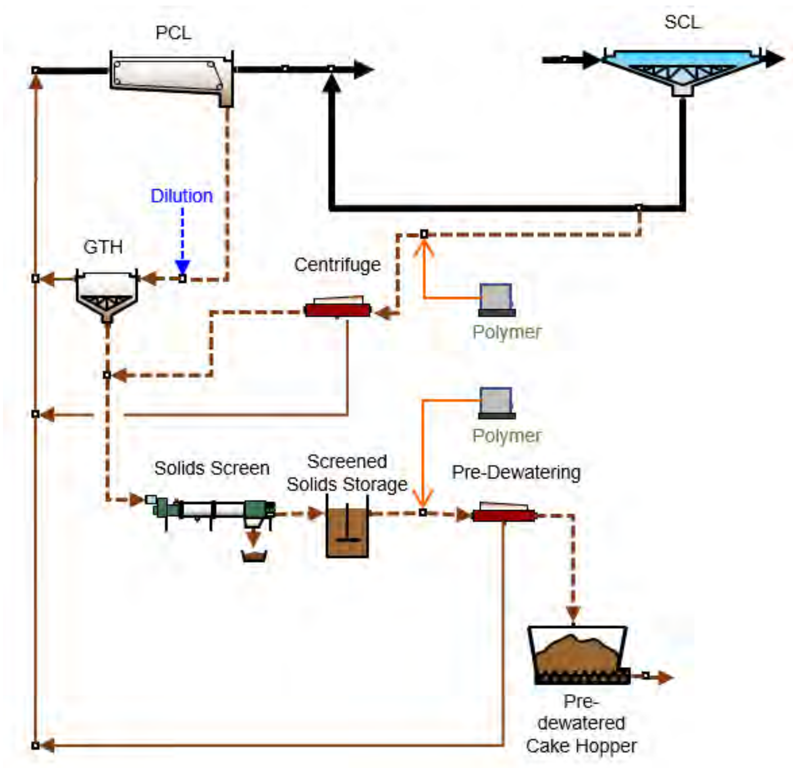

Figure 20. Alternative 5 Process Flow Diagram

This alternative provides similar benefits as Alternatives 3 (GT/GBT) and 4 (GT/RDT). However, there are some drawbacks for this alternative, especially that thickening centrifuges require much higher power demands and potential need for off-site maintenance. Based on these drawbacks, this alternative was eliminated from consideration during the March 17, 2021, workshop.

Table 21. Alternative 5 Design Criteria

Parameter	30.8 mgd	40.0 mgd
Thickened PS/TWAS concentration	4.28%	4.28%
Number of GTs (duty/standby)	1/1 [a]	1/1 [a]
Number of thickening centrifuges (duty/standby)	1/1	2/1 [b]
PS/WAS flow to screens (gpm)	270	350
Number of solids screens (duty/standby)	2/1	2/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	2/1
Liquid solids storage tanks	1	
Conceptual cost	$38M	

Notes:

a. At 30.8 mgd, peak 3-day solids projections, and at 40.0 mgd, peak 30-day solids projections and above, GT loading is exceeded. A portion of un-thickened PS would need to bypass the GTs if two GTs are not online.

b. Two centrifuges are required at peak load conditions because of hydraulic capacity limitations.

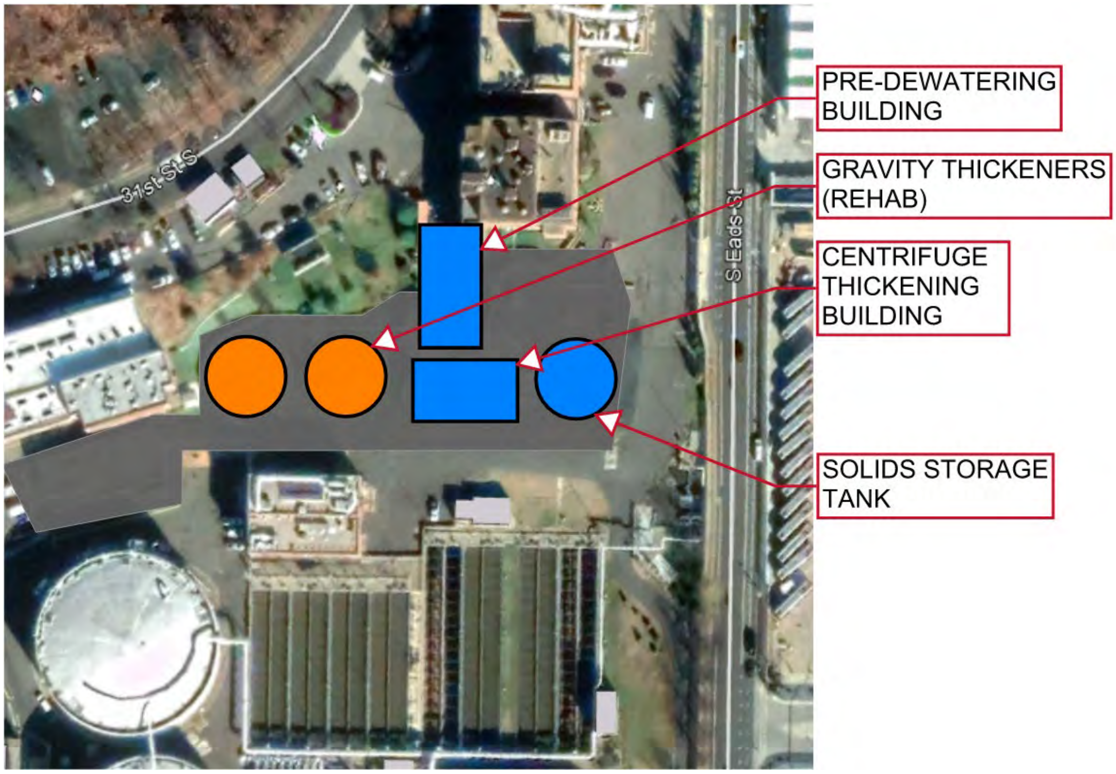

Figure 21. Alternative 5 General Site Layout

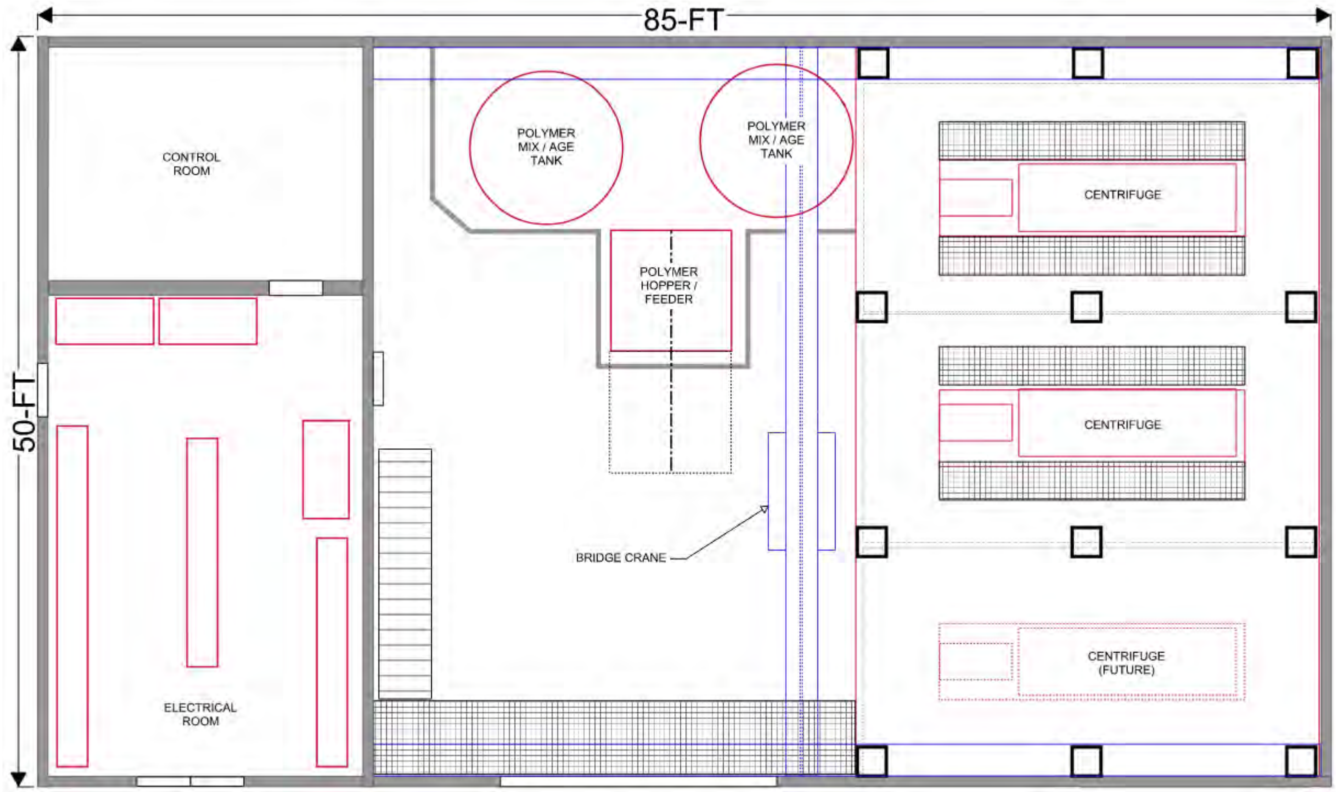

Figure 22. Alternative 5 Centrifuge Thickening Building Layout

4.2.6 Alternative 6: Co-Thickening (Gravity Thickeners)

Alternative 6 would include co-thickening of PS and WAS with GTs. The existing GTs would require rehabilitation, similar to previous alternatives. Additional GTs would be needed to meet 30.8 mgd and 40.0 mgd solids loading projections. The pre-dewatering equipment and building layout for this option would be similar to the one shown for Alternative 2.

A PFD for Alternative 6 is shown on Figure 23. Table 22 presents design criteria for Alternative 6. Figure 24 below shows a site layout for Alternative 6.

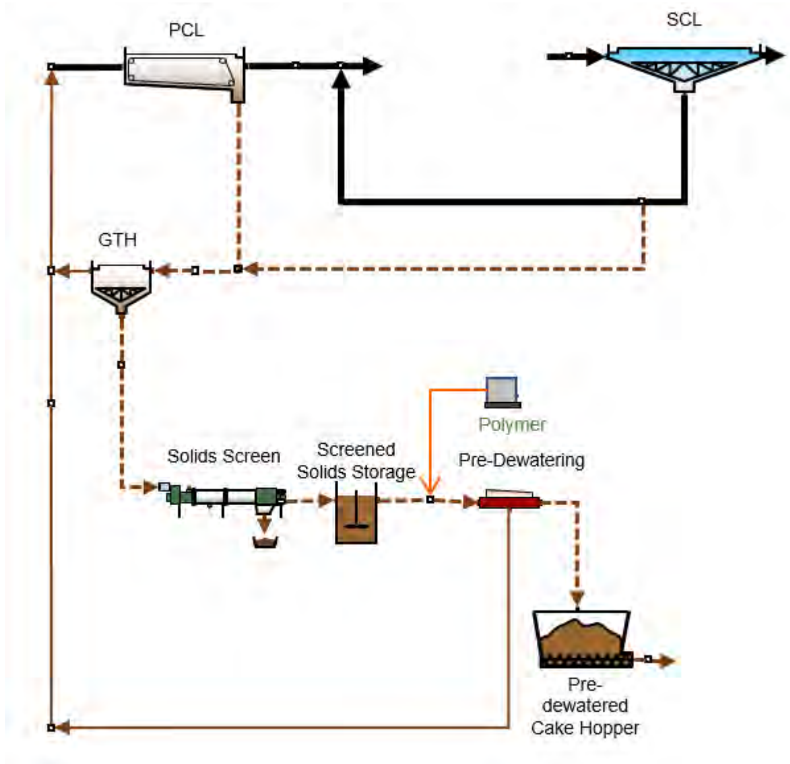

Figure 23. Alternative 6 Process Flow Diagram

Table 22. Alternative 6 Design Criteria

Parameter	30.8 mgd	40.0 mgd
Thickened PS/TWAS concentration	3%	3%
Number of GTs (duty/standby)	3/1	4/1
PS/WAS flow to screens (gpm)	380	500
Number of solids screens (duty/standby)	2/1	3/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	2/1
Liquid solids storage tanks	1	
Conceptual cost	$42M	

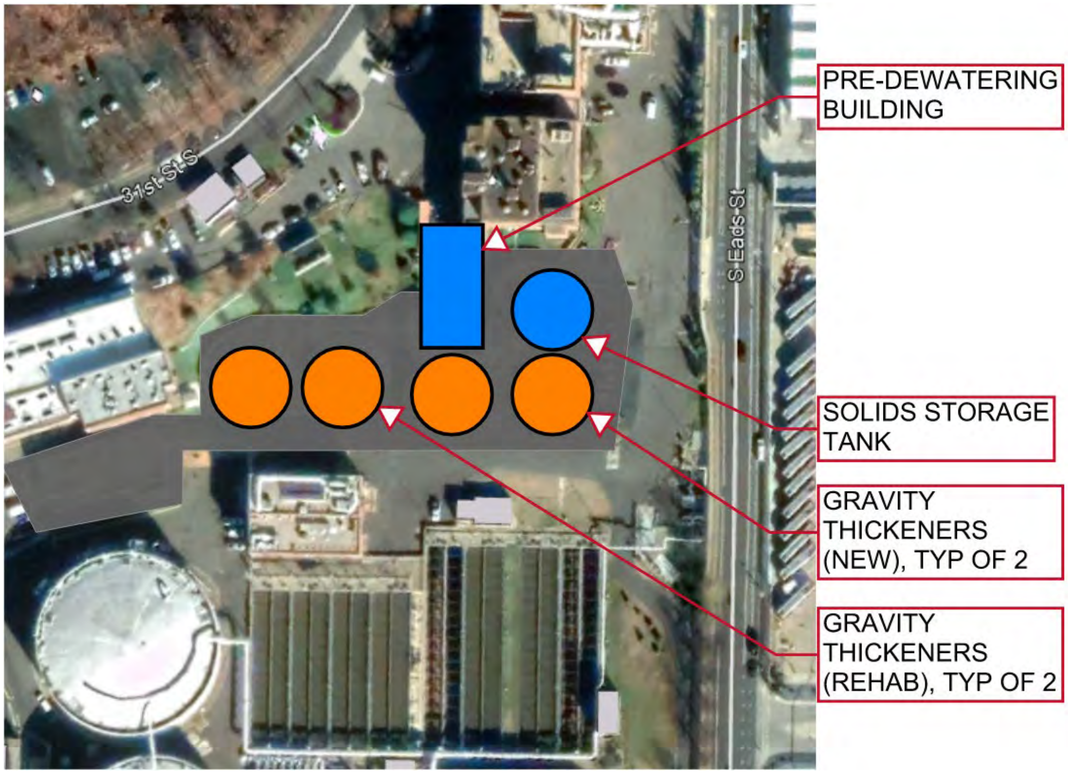

Figure 24. Alternative 6 General Site Layout

The site space required for additional GTs for co-thickening is a major drawback. In addition, co-thickening has the potential to cause process upsets and additional odors, and phosphorus release should the WPCP implement biological phosphorus removal in the future. For these reasons, this alternative was eliminated from further consideration during the March 17, 2021, workshop.

4.2.7 Alternative 7: Un-thickened PS/TWAS

Alternative 7 would include mechanical thickening for WAS, similar to Alternatives 3, 4, and 5 (GBTs, RDTs, or thickening centrifuges) but would not include PS thickening. Un-thickened PS and TWAS would be screened and stored prior to pre-dewatering, as shown in the PFD provided on Figure 25. Additional screened solids storage is needed for this option because of the large quantity of un-thickened PS. The existing GTs and DAFT building could be demolished to help make more space available around the site. The pre-dewatering facility would be minimized, similar in size to the pre-dewatering facility shown in Alternative 5. However, additional O&M attention would be necessary to process the larger hydraulic quantity associated with un-thickened PS. Table 23 presents design criteria for Alternative 7. Figure 26 shows a site layout for Alternative 7. The pre-dewatering building layout would be similar to that shown in Alternative 1.

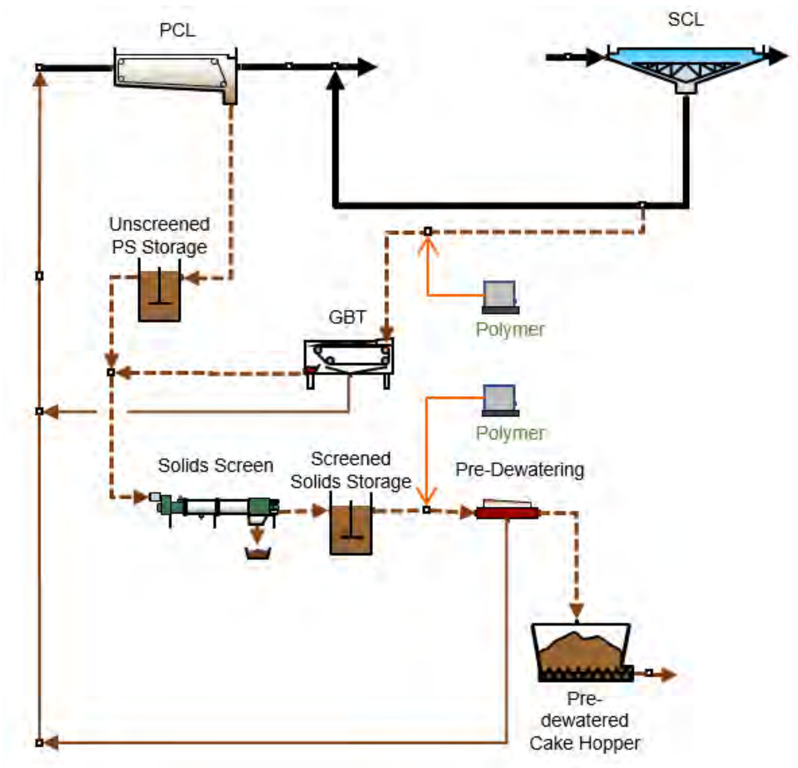

Figure 25. Alternative 7 Process Flow Diagram

Table 23. Alternative 7 Design Criteria

Parameter	30.8 mgd	40.0 mgd
Un-thickened PS/TWAS concentration	1.36%	1.36%
GBT (WAS thickening) (duty/standby)	1/1	2/1
RDT (WAS thickening) (duty/standby)	2/1	2/1
PS/WAS flow to screens (gpm)	850	1,100
Number of solids screens (duty/standby)	3/1	4/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	3/1
Liquid solids storage tanks	3[a]	
Conceptual cost	$31M	

Notes:

a. Includes 1 tank for un-thickened PS (8 hr storage).

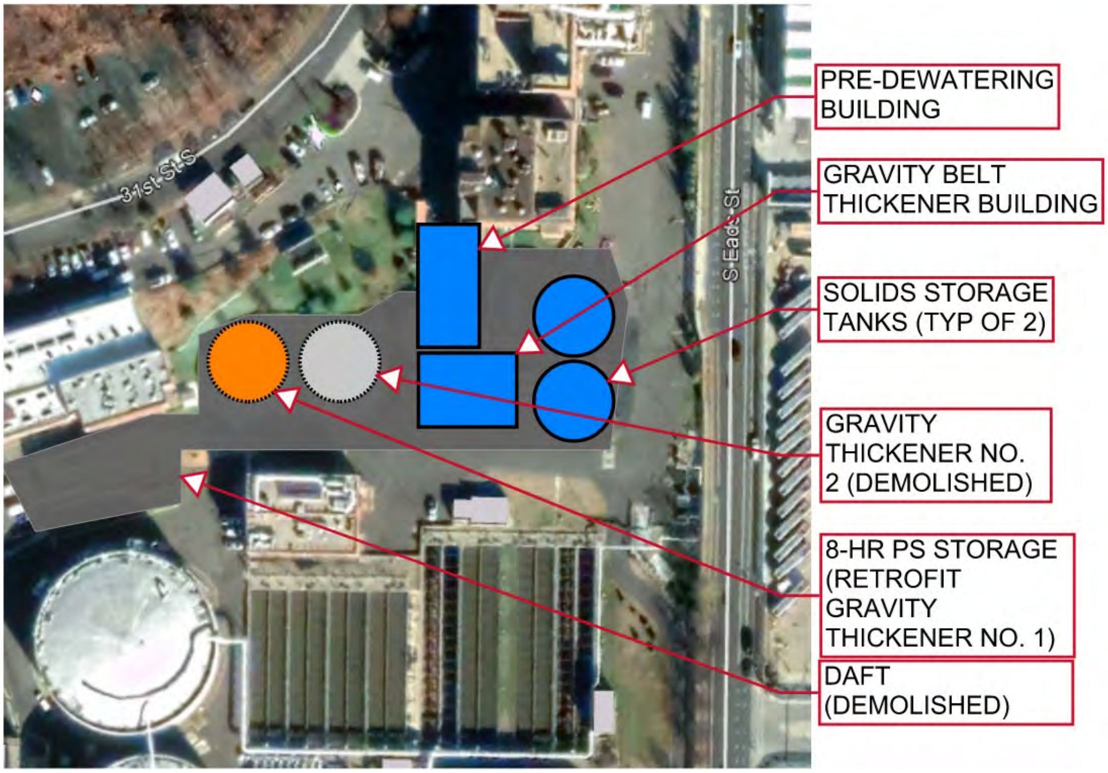

Figure 26. Alternative 7 General Site Layout

The advantages and disadvantages of this alternative are listed in Table 24.

Table 24. Alternative 7 Advantages and Disadvantages

Advantages	Disadvantages
GBTs/RDTs offer high thickening performance per square foot, minimizing WAS thickening footprint.	Site constrictions are more significant because of the volume of storage required for un-thickened PS as well as an 8-hour PS storage/buffer tank upstream of solids screening.
Lower conceptual capital and O&M costs.	Higher volume of storage for un-thickened PS results in increased volume of odorous air to treat from storage tank headspace although similar to GTs.
GBTs and RDTs both have relatively low energy requirements.	Additional solids screening and pre-dewatering equipment units required to process un-thickened PS, relative to other alternatives, other than Alternative 1.
GBTs/RDTs for WAS thickening is a common and effective practice.	Screening and pre-dewatering facility footprint increased in order to accommodate additional solids screening and pre-dewatering equipment units, relative to other alternatives, other than Alternative 1.
GBTs/RDTs operations and maintenance is less significant/intensive than other thickening technologies (thickening centrifuges and DAFTs).	GBTs/RDTs are new technology to the WPCP staff.
Open GBTs as well as many enclosures permit operator observation of thickening process, allowing for fine-tuning processes.	GBTs can have local odor issues if not enclosed. Some enclosures reduce operation observation and access for maintenance.
Thickening WAS upstream of solids screens, solids storage and pre-dewatering reduces equipment quantities some, relative to un-thickened PS/WAS and facility footprint on constrained site.	RDT solids thickening capacity is typically lower, requiring more units, and can require more polymer than GBTs.
	RDTs are enclosed, observation of thickening process is not available.
	RDTs offer less operator control for adjustments in thickening process and preventing "over-thickening" can be difficult.

4.2.8 Alternative 7A: Gravity Thickeners/Un-thickened WAS

Alternative 7A would include gravity thickening for PS and no thickening for WAS. A PFD for Alternative 7A is shown on Figure 27. Table 25 presents design criteria for Alternative 7A. Figure 28 provides the site plan with a new a new pre-dewatering building similar to that shown for Alternative 2.

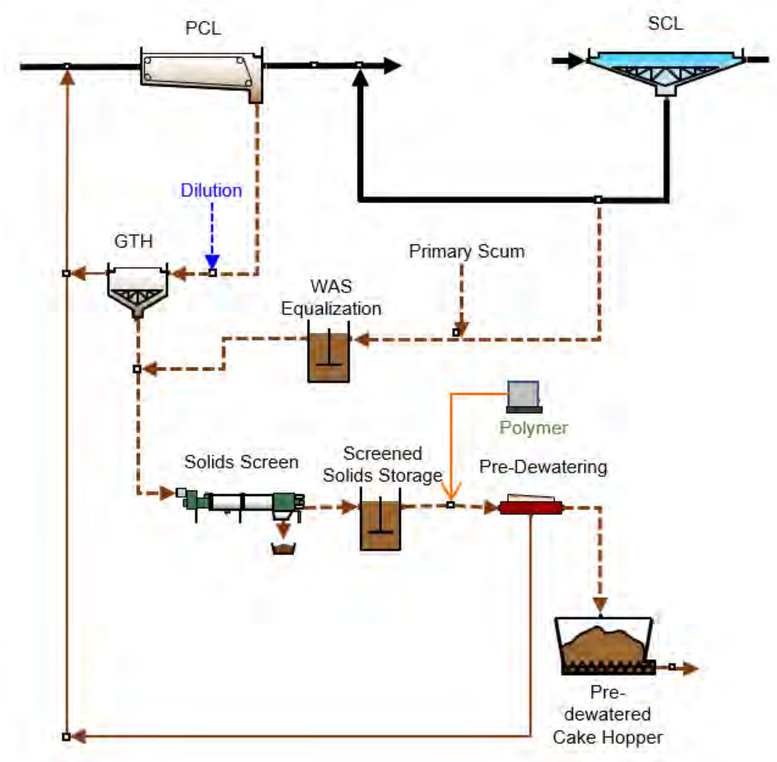

Figure 27. Alternative 7A Process Flow Diagram

Table 25. Alternative 7A Design Criteria

Parameter	30.8 mgd	40.0 mgd
Thickened PS/TWAS concentration	2.1%	2.1%
Number of GTs (duty/standby)	1/1	1/1 [a]
PS/WAS flow to screens (gpm)	540	700
Number of solids screens (duty/standby)	2/1	3/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	2/1
Liquid solids storage tanks	2 + 1 un-thickened	
Conceptual cost	$29M	

Notes:

a. At 40 mgd, peak 3-day solids projections, GT maximum loading is exceeded. There is sufficient time to evaluate GT performance at higher loading rates. Options for future consideration (post-2050) include: proofing performance with higher loading rates, operating both GTs during peak loading events, building a third GT in the future, or bypassing a portion of un-thickened PS (estimated at less than 20%) if only one GT is available and it is unable to perform at higher loading rates.

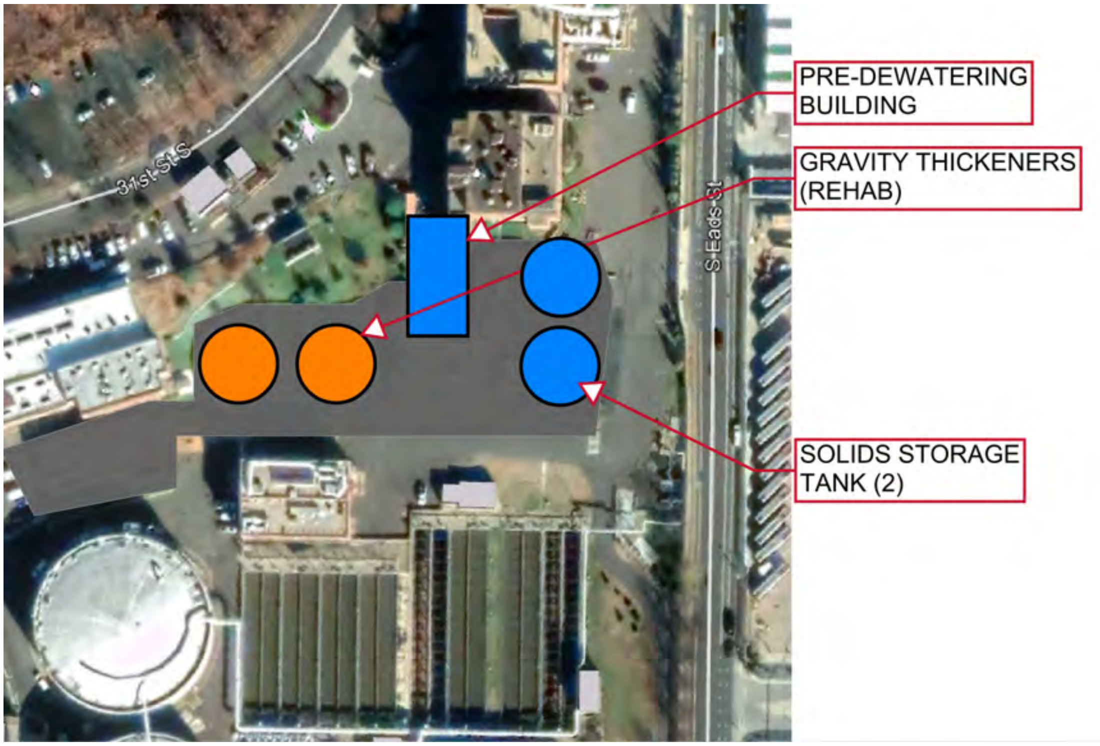

Figure 28. Alternative 7A General Site Layout

The advantages and disadvantages of this alternative are listed in Table 26.

Table 26. Alternative 7A Advantages and Disadvantages

Advantages	Disadvantages
Eliminating WAS thickening eliminates one unit process without impacting dewatering sizing.	Site constrictions are more significant because of volume of storage required for un-thickened WAS as well as an 8-hour WAS storage/buffer tank upstream of solids screening.
GTs provide a "buffer" for PS upstreaming of solids screens; no separate PS storage/buffer tank is necessary.	Higher volume of storage results in increased volume of odorous air to treat from storage tank headspace.
Lower conceptual capital and O&M costs.	GT loading is exceeded at 40.0 mgd, peak 3-day solids projections. Mitigation measures may be required beyond 2050.
GTs have relatively low energy requirements.	
Thickening PS upstream of solids screens, solids storage, and pre-dewatering reduces equipment quantities and facility footprint on a constrained site.	
Minimal wear components and maintenance.	

4.2.9 Alternative 8: Co-Thickening (GBT or RDT)

Alternative 8 would include co-thickening of PS and WAS using either GBTs or RDTs. The pre-dewatering equipment and building layout for this option would be similar to the one shown for Alternative 2. A new facility was assumed for the co-thickening process equipment. This facility would be larger compared to the WAS-only GBT or RDT facilities in previous alternatives as additional thickening units would be needed. Additionally, it is recommended that a separate storage tank be provided for un-thickened PS to provide a buffer upstream of thickening, as shown in the PFD on Figure 29. The site layout in Figure 30 below shows the two required solids storage tanks (one for un-thickened PS and one for thickened/screened solids) in new locations. Note that one existing GT has the volume to provide 8 hours of storage of PS at the 30.8 mgd, peak 3-day solids loading projections, and could be converted as an alternative to building a second solids storage tank. Table 27 presents design criteria for Alternative 8. Figure 31 shows the preliminary thickening building layout for Alternative 8.

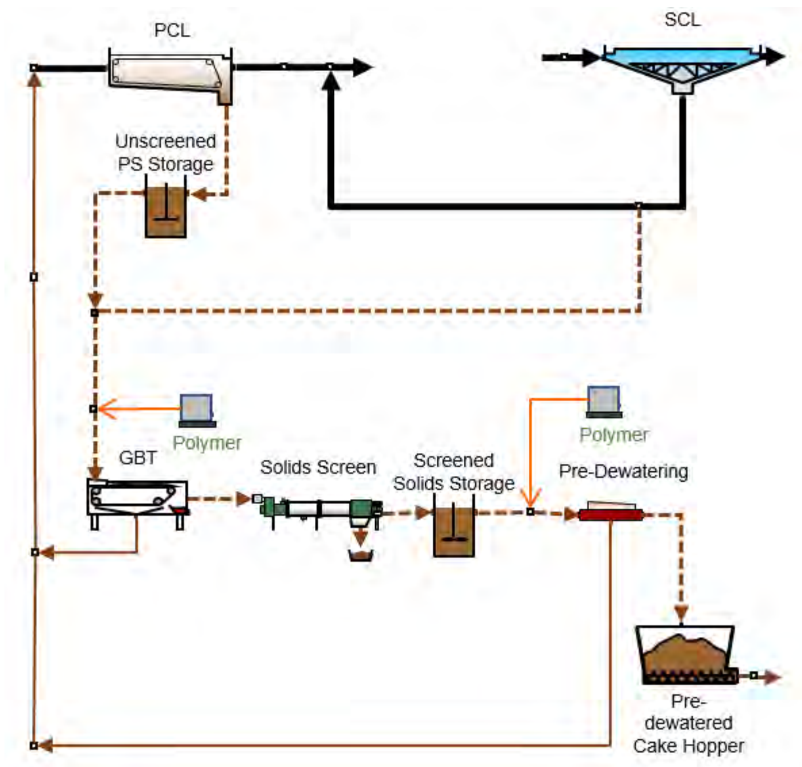

Figure 29. Alternative 8 Process Flow Diagram

The major drawback for this alternative is that co-thickening can lead to process issues such as additional odors and phosphorus release should the WPCP implement biological phosphorus removal in the future. The County agreed that this alternative should be eliminated from further consideration during the March 17, 2021, workshop. However, the County inquired about separate thickening of PS and WAS with GBTs or RDTs in the same facility. This has been added as Alternative 8A.

Table 27. Alternative 8 Design Criteria

Parameter	30.8 mgd	40.0 mgd
Thickened PS/TWAS concentration	5%	5%
Number of GBTs/RDTs (duty/standby)	4/1	5/1
PS/WAS flow to screens (gpm)	230	300
Number of solids screens (duty/standby)	2/1	2/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	2/1
Liquid solids storage tanks	2 [a]	
Conceptual cost	$36M	

Notes:
a. 1 tank for un-thickened PS (8 hr storage) and 1 tank for co-thickened PS and WAS.

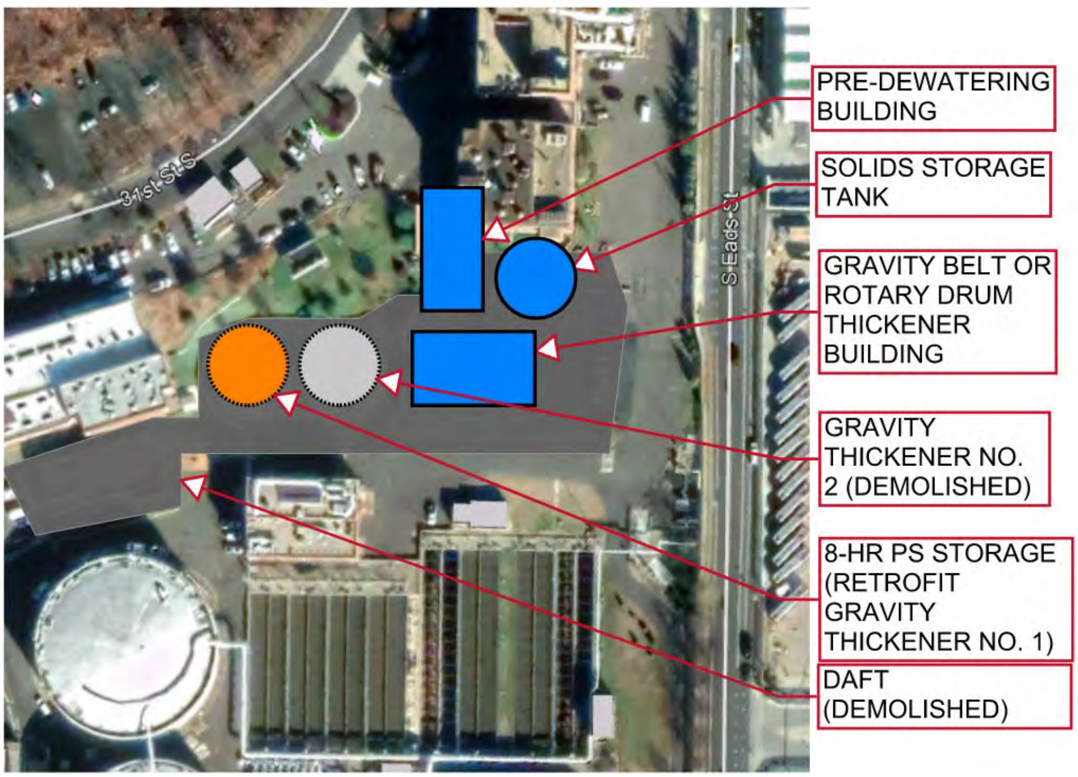

Figure 30. Alternative 8 General Site Layout

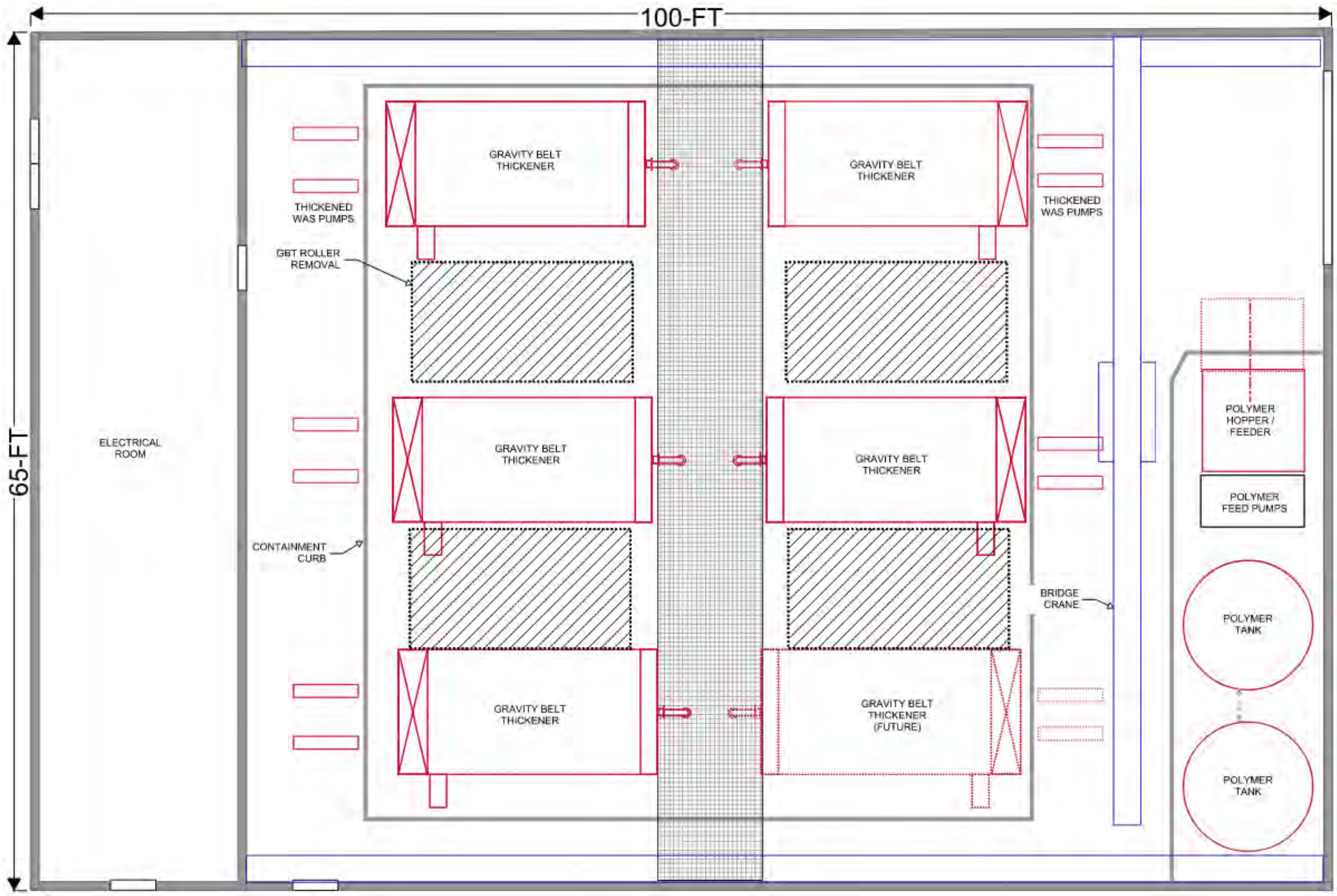

Figure 31. Alternative 8 Thickening Building Layout

4.2.10 Alternative 8A: Separate PS and WAS Thickening (GBT or RDT)

Alternative 8A includes separate thickening of PS and WAS using the same mechanical thickening technology (either GBTs or RDTs) in the same building. For the purposes of this evaluation, thickened PS concentration is 5.0 percent and 5.0 percent WAS. There are limited installations that use GBTs or RDTs for PS thickening only. A key challenge with thickening PS with GBTs or RDTs is the variability in solids concentration of the solids feed. Polymer could be overdosed or underdosed as the PS feed solids concentration varies, unless proper monitoring and controls are in place to monitor feed solids concentrations and adjusting polymer feed rate accordingly. Additionally, there is potential that different polymer types are required for PS and WAS. It is recommended that a separate storage tank be provided for un-thickened PS to provide a buffer upstream of thickening, as shown in the PFD on Figure 32. The number of GBT/RDT units listed in Table 28 below suggests that seven thickening units are required. However, this accounts for a redundant unit for both PS and WAS. One unit can be eliminated, and a single “swing” unit could be installed to back up the PS and WAS units. This would make the thickening building layout similar to the layout shown in Alternative 8. The pre-dewatering equipment and building layout for this option would be similar to the one shown for Alternative 2. The site layout would also be similar to Alternative 8.

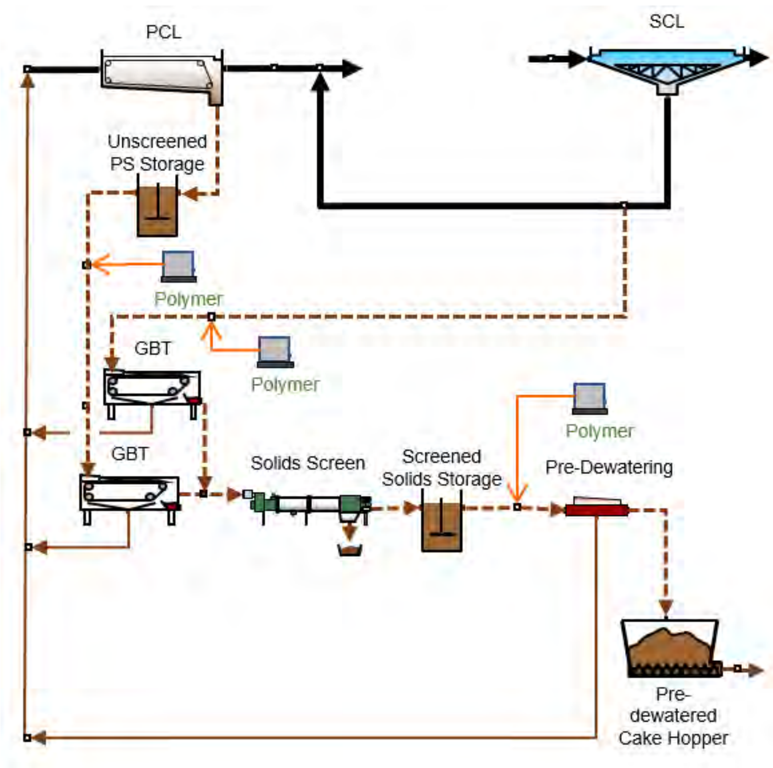

Figure 32. Alternative 8a Process Flow Diagram

Table 28. Alternative 8A Design Criteria

Parameter	30.8 mgd	40.0 mgd
Thickened PS/TWAS concentration	5.0%	5.0%
Number of GBTs/RDTs for PS (duty/standby)	3/1	3/1
Number of GBTs/RDTs for WAS (duty/standby)	2/1	2/1
PS/WAS flow to screens (gpm)	230	300
Number of solids screens (duty/standby)	2/1	2/1
Number of pre-dewatering centrifuges (duty/standby)	2/1	2/1
Liquid solids storage tanks	2 [a]	
Conceptual cost	$38M	

Notes:

a. One storage tank required for screen solids storage. One storage tank is required to provide 8-hours of un-thickened primary solids storage prior to thickening. One existing GT tank has the capacity to provide 8-hours of un-thickened primary solids storage at 30.8 mgd, peak 3-day solids loading.

The advantages and disadvantages of this alternative are listed in Table 29.

Table 29. Alternative 8A Advantages and Disadvantages

Advantages	Disadvantages
GBTs/RDTs offer high thickening performance per square foot, minimizing WAS thickening footprint.	Higher conceptual capital and O&M costs. Highest net present value of all alternatives.
GBTs and RDTs both have relatively low energy requirements.	Additional tank required for 8-hour PS storage/buffer tank upstream of mechanical thickening.
GBTs/RDTs for WAS thickening is a common and effective practice.	
GBTs/RDTs operations and maintenance is less significant/intensive than other thickening technologies (thickening centrifuges and DAFTs).	
Open GBTs as well as many enclosures permit operator observation of thickening process, allowing for fine-tuning processes.	Challenges with uncommon operation of thickening PS on GBTs RDTs.
Thickening PS/WAS upstream of solids screens, solids storage and pre-dewatering reduces equipment quantities and facility footprint on constrained site.	GBTs/RDTs are new technology to the WPCP staff.
	GBTs can have local odor issues if not enclosed, likely exacerbated with thickening PS. Some enclosures reduce operation observation and access for maintenance.
	RDT solids thickening capacity is typically lower, requiring more units, and can require more polymer than GBTs.
	RDTs are enclosed, observation of thickening process is not available.
	RDTs offer less operator control for adjustments in thickening process.

5.0 O&M Cost Comparison for Shortlisted Alternatives

Alternatives 1, 3, 4, 7, and 8A were selected during the March 17, 2021, workshop for further consideration. O&M cost estimates were prepared at a conceptual level for each of these shortlisted alternatives for comparison purposes. O&M costs were developed based on the following:

- **GTs:** power costs, elutriation water
- **GBTs and RDTs:** power, polymer, washwater, and maintenance costs
- **Solids screening, storage (mixing), and pre-dewatering centrifuge costs:**
  - **Solids screening:** power cost
  - **Solids storage:** power cost for storage mixing
  - **Pre-dewatering centrifuges**: power, polymer, and annual maintenance cost

Table 30 shows the annual O&M costs (based on a WPCP influent flow of 28 mgd) and associated present value. Annual O&M costs were estimated at 28 mgd, the approximate midpoint flow condition and assumed average annual O&M costs over the 20-year analysis period.

Table 30. O&M Cost Comparison

Category	1: No Thickening	3: GT/GBT	4: GT/RDT	7: UT PS/RDT WAS	7A: GT/UT WAS	8A: Separate Mechanical
Electricity	$110,000	$70,000	$70,000	$90,000	$70,000	$80,000
Polymer	$590,000	$690,000	$730,000	$730,000	$590,000	$990,000
Water	--	$140,000	$140,000	$5,000	$130,000	$20,000
Maintenance	$30,000	$20,000	$30,000	$40,000	$20,000	$30,000
Total	**$730,000**	**$920,000**	**$970,000**	**$860,000**	**$810,000**	**$1,120,000**
Annual present worth	**$12.0M**	**$15.1M**	**$15.9M**	**$14.1M**	**$13.3M**	**$18.4M**

Notes:

a. Inflation rate: 2%

b. Interest rate (nominal): 4.0%

c. Interest rate (real): 1.96%

d. Term: 20 years

e. Power cost: $0.06/kWh

f. Polymer cost: $2.45/lb

6.0 Summary and Conclusions

This section presents a summary and conclusions from the thickening evaluation.

6.1 Shortlisted Alternatives

The following alternatives were selected from through workshops for further consideration:

- **Alternative 1:** no thickening
- **Alternative 3:** GTs (PS)/GBTs (WAS)
- **Alternative 4:** GTs (PS)/RDTs (WAS)
- **Alternative 7:** un-thickened PS/GBT or RDT-thickened WAS
- **Alternative 7A:** GTs (PS)/un-thickened WAS
- **Alternative 8A:** separate thickening (either GBT or RDT) in same facility

A summary of the major considerations for these shortlisted alternatives is presented in Table 31 including key advantages and/or disadvantages and a summary of conceptual capital and O&M costs.

Table 31. Summary of Shortlisted Alternatives

Parameter	Alt. 1: No Thickening	Alt. 3: GT/GBT	Alt. 4: GT/RDT	Alt. 7: Un-thickened PS/TWAS	Alt. 7A: GT/ Un-thickened WAS	Alt. 8A: Separate GBT/RDT
Site impacts	• Requires most solids storage volume (can consider reusing GTs) • Largest pre-dewatering facility footprint	• Provides one of the most compact layouts • Smallest pre-dewatering facility footprint	• Provides the most compact layout • Smallest pre-dewatering facility footprint	• Large volume of storage required for un-thickened PS • Larger pre-dewatering facility footprint	• Additional WAS storage required upstream of screening • More storage than Alt. 3 or 4	• Additional PS storage required upstream of thickening • Smallest pre-dewatering facility footprint
Operability	• Fewer unit processes to operate • Limited flexibility (with 1 day of solids storage) • 24/7 solids screening and pre-dewatering is required	• GTs are a familiar process to WPCP staff and have performed well • GBTs require periodic operator attention, but do not require constant care	• GTs are a familiar process to WPCP staff and have performed well • RDTs require even less operator attention than GBTs	• Limited flexibility because of un-thickened PS • GBT/RDT requires periodic operator attention	• GTs are a familiar process to WPCP staff and have performed well • Un-thickened WAS eliminates a unit process	• GBT/RDT for PS thickening would require more operator attention because of PS solids concentration variability • Potentially two types of polymer required for PS and WAS
Maintenance	• No thickening maintenance • Largest number of solids screens, mixing, and pre-dewatering units requiring additional attention	• GT maintenance is relatively low • GBT maintenance can be done in-house	• RDT maintenance is relatively low • RDT maintenance can be done in-house	• GBT/RDT maintenance similar to Alts. 3 and 4 • Larger number of solids screens, mixing, and pre-dewatering units requiring additional attention	• GT maintenance is relatively low • No maintenance for WAS as it will remain un-thickened	• GBT or RDT maintenance can be performed in-house, but will be greater than Alts. 3 and 4 because of more thickening units needed for PS and WAS
Energy	• No thickening energy required • High energy demands for multiple storage tanks	• Low energy demand for thickening • Lowest energy demand for pre-dewatering	• Low energy demand for thickening • Lowest energy demand for pre-dewatering	• Lowest energy demand for thickening WAS only • Higher energy demand for pre-dewatering	• Lowest energy demand for thickening • Slightly higher energy demand for pre-dewatering	• Higher energy demand for mechanical thickening of PS and WAS

Parameter	Alt. 1: No Thickening	Alt. 3: GT/GBT	Alt. 4: GT/RDT	Alt. 7: Un-thickened PS/TWAS	Alt. 7A: GT/ Un-thickened WAS	Alt. 8A: Separate GBT/RDT
	• Highest energy demand for pre-dewatering					• Lowest energy demand for pre-dewatering
Downstream process impacts	• Requires the most screening and pre-dewatering capacity	• Minimizes screening and pre-dewatering	• Minimizes screening and pre-dewatering	• Greater screening and pre-dewatering capacity	• Slightly larger screening but pre-dewatering capacity same as other thickening options.	• Minimizes screening and pre-dewatering
Odors	• Significant odor control needed for storage volume	• GTs are covered, and GBTs can be enclosed to reduce odors	• GTs are covered and RDTs are enclosed	• Significant odor control needed for large PS storage volume	• GTs and solids storage tanks are covered	• Local odor issues associated with GBTs especially for thickening PS; RDTs are enclosed
Conceptual capital cost	$31.1M	$32.1M	$32.6M	$31.7M	$28.8M	$37.7M
O&M present value	$12.0M	$15.1M	$15.9M	$14.1M	$13.3M	$18.4M
Net present value	$43.3M	$47.1M	$48.5M	$45.8M	$42.1M	$56.1M

6.2 Conclusions and Recommendation

Alternative 1 offers the lowest O&M cost because of the avoided costs of thickening (power, polymer, and equipment maintenance). However, the drawback associated with this alternative is the significant storage volume needed for un-thickened solids, including an 8-hour buffer tank for PS, the additional process capacity for solids screening and pre-dewatering, and significantly more odor control equipment and volume (sizing of which was beyond the scope of this evaluation). If this alternative is retained for further evaluation, implications for storing and dewatering un-thickened solids will need to be further evaluated in the solids screening and pre-dewatering and site impact evaluations.

Alternatives 3 and 4 are similar, except Alternative 3 uses GBTs for WAS thickening and Alternative 4 uses RDTs for WAS thickening. The major differences are that GBTs can typically process more solids and require less polymer than RDTs. These major differences contribute to the O&M cost differences between GBTs and RDTs. Alternatives 3 and 4 offer advantages from a site layout perspective; have moderately low O&M cost; and minimize solids screening, storage, and pre-dewatering facility capacities.

Alternative 7 occupies significant site space for storage, which is due to the added storage volume needed for un-thickened PS. O&M costs are similar to Alternatives 3 and 4. This alternative does not seem to provide any advantages to set it apart from others and is recommended to be eliminated from further consideration.

Alternative 7A reduces the site space needed for storage from Alternative 7 and has lower O&M costs than Alternatives 3 and 4 with the avoidance of polymer. The sizing for screening and pre-dewatering is similar to Alternatives 3 and 4, and it has the advantage of eliminating one unit process.

Alternative 8A is less advantageous from a cost perspective. The higher O&M cost for this alternative is largely due to polymer cost for mechanical thickening PS. Additionally, limited installations thicken PS only with either GBTs or RDTs. While PS thickening can be achieved with either GBTs or RDTs, polymer dosage is a challenge as PS concentration can vary. This would result in inconsistent thickened PS concentration and/or potential overdosing/underdosing of polymer. These factors can significantly impact the O&M cost. This alternative does not provide advantages that set it apart from others and is recommended to be eliminated from further consideration.

Two preferred alternatives were identified in workshops and discussed with the County: Alternative 3 or 4 (GT/mechanically thickened WAS) and Alternative 7A (GT/un-thickened WAS). Alternatives 3 and 4 are considered together as they are very similar and a decision on the type of mechanical thickening could come at a later date. A comparison of the various design criteria for these preferred alternatives is provided in Table 32.

Table 32. Preferred Alternative Comparison

Component	3/4: GT/Mechanical WAS		7A: GT/Un-thickened WAS	
	30.8 mgd	40.0 mgd	30.8 mgd	40.0 mgd
Un-thickened WAS storage volume (gallons)	0	0	180,000	180,000
Peak 3-day un-thickened WAS storage time (hours)	0	0	8.7	6.7
Number of installed WAS thickeners	3	3	0	0
Flow to screens and pre-dewatering (gpm)	270	350	540	700
Thickened solids concentration	4.3%	4.3%	2.1%	2.1%
Number of installed screens	3	3	3	4
Thickened solids storage volume (gallons)	400,000	400,000	800,000	800,000
Peak 3-day thickened storage time (days)	1.0	0.8	1.0	0.8
Number of installed pre-dewatering centrifuges	3	3	3	3
Conceptual capital cost	**$32.6 M**		**$28.8M**	
Total annual costs ($/yr)	**$920,000**		**$810,000**	
Annual present worth	**$15.9M**		**$13.3M**	
Total present worth	**$48.5M**		**$42.1M**	

In conclusion, Alternative 7A (GT/un-thickened WAS) is the recommended thickening alternative based on its operational flexibility, proven performance, lower energy profile, and ability to fit within the site constraints. Alternative 7A is preferred over Alternatives 3 and 4 because of the lower cost and one less unit process. Space should be allocated for future mechanical WAS thickening should process considerations change (e.g., biological phosphorus removal). This alternative will be carried forward and used as the basis for the pre-dewatering evaluation that will include pre-dewatering technology selection, thickening and pre-dewatering building configurations, including potential reuse of the existing dewatering building, and site plan development.

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Technical Memorandum No. 7

Date:	January 5, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Dewatering Equipment Evaluation

Contents

Tables

Figures

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1.0 Introduction

This introductory section presents the background and purpose of this project and the dewatering evaluation, followed by a description of the dewatering evaluation approach.

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary sludge (PS) and waste activated sludge (WAS) thickening, dewatering, and lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a thermal hydrolysis process (THP) and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

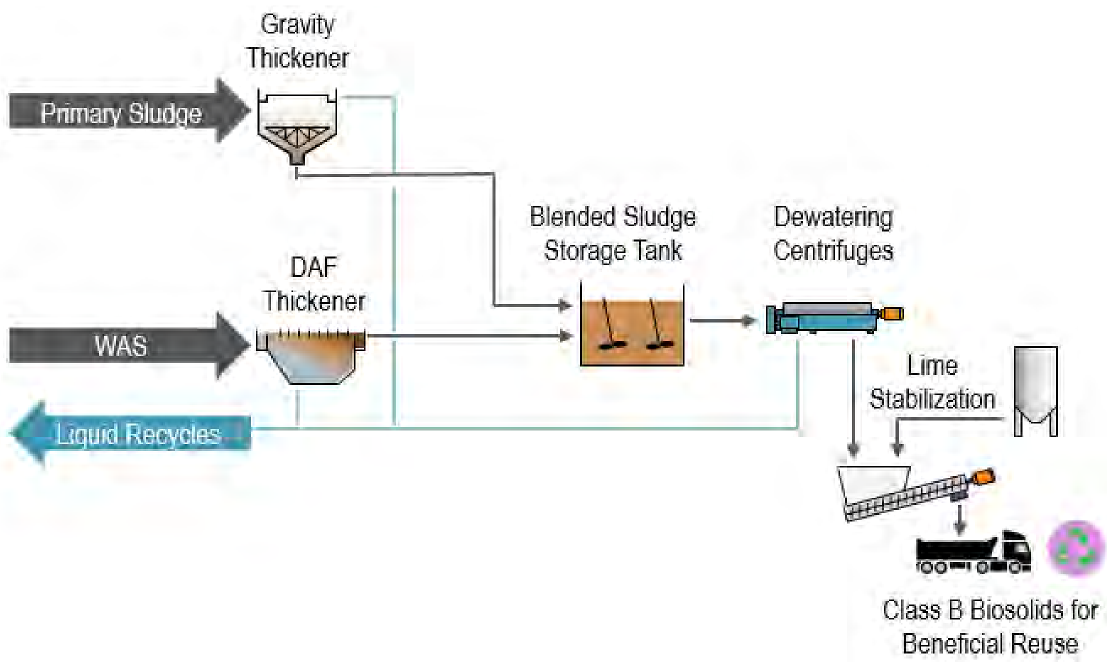
The purpose of this dewatering evaluation is to further assess and compare dewatering alternatives. The results of this evaluation will inform and validate a final decision on which technology will be chosen for pre-dewatering and final dewatering for inclusion in the Facilities Plan.

1.2 Evaluation Approach

A suite of alternatives using various dewatering technologies was developed for pre-dewatering and final dewatering. Conceptual process sizing, configurations, site layouts, and conceptual costs for dewatering facilities were prepared. Technology options were presented and reviewed at the April 26 and May 10, 2021, project workshops with the County. Workshop participants screened and selected a short list of preferred technologies. In this evaluation, the shortlisted technologies are further evaluated and compared based on conceptual operations and maintenance (O&M) cost estimates and non-cost considerations, site layout and space requirements, and odors.

2.0 Summary of Existing Facilities and Processing

A process flow diagram for existing solids handling at the WPCP is shown in Figure 1. Solids are thickened using gravity thickeners (GTs) for PS and dissolved air flotation thickeners (DAFTs) for WAS. Thickened solids are blended in solids storage tanks and dewatered using centrifuges. Liquid centrate from the centrifuges is returned to the head of the WPCP. Lime is added to the dewatered solids to achieve Class B pathogen and vector attraction reduction. Lime-stabilized biosolids are hauled off site for beneficial use through bulk land application.



The new solids handling process will include two dewatering steps, as shown in Figure 2: a pre-dewatering process to provide the appropriate solids concentration to feed the THP and subsequent digestion process, and a final dewatering process for creation of the dewatered cake for beneficial use. The equipment evaluations for both dewatering processes, indicated in the blue dashed area in the figure, are included in this technical memorandum (TM).

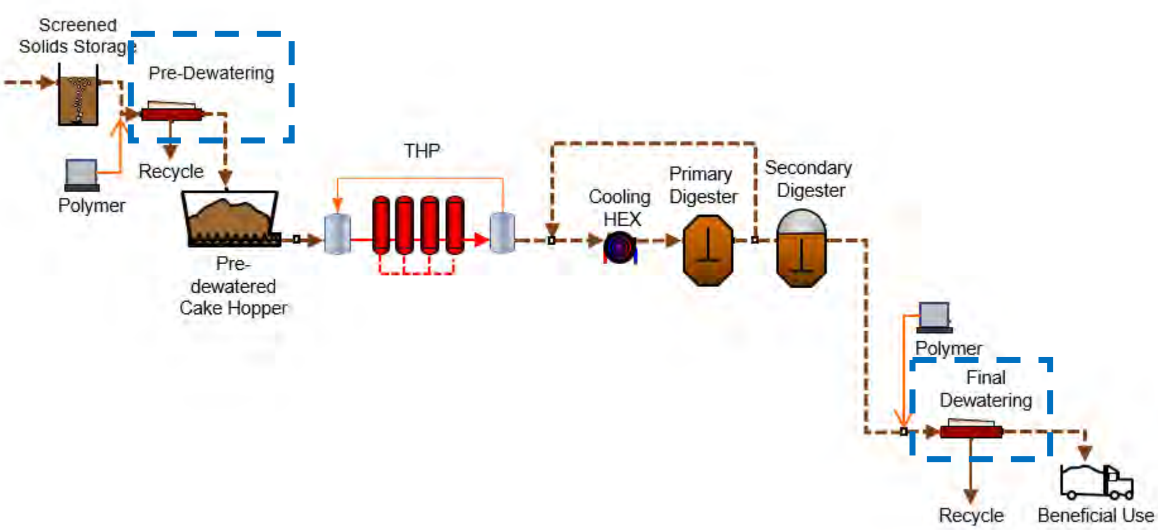


Figure 2. Future Solids Handling Process Dewatering Locations

3.0 Design Criteria

Three design loading conditions were considered for dewatering equipment evaluation:

- **23.0 million gallons per day (mgd):** 2020 current conditions
  - Annual average (AA) loading was considered for “minimum” operating conditions and as a baseline for annual O&M costs
- **30.8 mgd:** 2052 projected conditions
  - Used as the basis for equipment sizing and number of units required for the Facilities Plan
- **40.0 mgd:** final/buildout conditions
  - Used to establish total footprint requirements and dewatering facility sizing with space reserved for potential future equipment

Equipment sizing and number of units required is based on peak 3-day loadings for pre-dewatering and peak 14-day loadings for final dewatering. Annual average and peak 30-day (maximum month) loadings are used for a sensitivity analysis.

Summaries of the design loading criteria for pre-dewatering and final dewatering are provided in Table 1 and Table 2, respectively. For pre-dewatering, the feed solids concentration is assumed to be 4.3 percent with a PS:WAS ratio of 70:30. THP is required to be fed at 15 to 18 percent solids. However, it is understood that any of the pre-dewatering systems being evaluated will have a higher solids concentration and additional dilution will be required prior to feeding THP. The operation schedule for pre-dewatering will be 24 hours per day, 7 days per week. For final dewatering, the feed solids concentration is assumed to be 4.6 percent. The targeted dewatered cake concentration is expected to be greater than 30 percent. The operation schedule for final dewatering will be 24 hours per day, 5.5 days per week.

Table 1. Summary of Pre-Dewatering Loading Design Criteria

Design Condition	Avg (gpm)	Avg (lb/hr)	3-day (gpm)	3-day (lb/hr)
23.0 mgd	120	2,700	210	4,400
30.8 mgd	170	3,600	280	**5,900**
40.0 mgd	215	4,600	358	7,700

Table 2. Summary of Final Dewatering Loading Design Criteria

Design Condition	Avg (gpm)	Avg (lb/hr)	14-day (gpm)	14-day (lb/hr)
23.0 mgd	70	1,600	100	2,300
30.8 mgd	100	2,200	140	**3,100**
40.0 mgd	125	2,900	180	4,000

4.0 Solids Dewatering Technologies

This section describes the following dewatering technologies applicable to the Arlington WPCP:

- Belt filter press (BFP)
- Screw press
- Centrifuge
- Rotary fan press
- Bucher press

For each technology, the following information is presented:

- Design criteria including equipment sizing and number of units required
- Space requirements and layouts for both pre-dewatering and final dewatering facilities
- Equipment and annual O&M cost estimates (for shortlisted alternatives)

4.1 Belt Filter Presses

BFPs are widely used in the United States for municipal solids dewatering. The BFP, an example of which is shown in Figure 3, uses two or more serpentine belts and a series of rollers to mechanically filter and separate solids from free liquid. The BFP is typically not enclosed to allow the operator to visually inspect the operation and performance as the basis for making adjustments to the belt speed, incoming sludge feed rate, and polymer dosing. This results in increased fugitive odors around the equipment, a less comfortable working environment, a more corrosive environment, and larger odor control systems. Odor is a particular concern with dewatering undigested solids. BFPs also have a continuous and relatively high belt wash water demand. BFPs require a large footprint and high ceiling because of their size. While capital costs for equipment are typically moderate, building infrastructure and ancillary systems add to the overall cost. Maintenance costs are moderately high because of the periodic replacement of belts. However, this work can generally be completed in-house.

Figure 3. Belt Filter Press

HDR Engineering, Inc. (HDR) contacted two BFP manufacturers, Komline-Sanderson and Alfa Laval, for information and cost proposals for both pre-dewatering and final dewatering. Additional equipment manufacturers offer similar equipment, but these two contacts are sufficient for the purposes of this technology review. Preliminary design criteria, shown below in Table 3 for pre-dewatering and Table 4 for final dewatering, are based on the vendor proposals, assuming that the equipment is a 2-meter BFP unit. The maximum solids loading for the final dewatering units is anticipated to be lower than a pre-dewatering application for the following reasons:

- The goal total solids (TS) content for pre-dewatered cake solids is between 15 and 18 percent TS, whereas for final dewatering it is above 30 percent TS. Because pre-dewatering requires a lower cake solids, the belt is able to run faster.
- Pre-dewatered solids are undigested and easier to dewater than digested solids. In final dewatering applications, the belt is expected to run slower to allow for more squeeze time in order to remove as much free water from the solids as possible.

Polymer consumption for final dewatered solids is expected to be twice the consumption of pre-dewatering applications because of the sludge properties of digested solids. This is also reflected in the O&M cost comparison.

Table 3. Belt Filter Press Preliminary Design Criteria: Pre-Dewatering

Parameter	Belt Filter Press	Unit
Solids loading	2,400	lb/hr (per unit)
Number of units at 30.8 mgd	3/1	Duty/standby
Number of units at 40.0 mgd	4/1	Duty/standby
Estimated solids capture	97	Percent
Equipment space required	34 × 100 3,400	ft (total) SF (total)
Dry equipment weight	25,000 100,000	lb/unit lb total weight
Water consumption (AA)	345,600	gpd (total)
Power requirement (AA)	8	hp/unit
Polymer consumption	10	Active lb/dry ton
Used with THP	Yes	
Equipment cost	$350k $1.4M	$/unit $ total equipment cost

Table 4. Belt Filter Press Preliminary Design Criteria: Final Dewatering

Parameter	Belt Filter Press	Unit
Solids loading	2,000	lb/hr (per unit)
Number of units at 30.8 mgd	2/1	Duty/standby
Number of units at 40.0 mgd	2/1	Duty/standby
Estimated solids capture	97	Percent
Anticipated cake dryness	30–35	Percent
Equipment space required	34 × 60 2,040	ft (total) SF (total)
Dry equipment weight	25,000 75,000	lb/unit lb total weight
Water consumption (AA)	230,400	gpd (total)
Power requirement (AA)	7	hp/unit
Polymer consumption	20	Active lb/dry ton
Used with THP	Yes	
Equipment cost	$440k $1.32M	$/unit $ total equipment cost

The relative advantages and disadvantages of BFPs are listed in Table 5. BFPs generally have a higher solids capture rate with a lower polymer and electrical demand than the other technologies. However, BFPs have a high continuous water demand, and generally are open to the air, creating a more corrosive and odorous work environment.

Table 5. Belt Filter Press Advantages and Disadvantages

Advantages	Disadvantages
Low polymer demand	Medium footprint
Simple to operate	Not enclosed, requires additional odor control
High solids capture (97% +/-)	Expect lower dewatered cake solids content than centrifuges
Low electrical demand	High and continuous water demand
Maintenance can be performed on site by WPCP staff	Unfamiliar to current operating staff
Visual observation of feed solids and cake	Higher level of corrosion resistance required in building because of humidity and ammonia potential
	Frequent belt replacement and potential belt alignment issues
	Require platforms for O&M access
	Many moving parts and pieces of equipment

Space requirements for BFPs are based on providing 5 feet of space on all sides of the units (exclusive of platforms) for personnel access and the removal of rollers. Platforms are provided to move and take out rollers and to provide access for observing the process, raising the plow handles, and washing the machine after shutdown. Space requirements for BFPs are summarized as follows:

- **Pre-dewatering:** 34 feet by 100 feet, or 3,400 square feet (SF)
- **Final dewatering:** 34 feet by 60 feet, or 2,040 SF

Figure 4 and Figure 5 show the pre-dewatering and final dewatering space footprints, respectively. These footprints are for equipment only and do not include polymer, odor control, or operational areas.

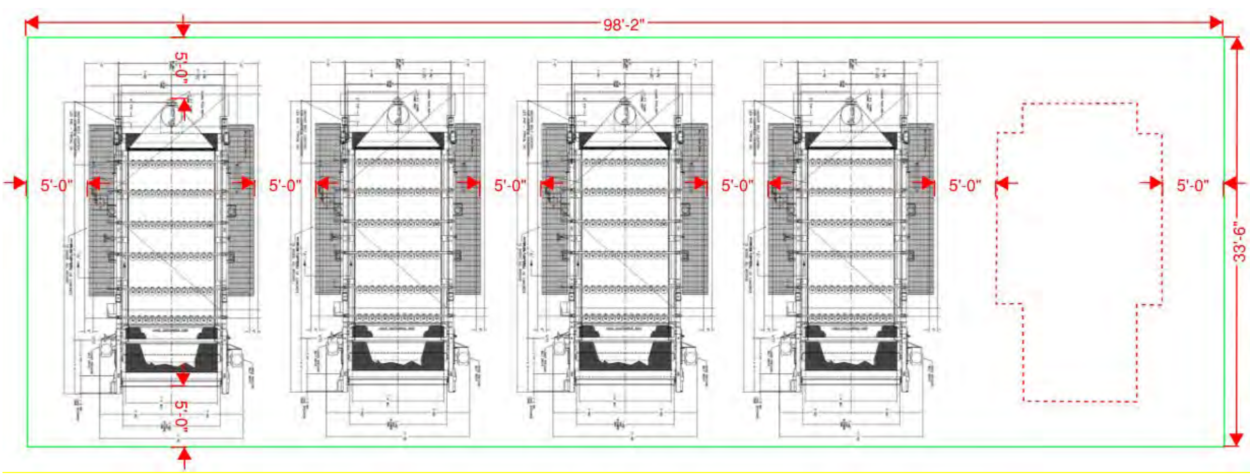


Figure 4. Belt Filter Press Pre-Dewatering Space Requirement

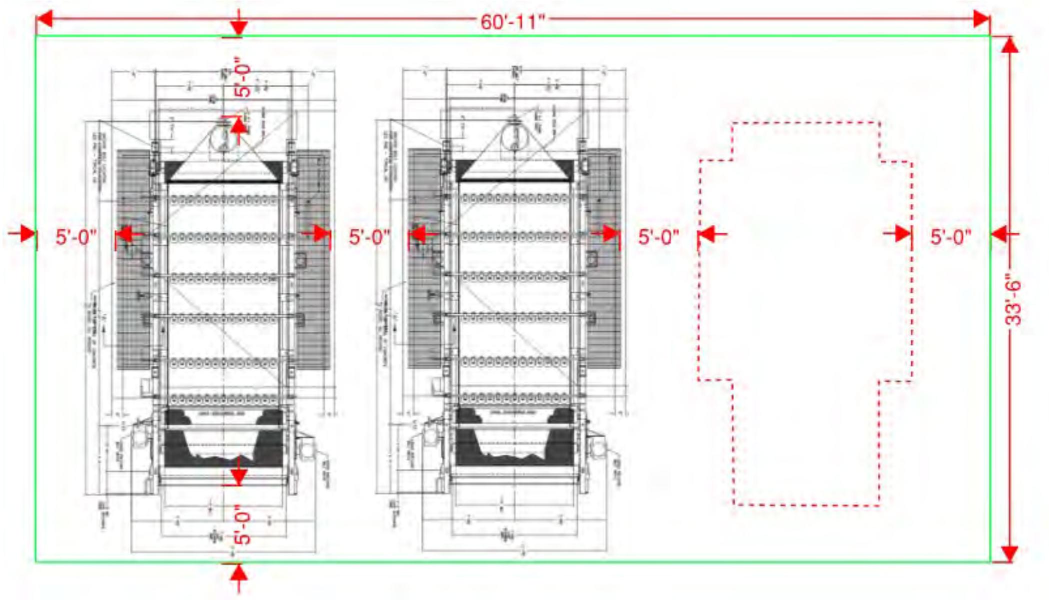


Figure 5. Belt Filter Press Final Dewatering Space Requirement

As a comparison, Figure 6 displays the BFP space required within the existing dewatering space on the fourth floor of the Dewatering Building. The existing dewatering space can fit only four units, so BFPs could fit in the space for final dewatering but not for pre-dewatering because there would be no place to expand for the final buildout condition. The use of the existing space for dewatering would also be contingent on the structural evaluation of the space and layouts of discharge screw conveyors, feed piping, and other ancillary equipment. The ultimate locations of pre-dewatering and final dewatering will be documented in a separate evaluation.

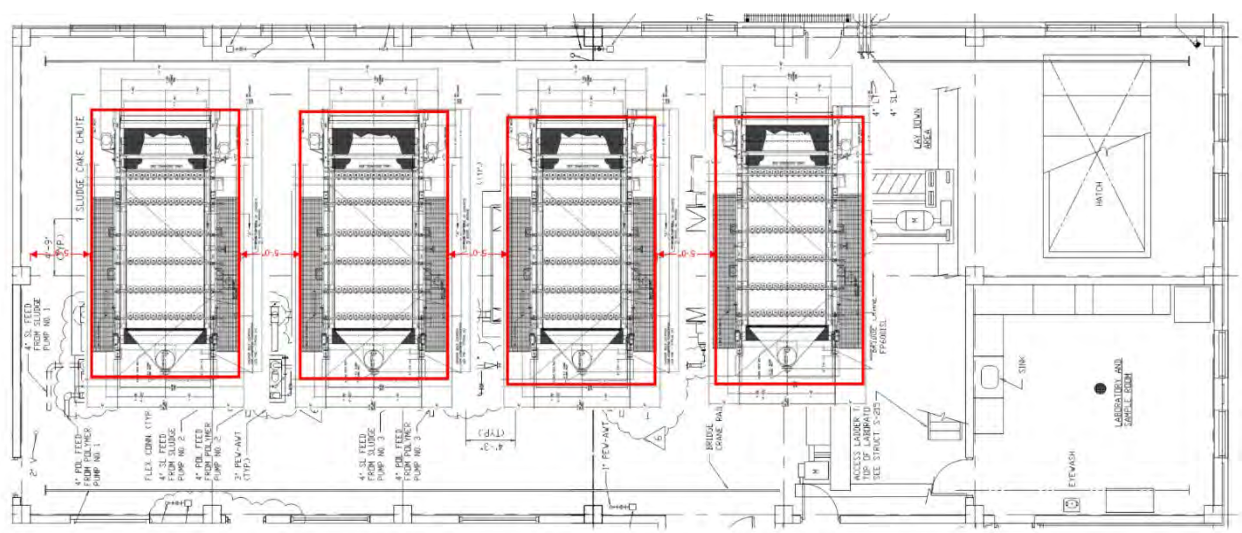


Figure 6. Belt Filter Press Existing Dewatering Space Comparison

4.2 Screw Presses

The screw press is a low-speed, low-shear dewatering process that uses a slow rotating auger inside a porous wire cage to compress solids and filter water. Free water is released through the wire cage and the dewatered solids cake is pushed out through the end of the wire cage. Screw presses operate at a low rotating speed and have low energy requirements. Because the pressure inside the screw press can occasionally result in blinding of the wire cage, a wash cycle is programmed for 5 minutes every 30 to 60 minutes to remove any solids that have squeezed through the basket screen or cage. Figure 7 shows an example screw press.

Figure 7. Screw Press

HDR contacted two screw press manufacturers, Huber and Andritz, for information and cost proposals for screw presses for pre-dewatering and final dewatering. Additional equipment manufacturers are available, but these two contacts are sufficient for the purposes of this technology review. Preliminary design criteria, shown in Table 6 for pre-dewatering and Table 7 for final dewatering, are based on these vendor proposals.

For both pre-dewatering and final dewatering, the screw press has low design loading rates resulting in additional units required compared to other technologies. The screw press has relatively low water consumption and energy demands, with a tradeoff of high polymer demands and the lowest capture rate of any technology, as the separation forces are not as high as those of other technologies. Note that there are currently no installations using screw presses for final dewatering with THP. h

Table 6. Screw Press Preliminary Design Criteria: Pre-Dewatering

Parameter	Screw Press	Unit
Solids loading	1,280	lb/hr (per unit)
Number of units at 30.8 mgd	5/1	Duty/standby
Number of units at 40.0 mgd	6/1	Duty/standby
Estimated solids capture	90	Percent
Equipment space required	30 × 90 2,700	ft (total) SF (total)
Dry equipment weight	8,200 49,200	lb/unit lb total weight
Water consumption (AA)	6,120	gpd (total)
Power requirement (AA)	5	hp/unit
Polymer consumption	15	Active lb/dry ton
Used with THP	Yes	
Equipment cost	\$310k \$1.86M	\$/unit \$ total equipment cost

Table 7. Screw Press Preliminary Design Criteria: Final Dewatering

Parameter	Screw Press	Unit
Solids loading	1,280	lb/hr (per unit)
Number of units at 30.8 mgd	3/1	Duty/standby
Number of units at 40.0 mgd	4/1	Duty/standby
Estimated solids capture	90	Percent
Anticipated cake dryness	30–35	Percent
Equipment space required	30 × 70 2,100	ft (total) SF (total)
Dry equipment weight	8,200 32,800	lb/unit lb total weight
Water consumption (AA)	4,080	gpd (total)
Power requirement (AA)	5	hp/unit
Polymer consumption	30	Active lb/dry ton
Used with THP	No	
Equipment cost	\$310k \$1.24M	\$/unit \$ total equipment cost

The relative advantages and disadvantages of screw presses are listed in Table 8.

Table 8. Screw Press Advantages and Disadvantages

Advantages	Disadvantages
Low energy use	Several units are required
Simple to operate	High polymer usage
Few moving parts	Medium-sized footprint
Require minimal operator attention	Lower solids capture (90%)
Enclosed process, which results in low odors	Unfamiliar to current operating staff
Light pieces of equipment	No THP installations for final dewatering

Screw press space requirements are based on providing 5 feet of space on all sides of the units for O&M access. Screw presses require 15 additional feet of open space for laydown for maintenance of the basket and scroll. Space requirements for screw presses are summarized as follows:

- **Pre-dewatering:** 30 feet by 90 feet, or 2,700 SF (includes laydown)
- **Final dewatering:** 30 feet by 70 feet, or 2,100 SF (includes laydown)

Note that compared to BFPs, screw presses would require less total space even though more units and laydown space are required, which is due to the smaller footprint of each individual screw press.

Figure 8 and Figure 9 display the pre-dewatering and final dewatering space requirement, respectively, including the laydown space required.

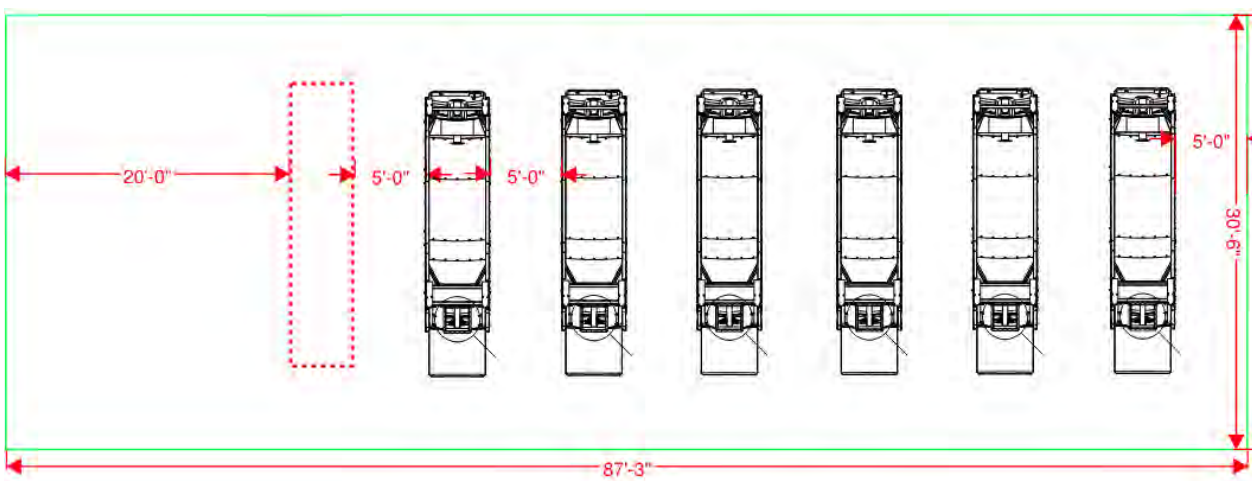


Figure 8. Screw Press Pre-Dewatering Space Requirement

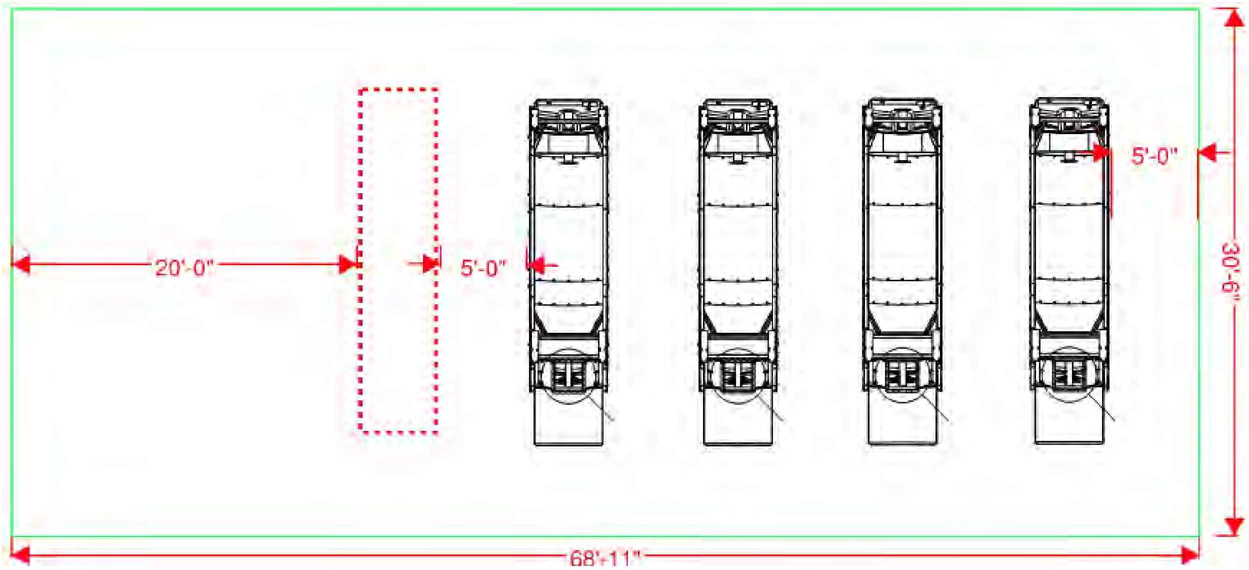


Figure 9. Screw Press Final Dewatering Space Requirement

As a comparison, Figure 10 displays the screw press space required within the existing dewatering space on the fourth floor of the Dewatering Building. The existing dewatering space allows room for laydown and room for expansion for final dewatering, but no room for laydown other than the space near the hatch, and no room for expansion for pre-dewatering. The use of the existing space for dewatering would also be contingent on the structural evaluation of the space and layouts of discharge screw conveyors, feed piping, and other ancillary equipment. The ultimate locations of pre-dewatering and final dewatering will be documented in a separate evaluation.

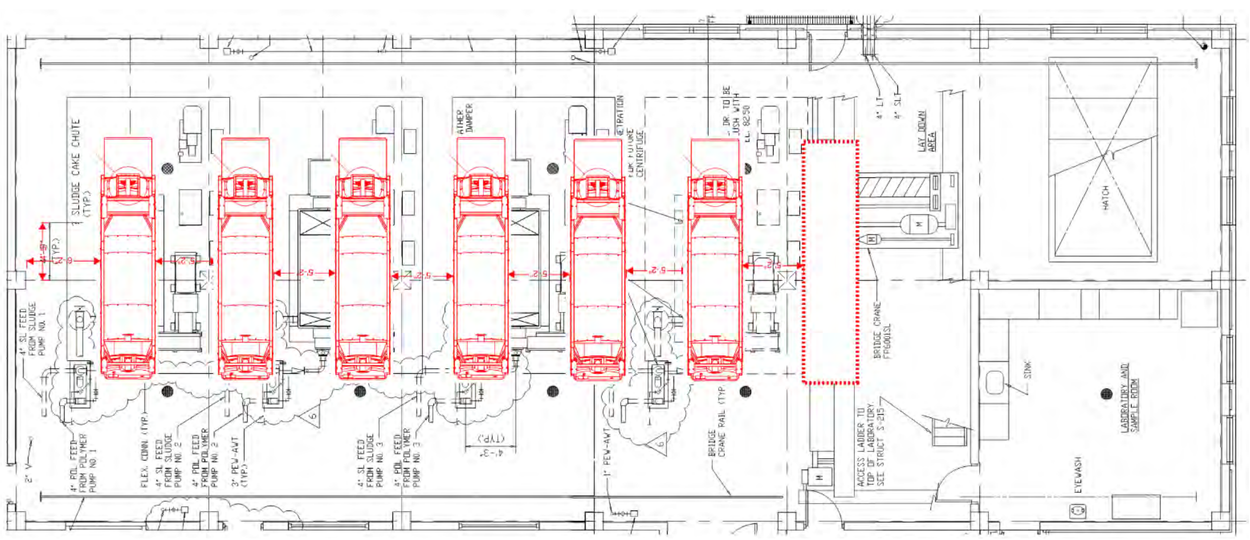


Figure 10. Screw Press Existing Dewatering Space Comparison

4.3 Centrifuges

An overview of centrifuge operation principles was described previously for WAS thickening in TM No. 6: *Thickening Evaluation*. Centrifuges work in a similar manner for solids dewatering.

Centrifuges are an enclosed process with high solids loading, low water consumption, and a small footprint. They are high-speed machines that are complex with many wear components. Figure 11 shows a dewatering centrifuge.

Figure 11. Dewatering Centrifuge

HDR contacted three centrifuge manufacturers—GEA, Alfa Laval, and Centrisys—for information and cost proposals for dewatering centrifuges for pre-dewatering and final dewatering. Additional manufacturers are available, but the contacted manufacturers are sufficient for purposes of this technology review. Preliminary design criteria, shown in Table 9 for pre-dewatering and Table 10 for final dewatering, are based on these vendor proposals.

Table 9. Centrifuge Preliminary Design Criteria: Pre-Dewatering

Parameter	Centrifuge	Unit
Solids loading	4,240	lb/hr (per unit)
Number of units at 30.8 mgd	2/1	Duty/standby
Number of units at 40.0 mgd	3/1	Duty/standby
Estimated solids capture	95	Percent
Equipment space required	32 × 72 2,304	ft (total) SF (total)
Dry equipment weight	20,000 60,000	lb/unit lb total weight
Water consumption (AA)	9,000 (1,290)	gal/wk (total) gpd (total)
Power requirement (AA)	165	hp/unit
Polymer consumption	8	Active lb/dry ton
Used with THP	Yes	
Equipment cost	\$600k–\$800k \$2.1M	\$/unit \$ total equipment cost

Table 10. Centrifuge Design Criteria: Final Dewatering

Parameter	Centrifuge	Unit
Solids loading	4,240	lb/hr (per unit)
Number of units	1/1	Duty/standby
Estimated solids capture	95	Percent
Anticipated cake dryness	32–38	Percent
Equipment space required	30 × 60 1,800	ft (total) SF (total)
Dry equipment weight	20,000 40,000	lb/unit lb total weight
Water consumption (AA)	9,000 (1,640)	gal/wk (total) gpd (total)
Power requirement (AA)	165	hp/unit
Polymer consumption	16	Active lb/dry ton
Used with THP	Yes	
Equipment cost	\$600k–\$800k \$1.4M	\$/unit \$ total equipment cost

The relative advantages and disadvantages of centrifuges are listed in Table 11.

Table 11. Centrifuge Advantages and Disadvantages

Advantages	Disadvantages
High solids loading throughput	High energy demand
Enclosed, which minimizes odors	Additional operator attention to changing solids
Smaller footprint	Long startup and shutdown times with potential solids discharge (slop)
Operators are familiar with equipment	Require lengthy off-site rebuilds
	Higher maintenance

Space requirements are based on providing 6.5 feet of space between centrifuges and 9.75 feet of space from the ends of the centrifuge to the walls for O&M access plus additional 20 ft for laydown space for bowl and scroll maintenance. Figure 12 and Figure 13 show the pre-dewatering and final dewatering space requirements, respectively, including laydown. Centrifuge space requirements are summarized as follows:

- **Pre-dewatering:** 32 feet by 72 feet, or 2,304 SF (includes laydown)
- **Final dewatering:** 32 feet by 60 feet, or 1,920 SF (includes laydown)

Centrifuges require the least amount of space of the technologies evaluated because of their compact footprint and the fewest number of units required for both pre-dewatering and final dewatering.

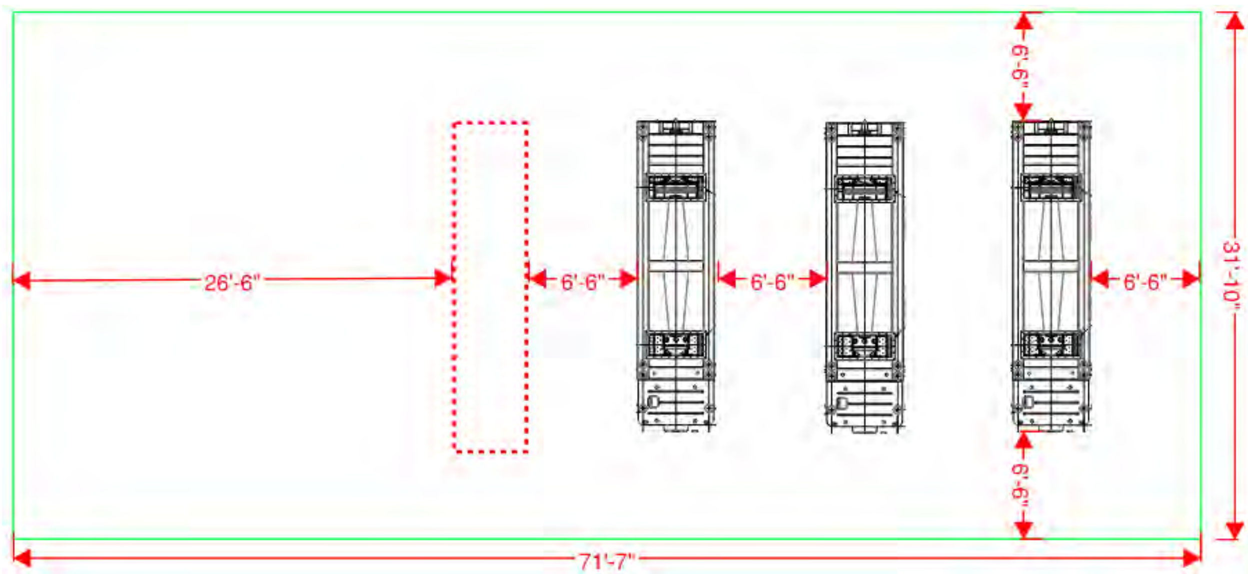


Figure 12. Centrifuge Pre-Dewatering Space Requirement

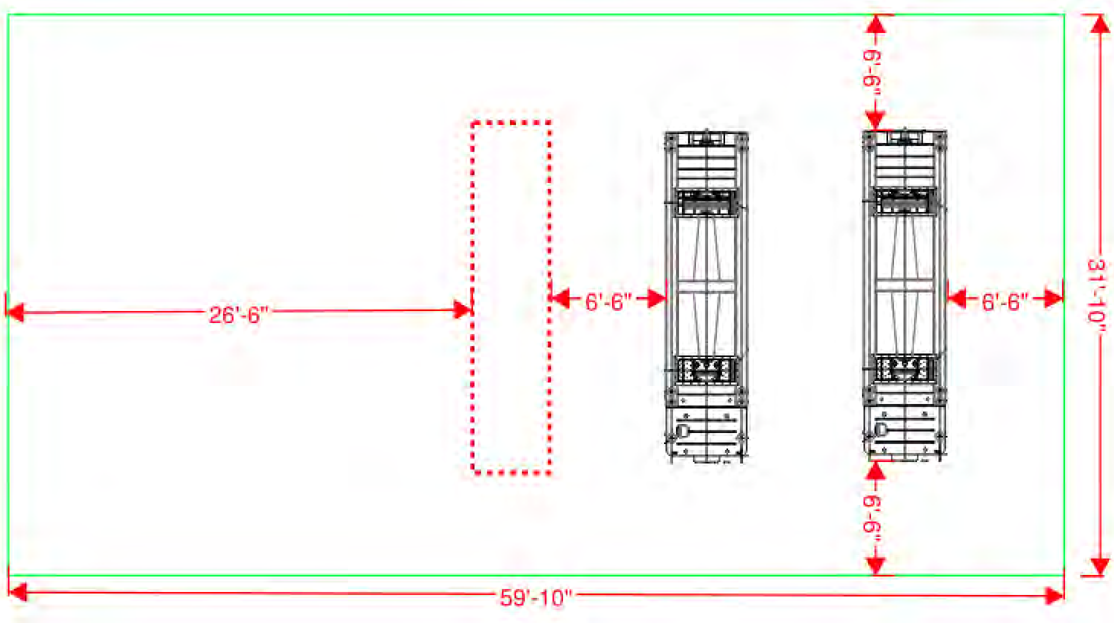


Figure 13. Centrifuge Final Dewatering Space Requirement

As a comparison, Figure 14 displays the centrifuge space required within the existing dewatering space on the fourth floor of the Dewatering Building. The existing dewatering space allows room for laydown and room for expansion for final dewatering or pre-dewatering. A structural analysis using the weight and rotational dynamics of proposed units would be required to confirm if the existing dewatering space can be used for new centrifuges. The use of the existing space for dewatering would also be contingent on the structural evaluation of the space and layouts of discharge screw conveyors, feed piping, and other ancillary equipment. The ultimate locations of pre-dewatering and final dewatering will be documented in a separate evaluation.

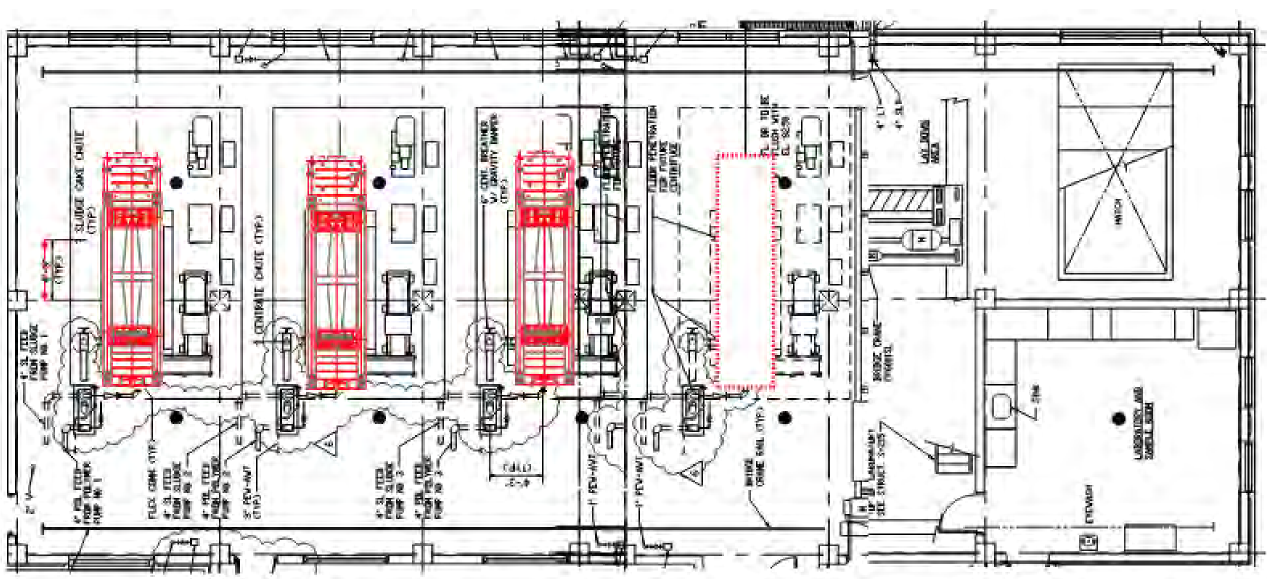


Figure 14. Centrifuge Existing Dewatering Space Comparison

4.4 Rotary Fan Presses

The rotary fan press consists of two round, porous, metal discs that slowly rotate on a horizontal shaft. Solids are pumped between the discs and water is released through the pores in the discs as the discs rotate and compress the sludge against a pressure bar. Rotary fan presses have a low power requirement because of the slow rotational speed. The machine operates with few moving parts. Rotary fan presses have a smaller hydraulic capacity than a centrifuge for the footprint of the machine. Additionally, this equipment typically requires a higher polymer dose. Figure 15 shows a rotary fan press.

Figure 15. Rotary Fan Press

HDR contacted Fournier for information and cost proposals for rotary fan presses for pre-dewatering and final dewatering. Fournier is the most reputable manufacturer of rotary fan presses with limited competition that has significant experience. Preliminary design criteria, shown in Table 12 for pre-dewatering and Table 13 for final dewatering, are based on the vendor proposal. For both pre-dewatering and final dewatering, the rotary fan press has the lowest solids loading rate, resulting in additional units. There is one existing installation using rotary fan presses for final dewatering with THP.

Table 12. Rotary Fan Press Preliminary Design Criteria: Pre-Dewatering

Parameter	Rotary Fan Press	Unit
Solids loading	1,090	lb/hr (per unit)
Number of units at 30.8 mgd	6/1	Duty/standby
Number of units at 40.0 mgd	7/1	Duty/standby
Estimated solids capture	92	Percent
Equipment space required	35 × 110 3,850	ft (total) SF (total)
Dry equipment weight	19,000 133,000	lb/unit lb total weight
Water consumption (AA)	5,800	gpd (total)
Power requirement (AA)	30 180	hp/unit hp total
Polymer consumption	15	Active lb/dry ton
Used with THP	Yes	
Equipment cost	$440k $3.08M	$/unit $ total equipment cost

Table 13. Rotary Fan Press Preliminary Design Criteria: Final Dewatering

Parameter	Rotary Fan Press	Unit
Solids loading	1,090	lb/hr (per unit)
Number of units at 30.8 mgd	3/1	Duty/standby
Number of units at 40.0 mgd	4/1	Duty/standby
Estimated solids capture	92	Percent
Anticipated cake dryness	30–35	Percent
Equipment space required	35 × 82 2,870	ft (total) SF (total)
Dry equipment weight	19,000 76,000	lb/unit lb total weight
Water consumption (AA)	4,420	gpd (total)
Power requirement (AA)	30	hp/unit
Polymer consumption	30	Active lb/dry ton
Used with THP	Yes (1 Installation)	
Equipment cost	$440k $1.76M	$/unit $ total equipment cost

The advantages and disadvantages of rotary fan presses are listed in Table 14.

Table 14. Rotary Fan Press Advantages and Disadvantages

Advantages	Disadvantages
Low energy use	Higher polymer usage
Enclosed, which minimizes odors	Not a highly used technology for medium to large facilities
Require minimal operator attention	Limited competition
Simple to operate	Unfamiliar technology to operators
	Require high levels of maintenance
	Several units required
	Lower solids capture (92%)
	Only one installation with THP for final dewatering (in Norway)

Space requirements for rotary fan presses are based on input by the manufacturer for removal of the channels and other maintenance items. Figure 16 and Figure 17 display the pre-dewatering and final dewatering space requirement, respectively, including laydown. However, this will be needed on a limited basis because channels are small and easier to maintain. Space requirements for rotary fan presses are summarized as follows:

- **Pre-dewatering:** 35 feet by 110 feet, or 3,850 SF
- **Final dewatering:** 35 feet by 82 feet, or 2,870 SF

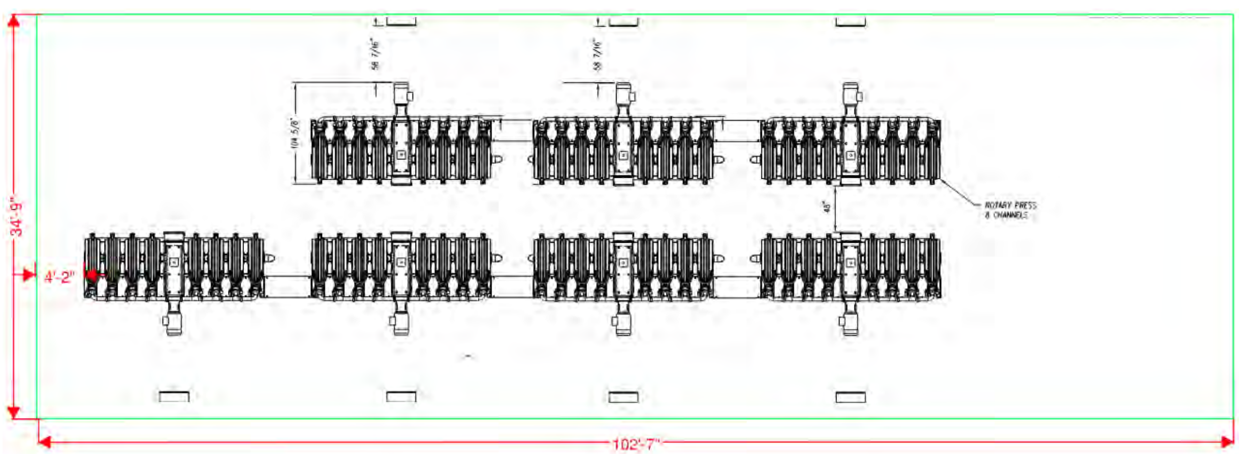


Figure 16. Rotary Fan Press Pre-Dewatering Space Requirement

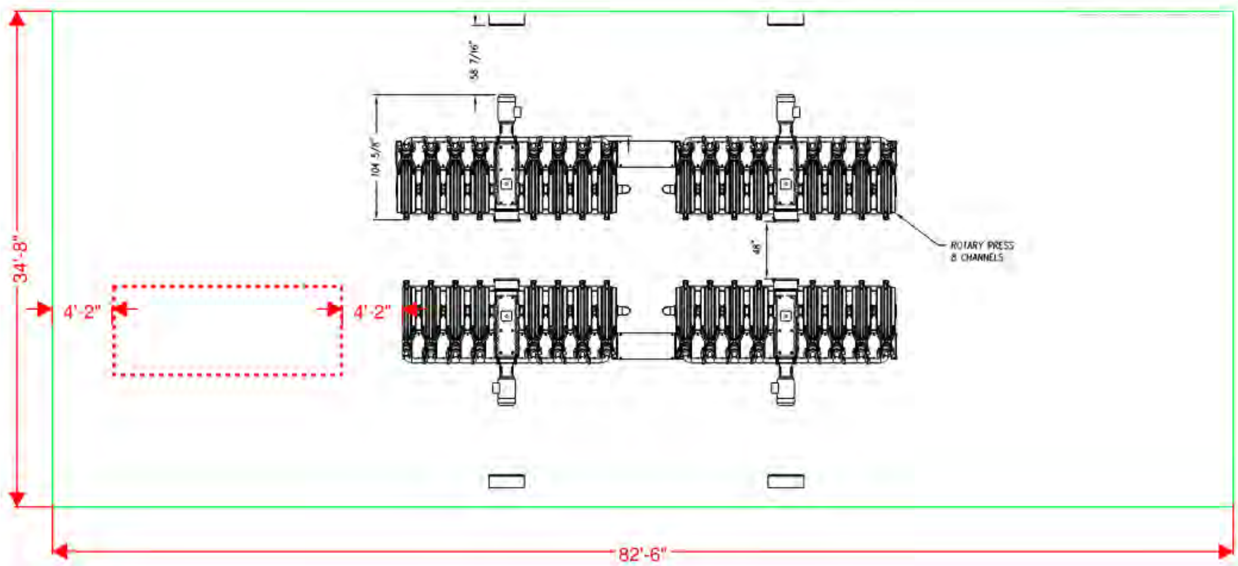


Figure 17. Rotary Fan Press Final Dewatering Space Requirement

As a comparison, Figure 18 displays the rotary fan press space required within the existing dewatering space on the fourth floor of the Dewatering Building. The existing dewatering space does not allow room for a redundant unit for pre-dewatering. The space does have adequate space for final dewatering. The use of the existing space for dewatering would also be contingent on the structural evaluation of the space and layouts of discharge screw conveyors, feed piping, and other ancillary equipment. The ultimate locations of pre-dewatering and final dewatering will be documented in a separate evaluation.

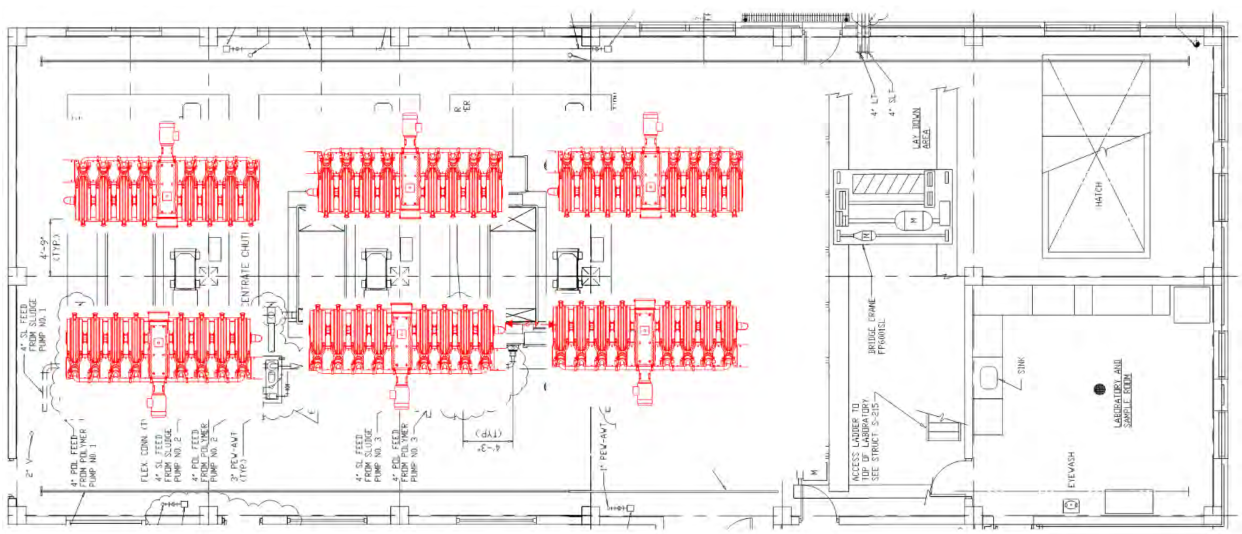


Figure 18. Rotary Fan Press Existing Dewatering Space Comparison

4.5 Bucher Press

The Bucher press, often referred to as a "hydraulic filter press" or piston press, was originally used in the fruit juice industry. The Bucher press consists of a slowly rotating body with a series of cloths through which the filtrate passes. The cake drops from the bottom when the press fully opens, and more sludge moves into the unit. The Bucher press runs on a batch cycle with 2-hour duration. The cycle consists of filling, pressing, loosening, and emptying. It is recommended to use a dynamic inline mixer with the Bucher press to incorporate polymer into the solids. Figure 19 shows a Bucher press.

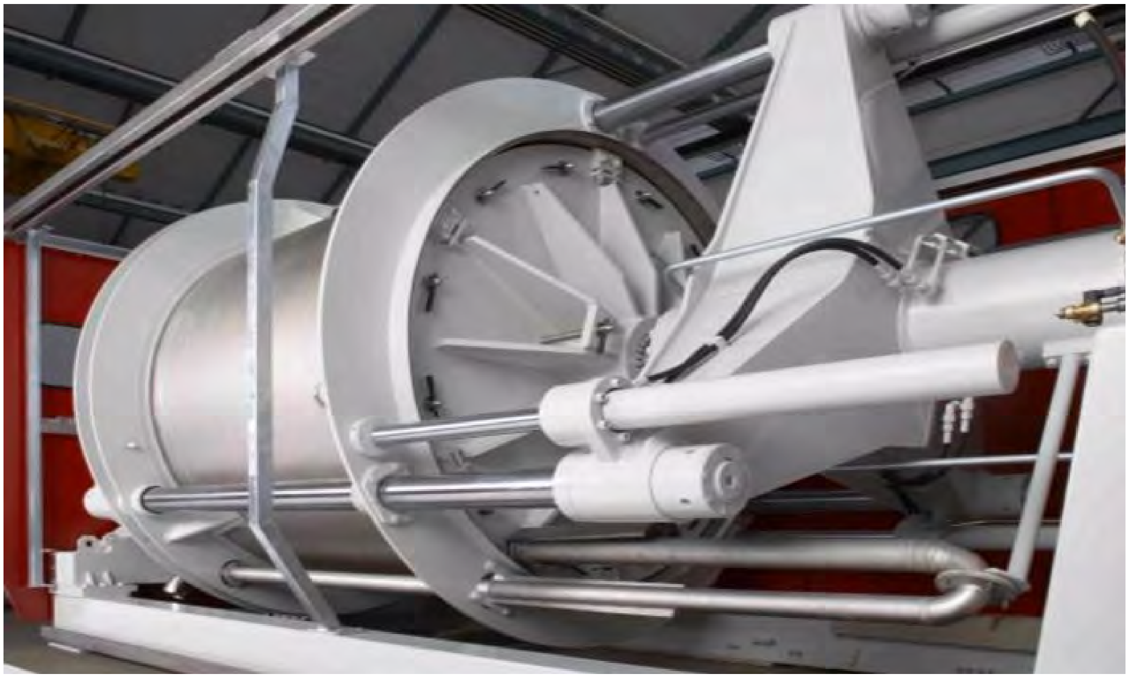


Figure 19. Bucher Press

HDR contacted Bucher for information and cost proposals for the Bucher press for final dewatering only. The main advantage of the Bucher press is higher cake solids, which is not required for pre-dewatering because required dewatered cake is between 15 and 18 percent TS. Therefore, the technology is considered for final dewatering only where a greater cake dryness is an advantage. Preliminary design criteria, shown in Table 15, are based on that proposal.

The units are relatively large and require the most space for dewatering of any technology. In addition, there is currently no U.S. representation for Bucher.

Table 15. Bucher Press Preliminary Design Criteria: Final Dewatering

Parameter	Bucher Press	Unit
Solids loading	1,500	lb/hr (per unit)
Number of units at 30.8 mgd	3/1	Duty/standby
Number of units at 40.0 mgd	3/1	Duty/standby
Estimated solids capture	98	Percent
Anticipated cake dryness	38+	Percent
Equipment space required	38 × 85 3,230	ft (total) SF (total)
Dry equipment weight	62,600 250,400	lb/unit lb total weight
Water consumption (AA)	265+ 800	gpd (total) gal/wk (total)
Power requirement (AA)	65	hp/unit
Polymer consumption	22	Active lb/dry ton
Used with THP	Yes	
Equipment cost	$865k $3.46M	$/unit $ total equipment cost

The relative advantages and disadvantages of Bucher presses are listed in Table 16.

Table 16. Bucher Press Advantages and Disadvantages

Advantages	Disadvantages
High solids capture	High energy costs
High cake dryness	Uncommon technology
Used with THP	Unfamiliar to WPCP staff
Maintenance can be performed in place	Require a large footprint
Require low operator attention	There is currently no U.S. representation (but soon Thermax will represent Bucher)
Relatively quick startup	High capital cost
Low odors because of being mostly enclosed	High maintenance in replacement of socks
	Sludge pumping and polymer dosing complexity because of batch process operation

Space requirements for the Bucher press are based on manufacturer input for O&M space requirements. No laydown space is required because the Bucher press can be serviced in place. Figure 20 shows the final dewatering space requirement, measuring 38 feet by 85 feet for a total of 3,230 SF.

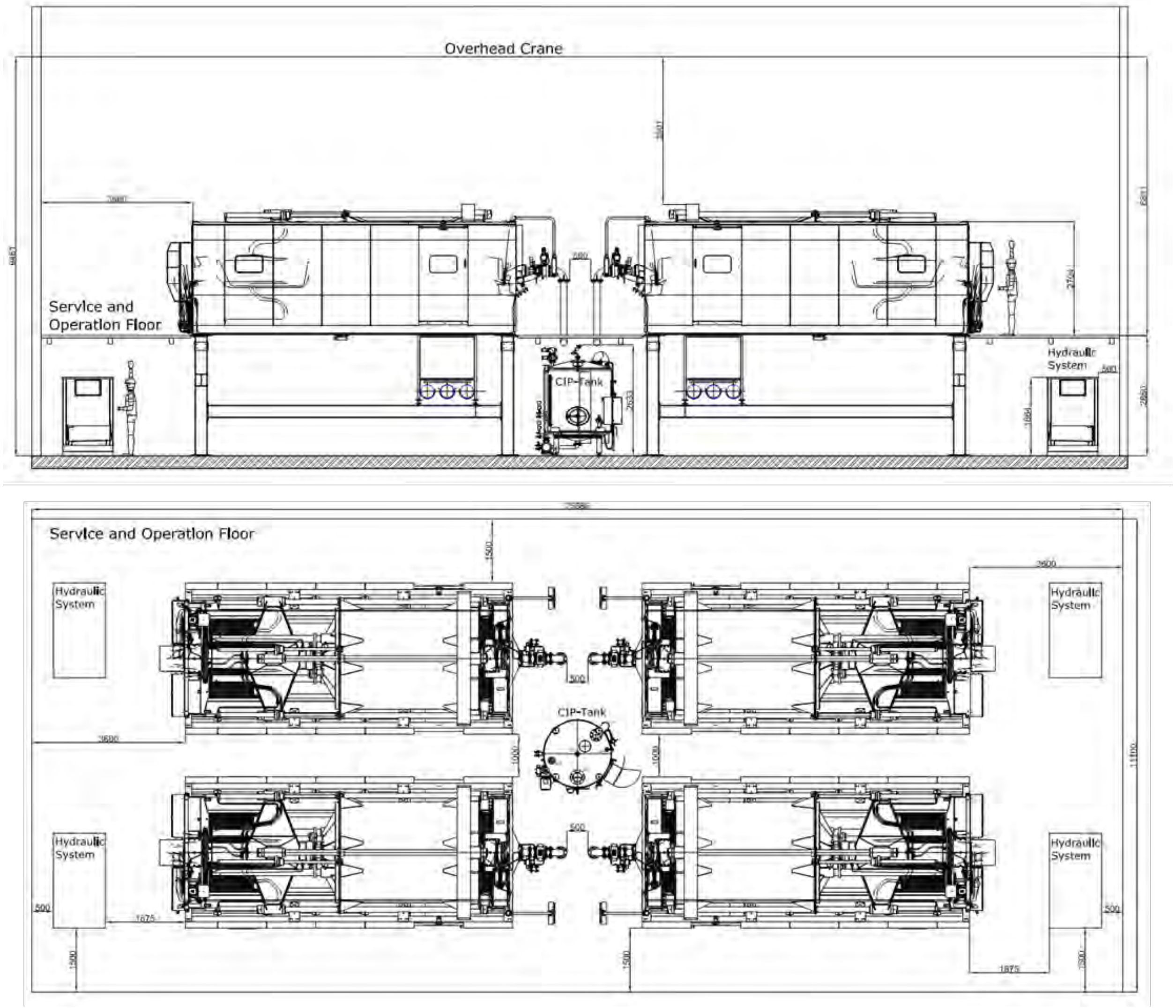


Figure 20. Bucher Press Final Dewatering Space Requirement

As a comparison, Figure 21 displays the Bucher press space required within the existing dewatering space on the fourth floor of the Dewatering Building. The Bucher press fits in the existing dewatering space if the hydraulic units are located in a separate part of the building. There would not be any room for future expansion, but additional units would not be needed for the buildout condition. The use of the existing space for dewatering would also be contingent on the structural evaluation of the space and layouts of discharge screw conveyors, feed piping, and other ancillary equipment. The ultimate locations of pre-dewatering and final dewatering will be documented in a separate evaluation.

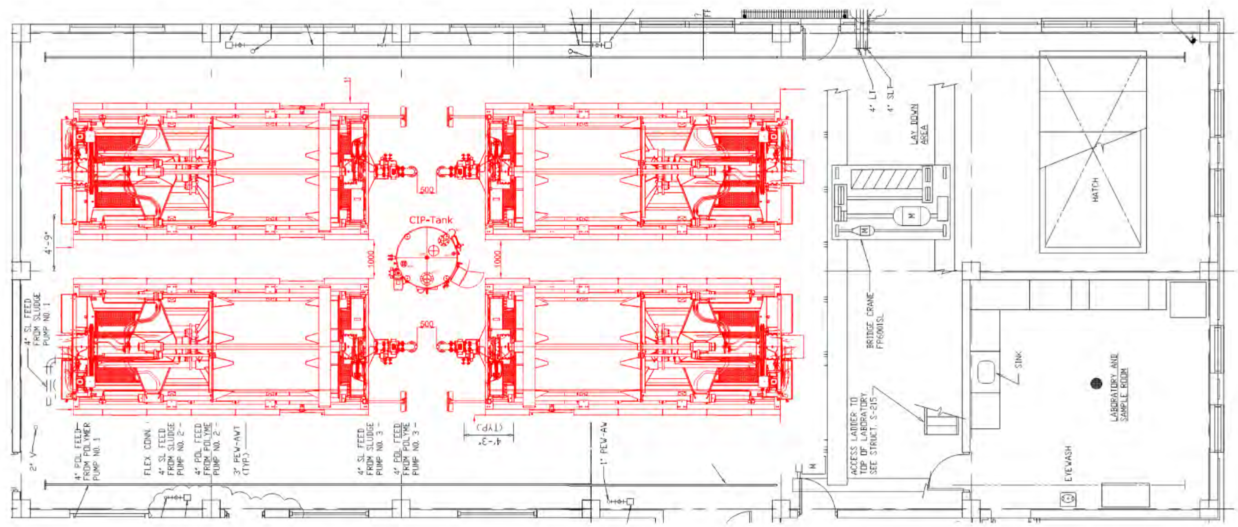


Figure 21. Bucher Press Existing Dewatering Space Comparison

5.0 Equipment Comparison

This section presents a side-by-side comparison of the relative advantages and disadvantages, design criteria, and equipment costs for the dewatering technologies evaluated. It also identifies and compares O&M costs for the shortlisted technologies selected at the May 10, 2021, workshop.

5.1 Technology Comparison

Table 17 provides a side-by-side comparison of the relative advantages and disadvantages of each technology. Design criteria are compared in Table 18 for pre-dewatering and Table 19 for final dewatering.

Table 17. Advantages and Disadvantages Technology Comparison

Advantages/ Disadvantages	Belt Filter Press	Screw Press	Centrifuge	Rotary Press	Bucher Press
Advantages	+ Low polymer demand + Simple to operate + High solids capture (97% +/-) + Low electrical demand + On-site maintenance + Visual operation of feed solids and cake + Commonly used with THP	+ Low energy use + Simple to operate + Few moving parts + Requires minimal operator attention + Enclosed; low odors + Low shear	+ Large solids loading throughput + Enclosed; low odors + Small footprint + Operator familiarity + Commonly used with THP	+ Low energy use + Enclosed; low odors + Minimal operator attention + Simple to operate	+ High solids capture (98%) + High cake dryness (35+%) + Used with THP + Maintenance in place + Low operator attention + Start up immediately + Low odors (mostly enclosed)
Disadvantages	- Medium footprint - Not enclosed, requires additional odor control - Lower cake solids content than centrifuge - High water demand (continuous) - Unfamiliar to current operating staff - High building wear - Frequent belt-related O&M - Access platforms required - Many moving parts	- Several units required - High polymer usage - Medium-sized footprint - Lower solids capture (90%) - Unfamiliar to current operating staff - No THP installations (final dewatering)	- High energy costs - Operator-intensive - Long startup and shutdown times - Lengthy off-site rebuilds - Higher maintenance	- Higher polymer usage - Not widely used technology - Low competition - Not a visible process - Unfamiliar technology to operators - High maintenance - Several units required - Lower solids capture (92%) - One installation with THP (Norway)	- High energy costs - Uncommon technology - Unfamiliar to WPCP staff - Large footprint - No U.S. representation (soon Thermax) - High capital cost - High maintenance (sock replacement) - Sludge pumping and polymer dosing complexity because of batch process operation

Table 18. Pre-dewatering Design Criteria Technology Comparison

Parameter	Belt Filter Press	Screw Press	Centrifuge	Rotary Press	Unit
Solids loading	2,400	1,280	4,240	1,090	lb/hr (per unit)
Number of units at 30.8 mgd	3/1	5/1	2/1	6/1	Duty/standby
Estimated solids capture	97	90	95	92	Percent
Equipment space required	34 × 100 3,400	30 × 90 2,700	32 × 72 2,304	35 × 110 3,850	ft (total) SF (total)
Dry equipment weight	25,000 100,000	8,200 49,200	20,000 60,000	19,000 133,000	lb/unit lb total weight
Water consumption (AA)	230,400	6,120	1,290	5,800	gpd
Power requirement (AA)	7 21	5 25	165[a] 330	30 180	hp/unit hp total
Polymer consumption	10	15	8	15	Active lb/dry ton
Used with THP	Yes	Yes	Yes	Yes	
Equipment cost	$353k $1.4M	$325k $1.95M	$625k–$725k $1.9M	$440k $3.08M	$/unit $ total equipment cost

a. 125 hp for the main drive and 40 hp for the scroll drive per centrifuge.

Table 19. Final Dewatering Design Criteria Technology Comparison

Parameter	Belt Filter Press	Screw Press	Centrifuge	Rotary Press	Bucher Press	Unit
Solids loading	2,000	1,280	4,240	1,080	1,500	lb/hr (per unit)
Number of units	2/1	3/1	1/1	3/1	3/1	Duty/standby
Estimated solids capture	97	90	95	92	98	Percent
Anticipated cake dryness	33	33	35	33	40	Percent
Equipment space required (buildout)	34 × 60 2,040	30 × 70 2,100	30 × 60 1,800	35 × 82 2,870	38 × 85 3,230	ft (total) SF (total)
Dry equipment weight	25,000 75,000	8,200 32,800	20,000 40,000	19,000 76,000	62,600 250,400	lb/unit lb total weight
Water consumption (AA)	230,400	4,080	1,290	4,420	400	gpd
Power requirement (AA)	7 14	5 15	165 165	30 90	65 195	hp/unit hp total
Polymer consumption	20	30	16	30	22	Active lb/dry ton
Used with THP	Yes	No	Yes	Yes (1 Installation)	Yes	
Equipment cost	$440k $1.32M	$310k $1.24M	$625k–$725k $1.25M	$440k $1.76M	$865k $3.46M	$/unit $ total equipment cost

5.2 Shortlisted Technologies

Technology options were presented and reviewed at a May 10, 2021, project workshop with the County. Workshop participants screened and selected a short list of preferred technologies.

5.2.1 Pre-dewatering

For pre-dewatering, screw presses, BFPs, and centrifuges were shortlisted. Rotary presses were removed from consideration because of the high equipment cost, high number of units required, and large amount of required space.

5.2.2 Final Dewatering

For final dewatering, BFPs and centrifuges were shortlisted. Screw presses were removed from consideration because of the low capture and lack of any installations used with THP for final dewatering. Rotary presses were removed from consideration because of the high equipment cost, high number of units required, large amount of required space, and limited operating history with only one existing installation used for dewatering THP solids. Bucher presses were removed from consideration because of the high equipment cost, high equipment weight, and large amount of required space.

5.3 O&M Cost Comparison for Shortlisted Technologies

Annual and 20-year present-value O&M costs were estimated for the shortlisted pre-dewatering and final dewatering technologies. O&M estimates include annual costs for power (at $0.06 per kilowatt-hour [kWh]), polymer (at $2.45 per pound [lb]), wash water at $0.50/1,000 gallons, and staff maintenance hours for both pre-dewatering and final dewatering technologies. Off-site maintenance for centrifuges is also included at a cost of $250,000 per unit once every 10 years. The labor hourly rate is the raw pay rate plus overhead and benefits for the employee. For final dewatering technologies, contract hauling and beneficial use costs were also included. Annual O&M costs were estimated at 28 mgd, the approximate midpoint flow condition, and used as the average annual O&M costs over the 20-year analysis period. Present-value costs were calculated for the 20-year analysis period using an inflation rate of 2 percent, a nominal interest rate of 4.0 percent, and a real interest rate of 1.96 percent.

5.3.1 Pre-dewatering

Pre-dewatering O&M costs are compared in Table 20. Centrifuges and BFPs have similar O&M costs. The lower power usage for BFPs is offset by higher polymer and water use. Screw presses have the highest O&M cost, largely due to the higher polymer cost compared to BFPs and centrifuges. At current condition of 28.0 mgd, the same number of units would be operational as the 30.8 mgd condition.

Table 20. Pre-Dewatering O&M Cost Summary

Criteria	BFP	Screw Press	Centrifuge
Number of units at 28 mgd (duty/standby)	3/1	5/1	2/1
Electricity	$6,000	$6,000	$69,000
Polymer	$353,000	$530,000	$283,000
Water	$42,000	$1,000	$0
Maintenance	$39,000	$59,000	$118,000
Total ($/year)	**$440,000**	**$596,000**	**$470,000**
Total (annual PW)	**$7,200,000**	**$9,800,000**	**$7,700,000**

5.3.2 Final Dewatering

Final dewatering O&M costs are compared in Table 21. Centrifuges have slightly lower O&M costs as higher power costs are offset by lower polymer and disposal costs.

Table 21. Final Dewatering O&M Cost Summary

Criteria	BFP	Centrifuge
Electricity	$4,000	$69,000
Polymer	$444,000	$355,000
Water	$33,000	$0
Maintenance	$29,000	$84,000
Beneficial use (hauling)	$1,032,000	$973,000
Total ($/year)	**$1,542,000**	**$1,481,000**
Total (annual PW)	**$25,300,000**	**$24,400,000**

6.0 Summary and Conclusions

The following technologies were selected from the May 10, 2021, workshop for further consideration:

- **Pre-dewatering:** Screw press, BFP, and centrifuge
- **Final dewatering:** BFP and centrifuge

Summaries of the major considerations for these shortlisted pre-dewatering and final dewatering technologies are presented in Table 22 and Table 23, respectively, including key design criteria and a summary of conceptual capital and O&M costs.

Table 22. Summary of Pre-Dewatering Technologies

Parameter	Belt Filter Press	Screw Press	Centrifuge	Unit
Solids loading	2,400	1,280	4,240	lb/hr (per unit)
Number of equipment	3/1	5/1	2/1	Duty/standby
Estimated capture	97	90	95	Percent
Equipment space required	34 × 100 3,400	30 × 90 2,700	32 × 72 2,304	ft (total) SF (total)
Dry equipment weight	25,000 125,000	8,200 49,200	20,000 80,000	lb/unit lb total weight
Water consumption (AA)	230,400 gpd	6,120 gpd	9,000 gal/wk	As labeled (total)
Power requirement (AA)	7 14	5 15	165 165	hp/unit hp total
Polymer consumption	10	15	8	Active lb/dry ton
Used with THP	Yes	Yes	Yes	
Equipment cost	\$353k \$1.4M	\$310k \$1.86M	\$600k–\$800k \$2.1M	\$/unit \$ total equipment cost
O&M present value	\$7,200,000	\$9,800,000	\$7,700,000	\$

Table 23. Summary of Final Dewatering Technologies

Parameter	Belt Filter Press	Centrifuge	Unit
Solids loading	2,000	4,240	lb/hr (per unit)
Number of equipment	2/1	1/1	Duty/standby
Estimated capture	97	95	Percent
Anticipated cake dryness	33	35	Percent
Equipment space required	34 × 80 2,720	30 × 60 1,800	ft (total) SF (total)
Dry equipment weight	25,000 100,000	20,000 60,000	lb/unit lb total weight
Water consumption (AA)	230,400 gpd	9,000 gal/wk (1,290 gpd)	As labeled (total)
Power requirement (AA)	7 14	165 165	hp/unit hp total
Polymer consumption	20	16	Active lb/dry ton
Used with THP	Yes	Yes	
Equipment cost	\$440k \$1.32M	\$600–\$800k \$1.4M	\$/unit \$ total equipment cost
O&M present value	\$25,300,000	\$24,400,000	\$

The O&M present value for pre-dewatering technologies shows that screw presses are the highest cost, with centrifuges as the second highest cost, and BFPs as the lowest cost. However, the difference in O&M present-value cost is negligible. For final dewatering, BFPs are the highest O&M present-value cost, with centrifuges at the lowest total O&M cost.

Centrifuges are a proven technology that is familiar to Arlington WPCP staff. Although there have been maintenance challenges with the existing centrifuges over the last several years, it is thought that this is primarily due to the age of the existing equipment exceeding its useful life. With newer technology and training, centrifuges should serve the County well for years to come. In addition, a common technology across all dewatering processes will benefit the County and allow for a common set of spare parts across both sets of equipment. WPCP staff are already familiar with this technology, which eases the transition of the completed project to O&M personnel. The learning curves and lessons learned for staff using similar dewatering equipment are paramount relative to other criteria.

Based on this, and the technology comparison, equipment costs, and O&M costs, it is recommended to use centrifuges for both pre-dewatering and final dewatering. Though BFPs have the lowest cost for pre-dewatering, using the same size centrifuges for pre-dewatering and final dewatering has O&M benefits that are not represented through a cost analysis. Additionally, centrifuges use less polymer and water, produce less odor, and create a less corrosive and humid work environment. For building layouts and facilities, centrifuges will be carried forward for these evaluations.

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Technical Memorandum No. 8

Date:	October 4, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Recycle Management and Sidestream Treatment

Contents

Tables

Figures

1.0 Introduction

Biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP) will include a new thermal hydrolysis process (THP) and anaerobic digestion (AD) process. These processes will generate a concentrated nitrogen recycle stream from final dewatering, which will increase the nitrogen load to the WPCP. The purpose of this Technical Memorandum (TM) No. 8 is to evaluate treatment approaches for the nitrogen recycle load. A sidestream deammonification nitrogen removal process was evaluated and compared with the baseline alternative of treating the full nitrogen recycle load in the mainstream activated sludge process.

This evaluation uses the nitrogen recycle load projections developed in TM No. 1: *Solids Production and Design Criteria*. Mainstream treatment operating costs were calculated based on conventional nitrification and denitrification, with costs included for methanol, supplemental alkalinity, additional electricity for aeration, and processing solids generated from methanol. Sidestream treatment costs were based on a dedicated deammonification process for the final dewatering recycle stream. A budgetary proposal was solicited from a deammonification process vendor. Using the vendor-supplied information, a conceptual process configuration and layout were developed for estimating construction costs. Sidestream treatment operating costs were calculated based on costs for operating a new deammonification process along with costs for removing the remaining nitrogen recycle in the mainstream process. The net present value (NPV) of each alternative was compared based on conceptual construction costs and projected 20-year operating cost. A sensitivity analysis was also conducted to illustrate the potential change in NPVs because of changes in key assumptions and commodity costs.

2.0 Evaluation Basis

This section describes the conceptual basis for the evaluation. This includes the flows and loads used for the evaluation as well as the treatment concepts and assumptions for both nitrogen removal alternatives.

2.1 Flows and Loads

Nitrogen recycle load projections from TM No. 1 (revised draft submittal, May 25, 2021) are summarized in Table 1 below. These loads are based on assumptions for volatile solids reduction and nitrogen content of the THP feedstock and may be updated based on future pilot testing results if the findings differ significantly. The ammonia-nitrogen concentration in the anaerobic digester is expected to be approximately 2,100 milligrams per liter (mg/L) with a 9 percent total solids feed to the digester. Without sidestream treatment, the final dewatering recycle would increase the total Kjeldahl nitrogen (TKN) load to the aeration basins by approximately 15 to 20 percent.

Table 1. Projected Sidestream Flows and Loads

Condition	WPCP Effluent Flow (mgd)	Recycle Ammonia Load (lb/d)	Recycle Flow before Dilution (gpd)
Using 2020 annual average	23.0	1,410	79,000
Design midpoint annual average	28.0	1,720	98,000
Design year annual average	30.8	1,890	108,000
Design year maximum month	36.7	2,490	141,000
Buildout annual average	40.0	2,460	140,000

a. Midpoint condition was applied where annual operating costs are listed.

The THP/AD process also produces refractory dissolved organic nitrogen (rDON), which is not removed by biological treatment and will contribute to WPCP effluent organic nitrogen. The rDON generated from THP was estimated based on conversion of 2.2 percent of the total nitrogen (TN) fed to THP, resulting in an additional 0.35 mg/L of effluent organic nitrogen. Table 2 illustrates the expected change in effluent TN due to rDON, assuming a similar level of treatment in the future. Current discharge permit limits are also listed. While rDON is not the focus of this TM, it should be noted that effluent organic nitrogen will increase with THP, and maintaining the current effluent TN would require using more methanol to achieve additional denitrification.

Table 2. Example Effluent Nitrogen Concentrations with THP-generated rDON

Effluent Nitrogen Species	Average Effluent, 2018–2020 (mg/L)	Effluent with THP-generated rDON (mg/L)	Effluent Limits (mg/L)
rDON from THP	-	0.35	-
Organic nitrogen (without THP)	0.7	0.7	-
Ammonia N	0.0	0.0	1.0/2.7 Apr.–Oct.[a] 3.5/4.2 Nov.–Mar.[a]
NOx	1.8	1.8	-
TN	2.5	2.85	3.0[b]

a. Weekly/monthly limits.
b. Annual limit.

2.2 Mainstream Treatment

The baseline alternative for treating the final dewatering nitrogen recycle load is to use the existing mainstream treatment process. This process uses conventional nitrification and denitrification. In this scenario, the final dewatering recycle load would be treated with the WPCP influent. This section describes the assumptions used to evaluate mainstream treatment.

2.2.1 Process Configuration

The existing activated sludge process is not reviewed in detail in this TM because extensive modifications are not anticipated as part of the biosolids upgrades. The only improvement identified was to provide additional capacity for storing and feeding supplemental alkalinity. The mainstream treatment alternative includes costs for new sodium hydroxide storage and feed facilities. The costs for this system are based on two new 12,500-gallon storage tanks for 25 percent caustic, providing an estimated 30 days of storage at 30.8 million gallons per day (mgd) WPCP flow, as well as feed pumps and accessories. Supplemental alkalinity demand and storage capacity should be evaluated further if mainstream treatment is selected.

2.2.2 Operating Cost Assumptions

The major operating costs for mainstream treatment of the recycle load are methanol for denitrification, handling solids generated from denitrification, supplemental alkalinity, and additional air for nitrification. Details for each of these cost factors are provided below.

Methanol is currently used as a carbon source for denitrification. Final dewatering recycle stream has a low biochemical oxygen demand (BOD)-to-TKN ratio and does not provide the carbon required for denitrification. For this analysis it was assumed that 100 percent of the final dewatering ammonia-nitrogen load recycled to the mainstream process will be denitrified with methanol. For sidestream treatment, this same assumption was applied to the ammonia load not removed by deammonification and thus recycled to the mainstream process. The methanol dosing ratio applied was 3.5 pounds (lb) of methanol per 1.0 pound of nitrogen. This ratio was based on an analysis of recent WPCP data and is in line with literature values.

The use of methanol for denitrification generates biological solids that must be processed and removed from the WPCP. Additional solids handling costs were estimated based on the increased methanol use for mainstream treatment. The additional solids production was estimated based on an estimated overall biomass yield of 0.3 pound total suspended solids per pound chemical oxygen demand (lb-TSS/lb-COD), and incremental solids handling cost of $175 per dry ton (DT) of biological solids generated and sent to THP/AD[1]. This solid handling cost captures the product hauling cost and polymer use associated with the additional biological solids from methanol.

Currently the WPCP does not normally add supplemental alkalinity to the activated sludge process. Supplemental alkalinity can be added as needed in the form of 25 percent caustic (sodium hydroxide). The activated sludge effluent (ASE) alkalinity averages 48 mg/L with an average pH of 7.05, and the outfall alkalinity averages 62 mg/L. The ASE pH is strongly correlated to alkalinity. Based on this correlation, the ASE pH would likely drop below 7.0 when the alkalinity is below 44 mg/L. The outfall alkalinity is higher than the ASE because of additional denitrification, which recovers alkalinity. At average flows and loads, the future final dewatering recycle load would consume about 30 mg/L of the mainstream alkalinity after full nitrification and before denitrification, accounting for the alkalinity provided by the recycle stream itself which is about 50% of the alkalinity required for full nitrification. Although denitrification can recover much of this alkalinity, it is expected that some amount of supplemental alkalinity will be required to treat the recycle load and maintain an acceptable pH throughout the activated sludge process. The amount of supplemental alkalinity required will depend on the target activated sludge pH, internal recycle and return activated sludge (RAS) rates, and amount of denitrification within the activated sludge process. For this analysis it was assumed that 35 percent of the alkalinity deficiency for full nitrification and denitrification would be supplemented by caustic. For reference, an assumption of 100 percent replacement would maintain the current ASE alkalinity without denitrification of the new recycle load in the activated sludge process, and an assumption of 0 percent

[1] Estimated biomass yield from methanol was based on literature. Cost for handling additional WAS generated from methanol was calculated based on the following assumptions: 72% volatile solids; 50% volatile solids reduction for WAS only; thickening, pre-dewatering, and final dewatering polymer doses of 5, 10, and 20 lb/DT, respectively; $2.50 per pound active polymer; and final dewatered cake at 33% total solids and $55/WT hauling cost. Additional energy costs were not included.

replacement would require full denitrification of this load in the activated sludge to maintain the current ASE alkalinity.

Mainstream aeration energy costs were estimated based on a typical aeration energy use of 1.2 kilowatt-hours per pound of nitrogen (kWh/lb-N)[2]. This typical energy demand for nitrification was not modified for WPCP conditions because available data were limited on the actual energy use for nitrification. This mainstream aeration energy use factor was also applied for ammonia not removed in the sidestream treatment alternative. For mainstream treatment, the existing aeration system should be evaluated to determine the excess capacity available to treat the recycle loads. The evaluation should consider that the centrate will be returned 5.5 days per week (during dewatering operation) because centrate equalization is not anticipated without sidestream treatment.

2.3 Sidestream Treatment

An alternative approach for treating the final dewatering nitrogen recycle load is to use a sidestream deammonification process. This would require a new treatment process that takes advantage of the warm, concentrated recycle stream to remove nitrogen in a relatively compact footprint and with less air and chemicals compared to mainstream treatment. The deammonification process converts a portion of the ammonia to nitrite aerobically by ammonia-oxidizing bacteria (AOB), and anaerobic ammonia-oxidizing biomass (anammox) consumes the combination of ammonia and nitrite. These reactions occur simultaneously in one reactor at low dissolved oxygen (DO) conditions. The process is successful on sidestreams because the warm temperature increases activity of the slow-growing anammox biomass, and the dewatering stream provides a consistent ammonia load to the process. Benefits of sidestream deammonification include:

- **Less aeration:** Deammonification has 60 percent less oxygen demand than full nitrification/denitrification and operates at a low DO concentration.
- **Less supplemental alkalinity:** Deammonification typically operates without supplemental alkalinity.
- **Less methanol:** Supplemental carbon is not used in the process.
- **Less sludge production:** Deammonification has a low biomass yield and avoids biomass growth from supplemental carbon.

Sidestream deammonification systems typically achieve about 85 percent ammonia removal and 75 percent TN removal without supplemental alkalinity. The nitrogen that is not removed in the sidestream process would be treated in the mainstream activated sludge process. While sidestream deammonification requires construction of a new facility, the operating costs are significantly less than those for full mainstream treatment because of less overall methanol use, supplemental alkalinity, energy for aeration, and solids production.

This section describes the process configuration and operating cost assumptions for sidestream treatment. Background information regarding deammonification downstream of THP is provided as part of the process description.

[2] Aeration energy based on “Economic analysis of electrodialysis, denitrification, and anammox for nitrogen removal in municipal wastewater treatment,” Vineyard et al., *Journal of Cleaner Production*, Vol. 262, July 20, 2020.

2.3.1 Process Configuration

Multiple vendors have provided systems for deammonification downstream of THP, as shown in Table 3. A single system, ANITA™ Mox, was used as the basis for this evaluation. Costs between vendors are expected to be similar for this level of evaluation, and therefore a single process configuration was used as the basis of evaluation. If sidestream deammonification is implemented, a separate process selection evaluation should be conducted.

Table 3. Deammonification Systems with THP

Facility	THP and Deammonification Systems
Växjö (Sweden)	Cambi THP + ANITA™ Mox
Five Fords (UK)	Cambi THP + ANITA™ Mox
Piscataway (USA): in construction	Cambi THP + ANITA™ Mox
Raleigh, NC (USA): in construction	Cambi THP + ANITA™ Mox
Washington, D.C. (USA)	Cambi THP + Demon™
Santiago (Chile)	Cambi WAS-only THP + Demon™
Vigo (Spain)	Cambi THP + Demon™
Basingstoke (UK)	Cambi THP + Demon™
Ourense (Spain)	Cambi THP + Clear green™
Burgos (Spain)	Cambi THP + Clear green™
Leigh (UK)	Cambi THP + Am treat
Tilburg (Netherlands)	Cambi THP + Anammox™
Minworth (UK)	Cambi THP + Anammox™
Hengelo (NL)	WAS-only THP + Colsen NAS
Beijing plants	Reno car Anammox process
Whittingham (UK)	Cambi THP + Sharon™

There are several design considerations particular to deammonification systems downstream of THP. Compared to conventional anaerobic digestion, the recycle stream from THP has higher concentrations of soluble chemical oxygen demand (sCOD) and ammonia-nitrogen. As a result, dilution water is required to help mitigate biological inhibition, which has been attributed to COD in the THP recycle stream, and to control temperature rise in the reactor because of the exothermic biological process. Dilution ratios are typically in the range of 1:1 to 2:1. While the dilution water helps to overcome the biological inhibition from THP recycles, deammonification systems downstream of THP are still designed for lower nitrogen loading rates compared to systems paired with conventional AD. This is a result of biological inhibition associated with THP.

An important design consideration for all deammonification systems is the TSS content of the recycle stream. Poor solids capture in the final dewatering process (e.g., centrate TSS greater than 1,000 mg/L) can result in high solids loads to sidestream deammonification and negatively impact the performance because of inhibition, increased oxygen demand, and displacement of active biomass. Deammonification systems should be designed based on the expected solids content of the recycle stream and with consideration to removing settled solids from equalization. Excess polymer dosed to final dewatering may lead to foaming in the deammonification reactor, and management of foam must also be considered in the design.

All sidestream deammonification systems benefit from upstream equalization to decouple the operation from dewatering, resulting in a steadier loading to the deammonification system. Deammonification systems achieve better nitrogen removal performance when the nitrogen load is consistent. For this analysis the equalization tank was sized based on 24 hours of equalization volume at design average conditions. The size of the equalization tank should be refined during detailed design, with consideration to dewatering schedule and the selected deammonification process. THP recycle streams have a high ammonia concentration which results in a strong ammonia odor near the equalization tank. The ammonia is expected to dissipate quickly and not result in offsite odors. Because the deammonification process is aerobic it has low odor potential. No odor control measures were included in this evaluation.

The ANITA™ Mox system configuration that was evaluated is shown schematically in Figure 1. It is a continuous-flow process, where anammox biomass is retained on plastic media. Suspended biomass is wasted periodically from the RAS with a motorized valve.

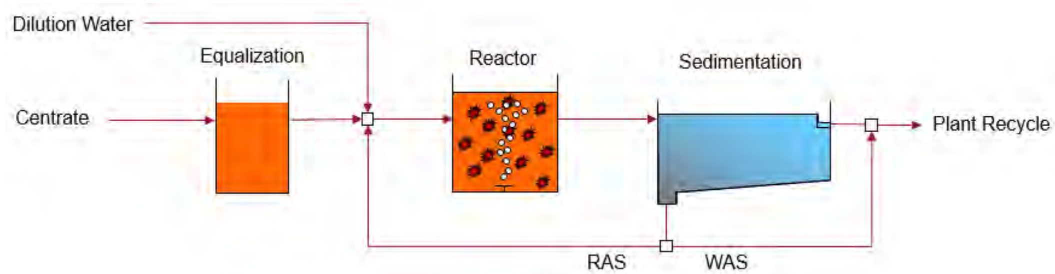

Figure 1. ANITA™ Mox IFAS General Process Flow Diagram

ANITA™ Mox is typically configured as a flow-through moving-bed biofilm reactor (MBBR) with conventional anaerobic digestion. However, with THP, an integrated fixed-film activated sludge (IFAS) process with a clarifier is recommended. The IFAS configuration is more robust for treating THP recycles with high sCOD and can operate at a higher loading rate compared to the MBBR configuration. The IFAS configuration is less sensitive to incoming COD because the mixed liquor suspended solids (MLSS) contain heterotrophic organisms and the MLSS concentration can be adjusted. This also helps to reduce the amount of dilution water required because dilution water is added to help mitigate inhibition from sCOD. The IFAS system operates at lower DO (0.2 to 0.5 mg/L) compared to MBBR (0.5 to 1.5 mg/L), which helps AOB to outcompete nitrite-oxidizing bacteria (NOB). This further improves process stability. Aeration is typically operated continuously in the ANITA™ Mox system.

The structures, equipment, and instrumentation for the ANITA™ Mox system are listed in Table 4. The process was configured with one reactor and one clarifier. The use of one large reactor rather than parallel reactors results in lower construction cost and simpler operation and monitoring. Reactor volume is based on the nitrogen loading rate at design maximum month conditions. The ANITA™ Mox vendor recommended a design loading rate of 1.0 kilogram nitrogen per cubic meter per day (kg-N/m^3/d), which results in a reactor volume of 0.34 million gallons (MG).

A conceptual layout for the sidestream treatment system is shown in Figure 2. Common wall construction was used where possible, and tank dimensions in the figure account for typical wall thicknesses. The building is configured between the tanks with pumps on the lower level for RAS/waste activated sludge (WAS) and feeding from the equalization tank to the reactor. The upper level would be used for blowers, variable-frequency drives (VFDs), and controls. The reactor and clarifier would not be covered since it is an aerobic process with relatively low odor, similar to aerobic activated sludge. The equalization tank may be covered if there is a need to limit ammonia odors in the selected location.

A general site layout is shown in Figure 3. The sidestream deammonification system is shown in the location of the current dissolved air flotation thickeners (DAFTs) which are slated to be demolished. Costs for demolition of the DAFTs is not included in the analysis as this was included in the thickening evaluation. To install sidestream treatment in this location, consideration must be given to conveying the recycle flow to the facility. It is likely that an existing drain from the DAFTs could be configured for the sidestream treatment effluent, and existing plant effluent water (PEW) piping to the DAFTs could be repurposed for dilution water.

Table 4. Sidestream Treatment Equipment and Instrumentation

Structure	Size and Details
Equalization tank	0.11 MG, 35 ft × 21 ft × 20 ft SWD
Reactor	0.34 MG, 50 ft × 45 ft × 20 ft SWD
Clarifier	35 ft × 13 ft × 13 ft SWD
Building	Two levels, 35 ft × 16 ft
Equipment	Quantity and Details
Plastic carrier media	20,900 ft^3
Media retention screens	2
Medium-bubble diffusers	5 grids
Airlift pumps for foam control	5
Hybrid screw blowers with VFD	1 duty/1 standby, ~100 hp ea.
Top-entry mixer with VFD	1
Reactor feed pumps with VFD	1 duty/1 standby
RAS/WAS pumps with VFD	1 duty/1 standby
Chain and flight clarifier mechanism	1
Equipment	Quantity and Details
PLC control panel	1
RAS/WAS control valves	2
RAS/WAS flow meters	2
Reactor feed flow meter	1
Dilution water flow control valve	1
Dilution water flow meter	1
Air supply flow meter	1
Level indication transmitter: equalization	1
Level float: reactor and equalization	2
DO probe: reactor	1
pH probe: reactor	1
Nitrate probe: reactor	1
Ammonia analyzer: reactor and equalization	1

ft = feet.
ft^3 = cubic feet.
hp = horsepower.

PLC = programmable logic controller.
SWD = side water depth.

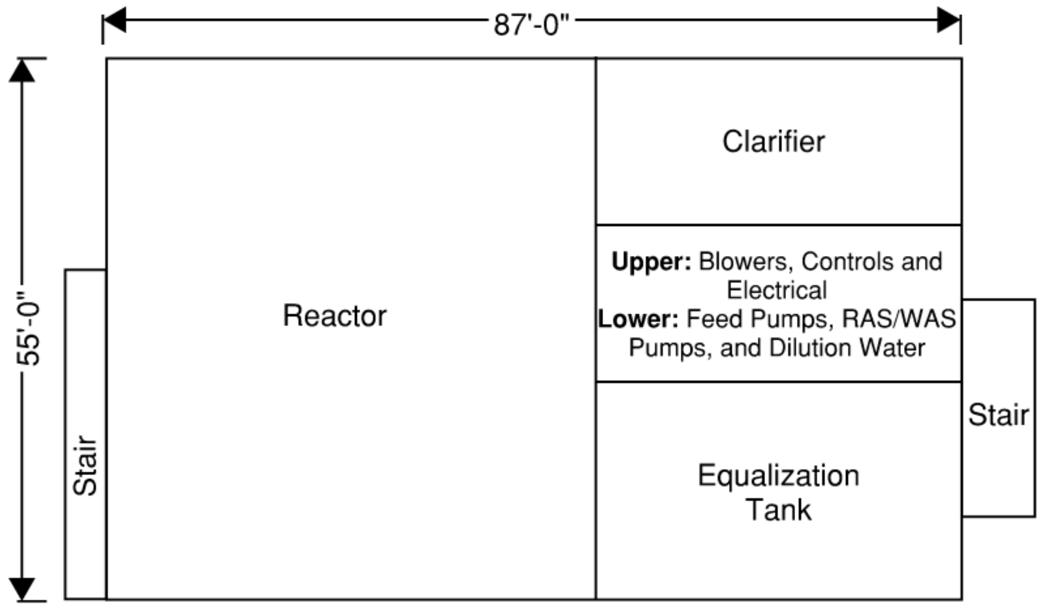

Figure 2. Sidestream Deammonification Conceptual Facility Layout

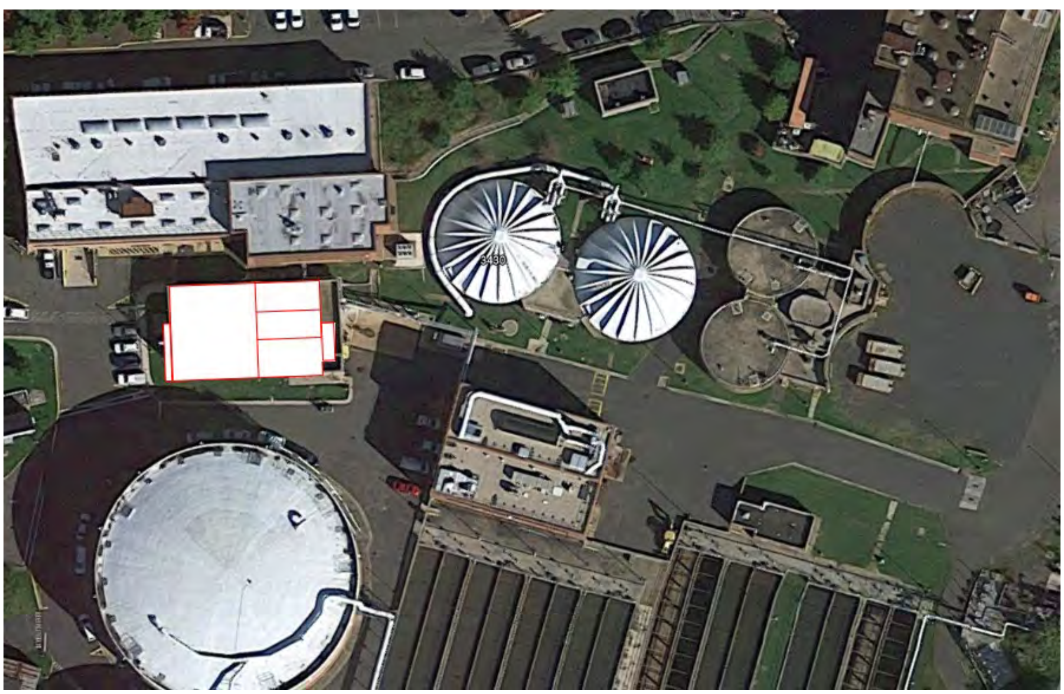

Figure 3. Sidestream Deammonification General Site Layout

2.3.2 Operating Cost Assumptions

Operating costs for the sidestream treatment alternative were evaluated assuming 85 percent ammonia removal in the sidestream process, with the remaining removal occurring in the mainstream process.

Approximately 10 percent of the ammonia removed in the sidestream treatment process is converted to nitrate, which is recycled to the head of the WPCP along with the residual ammonia. The costs for treating this nitrate recycle are assumed to be negligible because it will be mixed with the raw influent and may be consumed through denitrification before reaching the aeration basins.

Costs to operate sidestream treatment include electricity, dilution water, operations labor, and equipment maintenance. Methanol cost is included for treating the residual ammonia load that is recycled to the mainstream process. Costs were also included for handling additional solids generated by methanol, similar to the mainstream alternative. It was assumed that with sidestream treatment, supplemental alkalinity will not be required to treat the remaining portion of the nitrogen load in the mainstream process.

3.0 Alternatives Evaluation and Comparison

This section summarizes the costs assumptions applied for the evaluation and overall NPV of each alternative.

3.1 Cost Factors

The cost factors listed in Table 5 were used to develop the conceptual costs for deammonification. Base costs were first established using the vendor proposal along with concrete, structural, and additional equipment and piping costs based on the conceptual layout. Sitework, electrical, instrumentation and controls (I&C), and geotechnical factors were applied to the base cost. The remaining three cost factors were applied in series (contingency, mobilization/staging plus bonds/insurance, and overhead/profit).

Table 5. General Percentages for Cost Preparation

Parameter	Percentage
Sitework	15%
Electrical	20%
Instrumentation and controls	8%
Geotechnical	7%
Project contingency	20%
Contractor mobilization/staging, bonds/insurance	8%
Contractor overhead and profit	15%

Operations and maintenance (O&M) and present-value costs applied to the evaluation are summarized in Table 6. Commodity costs were based on current delivery contracts. Caustic price is based on 25 weight percent solution, which is used in the current system. The price for 50 weight percent caustic is currently 10 percent less ($648/DT). To avoid crystallization, 50 percent caustic should be used only with heat tracing, and therefore 25 percent caustic has been used historically at Arlington WPCP. Solids handling costs for additional solids generated from methanol were estimated based on final product hauling costs and polymer use, as described in Section 2.2.2.

Table 6. Cost Assumptions for Commodities, Labor, Maintenance, and Present Value

Parameter	Percentage
Methanol	$0.215/lb
Caustic, 25wt%	$721/DT
Electricity	$0.06/kWh
Solids handling (growth on methanol)	$175/DT
Dilution water	$0.50/1,000 gallons
Operations labor	$70/hr
Annual maintenance	2.5% of moving equipment cost
Present value factors	4% interest, 2% inflation

3.2 Comparison of Alternatives

Quantities for chemicals, electricity, and sludge production for each alternative are summarized in Table 7. The values shown are at design midpoint conditions (28 mgd WPCP flow).

Table 7. Chemicals, Energy, Sludge Production and Operations Labor

Item	Unit	Mainstream	Sidestream	Notes
Additional methanol	gpd	1,050	160	100% of ammonia recycled to mainstream is denitrified with methanol at 3.5 lb methanol/lb-N
Additional caustic	gpd at 25wt%	740	0	Supplementing 35% of alkalinity deficiency for complete nitrification prior to denitrification
Additional electricity	kWh/d	2,400	1,600	
Additional solids to THP (from methanol)	DT/d	1.23	0.18	
Dilution Water	gpd	0	98,000	Assuming 1:1 dilution ratio for sidestream
Additional operations labor	Full-time equivalent	0	0.25	

Costs for both alternatives are compared in Table 8. The annual costs shown are at design midpoint conditions, while present-value calculations consider operating conditions for each year as flows increase. Sidestream treatment has a much lower annual operating cost, primarily because of lower chemical requirements, but requires construction of a new facility at a significant capital expenditure. The sidestream treatment alternative has a lower overall 20-year NPV based on the assumptions used in this evaluation.

Table 8. Alternatives Cost Comparison

Parameter	Mainstream	Sidestream
Annual O&M	$932,000	$216,000
Methanol	$544,000	$82,000
Caustic	$258,000	$0
Electricity	$52,000	$33,000
Mainstream solids (from methanol)	$78,000	$12,000
Dilution water	$0	$18,000
Operations	$0	$36,000
Maintenance	$0	$35,000
Conceptual capital costs	$900,000	$9,500,000
O&M present value (20 year)	$15,150,000	$3,530,000
Net present value (20 year)	$16,050,000	$13,030,000

A year-by-year comparison of NPV is shown in Figure 4. Costs are based on projected operating conditions each year after startup. Based on the calculated NPVs over time, the payback period for sidestream treatment is approximately 14.3 years.

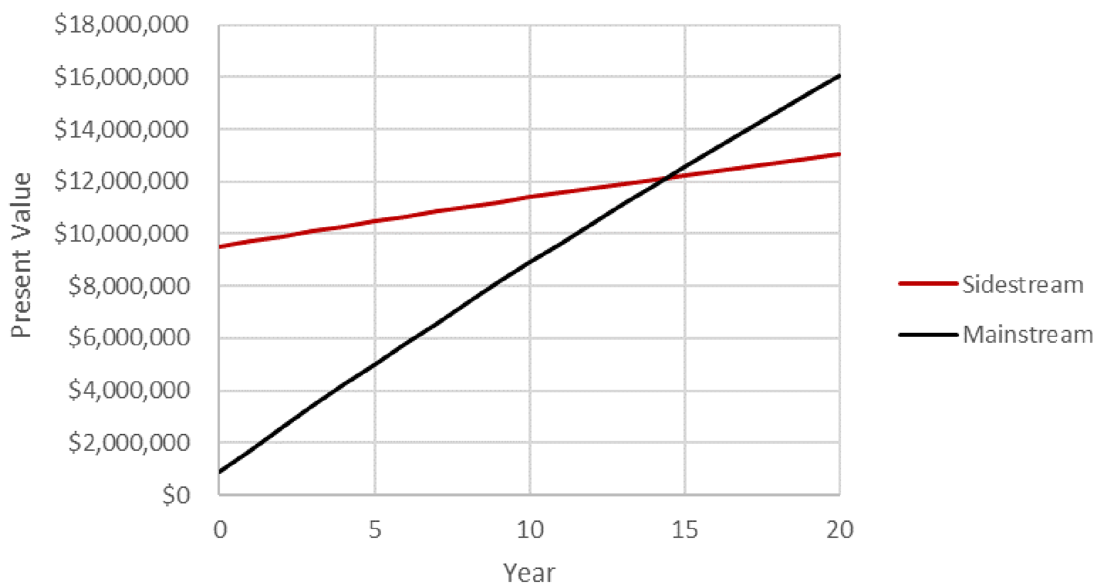

Figure 4. Net Present Value of Alternatives

A sensitivity analysis was conducted to evaluate the effect of assumptions for commodity costs and other factors that could be different in the future. Table 9 lists the 20-year NPV and years to equal NPV (i.e., payback) when cost factors are adjusted. Higher chemical costs would result in a shorter payback period for sidestream treatment. The sidestream treatment alternative is less sensitive to fluctuations in commodity costs because of lower chemical and energy use.

Table 9. Cost Sensitivity Analysis

Change	Mainstream NPV	Sidestream NPV	Years to Equal NPV
Baseline assumptions	$16,050,000	$13,030,000	14.3
Methanol cost increases by 40%, from $0.215/lb to $0.301/lb	$19,590,000	$13,560,000	11.3
Caustic cost increases 20%, from $721/DT to $865/DT	$16,900,000	$13,030,000	13.3
Electricity cost increases 50%, from $0.06/kWh to $0.09/kWh	$16,470,000	$13,300,000	14.2
Methanol, caustic, and electricity costs all increase as listed above	$20,850,000	$13,820,000	10.5
Mainstream alkalinity replacement is 20% (rather than 35%) of the alkalinity deficiency for complete nitrification	$14,260,000	$13,030,000	17.3
Mainstream alkalinity replacement is 50% (rather than 35%) of the alkalinity deficiency for complete nitrification	$17,850,000	$13,030,000	12.4

Mainstream treatment costs may be lower than predicted if actual chemical requirements for mainstream treatment are lower than the estimates in this evaluation. Additional confidence in the cost projections could be gained by a more detailed evaluation of the existing biological process and particularly the need for supplemental alkalinity. Currently 25 percent caustic can be fed to the activated sludge process. For mainstream treatment at design midpoint conditions (28 mgd WPCP flow) and with the baseline assumptions used for this analysis, caustic feed would be about 740 gallons per day (gpd) for 25 percent caustic or 310 gpd for 50 percent caustic. Lower-cost options for supplemental alkalinity could also be evaluated.

4.0 Summary and Conclusions

Sidestream deammonification has a lower annual operating cost than treating the final dewatering nitrogen recycle load in the existing mainstream activated sludge process. The lower operating cost for sidestream treatment is primarily due to lower chemical requirements, as well as lower energy use and sludge production. On the other hand, a new sidestream treatment process comes with a significant capital cost and would require operating and maintaining an additional facility.

A sensitivity analysis was conducted to evaluate the impact of chemical requirements and commodity costs on the NPV of each alternative. The payback period for sidestream treatment was estimated at 14.3 years with a range of 10.5 to 17.3 years. A key area of uncertainty is the chemical demands for mainstream treatment, particularly the amount of supplemental alkalinity.

Further evaluation of the mainstream activated sludge process is recommended to quantify the supplemental alkalinity requirements and help optimize the process for treating additional nitrogen load. This evaluation should include process modeling and evaluations of equipment and processes to confirm sufficient nitrogen removal capacity and to develop measures for improving nitrogen removal performance. Chemical storage and feed facilities should be evaluated based on the projected chemical demands and commodity costs.

It is recommended that space be reserved for a future sidestream deammonification process, which would be selected and constructed in a later project. The future sidestream deammonification process should ideally be located close to final dewatering to minimize the distance for conveying centrate to the equalization tank. Initially the recycle load can be treated in the activated sludge process. The activated sludge process currently has excess aeration capacity because the blowers are sized for WPCP buildout flow. Methanol use will increase significantly, and it is likely that supplemental alkalinity will be required. Chemical storage and feed facilities for the existing process should be reviewed to confirm capacity and expanded as required. Postponing the design and construction of a new deammonification process to a future project would allow for additional local experience treating thermal hydrolysis recycles in similar processes. The economic justification for a new sidestream deammonification process could also be confirmed based on full-scale operating data for mainstream treatment at Arlington WPCP.

Technical Memorandum No. 9

Date:	October 20, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Dewatering Facility Evaluation

Contents

Tables

Figures

1.0 Introduction

This introductory section presents the background and purpose of this project and the dewatering facilities evaluation, followed by a description of the evaluation approach.

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary solids (PS) and waste activated solids (WAS) thickening, dewatering, and lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a thermal hydrolysis process (THP) and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The purpose of this dewatering facilities evaluation is to further assess and compare dewatering equipment locations and the reuse or repurposing of existing facilities. The results of this evaluation will inform a decision on whether existing facilities will be retained or decommissioned and the overall site planning for inclusion in the Facilities Plan.

1.2 Evaluation Approach

Various existing and new building layouts were developed for pre-dewatering and final dewatering. Conceptual building configurations, site layouts, and costs for dewatering facilities were prepared. Facility alternatives are evaluated and compared based on conceptual cost estimates, non-cost considerations, site layout, and space requirements.

2.0 Summary of Existing Facilities and Future Solids Processing

A process flow diagram for existing solids handling at the WPCP is shown in Figure 1. Solids are thickened using gravity thickeners (GTs) for PS and dissolved air flotation thickeners (DAFTs) for WAS. Thickened solids are blended in solids storage tanks and dewatered using centrifuges. Liquid centrate from the centrifuges is returned to the head of the WPCP. Lime is added to the raw dewatered solids to achieve Class B pathogen and vector attraction reduction. Lime-stabilized biosolids are hauled off site for beneficial use through bulk agricultural land application.

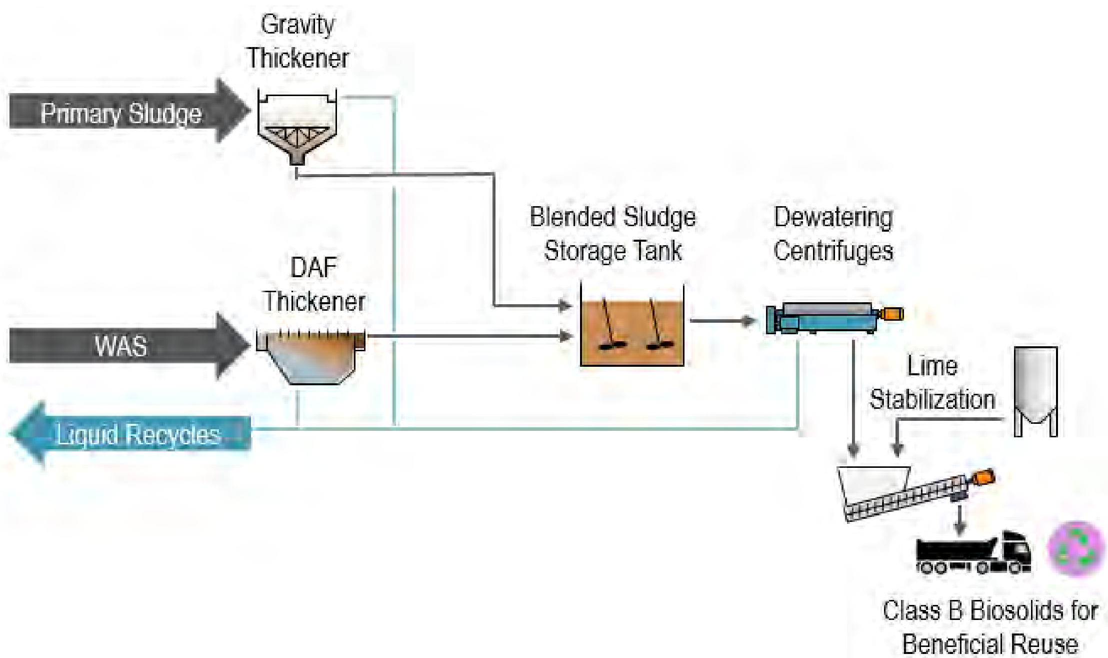

Figure 1. Existing PS and WAS Process Flow Diagram

All existing dewatering and lime stabilization processes are housed in the existing dewatering building (DWB). The DWB, constructed in the 1990s, includes the following equipment:

- Dry and liquid polymer storage and feed (only liquid polymer is used, the dry polymer system is abandoned)
- Centrifuge feed well and centrifuge feed pumps
- Dewatering centrifuges
- Dewatered cake bins and conveyors
- Lime storage and feed, including storage silo, day bins, and lime metering system
- Sludge/lime mixers
- Truck loading bays
- Ancillary facilities, including air compressors; boilers; heating, ventilation, and air conditioning (HVAC); and fire suppression
- Bathrooms
- Egress (stairways/elevator)

As noted in Technical Memorandum (TM) No. 2, *Condition of Existing Facilities*, the DWB structure is sound and could continue to be used for future facilities. The existing process mechanical equipment is approaching the end of its useful life, and it is recommended that all new equipment be provided and the building be reconfigured as necessary to serve the new treatment processes. Although some recent HVAC modifications have been made, it is likely that any building reconfiguration will require a complete HVAC overhaul, as well as retrofits to the electrical and controls systems.

The new solids handling process will include two dewatering steps, as highlighted in Figure 2: a pre-dewatering process to provide the appropriate solids concentration to feed the THP and subsequent digestion process and a final dewatering process for creation of the dewatered cake for beneficial use.

This TM includes evaluations of facility configurations for both dewatering processes. Thickening and screening processes noted in previous evaluations (TM No. 6, *Thickening Evaluations*) are also accounted for in these facility configurations.

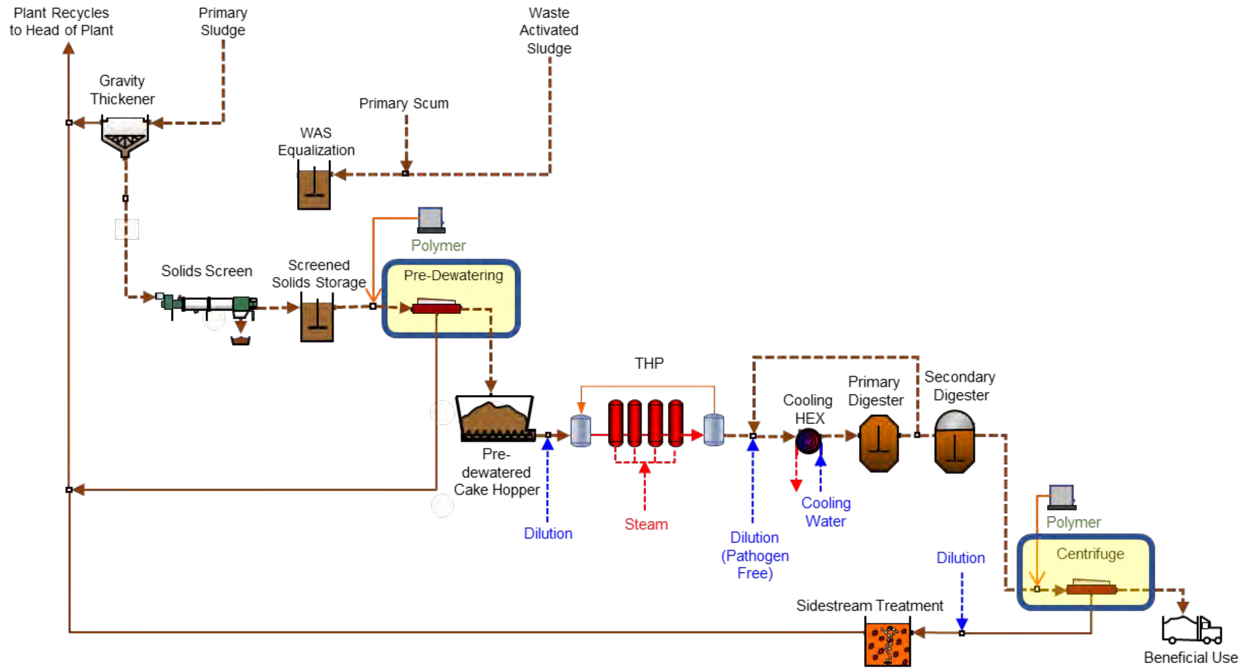

Figure 2. Future Solids Handling Process Flow Diagram

Preliminary evaluations presented in Workshop 4.1 on June 16, 2021, considered reuse of the existing DWB and new facilities for both pre-dewatering and final dewatering. At that workshop, it was concluded that the existing DWB should be considered only for pre-dewatering for the following reasons:

- The existing DWB space is very large and exceeds what is needed for final dewatering. The space can be used more effectively to add unit processes such as mechanical WAS thickening and solids screening.
- The existing truck loadout requires trucks to back into the facility from Eads Street, which presents safety concerns.
- The existing dewatered cake bins and conveyors are not well suited for rapid truck loadout and could provide greater benefit as pre-dewatered cake storage ahead of thermal hydrolysis.

At Workshop 5.2 on August 6, 2021, it was decided to evaluate an alternative where final dewatering and pre-dewatering are in a common building. Based on Workshop 4.1 and Workshop 5.2 conclusions, this TM compares the following alternatives:

1. **Alternative 1: Renovate the Dewatering Building.** The existing DWB would be rehabilitated and renovated for pre-dewatering, and a new final DWB would be constructed.
2. **Alternative 2: Demolish the Dewatering Building.** New pre-dewatering and final dewatering buildings would be constructed, and the existing DWB would be demolished.
3. **Alternative 3: Decommission the Dewatering Building.** A new combined pre-dewatering and final dewatering building would be constructed without impacting the existing DWB.

This TM presents building concepts for the facilities included in the alternatives listed above.

Note that while the focus of this TM is on the dewatering facilities, space within the new or renovated building(s) is also allocated for the following:

- Future mechanical WAS thickening
- Solids screening and associated pumping
- Solids storage mixing systems and associated pumping

In addition, given the available space of the existing DWB, Alternative 1 would include allocated space for the steam boilers and associated equipment. As the evaluation progressed, space was also identified in Alternative 3 for steam boilers (to provide a direct comparison to Alternative 1 as described later in this TM).

3.0 Design Criteria

Two design loading conditions were considered for the dewatering facilities evaluation. These conditions were defined based on WPCP flow treated, as follows:

- **30.8 million gallons per day (mgd):** design conditions:
  - Used as the basis for equipment sizing and number of units required for the Facilities Plan
  - Based on projected 2052 WPCP flow
- **40.0 mgd:** buildout conditions:
  - Used to establish total footprint requirements and dewatering facility sizing with space reserved for potential future equipment

Equipment sizing and number of units required were based on peak 3-day loadings for pre-dewatering and peak 14-day loadings for final dewatering as established in TM No. 1, *Solids Production and Design Criteria*. A lower peaking factor is appropriate for final dewatering as the solids loads are buffered through the digestion process.

Summaries of the design loading criteria for pre-dewatering and final dewatering are provided in Table 1 and Table 2, respectively. For pre-dewatering, it is assumed that the PS will be thickened with GTs and mixed with un-thickened WAS to achieve a total feed solids concentration of 2.1 percent with a PS:WAS ratio of 70:30. THP is required to be fed at 15 to 18 percent solids. Any of the pre-dewatering systems being evaluated will produce a higher solids concentration and dilution of the pre-dewatered solids will be required prior to feeding THP. The operation schedule for pre-dewatering will be 24 hours per day, 7 days per week to maintain a consistent feed to the THP and digestion processes. For final dewatering, the feed solids concentration is assumed to be 4.4 percent. The final dewatered cake concentration is expected to be greater than 30 percent. The operation schedule for final dewatering will be 24 hours per day, 5.5 days per week, consistent with current dewatering operations.

Table 1. Summary of Pre-dewatering Loading Design Criteria

Design Condition	Avg (gpm)	Avg (lb/hr)	3-day (gpm)	3-day (lb/hr)
23.0 mgd (current)	250	2,700	395	4,500
30.8 mgd (year 2052)	330	3,600	530	6,000
40.0 mgd (buildout)	430	4,700	685	7,800

Flows and loads in this table are based on a 24-hour per day, 7-day per week operating schedule assumption.

Table 2. Summary of Final Dewatering Loading Design Criteria

Design Condition	Avg (gpm)	Avg (lb/hr)	14-day (gpm)	14-day (lb/hr)
23.0 mgd (current)	70	1,600	100	2,300
30.8 mgd (year 2052)	100	2,200	140	3,100
40.0 mgd (buildout)	125	2,900	180	4,000

Flows and loads in this table are based on a 24-hour per day, 5.5-day per week operating schedule assumption.

4.0 Facility Evaluation Assumptions

This section discusses the assumptions made for the thickening/pre-dewatering facility and final dewatering facility. The purpose of this evaluation is to provide reasonable building footprints and conceptual facility sizing. Internal building layouts are not yet optimized for site layout, and may require rotation, mirroring, or other reconfiguration. Details for equipment orientation will be provided during design of the facilities.

The sections below describe the assumptions for equipment selection and sizing of the major unit processes to be located within these facilities

4.1 Future Thickening Units

As discussed at Workshop 5.1 on July 22, 2021, mechanical WAS thickening will not initially be included, and un-thickened WAS will be combined with thickened PS prior to pre-dewatering. However, space will be allocated for future WAS thickening implementation , as it is anticipated that increased flows and loads over time will make WAS thickening a necessity in the future.

For Alternative 1, rotary-drum thickeners (RDTs) are assumed for future WAS thickening because they have a relatively compact footprint. Layouts allocate space for three RDTs, which meets both design and buildout conditions with one unit out of service. GBTs could also be considered in the future. For Alternatives 2 and 3, GBTs are assumed for future WAS thickening because of the increased available space in a new facility. Space for three GBTs would be provided to meet buildout conditions. RDTs would also fit in the space allocated.

4.2 Dewatering Units

For both pre-dewatering and final dewatering, centrifuges are assumed as documented in TM No. 7, *Dewatering Evaluation*. Three pre-dewatering centrifuges are required (two duty, one standby) with space for a fourth to meet buildout conditions. Final dewatering requires two centrifuges (one duty, one standby) with space for a third to meet buildout conditions. All alternatives include bridge cranes and floor hatches to facilitate maintenance of the centrifuges.

4.3 Polymer System

One polymer system is assumed to be dedicated to pre-dewatering and future WAS thickening. A second, separate polymer system is assumed to be dedicated to final dewatering. Each system includes two polymer storage tanks, providing more than 30 days of storage at 40 mgd WPCP flow conditions. All facility layouts include a rapid-mix polymer activation unit for each dewatering unit with space for similar future thickening polymer systems.

4.4 Pre-dewatering Cake Storage

A minimum 24 hours of storage at 40 mgd average conditions is recommended between the pre-dewatering centrifuges and THP pulper tank. Pre-dewatered cake will be pumped to THP using pulper feed pumps below the storage bins.

For Alternative 1, the existing cake storage bins would be used for cake storage. The existing bins have a total capacity of 430 cubic yards (CY) and would provide 29 hours of storage at 40 mgd average conditions.

Alternatives 2 and 3 would include two 175 CY cake storage bins, providing a total capacity of 350 CY, which is equivalent to 24 hours of cake storage at 40 mgd average conditions.

4.5 Final Dewatering Cake Storage

Final dewatering cake storage bin sizing was based on providing 1.5 days of cake storage at 30.8 mgd 14-day peak conditions, resulting in 200 CY of storage capacity. Screw conveyors are assumed for all cake conveyance for final dewatering.

4.6 Truck Loadout

Emergency truck loadout is assumed for pre-dewatering. During emergency loadout, the THP feed pumps would convey cake to a chute outside of the dewatering building as opposed to the THP.

A pull-through truck loadout with a truck scale is assumed for final dewatering.

4.7 Auxiliary Facilities

HVAC is assumed to be housed in the facility for the new final dewatering facility and repurposed pre-dewatering facility. For the new pre-dewatering facility, the HVAC equipment can be configured on a roof adjacent to the control room. Odor control is assumed to be housed outside of the facilities in a separate location. One elevator is planned for each of the new facility alternatives. Control rooms and lab space are included, as well as bathrooms and space for storage. Two stairways are shown to provide egress per Occupational Safety and Health Administration (OSHA) requirements.

4.8 Construction Costs

Conceptual construction costs were prepared for each alternative based on preliminary equipment quotes from vendors; cost per square foot for buildings; and general percentages for ancillary facilities, site work, contingencies, and general contractor costs shown in Table 3 (for new facilities). A built-up estimate for demolition, structural/architectural, and mechanical is provided. Percentage cost adders are applied to these built-up estimates to determine the final conceptual costs, as shown in Table 3. Percentage cost adders and estimates for Alternative 1 are described further in Section 5.1.6.

Table 3. General Percentages for Cost Preparation

Parameter	Percentage
Demolition	Built-up estimate
Structural/architectural	Built-up estimate
Mechanical	Built-up estimate
Base subtotal	*Base subtotal*
Sitework (percentage of base subtotal)	15%
Electrical (percentage of base subtotal)	20%
Instrumentation and controls (percentage of base subtotal)	8%
Large and specialty pipe (percentage of base subtotal)	5%
Geotechnical (percentage of base subtotal)	7%
Subtotal	*Subtotal*
Project contingency (percentage of subtotal)	20%
Contractor mobilization/staging (percentage of subtotal and project contingency)	5%
Contractor bonds/insurance (percentage of subtotal and project contingency)	3%
Contractor overhead and profit (percentage of subtotal and project contingency)	15%
Total construction cost	**Total**

The conceptual cost is only a rough order of magnitude to use for relative comparisons between the various alternatives. The conceptual costs presented herein are not for budgeting purposes. Opinions of probable construction costs (OPCCs) will be prepared as part of the Facilities Plan, separate from this dewatering evaluation.

5.0 Facility Alternatives

A description of each facility alternative, including layout, conceptual costs, and advantages and disadvantages, is provided in this section.

5.1 Alternative 1: Renovate the Existing Dewatering Building

In Alternative 1, the existing DWB would be renovated for screening and pre-dewatering processes, with space allocated for a future thickening process. This alternative must be paired with the new final dewatering facility (Section 5.3).

5.1.1 Process Equipment and Building Components

New process equipment and electrical equipment would include the following:

- Screen feed pumps
- Solids storage mixing compressors
- Steam boilers and boiler chemical feed
- Polymer storage and feed, shared for pre-dewatering and future WAS thickening
- Future RDTs for WAS thickening
- Sludge screens and screenings loadout
- Pre-dewatering centrifuge feed pumps
- Pre-dewatering centrifuges with emergency cake loadout
- New HVAC and electrical

- New process piping throughout
- New elevator, controls, and mechanical equipment

The following components would be reused:

- Existing cake bins with live bottoms: four bins at 107 CY each, providing 29 hours of storage at 40 mgd average conditions
- Overall building structure, with significant modifications for new equipment and processes
- Bathrooms
- Egress (stairways, elevator shaft)

The existing odor control system would be demolished and provided in a separate facility. One of the existing truck bays can be used for emergency dewatered solids unloading.

5.1.2 Building Layout

The first floor of the building would include the following equipment:

- Pre-dewatering feed pumps
- Space for future RDTs and thickened waste activated sludge (TWAS) pumps
- Polymer storage tanks and blend units for pre-dewatering, with space for additional blend units for future thickening
- Truck bay for emergency loadout (existing truck bay)
- Screen feed pumps
- Solids storage mixing compressors

The pre-dewatering feed pumps would replace the existing centrifuge feed pumps. The polymer system would be configured in the location of an existing truck bay and would include bulk storage tanks, a recirculation pump, and polymer blend units for pre-dewatering. One truck bay would be retained for emergency cake loadout. The location for the future RDTs would require demolishing the existing odor control chemical room, polymer tanks, and polymer feed pumps. The first-floor layout is shown in Figure 3, and a section is shown in Figure 4.

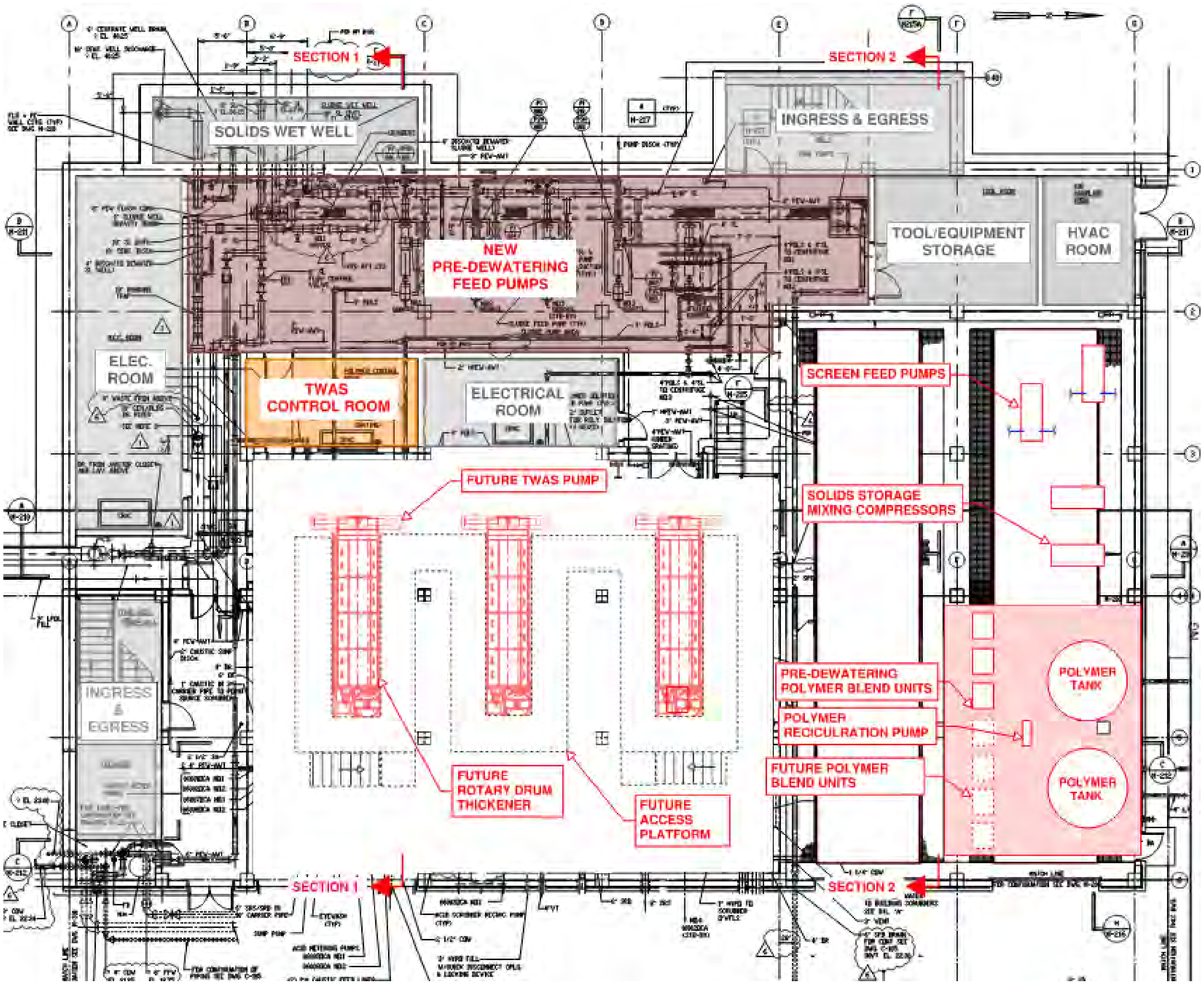

Figure 3. Existing Building First-Floor Plan

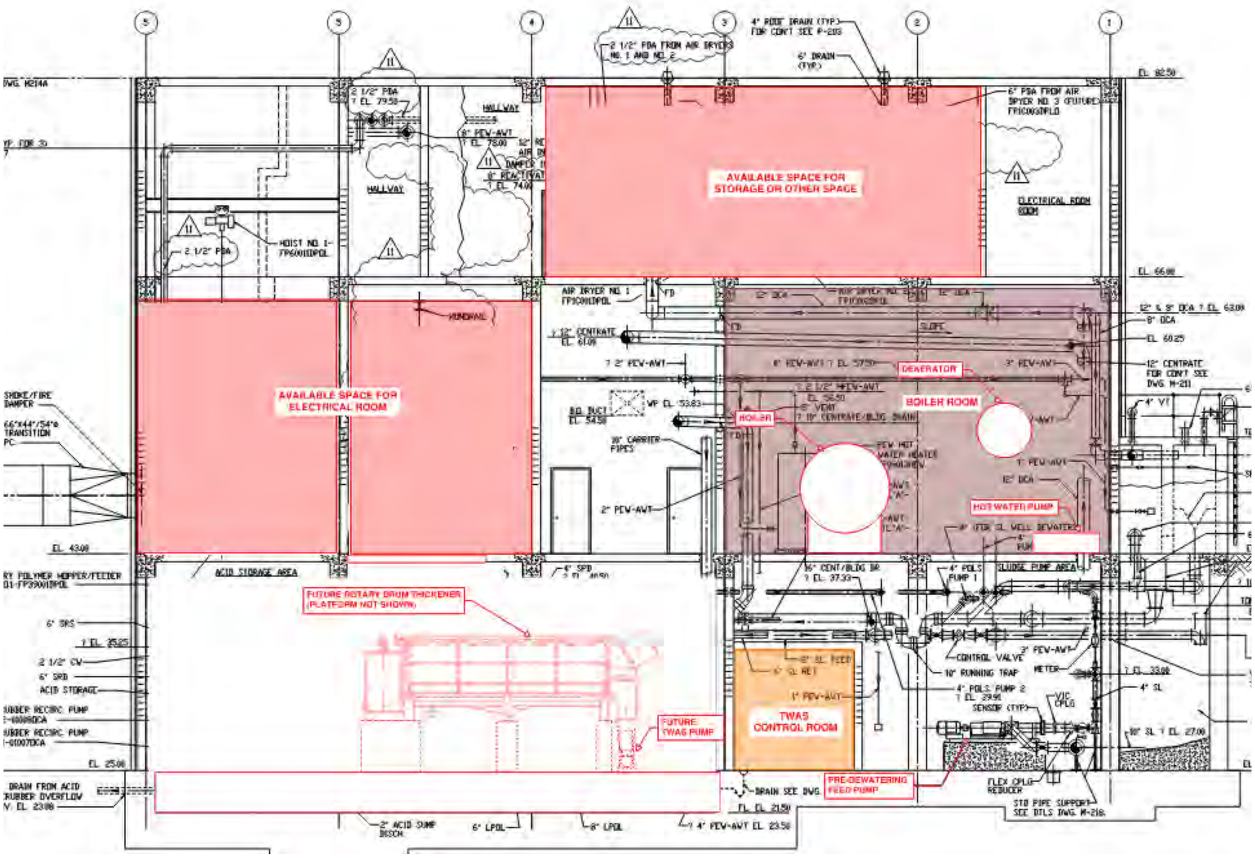

Figure 4. Existing Building Section 1

The second floor of the building would include the following equipment:

- Two cross conveyors
- Two THP pulper feed pumps
- Steam boilers and boiler chemical feed

Each cross conveyor would move pre-dewatered cake from the bins to a pulper feed pump. The layout on this floor would include an area for pre-dewatering cake piping, a floor hatch for centrifuge maintenance, and a boiler room. Additional electrical rooms or mechanical rooms could be created in the existing polymer rooms. The existing boiler room could be repurposed for the full THP boiler requirements. The layout is shown in Figure 5, and a section is shown in Figure 6.

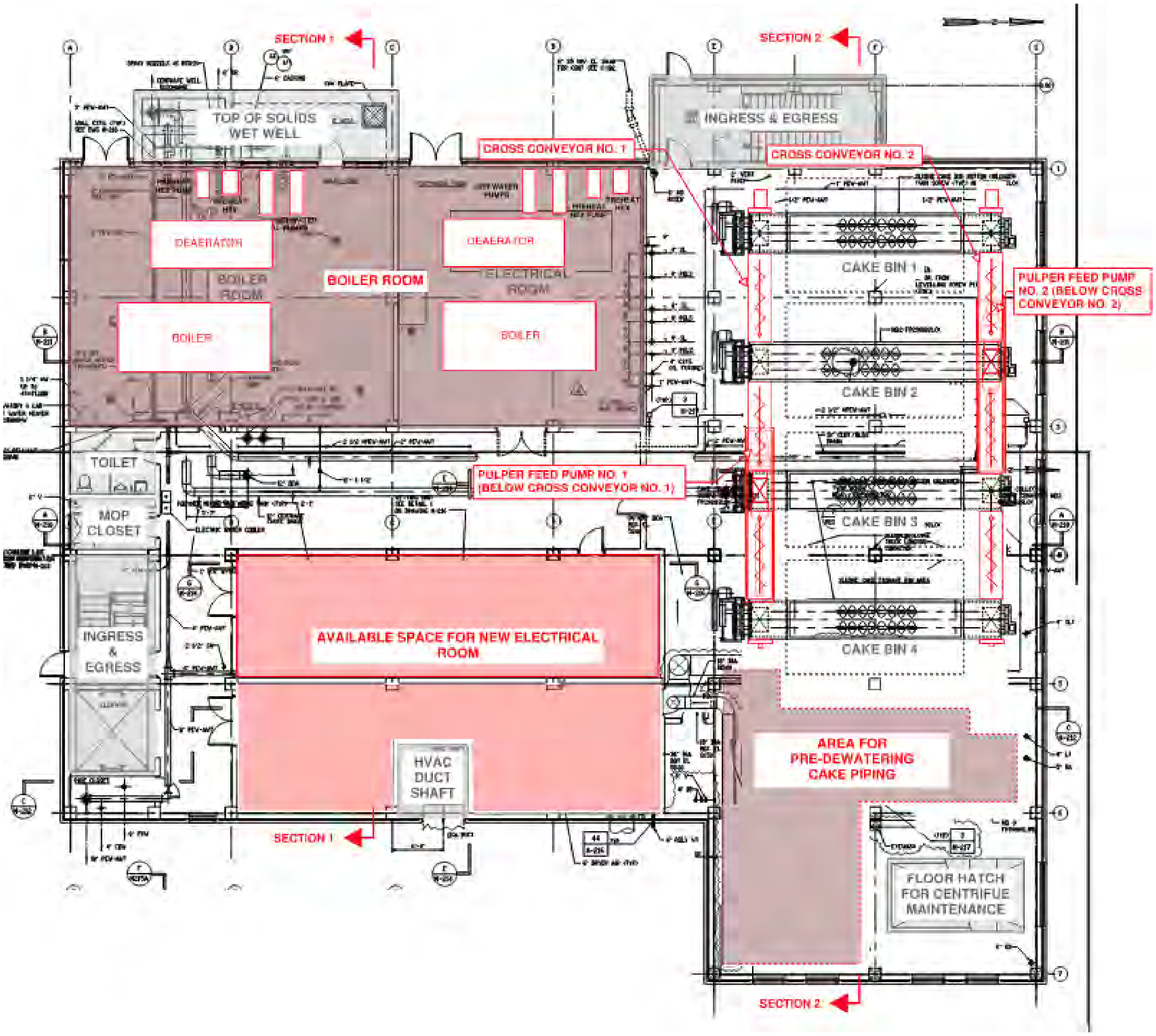

Figure 5. Existing Building Second-Floor Plan

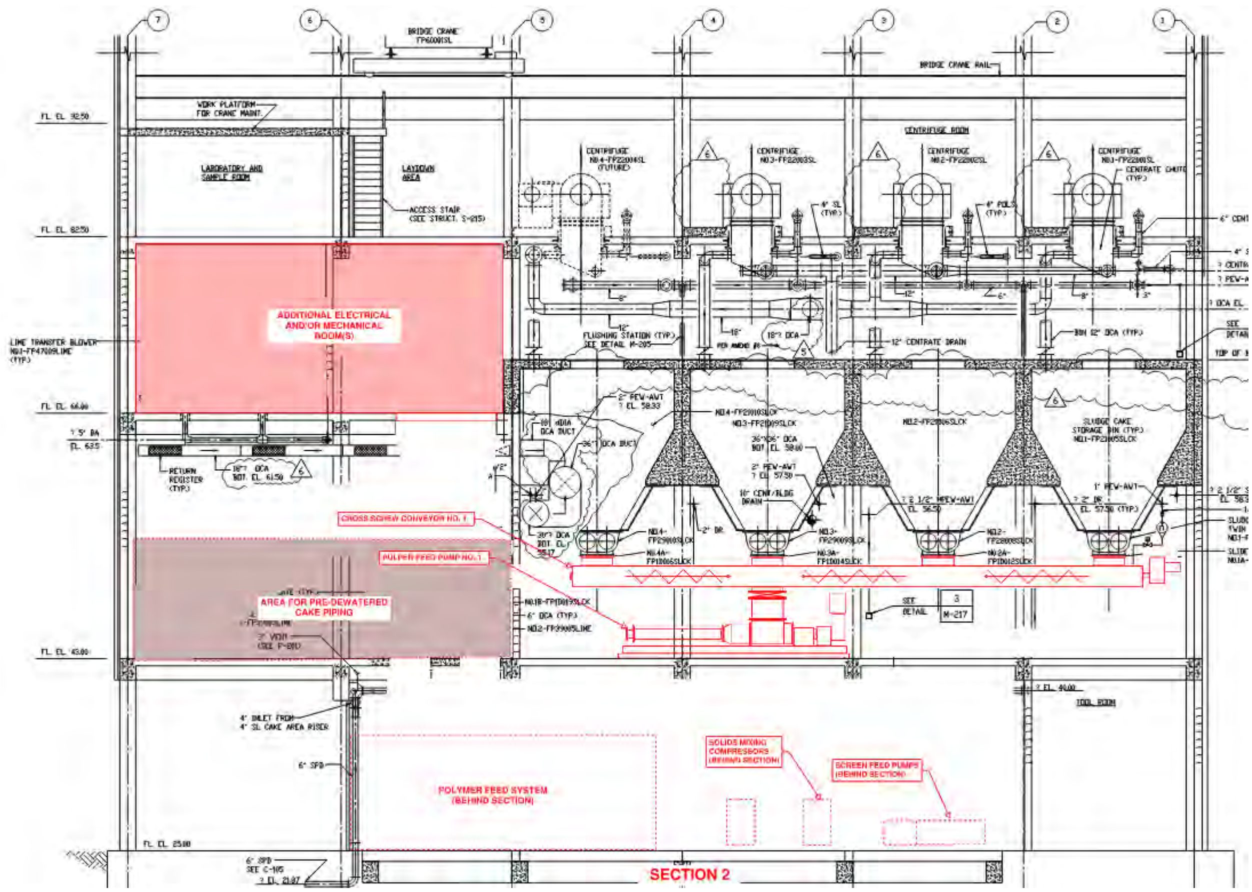

Figure 6. Existing Building Section 2

The third floor of the building would include the following equipment:

- Solids screens, with screenings conveyors to dumpster below
- Pre-dewatered cake pant-leg diverter gates and one screw conveyor

The pant-leg diverters below each centrifuge can divert cake directly to the bin below, or to a screw conveyor to deliver cake to any of the other adjacent bins. This configuration would allow for operation without using the conveyor. This floor as configured would retain the existing storage room. Demolition of the existing lime feed equipment would make additional space available for a mechanical or storage room. The third-floor layout is shown in Figure 7.

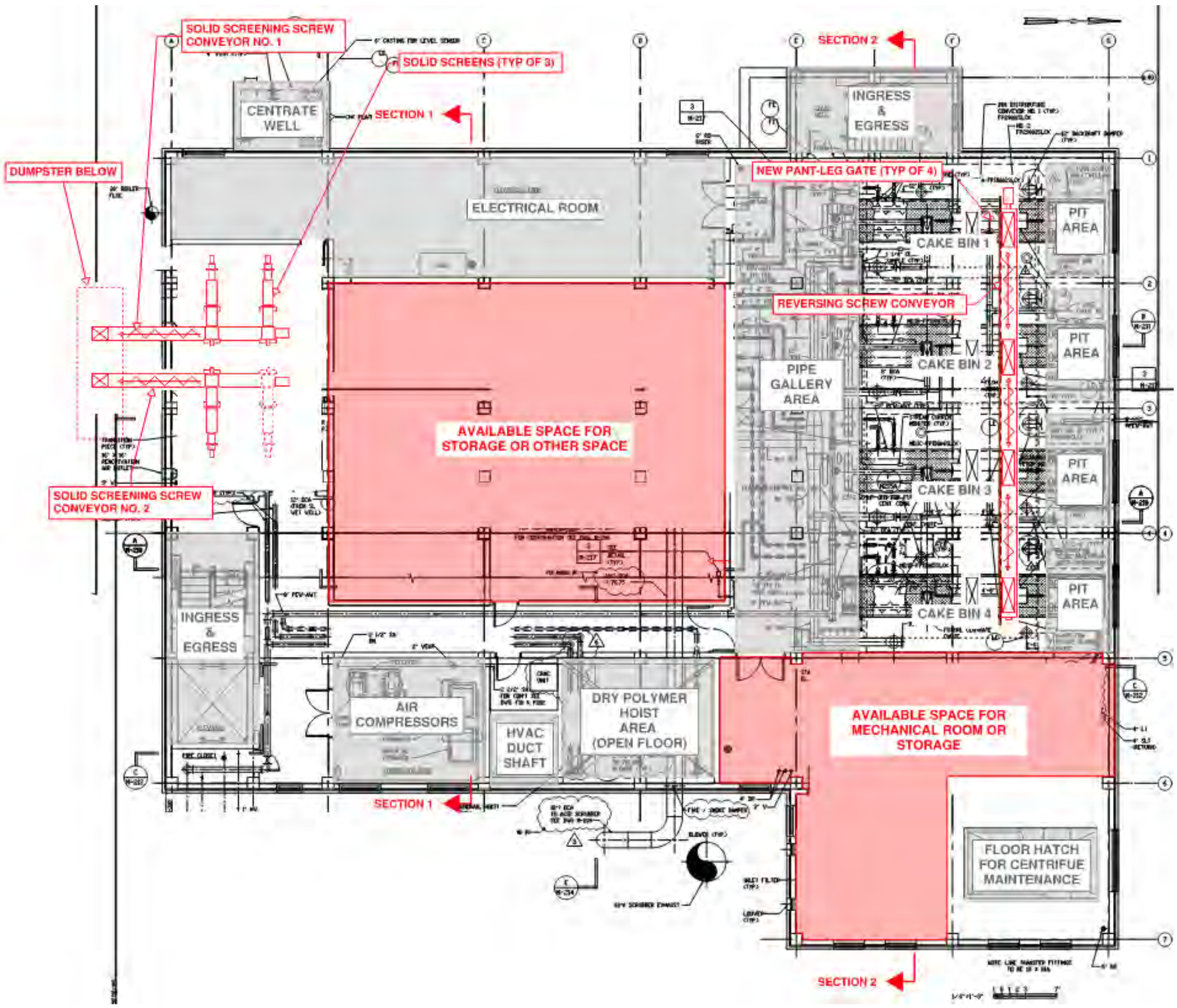

Figure 7. Existing Building Third-Floor Plan

The fourth floor of the building would include the following equipment:

- Pre-dewatering centrifuges
- Centrifuge control room

New pre-dewatering centrifuges would be provided. This floor also would retain space for centrifuge laydown, a lab/sample room, bathroom, and an HVAC room. The fourth-floor layout is shown in Figure 8. The existing floor hatch would need to be further analyzed for specific centrifuges to confirm that it can continue to be used.

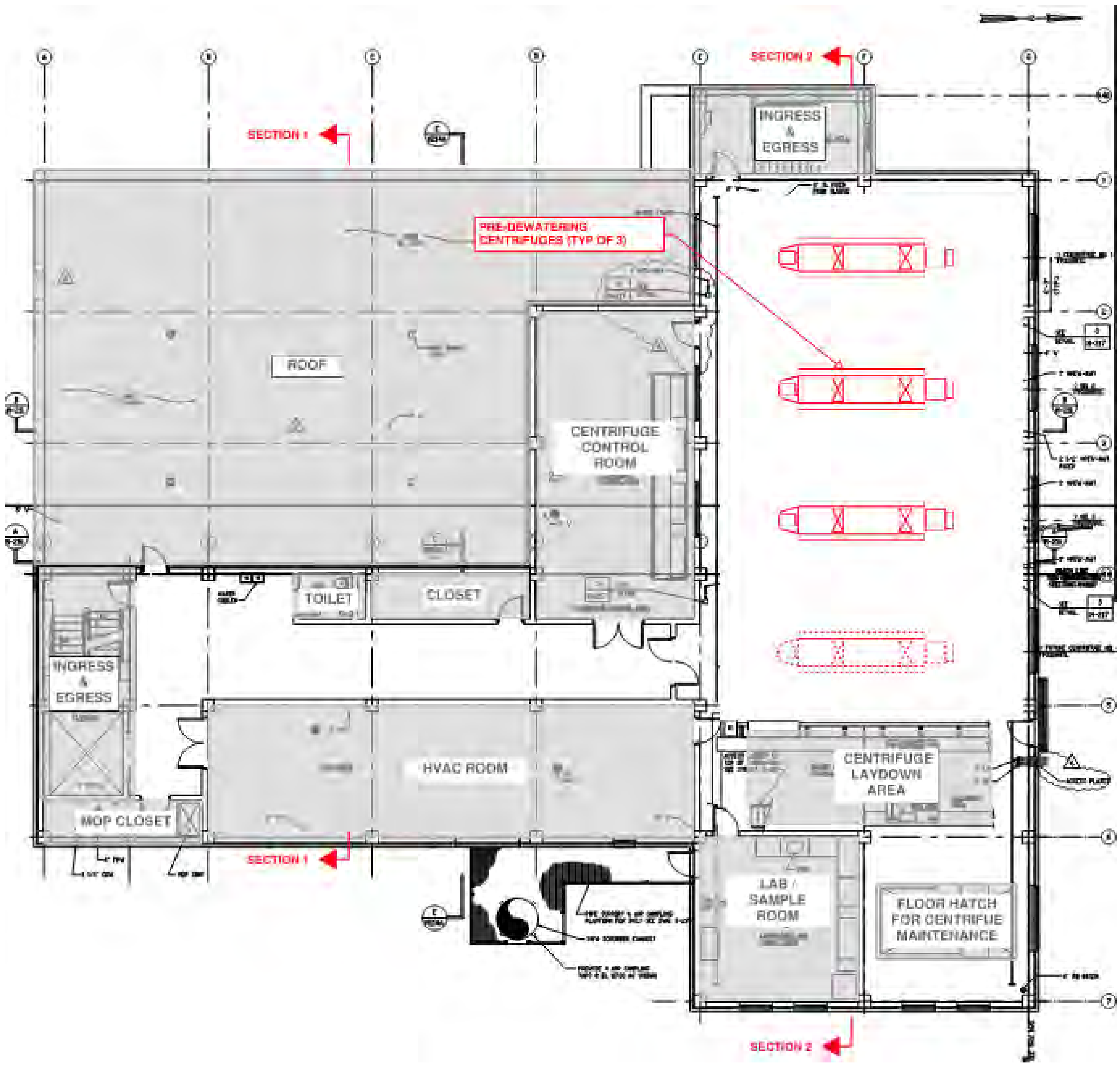

Figure 8. Existing Building Fourth-Floor Plan

5.1.4 Site Layout and Maintenance of Plant Operation Considerations

A potential site layout is shown in Figure 9 below.

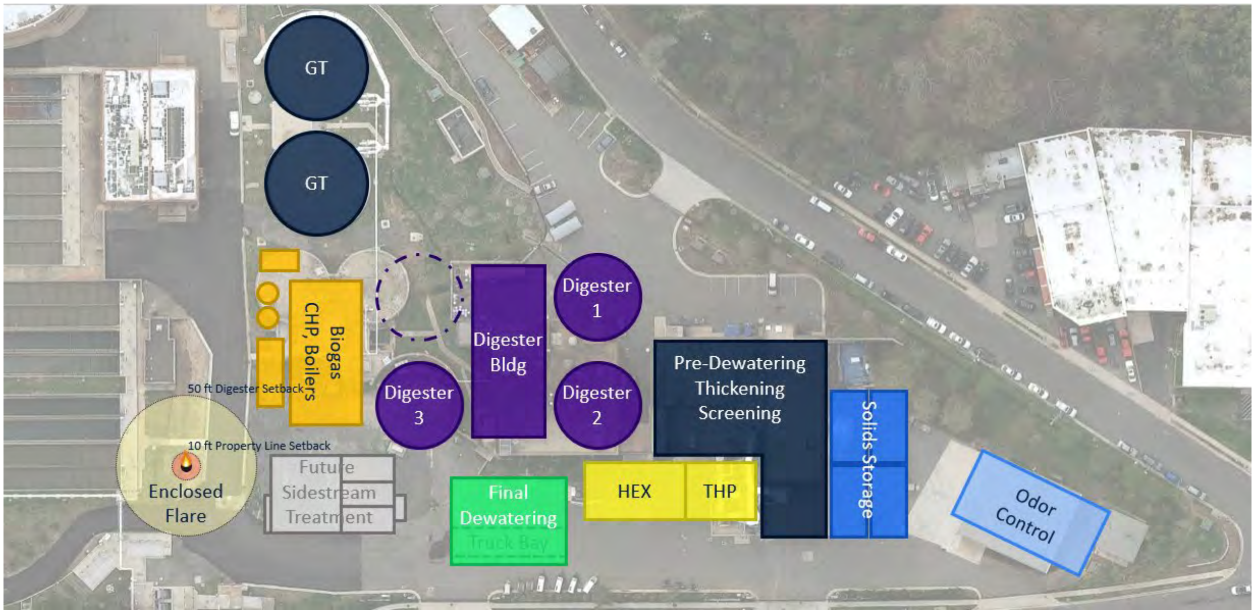

Figure 9. Preliminary Site Layout, Alternative 1: Renovate Existing DWB

This site layout is preliminary and will continue to be refined as unit processes are evaluated.

Key construction and maintenance of plant operation (MOPO) considerations for this alternative include:

- The new final dewatering facility coupled with a temporary lime stabilization facility would be constructed first and used for Class B bulk land application while the existing DWB is rehabilitated. To provide appropriate dewatering redundancy during temporary operations, additional trailer-mounted mobile dewatering equipment may be required as only two centrifuges would be installed for final dewatering. If the final dewatering facility is used during construction on raw solids, it would need to be cleaned and disinfected prior to use with Class A solids.
- Significant construction of the digester complex can occur prior to taking the existing DWB offline, reducing the time needed for temporary lime stabilization. It is assumed that temporary lime stabilization would be required for 18 months.
- A detailed code analysis of the existing building would be required to confirm that all applicable building and National Fire Protection Association (NFPA) codes could be met.
- THP would be screened from the neighbors located north and west of the WPCP by the height of the existing DWB.
- Odor control dispersion is likely to be negatively impacted by the height of the existing DWB. Tall stacks may be required to allow for proper dispersion.

5.1.5 Building Advantages and Disadvantages

The advantages and disadvantages for Alternative 1 are listed in Table 4.

Table 4. Alternative 1 Advantages/Disadvantages

Advantages	Disadvantages
• Reuse of existing infrastructure, which has significant useful design life remaining • Shorter period for temporary lime system during construction as more construction elements can proceed before or during DWB rehabilitation • Existing DWB would screen THP facilities from neighbors • Additional space in existing DWB could potentially be used for THP boilers, reducing footprint of biogas handling systems • Space for thickening units on first floor facilitates future installation	• Cost and design uncertainty due to modifying existing facility • Building is compartmentalized, which would require many modifications to the structure for both final use and constructibility • Potential code compliance issues • Significant unused space in building with the space not being optimized for current needs • Additional HVAC because of the larger footprint • Dewatering capacity limitations during temporary operations when final dewatering facilities are used on undigested solids • Cleaning and disinfection of final dewatering facilities prior to transitioning to Class A dewatering

5.1.6 Conceptual Construction Costs

Conceptual construction costs are presented in Table 5. Because the existing DWB is renovated, minimal costs were applied to concrete, sitework, and building materials categories. Demolition costs apply for demolition of interior rooms for repurposing for new spaces, as well as disposal costs for construction debris. Rehabilitation and HVAC costs were estimated based on total building square footage. Equipment costs for a new bridge crane and elevator were applied in the building/structural category, and new screening, pre-dewatering, and polymer systems were applied in the mechanical category. Costs for screen feed pumps, solids storage mixing systems, and boilers are not included to keep the comparison to subsequent alternatives with like equipment.

For Alternative 1, percentages of the base total cost were not used to develop the following discipline costs. Instead, the costs were developed as follows:

- **Sitework:** minimal with new structure, assumed to be 50 percent of the sitework cost for the new building alternative
- **Instrumentation and controls (I&C)/supervisory control and data acquisition (SCADA):** assumed to be equal to the I&C/SCADA cost for the new facility alternative
- **Electrical:** assumed to be 25 percent higher than the electrical cost for Alternative 2, as the new electrical facilities would need to fit in existing spaces with longer conduit runs
- **Large and specialty piping:** assumed to be equal to the large and specialty piping for the new facility alternative
- **Geotechnical:** not required as the existing DWB is already supported on piles

Temporary lime stabilization costs were applied for 18 months, the anticipated duration that the existing dewatering system is offline while the new space is being constructed. The construction contingency is higher for Alternative 1 in comparison to Alternatives 2 and 3, mainly to capture unknowns with a rehabilitation of this scale.

Table 5. Renovate Existing Dewatering Building Conceptual Cost Estimate

Demolition		$850,000
Building/structural		$1,970,000
Mechanical		$7,530,000
Subtotal		**$10,350,000**
Sitework		$1,180,000
I&C/SCADA		$1,260,000
Electrical		$3,930,000
Large and specialty piping		$790,000
Geotechnical		--
Temporary lime feed		$1,060,000
Subtotal		**$18,570,000**
Contingency	30%	$5,580,000
Subtotal		**$24,150,000**
Contractor mobilization, staging, and security	5%	$1,210,000
Contractor bonds and insurance	3%	$730,000
Subtotal		**$26,090,000**
Contractor overhead and profit	15%	$3,920,000
Total		**$30,010,000**

5.2 Alternative 2: Demolish Existing DWB, New Thickening, Screening, Dewatering Facility

In Alternative 2, a new facility would be constructed for screening, pre-dewatering, and future thickening. This alternative must be paired with the new final dewatering facility (Section 5.3).

5.2.1 Facility Features

New process equipment and electrical equipment would include the following:

- Polymer storage and feed, shared for pre-dewatering and future WAS thickening
- Future GBTs or RDTs for WAS
- Sludge screens and screenings loadout
- Pre-dewatering centrifuge feed pumps
- Pre-dewatering centrifuges with emergency cake loadout
- Cake bins and pulper feed pumps:
  - Two bins at 175 CY each, providing 24 hours storage at 40 mgd average conditions
- Auxiliary facilities:
  - Control room
  - Electrical room
  - Unisex bathroom
  - HVAC
- Egress:
  - Two stairways
  - Elevator

5.2.2 Facility Layout

The first floor of the facility would include the following equipment:

- Polymer storage tanks and blend units for pre-dewatering, with space for additional blend units for future WAS thickening (this assumes the same polymer would be used for pre-dewatering and thickening)
- Pre-dewatering centrifuge feed pumps
- Two pre-dewatered cake bins
- Two THP pulper feed pumps
- Emergency cake loadout/centrifuge loadout area
- Screenings dumpster

One pulper feed pump would be located below each cake bin. Access would be provided around the cake bins for removal of the live-bottom screws. The first-floor layout is shown in Figure 10. Section views are included at the end of this section.

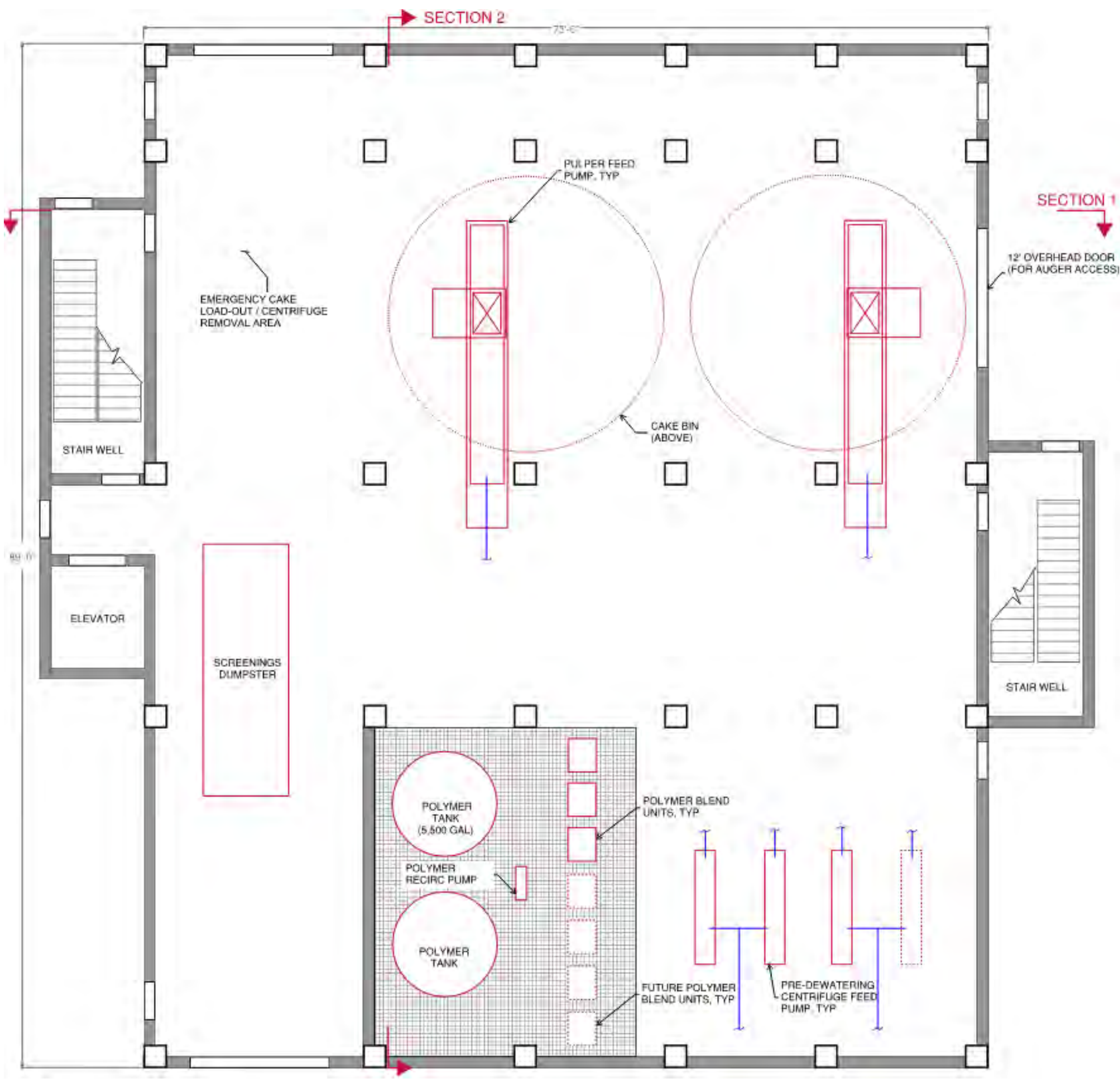

Figure 10. New Thickening/Screening/Dewatering Facility First-Floor Plan

The second floor of the facility would include the following equipment:

- Sludge screens
- Future mechanical WAS thickening (GBTs or RDTs)
- Future TWAS pumps

This floor also would include air compressors for the screens. The pre-dewatered cake bin area would be open to the first floor at this level. The layout is shown in Figure 11.

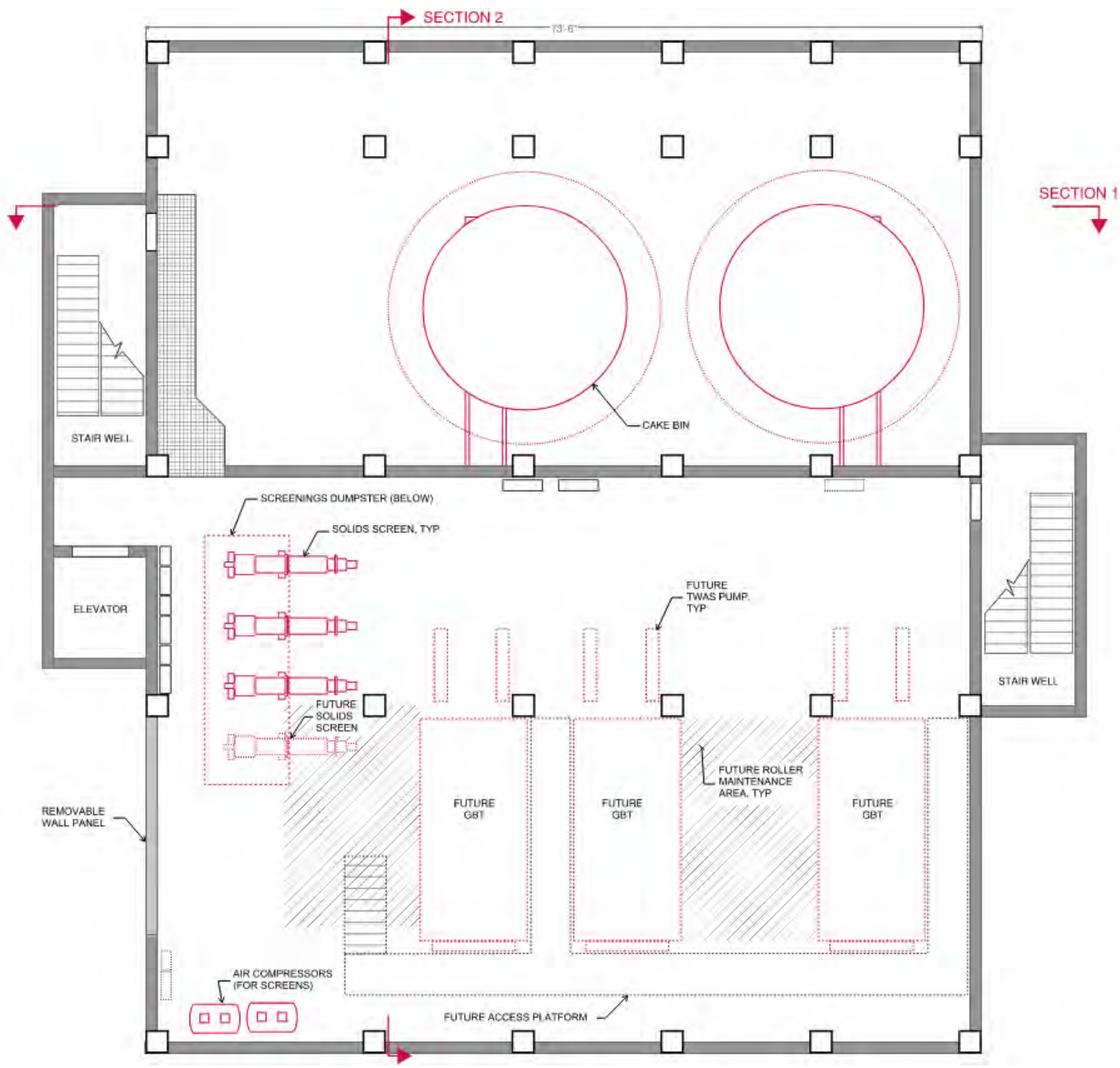

Figure 11. New Thickening/Screening/Dewatering Facility Second-Floor Plan

The mezzanine floor of the facility above the cake bins would include the following equipment:

- Pre-dewatered cake pant-leg diverter gates
- Reversing screw conveyor

The pant-leg diverter gates would direct the cake either to the bin below the centrifuge or to the screw conveyor for transfer to the adjacent bin. This level would also include piping for centrate, slop drain, and centrifuge feed. The layout is shown in Figure 12.

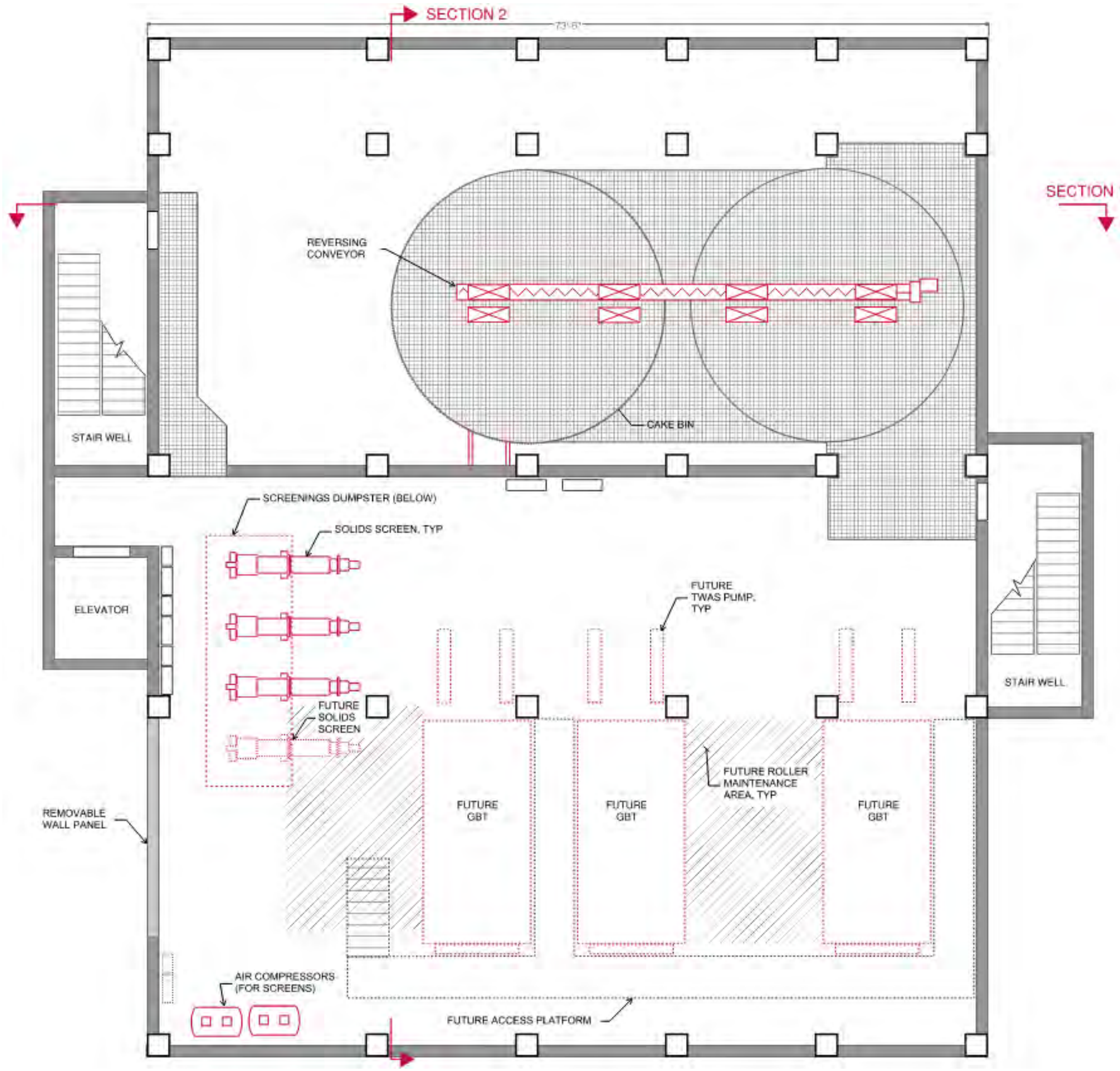

Figure 12. New Thickening/Screening/Dewatering Facility Mezzanine Floor Plan

The upper floor of the facility would include the following equipment:

- Pre-dewatering centrifuges
- Centrifuge control room
- Electrical room

This floor would include a bridge crane and an access hatch for centrifuge maintenance. A bathroom would be included as well as a small mechanical room. The HVAC equipment would be installed on the adjacent roof. This level of the facility could also be extended to enclose all HVAC equipment. The layout is shown in Figure 13. Section views for all levels are shown in Figure 14 and Figure 15.

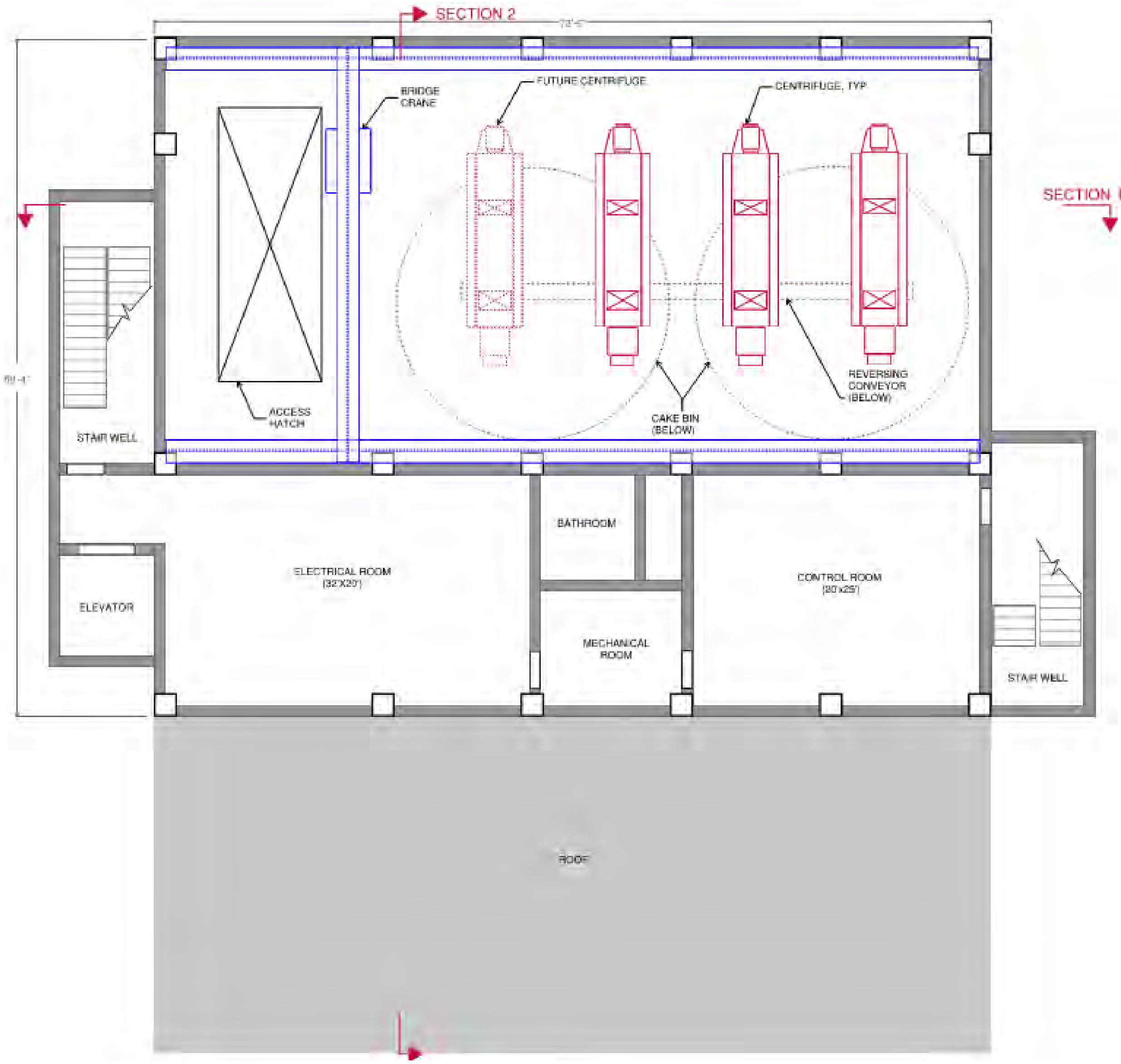

Figure 13. New Thickening/Screening/Dewatering Facility Upper Floor Plan

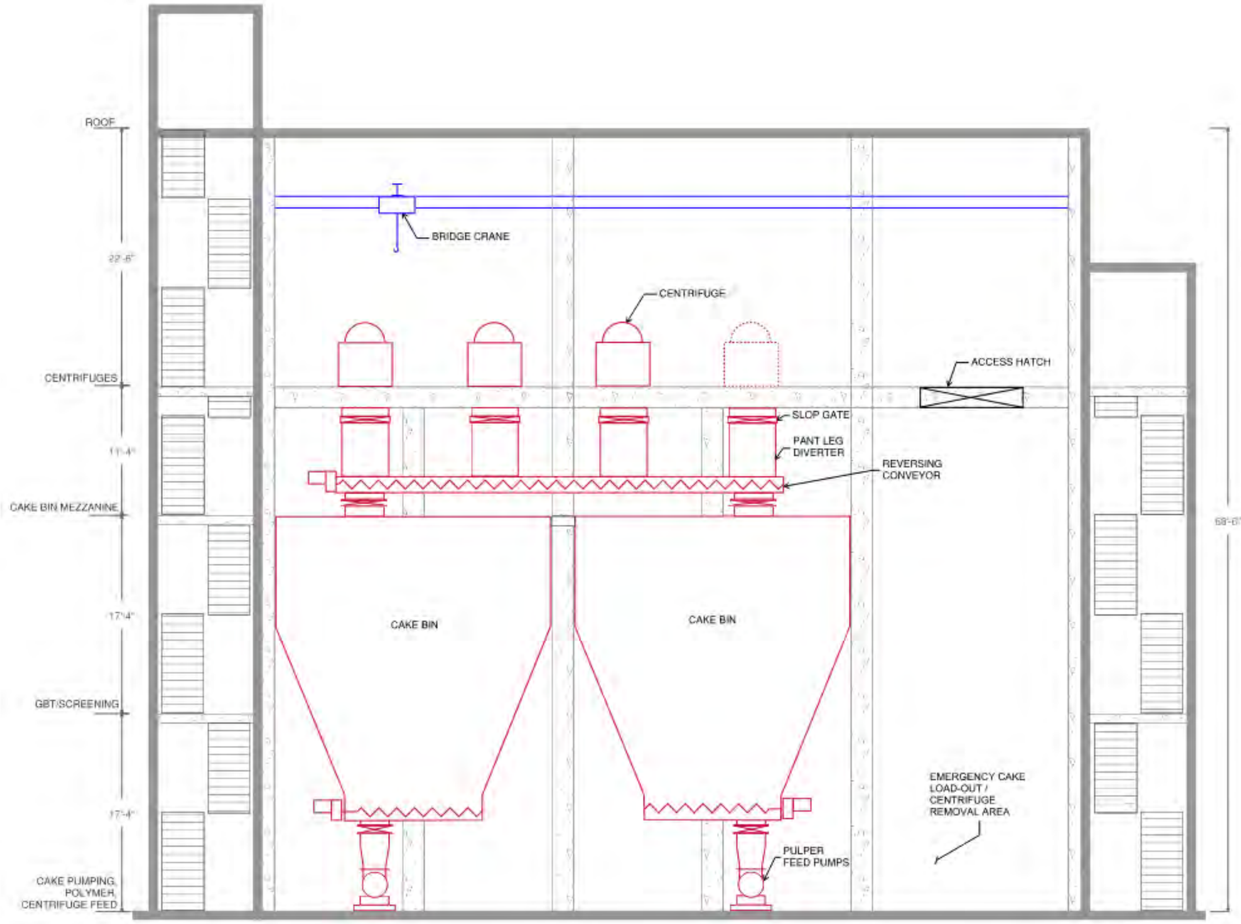

Figure 14. New Thickening/Screening/Dewatering Facility Section 1

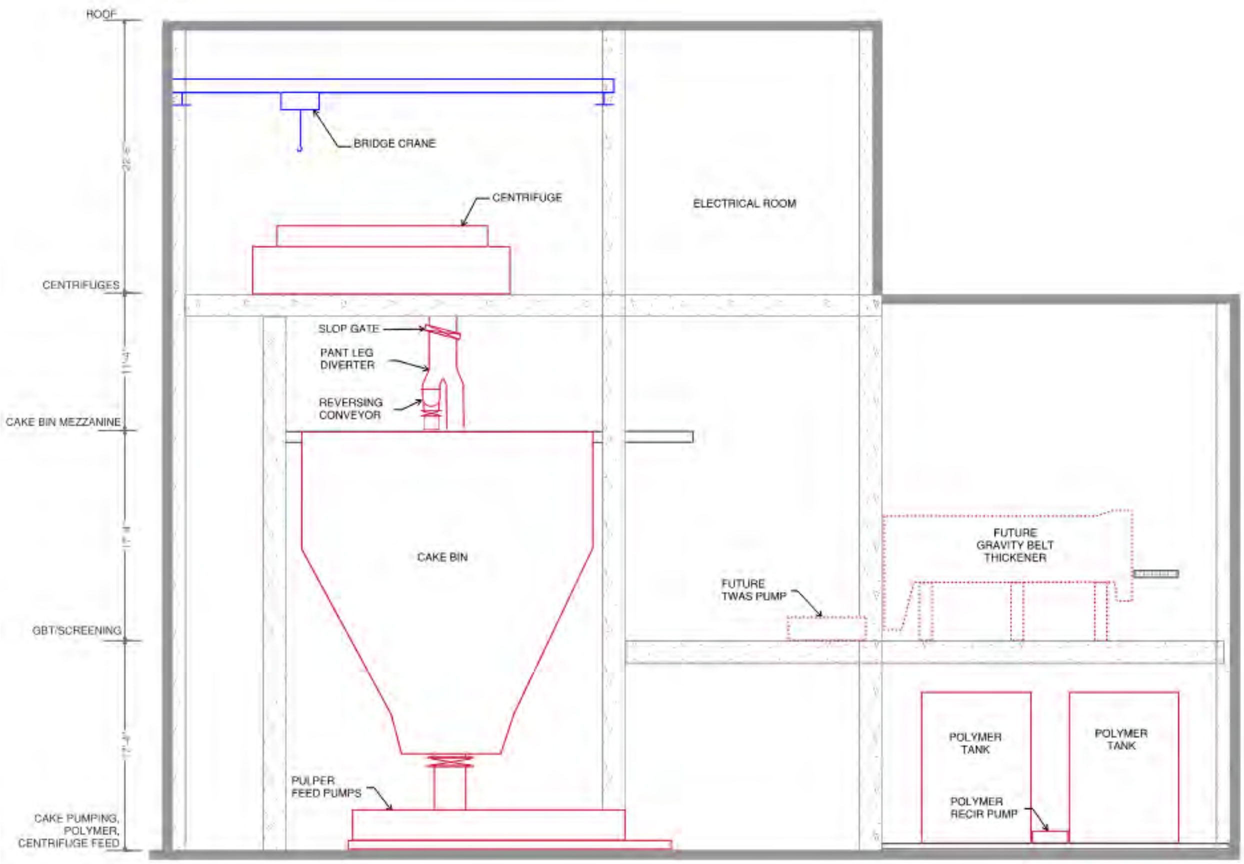

Figure 15. New Thickening/Screening/Dewatering Facility Section 2

5.2.4 Site Layout and MOPO Considerations

A potential site layout is shown in Figure 16.

Figure 16. Preliminary Site Layout, Alternative 2: New Dewatering Facility

This site layout is preliminary and will continue to be refined as unit processes are evaluated.

Key construction MOPO considerations for demolition of the existing DWB include the following:

- The new pre-dewatering facility coupled with a temporary lime stabilization facility would be constructed first and used for Class B bulk land application while the existing DWB is demolished and digesters are constructed in that area. As the new pre-dewatering facility would be sized for undigested solids, there would be no issues with dewatering redundancy during this temporary operation and no need to disinfect these facilities in the future.
- The digester complex would be constructed after the existing DWB is demolished. Digester construction is likely to have the longest schedule path and would result in potentially longer temporary lime stabilization operations compared to the option for reusing the existing DWB. It is assumed that temporary lime stabilization would be required for 35 months with Alternative 2.
- THP would be more visible to surrounding neighborhoods than with Alternative 1.
- Odor control would be centrally located away from the fence line and away from large buildings, improving dispersion.

5.2.5 Facility Advantages and Disadvantages

The advantages and disadvantages for Alternative 2 are listed in Table 6.

Table 6. Alternative 2 Advantages/Disadvantages

Advantages	Disadvantages
• All new facility • Can accommodate any type of thickening and dewatering equipment • Footprint can avoid unused space and be designed for intended uses • No dewatering capacity limitations during temporary lime stabilization • Final dewatering facilities would not be used for dewatering undigested solids, so no disinfection would be required prior to dewatering Class A biosolids	• Higher cost due to not reusing the existing DWB • Existing DWB infrastructure not reused • Likely longer period for temporary lime system during construction, as construction of digester facilities would need to await the demolition of the DWB • Would need to accommodate future installation of thickening units—may require roll-up doors or removable facility panels

5.2.6 Conceptual Construction Costs

Conceptual construction costs are presented in Table 7. Because Alternative 2 would involve construction of a new facility, sitework, concrete, and all building costs would apply. Discipline multipliers are provided as explained in Section 4.8. Demolition for this alternative would include removal of the existing DWB and all equipment. Temporary lime stabilization costs were applied for the anticipated duration from the time existing dewatering facilities are taken offline to the time the full new processes could be started (35 months).

Table 7. New Thickening, Screening, and Pre-dewatering Facility Conceptual Cost Estimate

Demolition		$2,550,000
Building/structural		$4,340,000
Mechanical		$8,780,000
Subtotal		**$15,670,000**
Sitework	15%	$2,360,000
I&C/SCADA	8%	$1,260,000
Electrical	20%	$3,140,000
Large and specialty piping	5%	$790,000
Geotechnical	7%	$1,100,000
Temporary lime		$1,400,000
Subtotal		**$25,7200,000**
Contingency	20%	$5,010,000
Subtotal		**$30,870,000**
Contractor mobilization, staging, and security	5%	$1,550,000
Contractor bonds and insurance	3%	$930,000
Subtotal		**$33,350,000**
Contractor overhead and profit	15%	$5,010,000
Total		**$38,360,000**

5.3 New Final Dewatering Facility

A new facility for final dewatering would be constructed and paired with either Alternative 1 or 2.

5.3.1 Facility Features

New process equipment and electrical equipment would include the following:

- Polymer storage and feed for final dewatering
- Final dewatering centrifuge feed pumps
- Final dewatering centrifuges
- Cake bin for final product:
    - One 200 CY bin, providing 1.5 days of storage at 30.8 mgd peak 14-day conditions
- Drive-through truck loading with viewing platform
- Auxiliary facilities:
    - Control room
    - Electrical room
    - Unisex bathroom
    - HVAC
- Egress:
    - Two stairways
    - Elevator

5.3.2 Facility Layout

The first floor of the facility would include the following equipment:

- Polymer storage tanks and blend units for final dewatering
- Drive-through truck bay with truck scale

The polymer system configuration would be similar to the pre-dewatering facility alternatives, with bulk liquid storage, recirculation pump, and a blend unit for each dewatering device. The truck bay would include a loading viewing platform and walking space around the truck. The layout is shown in Figure 17.

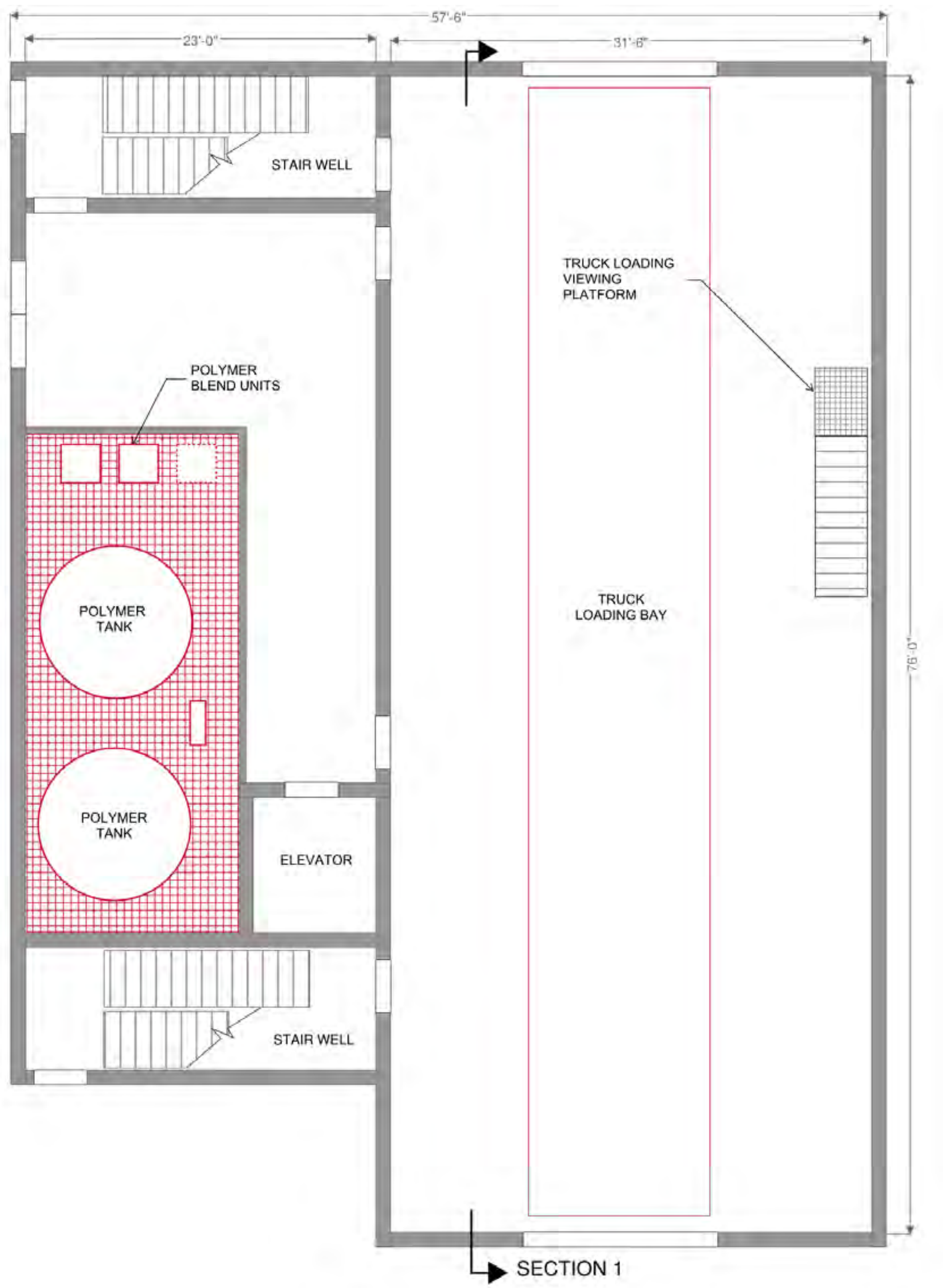

Figure 17. New Final Dewatering Facility First-Floor Plan

The mezzanine level of the facility, shown in Figure 18, would include the following equipment:

- Screw conveyor above cake bin
- Mechanical room

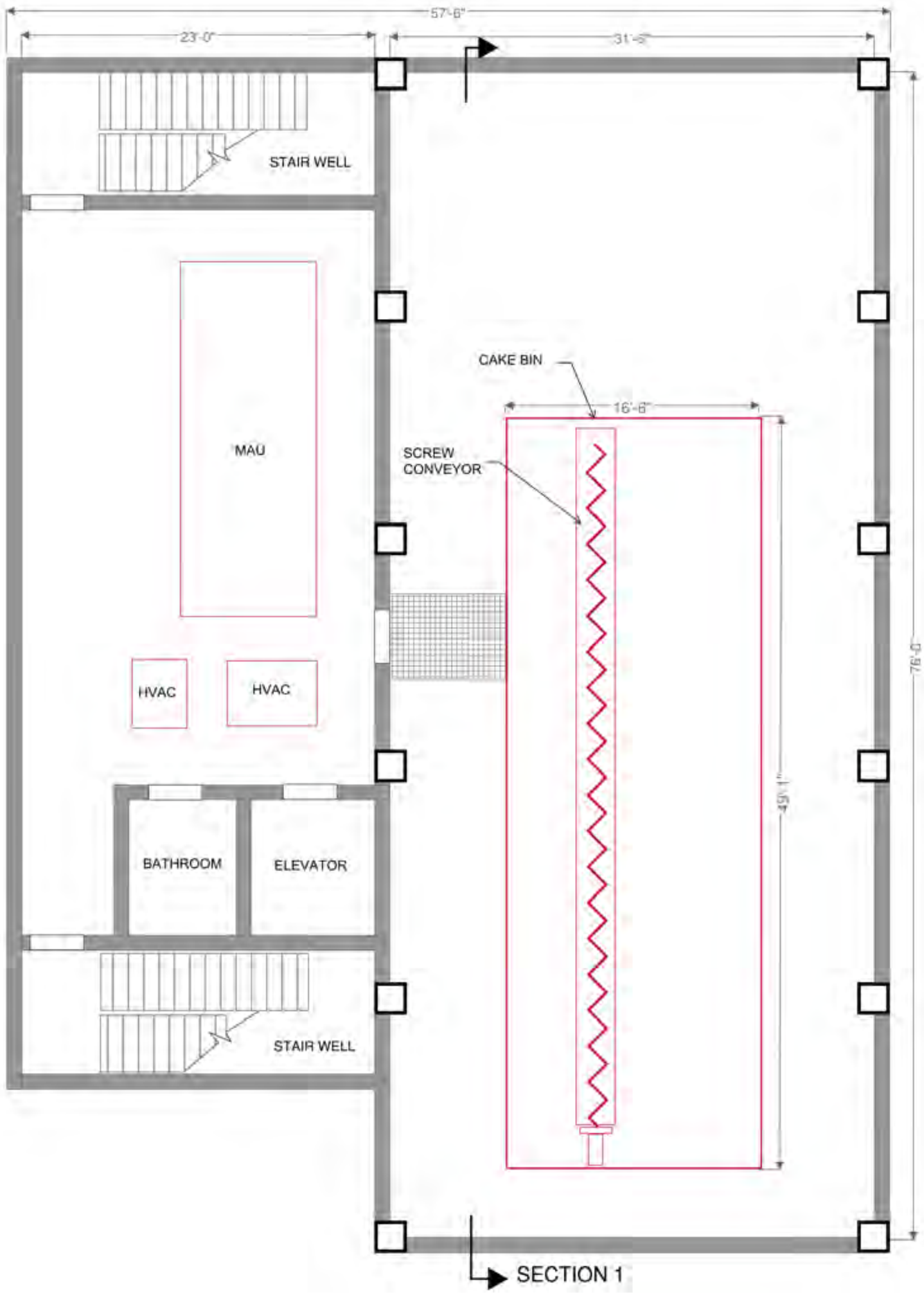

Figure 18. New Final Dewatering Facility Mezzanine Floor Plan

The upper floor of the facility would include the following equipment:

- Final dewatering centrifuges
- Control room
- Electrical room

The centrifuge room would include a laydown area, a floor access hatch, and a bridge crane for centrifuge maintenance. The layout is shown in Figure 19. A facility section is shown in Figure 20.

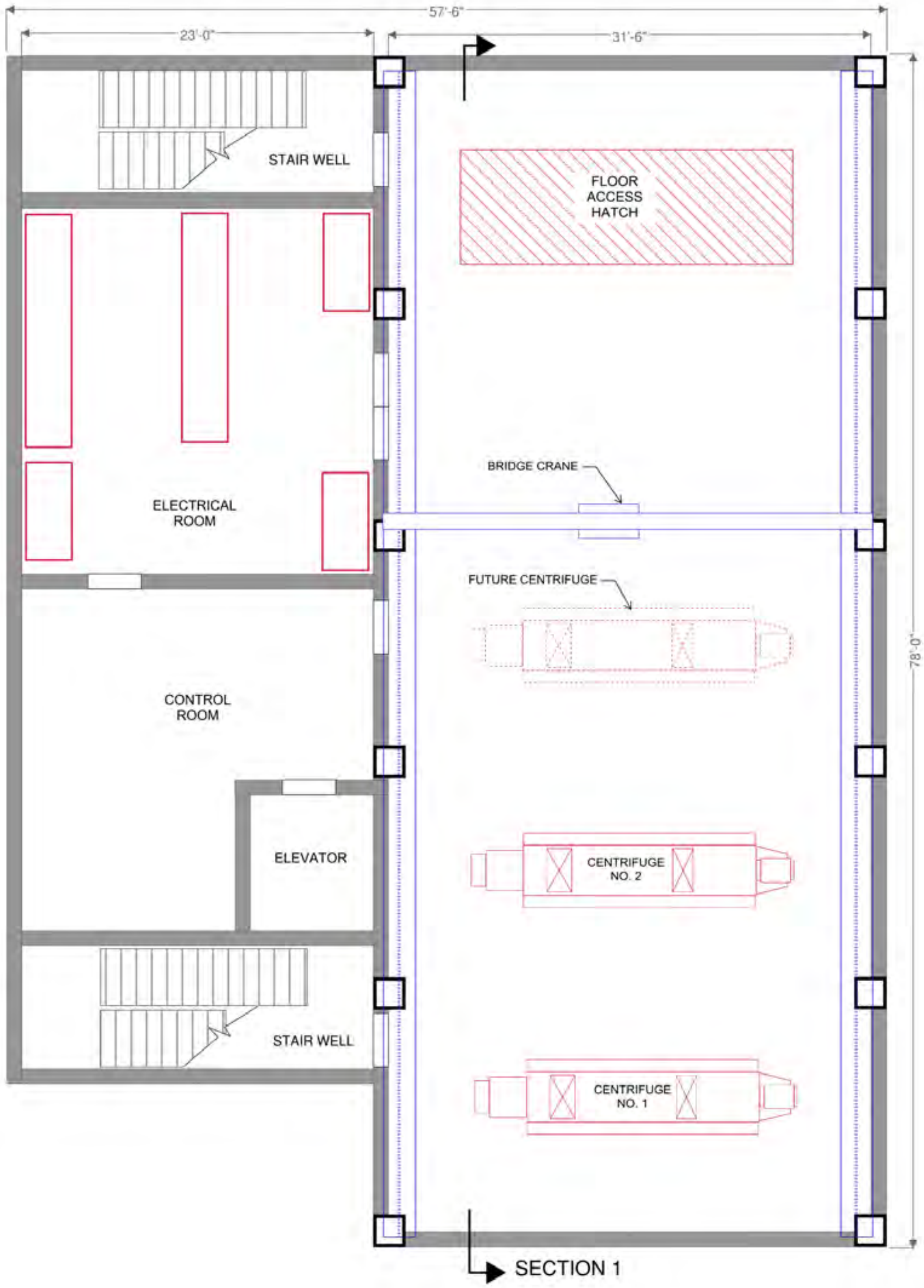

Figure 19. New Final Dewatering Facility Upper Floor Plan

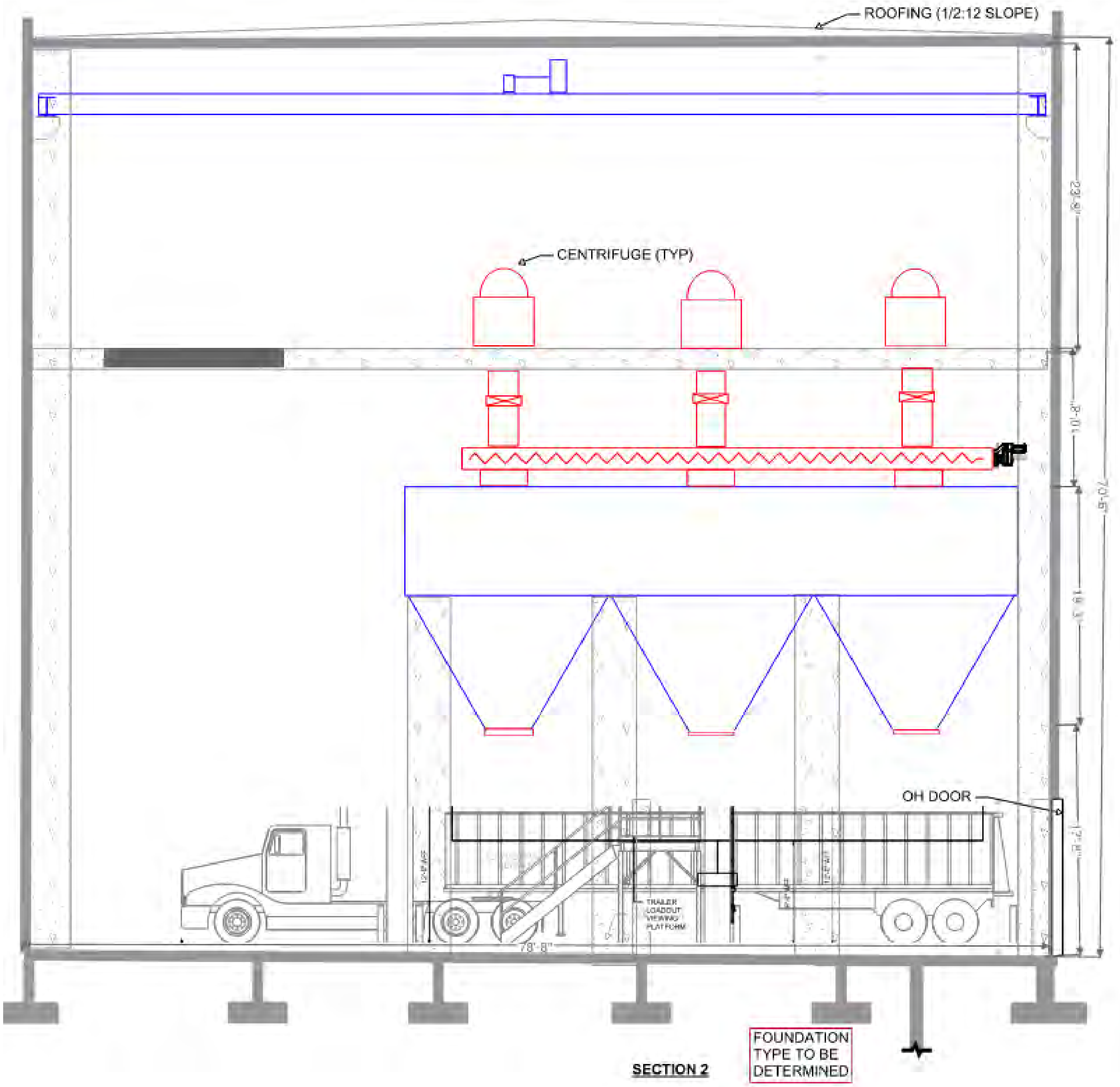

Figure 20. New Final Dewatering Facility Section

5.3.3 Site Layout

Potential site layouts including the final dewatering facility are shown on Figure 9 and Figure 16 above. In both layouts, the final dewatering facility is proposed to be located on the east side of the property, near Eads Street, to promote drive-through truck unloading.

5.3.4 Conceptual Construction Costs

Conceptual construction costs are presented in Table 8. Because this alternative would involve construction of a new facility, sitework, concrete, and all building costs would apply. Discipline multipliers are provided as explained in Section 4.8.

Table 8. New Final Dewatering Facility Conceptual Cost Estimate

Building/structural		$2,960,000
Mechanical		$4,610,000
Subtotal		**$7,570,000**
Sitework	15%	$1,140,000
I&C/SCADA	8%	$610,000
Electrical	20%	$1,520,000
Large and specialty piping	5%	$380,000
Geotechnical	7%	$530,000
Subtotal		**$11,750,000**
Contingency	20%	$2,350,000
Subtotal		**$14,100,000**
Contractor mobilization, staging, and security	5%	$710,000
Contractor bonds and insurance	3%	$430,000
Subtotal		**$15,240,000**
Contractor overhead and profit	15%	$2,290,000
Total		**$17,530,000**

5.4 Alternative 3: Decommission Existing DWB, New Combined Pre-dewatering and Final Dewatering Facility

For Alternative 3, a new building would be constructed to contain pre-dewatering, final dewatering, future thickening, as well as anaerobic digestion equipment and boilers. The existing DWB would be decommissioned but remain in place.

5.4.1 Facility Features

New process equipment and electrical equipment would include the following:

- Digester pumps in lower level (recirculation, mixing, transfer pumps, and final dewatering centrifuge feed)
- Polymer storage and feed for final dewatering and for pre-dewatering and future WAS thickening
- Future GBTs or RDTs for WAS thickening
- Sludge screen feed pumps
- Solids storage mixing compressors
- Sludge screens and screenings loadout
- Pre-dewatering centrifuge feed pumps
- Pre-dewatering centrifuges with emergency cake loadout
- Pre-dewatered cake bins and pulper feed pumps:
  - Two bins at 175 CY each, providing 24 hours storage at 40 mgd average conditions
- Final dewatering centrifuges
- Cake bin for final product:
  - One 200 CY bin, providing 1.5 days of storage at 30.8 mgd peak 14-day conditions
- Drive-through truck loading with viewing platform
- Auxiliary facilities:
  - Control room
  - Electrical room
  - Unisex bathroom
  - HVAC

- Egress:
  - Two stairways
  - Elevator

5.4.2 Facility Layout

The first floor of the facility would include the following equipment:

- Polymer storage tanks and blend units for pre-dewatering, with space for additional blend units for future thickening
- Polymer storage tanks and blend units for final dewatering
- Pre-dewatering centrifuge feed pumps
- Screen feed pumps
- Solids storage mixing compressors
- Digester mixing, recirculation, and transfer pumps
- Final dewatering centrifuge feed pumps
- Four THP pulper feed pumps, located below two pre-dewatered cake bins
- Emergency cake loadout/centrifuge loadout area
- Final dewatered cake loadout drive-through truck bay with truck scale
- Screenings dumpster
- Bathroom

This level would be at elevation 24 feet, which would be at grade and have a walkout and truck loading area on the east side. Digester pumps would be on the west side of the building, which is below grade in that area. The first-floor layout is shown in Figure 21. A section view is included at the end of this section.

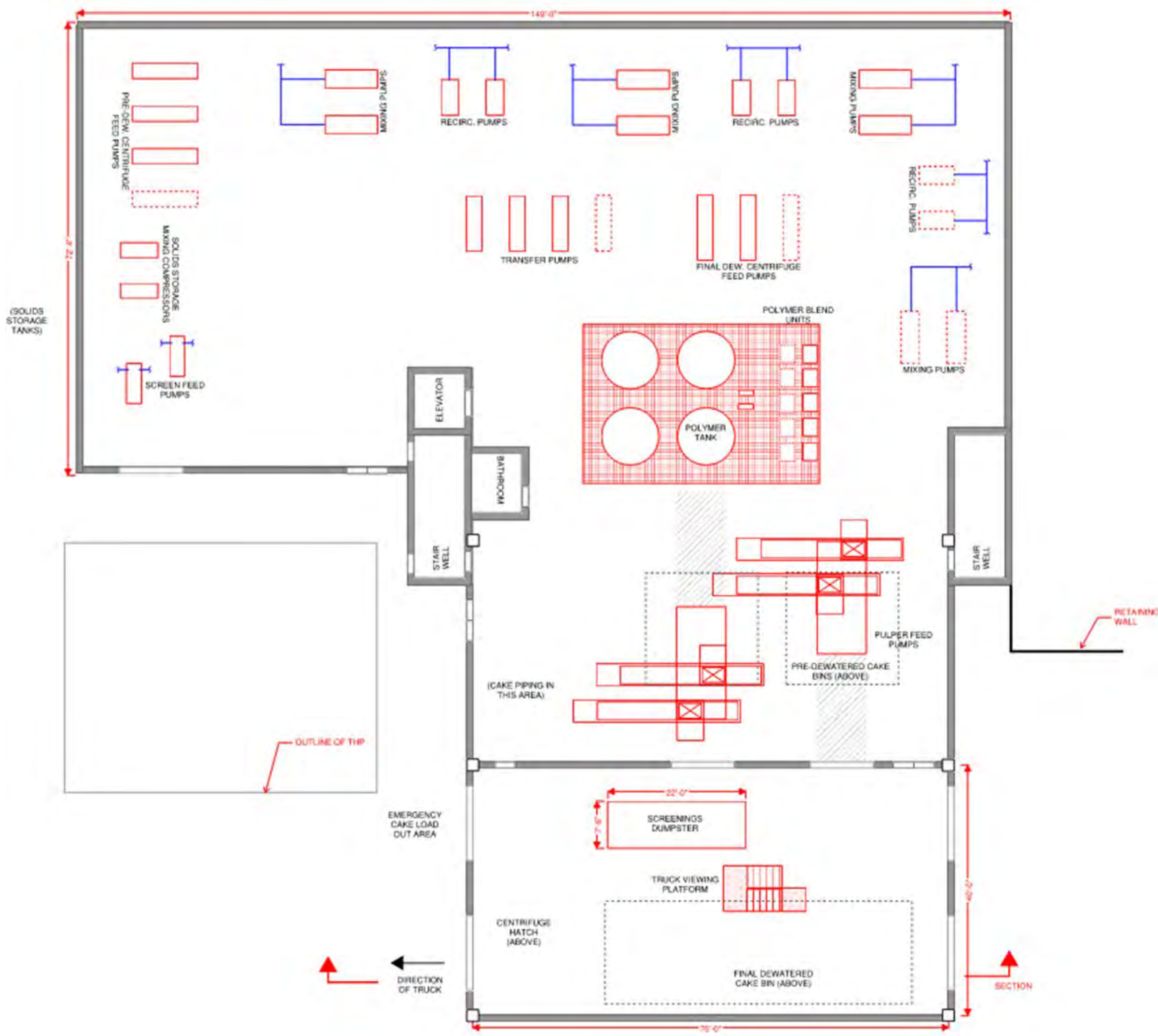

Figure 21. New Thickening/Screening/Pre-dewatering and Final Dewatering Facility First-Floor Plan

The second floor of the facility would include the following equipment:

- Sludge screens and air compressors
- Future mechanical WAS thickening (GBTs or RDTs)
- Future TWAS pumps
- Boiler room and boiler chemical feed
- Heat exchangers outside on roof of level below

This level would be at elevation 42 feet, which is at grade on the west side of the building. The layout is shown in Figure 22.

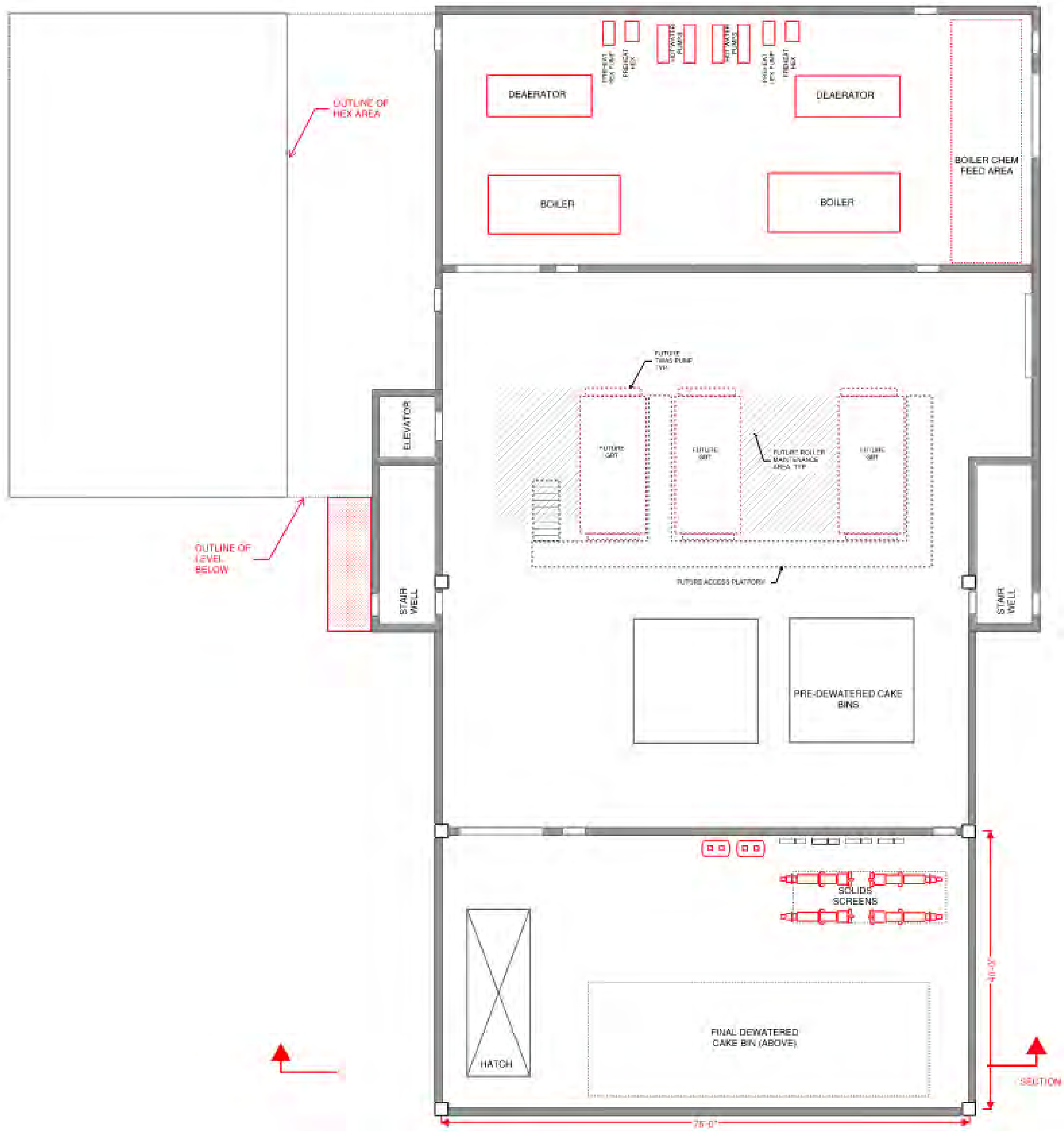

Figure 22. New Thickening/Screening/Pre-dewatering and Final Dewatering Facility Second-Floor Plan

The third floor of the facility would include the area above the cake bins and would include the following equipment:

- Cake pant-leg diverter gates and reversing screw conveyor above each cake bin
- Electrical room
- Mechanical room

The pant-leg diverter gates would direct the cake either to the bin below the centrifuge or to the screw conveyor for transfer to the adjacent bin. This level would also include piping for centrate, slop drain, and centrifuge feed. The layout is shown in Figure 23.

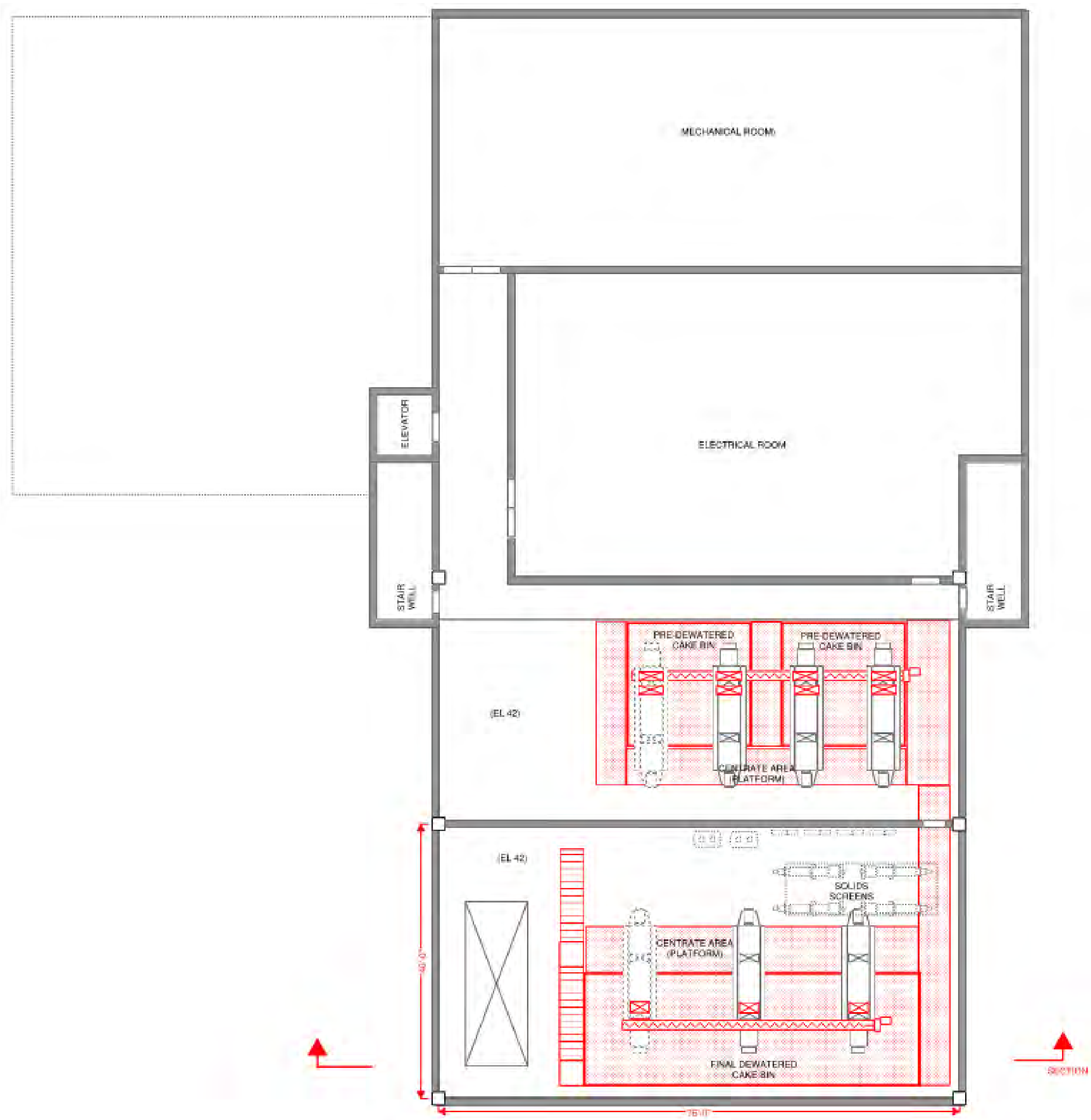

Figure 23. New Thickening/Screening/Pre-dewatering and Final Dewatering Facility Third-Floor Plan

The upper floor of the facility would include the following equipment:

- Pre-dewatering and final dewatering centrifuges
- Centrifuge control room
- Lab space
- Break room

- Bathroom

This floor would include two bridge cranes (one per set of centrifuges) and a shared access hatch for centrifuge maintenance. The layout is shown in Figure 24. A section view is shown in Figure 25.

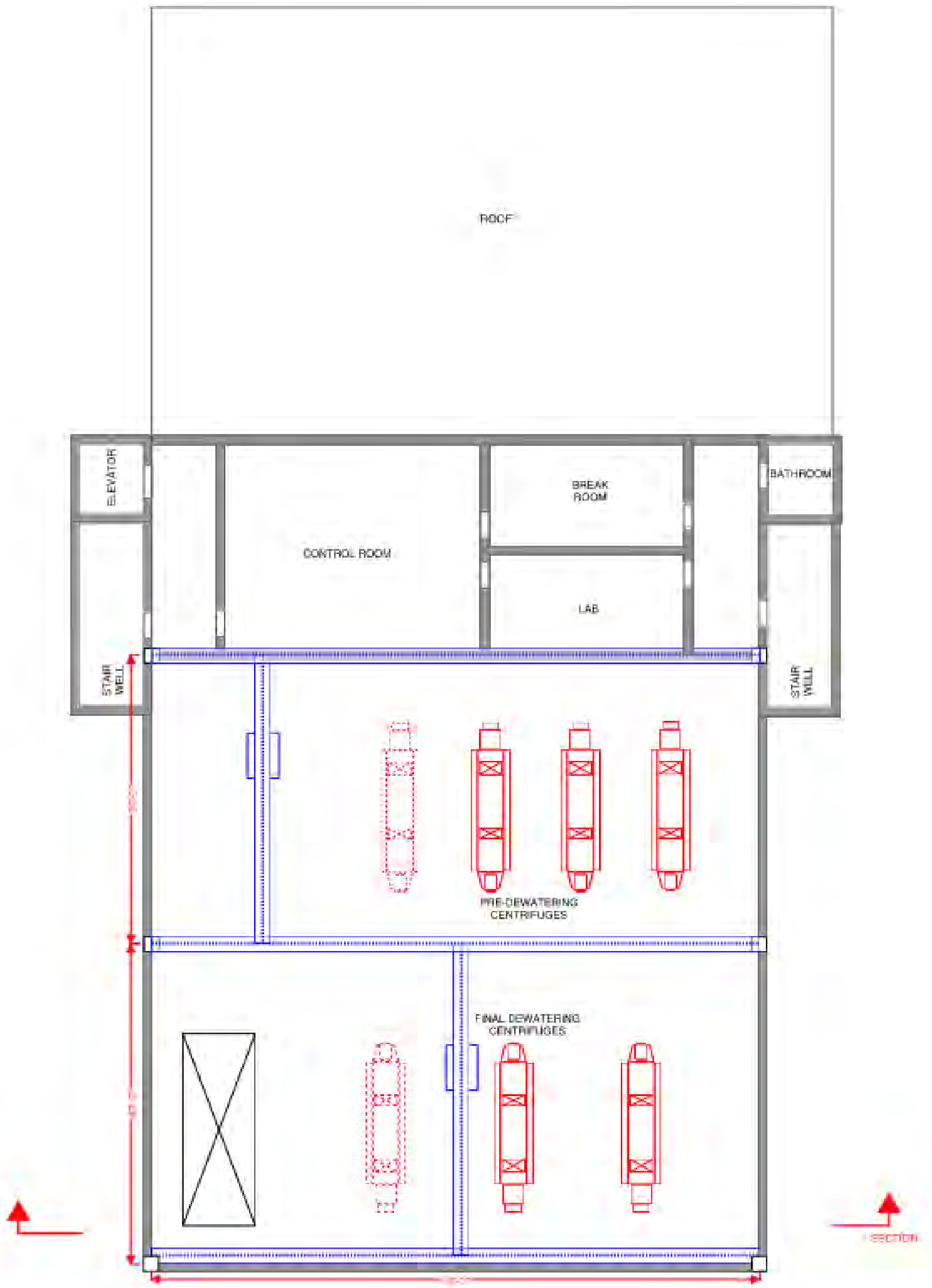

Figure 24. New Thickening/Screening/Pre-dewatering and Final Dewatering Facility Upper Floor Plan

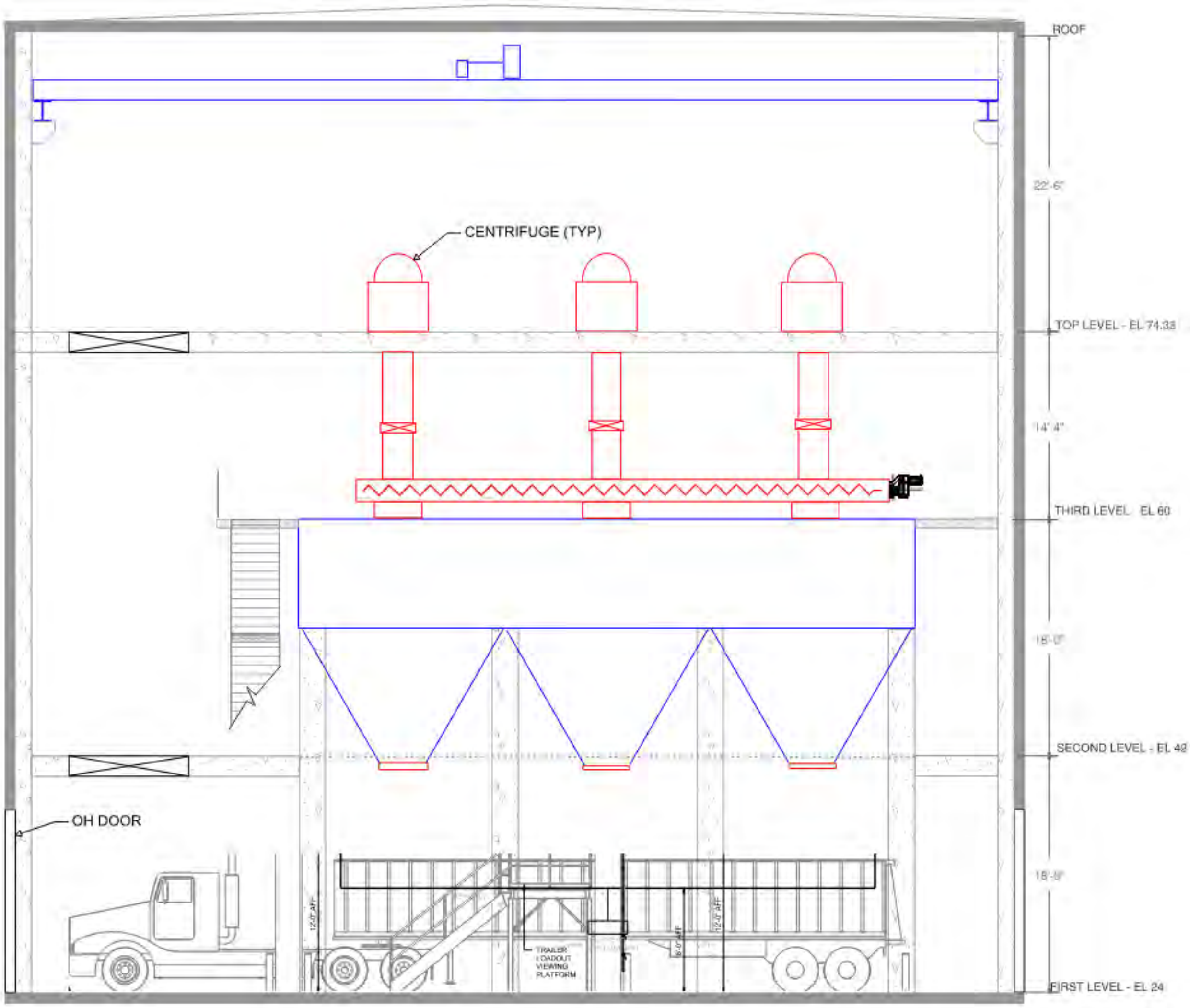

Figure 25. New Thickening/Screening/Pre-dewatering and Final Dewatering Facility Section 1

5.4.4 Site Layout and MOPO Considerations

A potential site layout is shown in Figure 26.

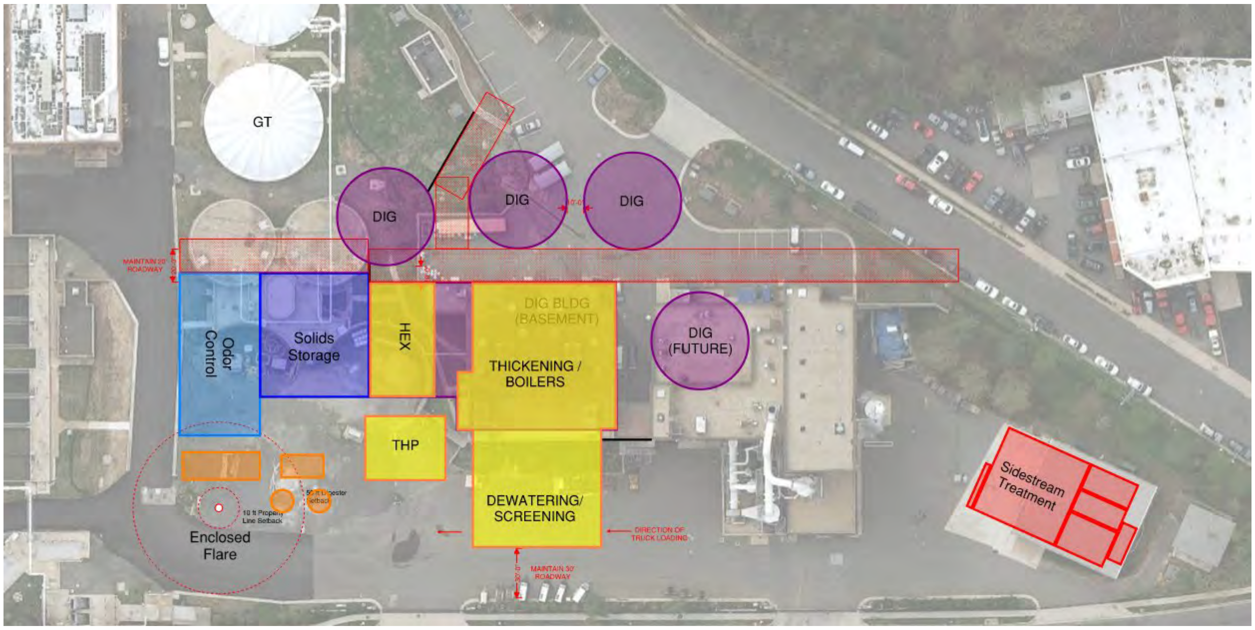

Figure 26. Preliminary Site Layout, Alternative 3: New Pre-dewatering and Final Dewatering Facility

This site layout is preliminary and will continue to be refined as unit processes are evaluated. As the existing DWB is not being reused and construction activities avoid the area of the existing DWB, no temporary lime stabilization is required, thereby minimizing MOPO risks. Coordination will be key, however, in maintaining operations with all of the construction activities occurring between the main treatment processes and the existing DWB.

5.4.5 Facility Advantages and Disadvantages

The advantages and disadvantages for Alternative 3 are listed in Table 9.

Table 9. Alternative 3 Advantages/Disadvantages

Advantages	Disadvantages
• All new facility • Can accommodate any type of thickening and dewatering equipment • Footprint can avoid unused space and be designed for intended uses • Flexibility in quantity of pre-dewatered cake storage volume and conveyance configuration • No temporary dewatering or lime stabilization facilities required	• Higher cost due to not reusing existing DWB • Existing DWB infrastructure not reused • Need to accommodate future installation of thickening units—may require roll-up doors or removable facility panels

5.4.6 Conceptual Construction Costs

Conceptual construction costs are presented in Table 10. Because Alternative 3 would involve construction of a new facility, sitework, concrete, and all building costs would apply. Discipline multipliers are provided as explained in Section 4.8. Building costs were included only for the future thickening, pre-dewatering, and final dewatering areas of the building to make it comparable to other alternatives evaluated in this TM. Building and equipment costs for the digester facilities are not included. No DWB demolition or temporary lime stabilization is required for this alternative.

Table 10. New Thickening, Screening, Pre-dewatering, and Final Dewatering Facility Conceptual Cost Estimate

Demolition		--
Building/structural		$8,780,000
Mechanical		$13,380,000
Subtotal		**$22,160,000**
Sitework	15%	$3,330,000
I&C/SCADA	8%	$1,780,000
Electrical	20%	$4,440,000
Large and specialty piping	5%	$1,110,000
Geotechnical	7%	$1,560,000
Temporary lime		--
Subtotal		**$34,380,000**
Contingency	20%	$6,880,000
Subtotal		**$41,260,000**
Contractor mobilization, staging, and security	5%	$2,070,000
Contractor bonds and insurance	3%	$1,240,000
Subtotal		**$44,570,000**
Contractor overhead and profit	15%	$6,690,000
Total		**$51,260,000**

6.0 Schedule and Overall Cost Comparison

Given the constraints on sequencing of work, each of the alternatives identified above will have a different overall construction schedule. This in turn impacts overall project costs through extended general conditions. A preliminary schedule analysis was completed for each alternative.

6.1 Alternative 1: Renovate the Existing Dewatering Building

A preliminary critical-path schedule for Alternative 1 is provided in Figure 27 below. The total duration (for comparison purposes) is 64 months. The critical path would be through construction of the final dewatering and temporary lime stabilization facilities, followed by the interior DWB demolition and reconstruction. Digesters, gas upgrading, and odor control would not be on the critical path. It is assumed that the new final dewatering facilities would be paired with a temporary lime stabilization facility for 18 months (16 months for DWB demolition and reconstruction plus 2 months for startup and shutdown).

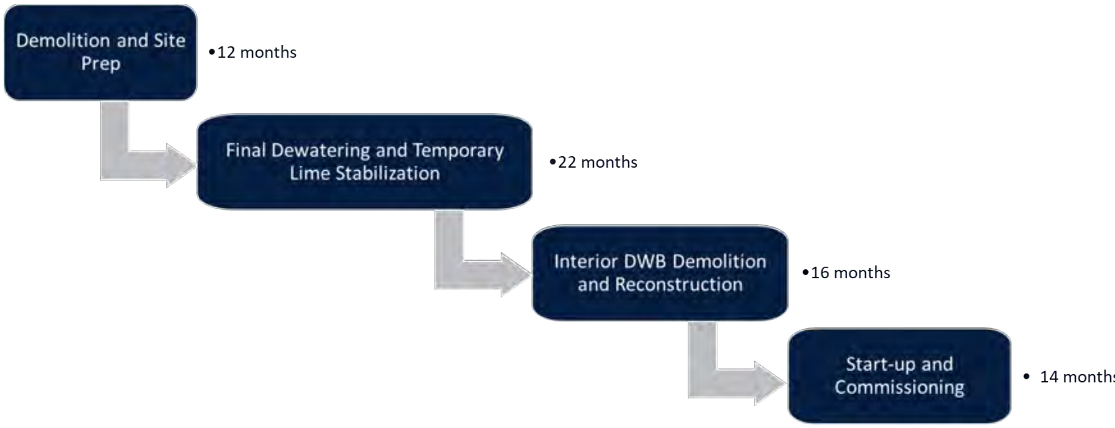

Figure 27. Critical-Path Schedule for Alternative 1: Renovate the Existing DWB

6.2 Alternative 2: Demolish the Existing Dewatering Building

A preliminary critical-path schedule for Alternative 2 is provided in Figure 28 below. The total duration (for comparison purposes) is 83 months. The critical path would be through construction of the pre-dewatering and temporary lime stabilization facilities, followed by the DWB demolition and construction of the new digester complex. Final dewatering, gas upgrading, and odor control would not be on the critical path. It is assumed that the new pre-dewatering facilities would be paired with a temporary lime stabilization facility for 35 months (33 months for DWB demolition and reconstruction plus 2 months for startup and shutdown). The overall schedule would be significantly longer because of the time required for the existing DWB demolition and digester construction.

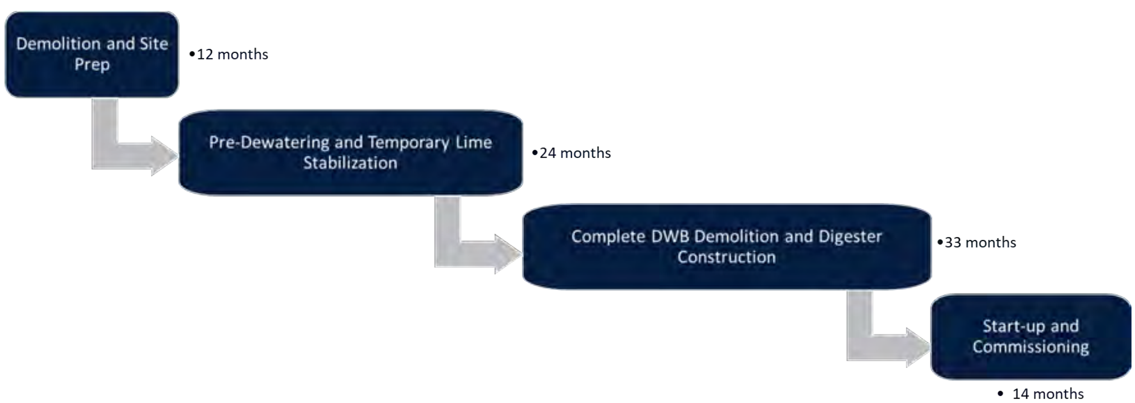

Figure 28. Critical-Path Schedule for Alternative 2: Demolish the Existing DWB

6.3 Alternative 3: Decommission the Existing Dewatering Building

A preliminary critical-path schedule for Alternative 3 is provided in Figure 29 below. The total duration (for comparison purposes) would be 58 months. The critical path would be through construction of the new digester complex. Dewatering, gas upgrading, and odor control would not be on the critical path. No temporary lime stabilization would be required if the existing DWB can remain in service throughout construction.

Figure 29. Critical-Path Schedule for Alternative 3: Decommission the Existing DWB

6.4 Cost Impacts for Different Schedules

The different schedules will impact overall project costs through additional general conditions. For comparison purposes, it is assumed that general conditions are approximately $300,000 per month. This value is based on knowledge of a similar project in the region. An overall cost and schedule comparison is provided in Table 11 below. The base cost provided includes the separate final dewatering facility for Alternatives 1 and 2.

Table 11. Overall Schedule and Cost Comparison

Parameter	Alternative 1: Renovate DWB	Alternative 2: Demolish DWB	Alternative 3: Decommission DWB
Schedule (months)	64	83	58
Length of temporary operations (months)	18	35	0
Base cost for pre-dewatering and final dewatering ($ millions)	$47.5	$55.9	$51.3
Adder for general contractors at $0.3M/month over base)	$1.8	$7.5	$0.0
Total costs	$49.3	$63.4	$51.3
Percentage of minimum	100%	128%	104%

7.0 Comparison of Alternatives

Table 12 provides a side-by-side comparison of the relative advantages and disadvantages of the alternatives.

Table 12. Alternatives Comparison

Consideration	Alternative 1	Alternative 2	Alternative 3
OPCC	$49.3 million	$63.4 million	$51.3 million
Overall schedule	5.3 years	6.9 years	4.8 years
Duration of temporary lime stabilization	18 months	35 months	Not required
Uses existing infrastructure	Reuse existing DWB, which has significant useful life remaining	Existing DWB is demolished	Existing DWB is decommissioned
Requires modifications to existing DWB	Building requires significant modifications for both final use and constructability	Existing DWB is demolished	Existing DWB is decommissioned
Site footprint utilization	Least site footprint available for future use (approx. 0.20 acre)	More site footprint available for future use (approx. 0.45 acre)	Most site footprint available for future use (approx. 0.75 acre)
Building utilization	Significant unused space in building; not optimized for current needs	Building will be designed for intended uses	Building will be designed for intended uses
Undesirable viewshed impacts	Ex. DWB would screen THP from neighbors	THP would be visible from 31st St.	New DWB would screen THP from neighbors
Code compliance	Existing DWB may require significant upgrades to meet current codes	New building will be designed for compliance with latest codes	New building will be designed for compliance with latest codes
Limitations in dewatering capacity during construction may require temp. dewatering	Final dewatering facility will be used during temporary operations, and it is not sized for undigested solids production	Pre-dewatering facility will be used during temporary operations	No temporary operations required
Requires cleaning and disinfection of final dewatering	Final dewatering will have to be disinfected after it has processed unstabilized solids	No, because final dewatering will not be used for temporary operations	No, because final dewatering will not be used for temporary operations
Future WAS thickening can be installed on the ground floor	Yes	No: located on second floor	No: located on second floor

8.0 Summary and Conclusions

This TM summarizes and compares the pre-dewatering and final dewatering facility alternatives for the Arlington County Biosolids program. Given the extended schedule and added costs of Alternative 2, it is recommended to remove that alternative from consideration.

It is recommended to continue to develop and evaluate Alternative 1, Renovate the Existing Dewatering Building, and Alternative 3, Decommission the Existing Dewatering Building. Site layout and risks will be further evaluated with both alternatives and will be described further in the Facilities Plan. It is anticipated that delivery team input will be sought prior to a final decision being made.

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Technical Memorandum No. 10

Date:	February 15, 2023
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Air Emissions Analysis

Contents

Tables

Figures

Appendices

1.0 Introduction

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary sludge (PS) and waste activated sludge (WAS) thickening, dewatering, and lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a thermal hydrolysis process (THP) and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The purpose of this air emissions evaluation is to assess the anticipated WPCP emission changes and resulting ambient air impacts associated with the planned improvements. This information will be used to develop the applicable air quality permit application, and to inform public stakeholders regarding the anticipated impacts on the air quality in the area surrounding the WPCP.

2.0 Air Emissions and Permitting Evaluation

This section presents a summary of the permitted air emissions of the existing WPCP, as well as a summary of the air emissions of the WPCP after implementation of the planned improvements. Also included is a discussion of the anticipated air permitting requirements that will be triggered by the planned improvements.

2.1 Existing Facility

The existing WPCP operates under air quality Registration 70026, issued by the Virginia Department of Environmental Quality (VDEQ) Northern Regional Office (NRO). The permit, which was issued on October 30, 2009, and amended on July 2, 2012, includes several emission units that are currently in operation at the WPCP as well as four boilers that have been replaced since the permit was issued (the two New Maintenance Building [NMB] boilers and the two Operations Control Building [OCB] boilers). Per guidance provided by the permitting manager of the VDEQ NRO, the permit did not need to be updated because the WPCP replaced minor sources with minor sources. The emission units currently at the WPCP are listed in Table 1, along with an indication of how they will be impacted by the planned improvements project.

Table 1. Existing Air Emission Units

Reference Number	Equipment Description	Affected by Planned Improvements Project?
A	Caterpillar 3516-C diesel engine-generator set	No
B	Caterpillar 3516-C diesel engine-generator set	No
C	Caterpillar 3516-C diesel engine-generator set	No
Tank 1	12,000 gal fixed-roof methanol storage tank	No
Tank 2	12,000 gal fixed-roof methanol storage tank	No
Tank 3	12,000 gal fixed-roof methanol storage tank	No
DWB-Boil	5.021 MMBtu/hr Kewanee water heater	Yes—will be removed
NMB-Boil 1	2 MMBtu/hr Cleaver-Brooks water heater	No
NMB-Boil 2	2 MMBtu/hr Cleaver-Brooks water heater	No
OCB-Boil 1	5 MMBtu/hr steam generator	No
OCB-Boil 2	5 MMBtu/hr steam generator	No

The current permitted “potential to emit” (PTE) of the WPCP is summarized in Table 2. By definition, the WPCP’s PTE represents the maximum emissions from all WPCP emission units operating full time at full capacity or as limited by enforceable permit terms. Actual emissions are expected to be significantly lower because only three of the five boilers will typically be used at less than capacity at a time and the engine-generator sets will be operated infrequently.

Table 2. Existing WPCP Potential to Emit (tons per year)

Pollutant	Engines A, B, and C [a]	Boilers[b]	Existing Total	Major NSR Threshold	Title V Major Source Threshold
PM/PM10/PM2.5	7.7	0.3	8.0	250	100
NO_x	23.1	2.2	25.3	100 [c]	100
SO_2	6.1	0.02	6.1	250	100
CO	31.2	2.9	34.1	250	100
VOC	3.9	0.4	4.3	50 [c]	50 [e]
CO_2e	59,748	4,168	63,916	-[d]	100,000

a. Obtained from Registration Permit 70026.
b. Calculated using the permitted boiler fuel use limit, 20 parts per million (ppm) oxides of nitrogen (NO_x) for the replacement NMB and OCB boilers and methanol tank volatile organic compound (VOC) emissions obtained from CDM Smith's Technical Memorandum (TM) 4.4 dated March 29, 2018.
c. Per the 9 VAC5-80-2010.C definition of major stationary source for facilities located in the Ozone Transport Region. The applicability of these thresholds will be verified with VDEQ as part of the permit application process.
d. CO_2e is a regulated pollutant for the Prevention of Significant Deterioration (PSD) major source pre-construction permitting program only if another PSD-regulated pollutant exceeds its major source threshold.
e. Per the 9 VAC5-80-60.C definition of major stationary source for facilities located in the Ozone Transport Region. The applicability of this threshold will be verified with VDEQ as part of the permit application process.

Based on the current VDEQ rule language and permitted PTE, the WPCP is an existing minor facility for both new source review (NSR) construction permit and Title V (operating permit) purposes.

2.2 Planned Improvements

The planned improvements include installation and operation of the following new sources at the WPCP:

- Two 350-horsepower (hp) boilers each with a rated heat input of 14.7 million British thermal units per hour (MMBtu/hr) and capable of combusting digester gas and natural gas. Emissions were calculated using Hurst, Series 300 boilers.
- One waste gas flare capable of combusting all of the gas produced by the new digesters being installed as part of the planned improvements. Emissions were calculated and modeled using a Varec 244E waste gas flare.
- One regenerative thermal oxidizer (RTO) that will treat (combust) the tailgas produced by the gas upgrading process. At this time no design information is available regarding the size of this RTO. That tailgas is a subset of the digester gas that would otherwise be combusted by the waste gas flare. Therefore, the emissions calculated for the waste gas flare conservatively reflect emissions that would be generated by the RTO.

2.2.1 Potential to Emit

Potential emissions for this new equipment were calculated based on anticipated vendor guarantees and U.S. Environmental Protection Agency (EPA) default emission factors obtained from the AP-42, Fifth Edition Compilation of Air Pollutant Emissions Factors, Volume 1: Stationary Point and Area Sources, accessed at AP-42: Compilation of Air Emissions Factors | US EPA. The resulting estimated PTE values are summarized in Table 3. The PTE calculation is based on the maximum amount of emissions with all boiler units and the flare in operation (i.e., the ability to emit simultaneously). Actual emissions are expected to be significantly lower as only one boiler will be used at a time and the flare will be operated infrequently. Based on the current VDEQ rule language and estimated PTE, the planned improvements project is a minor modification of an existing minor facility for NSR permitting purposes. However, the project will trigger VDEQ's minor NSR permitting requirements for modification of an existing source.

Table 3. Planned Improvements Project Potential to Emit (tons per year)

Pollutant	Boilers	Waste Gas Flare	Project Total	Major NSR Threshold	Minor NSR Threshold
$PM/PM_{10}/PM_{2.5}$	1.0	1.2	2.2	250	25/10/6
NO_x	12.6	5.2	17.8	100 [a]	10
SO_2	0.1	3.3	3.4	250	10
CO	10.6	22.9	33.5	250	100
VOC	0.7	1.6	2.3	50 [a]	10
CO_2e	15,098	9,171	24,269	- [b]	Not applicable

a. Per the 9 VAC5-80-2010.C definition of major stationary source for facilities located in the Ozone Transport Region. The applicability of these thresholds will be verified with VDEQ as part of the permit application process.

b. CO_2e is a regulated pollutant for NSR purposes only if another PSD-regulated pollutant exceeds its major source threshold.

2.2.2 Applicable Regulatory Requirements

This section presents applicable regulatory requirements of the planned improvements, including minor NSR permitting and other regulatory requirements.

2.2.2.1 Minor NSR Permitting

The planned improvements project will require a minor NSR construction permit, which will need to be issued prior to beginning construction of any of the applicable equipment.

Minor NSR permits do not go through public participation unless VDEQ determines that public interest concerning air quality issues warrants it. The air permitting process should be started well in advance of when construction is scheduled to commence in order to avoid undue delays associated with the permitting process. VDEQ indicates the following time frames associated with processing and issuing a minor NSR permit:

- **Completeness review:** 30 days from receipt of application
- **Processing of application:** 90 days from receiving a complete application, or 180 days if public participation is required

One key term in the application processing timeline is "complete." If VDEQ determines that additional information is required in order for VDEQ to process the submitted application, it will request that information and the time clock will stop until VDEQ receives the information. Within 30 days after receipt of any additional information VDEQ will either request additional information (starting another 30-day review cycle) or deem the application complete. Once VDEQ deems the application complete the processing timeline clock then begins.

2.2.2.2 Other Requirements

Based on their rated input capacity (greater than 10 MMBtu/hr), each of the new boilers will be subject to the requirements of Code of Federal Regulations (CFR) Title 40 Part 60, Subpart Dc: Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units. This rule will require submittal of a notification of the date that construction commenced, as well as daily or monthly monitoring of each fuel type used (biogas or pipeline natural gas) in each boiler.

2.3 Post-Project Facility

The estimated PTE values for the WPCP after completion of the planned improvements project are summarized in Table 4. Based on the current VDEQ rule language and estimated PTE the post-project WPCP will not trigger the Title V permitting requirements.

Table 4. Post-Project Potential to Emit (tons per year)

Pollutant	Existing Facility [a]	Project Emissions	Post Project Total	Title V Major Source Threshold
$PM/PM_{10}/PM_{2.5}$	7.8	2.2	10.0	100
NO_x	24.3	17.8	42.1	100
SO_2	6.1	3.4	9.5	100
CO	31.7	33.5	65.2	100
VOC	4.0	2.3	6.3	50 [b]
CO_2e	61,268	24,269	85,537	100,000

a. Values reflect removal of the dewatering building (DWB) and associated boilers.
b. Per the 9 VAC5-80-2010.C definition of major stationary source for facilities located in the Ozone Transport Region. The applicability of these thresholds will be verified with VDEQ as part of the permit application process.

3.0 Dispersion Modeling Analysis

Air quality dispersion modeling was performed for this project to assess local environmental impacts from the proposed equipment. This information will be used to inform public stakeholders regarding the anticipated impacts on the air quality in the area surrounding the WPCP.

3.1 Methodology

While there is currently no regulatory requirement for air dispersion modeling analysis at the WPCP, standard regulatory modeling methodology was used as outlined in the sections below. Dispersion analysis is limited to the project impacts only and does not represent a WPCP-wide analysis.

3.1.1 Dispersion Model Selection

EPA's American Meteorological Society (AMS)/EPA Regulatory Model (AERMOD) version 21112 was used in the analysis of direct pollutant emissions from this project. AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. AERMOD is listed as a preferred model in EPA's Guideline on Air Quality Models. Third-party software from Lakes Environmental (AERMOD View version 10.0.1) was used to facilitate model setup and produce graphical results.

The suite of AERMOD software includes the following associated programs:

- AERMAP (terrain data preprocessor)
- AERMET (meteorological data preprocessor)
- BPIP (building profile input preprocessor)

3.1.1.1 Selected Model Setup Options

For this analysis, the processing options for AERMOD were designed as follows:

- **Urban dispersion (236,842):** population of Arlington County, 2019
- **Tier 2 oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2) conversion:** Ambient Ratio Method (ARM2) with In-Stack Ratio default range of 0.5 to 0.9

3.1.2 Facility Layout

The WPCP spans two separate processing areas on the north and south sides of South Glebe Road. New equipment for this biosolids project will be located on the northern side of the property, with no changes to the equipment or facilities on the south side of S Glebe Road.

Spatial layout information is a key component of dispersion analysis. For this project, two alternate construction scenarios were modeled, as shown in Figure 1 through Figure 4 below. Figure 1 and Figure 2 show the proposed layout for decommissioning the existing dewatering building (DWB) (without demolition) and building a new DWB south of the existing structure. The boilers would be located within the new DWB and have exhaust stacks on the western side of the rooftop. This configuration is referenced as Iteration 1 in the analysis.

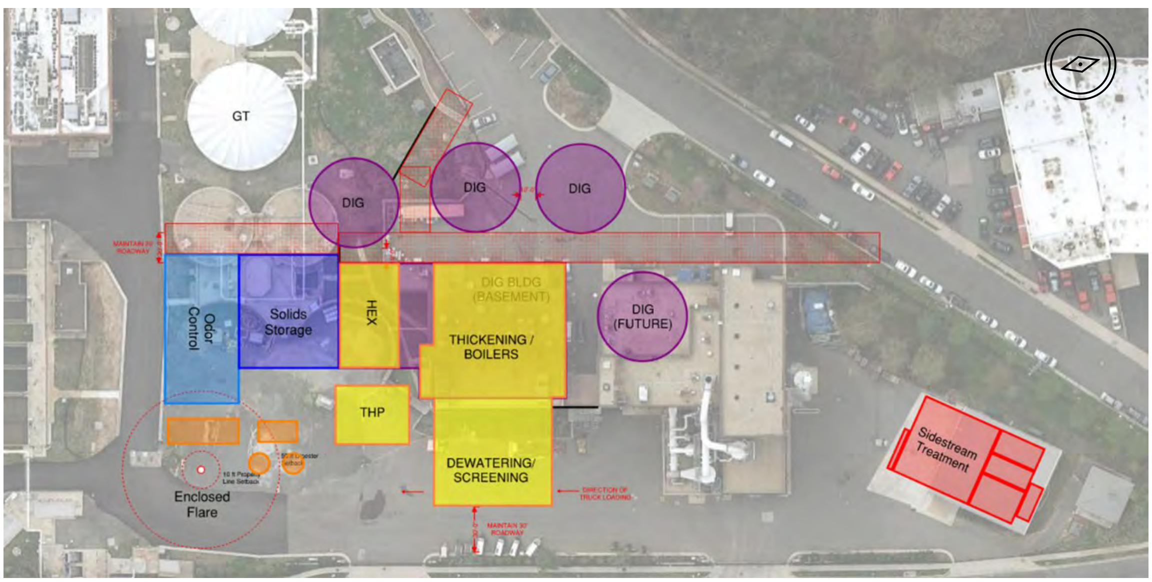

Figure 1. Decommission Existing Dewatering Building, Build New Dewatering Building

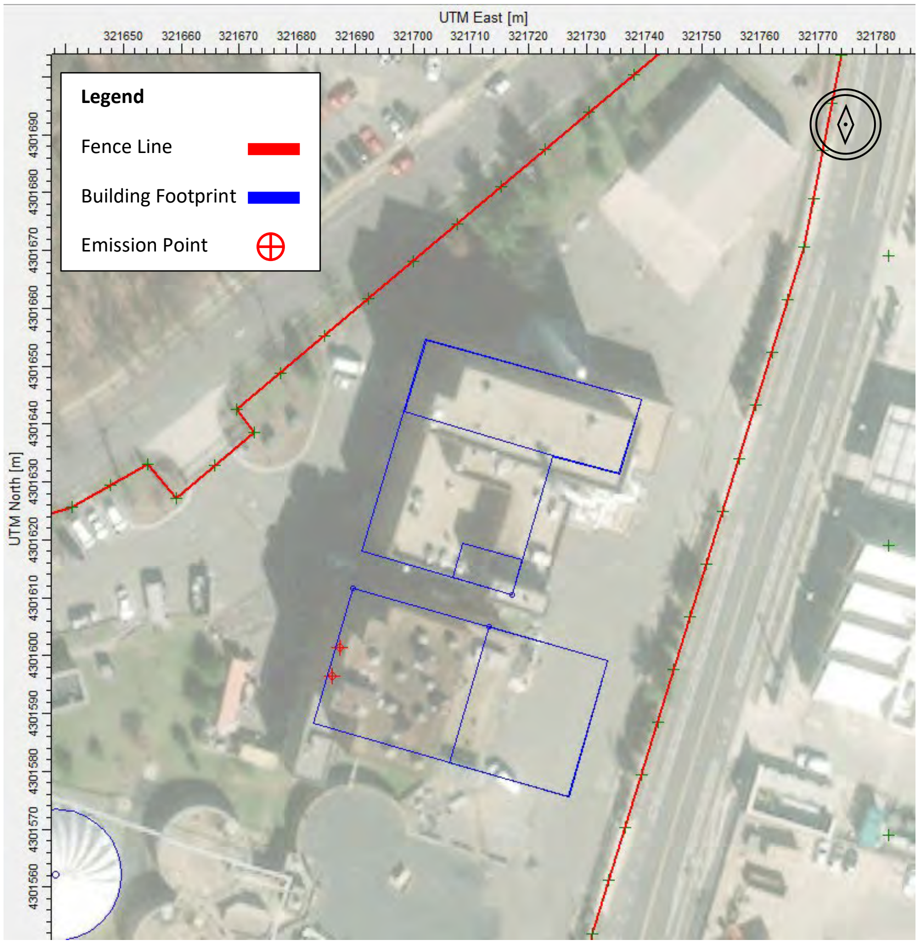

Figure 2. Modeled Boiler Stack Locations: Rooftop of New Dewatering Building

Figure 3 and Figure 4 show the proposed layout for renovating the existing DWB and adding new structures to the southeast of the structure for biosolids treatment. The boilers would be located within the existing DWB after renovation and have exhaust stacks on the western side of the rooftop. This configuration is referenced as Iteration 2 in the analysis.

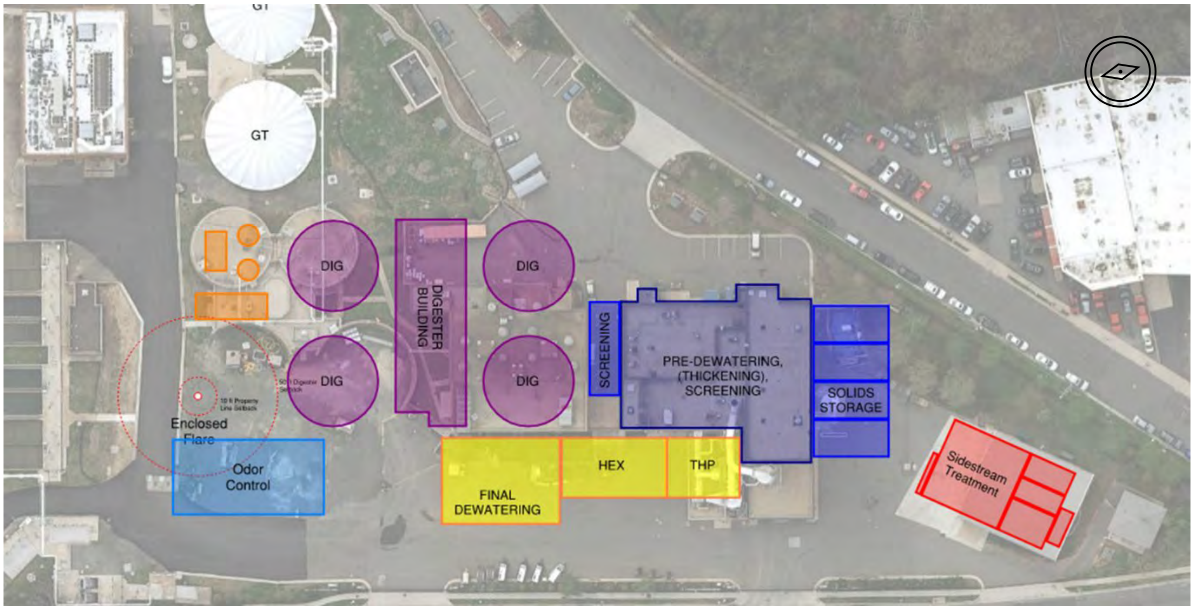

Figure 3. Renovate Existing Dewatering Building

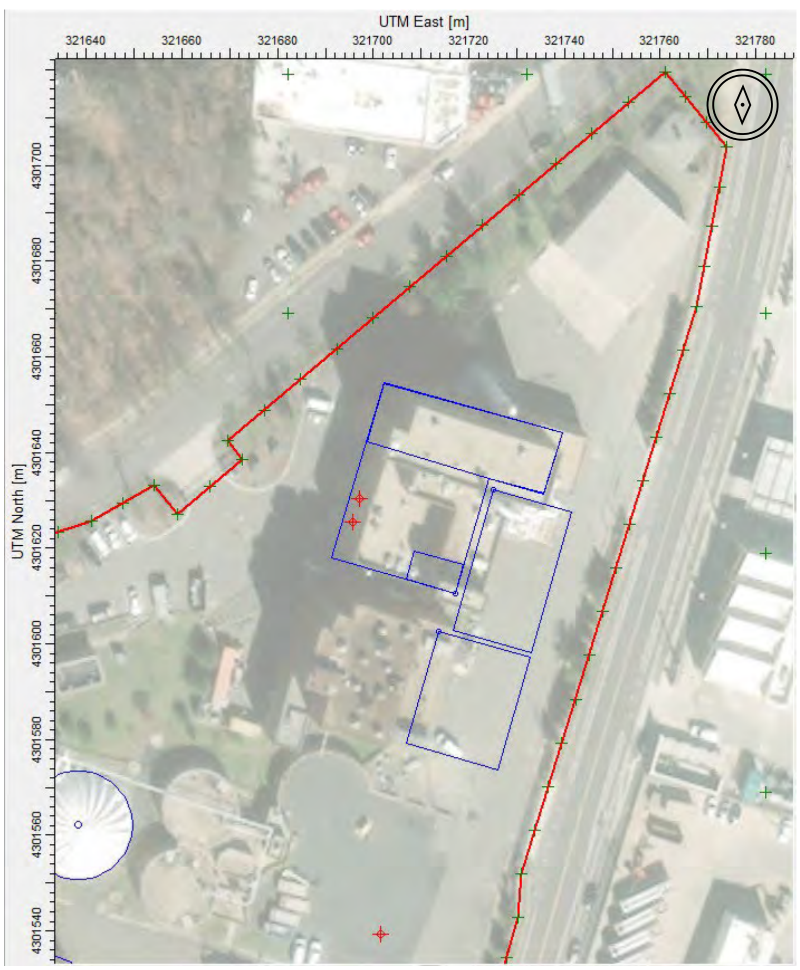

Figure 4. Modeled Boiler Stack Locations: Rooftop of Existing Dewatering Building

Results are presented for both site configurations for comparison, with detailed plot images included in Appendix B .

Building design information was used to produce three-dimensional structures within the dispersion model to assess the impacts of building downwash on the dispersion of pollutants at the site.

3.1.3 Elevation Data

Terrain values were sourced from the United States Geological Survey (USGS) National Elevation Database (NED) at a resolution of 1/3 arc second. All coordinate data for this analysis are referenced to the North American Datum of 1983 (NAD83) and listed in Universal Transversal Mercator (UTM) Zone 18 in meters (m).

3.1.4 Receptor Grid

A nested grid of receptors was placed surrounding the WPCP outward to a radius of 2,500 meters. Receptors were placed at the following densities:

- 25-meter spacing along the fence lines of the northern and southern portions of WPCP
- 50-meter spacing from the fence lines to 500 meters
- 100-meter spacing from 500 meters to 2,500 meters

The receptor grid is not shown on the Appendix B isopleths as the focus of the Appendix B plots is on the contours of the impacts, therefore the receptors are muted to not clutter the image and impact legibility.

3.1.5 Meteorological Data

AERMOD relies on real-world weather observations to produce calculated dispersion impacts. Data are combined in the AERMET preprocessing program from the following two sources:

- Hourly surface observation data
- Upper-level rawinsonde (weather balloon) observations collected twice per day

Consistent with regulatory methodology, the most recent 5 years of observation data were compiled from the most appropriate observation sites. For surface data, the Integrated Surface Hourly Database (ISHD) data files were obtained from Ronald Reagan Washington National Airport (Station 13473), including 1-minute data from the Automated Surface Observing System (ASOS) wind sensors. For upper air observations, data files were obtained from the National Oceanic and Atmospheric Administration (NOAA) rawinsonde observation (RAOB) database from Sterling, Virginia (Station 93734).

Data were processed within AERMET version 21112 for the period of 2016–2020. The following selections were made in AERMET for data processing:

- Default seasonal parameters for the Northern Hemisphere
- Non-arid region
- No continuous snow cover
- Average surface moisture
- Adjusted surface friction velocity (ADJ_U*)
- Inclusion of 1-minute surface observation data through AERMINUTE
- Calm threshold of 0.5 meter per second (m/s)

Wind speed and direction for each hourly time step in the 5-year data set are represented in the wind rose diagram shown in Figure 5 below. The prevailing wind direction is from the south, with a second distribution from the northwest.

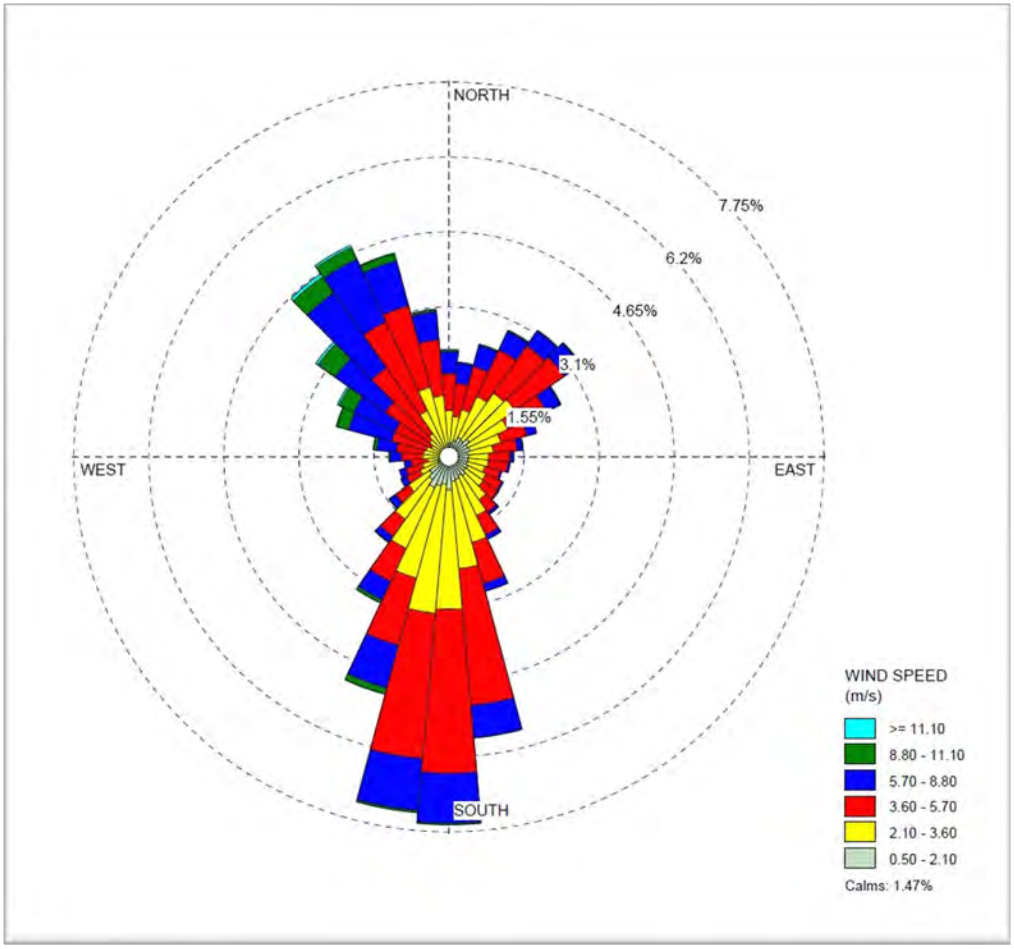

Figure 5. Observed Wind Speed and Direction, Ronald Reagan Washington National Airport, 2016–2020

3.1.6 Background Concentrations

Ambient air quality monitoring data were used to provide background levels for each analyzed pollutant to add to project impacts for a more comprehensive assessment of conditions surrounding the WPCP. Background concentrations from the most recent 3 years (2018–2020) were selected from the nearest monitoring stations.

Table 5 outlines the data and each monitor source.

Table 5. Ambient Monitor (Background) Data

Pollutant	Averaging Period	Statistical Ranking (averaged over 2018–2020)	Background Concentration (µg/m3)	Monitor Station
CO	1 hr	Max high–2nd high	1.53	S 18th and Hayes St. Arlington, Virginia
	8 hr	Max high–2nd high	0.40	
NO_2	1 hr	98th percentile	41.67	
	Annual	Max annual arithmetic mean	8.86	
$PM_{2.5}$	24 hr	98th percentile	17.67	
	Annual	Avg annual arithmetic mean	7.33	
PM_{10}	24 hr	Max high–2nd high 2017–2019 (null 2020 data)	14.67	435 Ferdinand Day Dr. Alexandria, Virginia
SO_2	1 hr	99th percentile	3.67	Station 46-B9, Lee Park, Telegraph Rd. Alexandria, Virginia
	24 hr	Max high–2nd high	1.70	
	Annual	Max annual arithmetic mean	0.38	

3.1.7 Emission Sources

Project emission sources were identified as the two proposed new boilers and the proposed ground flare, each of which was modeled as a POINT source within AERMOD. The FLARE modeling options were not selected for the proposed flare as the flame is enclosed by a surround that results in a similar dispersion profile to a traditional exhaust stack. Stack parameters reflect preliminary design values and engineering estimates and may or may not represent final design and construction.

Boiler stacks are assumed to be routed to the top of the building in which they are housed, which varies between the two potential construction layouts. Assumptions for stack heights are listed in Table 6 and Table 7 below. There are two potential locations for the proposed flare: one places the flare more than 100 feet from the fence line; the second location is 50 feet from the fence line. To ensure that the highest possible impacts are captured in the modeling demonstration, the flare is modeled at a worst-case placement in both models, 50 feet west of the eastern fence line.

Existing combustion emission sources were included in the modeling to calculate site-wide emission impacts to the surrounding area. Three diesel generators and two additional boiler sets (one active and one standby) are currently located at the portion of the WPCP that is on the south side of S Glebe Road.

Table 6. Modeled Parameters for Emission Sources: Iteration 1

Equipment	Easting X (m)	Northing Y (m)	Stack Height (ft)	Stack Diameter (ft)	Stack Temperature (°F)	Exit Velocity (m/s)
Proposed boiler 1	321,686	4,301,596	80	2.0	400	20.0
Proposed boiler 2	321,687	4,301,601	80	2.0	400	20.0
Proposed flare	321,701	4,301,539	25	6.6	1,832	20.0
Existing NMB boiler	321,534	4,301,573	30	1.3	200	1.6
Existing OCB boiler	321,491	4,301,430	30	1.0	200	7.1
Existing diesel generator A	321,528	4,301,408	30	1.5	572	56.0
Existing diesel generator B	321,534	4,301,404	30	1.5	572	56.0
Existing diesel generator C	321,540	4,301,401	30	1.5	572	56.0

Table 7. Modeled Parameters for Emission Sources: Iteration 2

Equipment	Easting X (m)	Northing Y (m)	Stack Height (ft)	Stack Diameter (ft)	Stack Temperature (°F)	Exit Velocity (m/s)
Proposed boiler 1	321,696	4,301,626	65	2.0	400	20.0
Proposed boiler 2	321,697	4,301,630	65	2.0	400	20.0
Proposed flare	321,701	4,301,539	25	6.6	1,832	20.0
Existing NMB boiler	321,534	4,301,573	30	1.3	200	1.6
Existing OCB boiler	321,491	4,301,430	30	1.0	200	7.1
Existing diesel generator A	321,528	4,301,408	30	1.5	572	56.0
Existing diesel generator B	321,534	4,301,404	30	1.5	572	56.0
Existing diesel generator C	321,540	4,301,401	30	1.5	572	56.0

This analysis presents two project scenarios based on differences in boiler stack locations (Iterations 1 and 2), and also two scenarios for WPCP operations. The first is a worst-case analysis for short-term emissions based on the maximum operation of WPCP combustion units all running simultaneously to illustrate the localized impacts and compare to the National Ambient Air Quality Standards (NAAQS). This is not an operationally feasible scenario. Short-term emissions are modeled as each unit operating at maximum allowable capacity (either permitted limit or maximum design capacity) simultaneously for all hours of the year:

1. The proposed boilers (one main unit and one standby unit) were modeled as operating together at maximum capacity; this is not a feasible scenario as that level of operation would exceed the steam demand for the WPCP and represents a worst-case, highly conservative estimate.

2. The proposed flare was modeled as operating at maximum hourly capacity; this is not a feasible scenario because it exceeds the availability of biogas during biosolids treatment for flaring and represents a worst-case, highly conservative estimate. The flare is expected to operate less than 5 percent of the year.
3. The existing NMB boiler was modeled as operating at maximum hourly capacity; this is not a feasible scenario as it would over-produce steam load for the WPCP and represents a worst-case, highly conservative estimate. The standby NMB boiler was not modeled as it is not permitted to run simultaneously with the main unit.
4. The existing OCB boiler was modeled as operating at maximum hourly capacity; this is not a feasible scenario as it would over-produce steam load for the WPCP and represents a worst-case, highly conservative estimate. The standby OCB boiler was not modeled as it is not permitted to run simultaneously with the main unit.
5. The diesel generators were modeled with their maximum permitted hourly operational limit and on a testing schedule of 1 hour per week. As a worst case, all three diesel generators are modeled as running during the same hour each week for testing.

The second is a long-term analysis for emissions based on actual operations, to show the low impacts due to intermittent operation of most of the sources. For existing units, reportable emissions data were used to develop annualized emission rates for comparison to annual NAAQS. As an example, the diesel generators have historically operated infrequently; therefore, their annualized emissions are low. For proposed equipment, the maximum hourly rate was applied to all hours of the year, resulting in a very conservative overestimation of the impacts from those units.

The short-term emission rates were developed for the WPCP based on hourly equipment capacity, including permitted values for existing equipment and design information for proposed equipment, and are attached to this technical memorandum (TM) as Appendix A . Annualized emissions are calculated based on historical operational data for existing emissions and expected operational conditions for proposed equipment.

3.2 Model Results

As outlined above, calculations were performed for all selected pollutants and averaging periods. The maximum impacted receptors were identified and, combined with background concentrations, were compared against the NAAQS with the corresponding form of each pollutant standard. The Clean Air Act (CAA) requires EPA to set the NAAQS for pollutants that are common in outdoor air. The NAAQS are established through a rigorous review process and are designed to be protective of human health for ambient air exposure, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly.[1] The NAAQS have been established for carbon monoxide (CO), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), NO_2, sulfur dioxide (SO_2), lead (Pb), and ozone (O_3). The pollutants for which NAAQS have been established are referred to as the criteria pollutants.

Ozone is a secondary pollutant, which forms in the atmosphere as a result of chemical reactions between other pollutants (precursor compounds) that can vary based on ambient regional concentrations. Ozone formation is seasonal and can be impacted by weather conditions and localized

[1] https://www.epa.gov/criteria-air-pollutants/naaqs-table

sources such as transportation emissions or other industrial facilities. Precursor compounds include NO_x and volatile organic compounds (VOC), which are included in this modeling study. Ozone has not been discretely modeled in this analysis.

Similarly, $PM_{2.5}$ is considered to be both a primary and secondary pollutant. There are direct $PM_{2.5}$ emissions from units at the WPCP, and $PM_{2.5}$ can also form through atmospheric reactions of precursor compounds. This analysis does not attempt to quantify the secondary formation of $PM_{2.5}$ based on WPCP emissions. In addition, lead is not emitted from this WPCP and therefore lead is not included in this modeling analysis.

Compliance with each NAAQS is determined based on meeting specified design values that differ by averaging period and pollutant. These design values incorporate allowable exceedances of the NAAQS. More information on the NAAQS is available at https://www.epa.gov/criteria-air-pollutants/naaqs-table. The NAAQS values, averaging periods, and design values are listed below in Table 8.

Table 8. National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS ($\mu g/m^3$)	Design Value
CO	1 hr	40,000	H2H
	8 hr	10,000	H2H
NO_2	1 hr	188	H8H
	Annual	100	5-year maximum
PM_{10}	24 hr	150	H6H
$PM_{2.5}$	24 hr	35	H8H
	Annual	12	5-year maximum
SO_2	1 hr	196	H4H
	24 hr	365	H2H
	Annual	78	5-year maximum

Contour plots were produced for each pollutant that was analyzed and can be found in Appendix B to this TM. Tabular results are presented for each iteration in Table 9 and Table 10 below. This project is not expected to cause any exceedances of the NAAQS. As stated previously, the modeling results are presented for all units operating simultaneously as a worst case; however, because of the operational design of the WPCP this scenario would not be operationally feasible.

An initial screening analysis was performed to determine the impact of various layout options as combined heat and power (CHP) gas utilization scenarios were being considered. Appendix C details preliminary modeling results for co-locating the proposed boilers with proposed engines that would combust the biogas from the digesters to produce electricity. The boilers and engines would have been housed in a smaller, separate structure (referred to as the "power block structure") with a much lower roof height than the surrounding biosolids handling facilities, so building downwash was a significant focus in the preliminary design modeling. The power block designs had boilers and engines exhausting much closer to ground level and, with wake cavities produced by the larger buildings, resulted in potential impacts above the NAAQS, as shown in Table C-2 of the Appendix.

In this current analysis, both Iterations 1 and 2 relocate the boiler exhaust stacks to the rooftop of the DWB (either new or renovated existing), which is significantly higher above ground level than the proposed power block structure and promotes good dispersion of pollutants before reaching ground-level receptors. This improvement of dispersion results in lowered air quality impacts for the boilers than what was previously identified in the preliminary screening analysis in Appendix C without changing operational design capacities. In summary, the results presented below for Iterations 1 and 2 show that despite overestimating emissions for all units and operational scenarios, WPCP-wide air quality impacts are significantly below any established NAAQS and do not pose a significant risk to human health.

Table 9. Iteration 1: Decommission Existing Dewatering Building

	Boiler stack heights are above new DWB rooftop; flare is at ground level south of thickening/dewatering									
	CO	CO	NO_2	NO_2	SO_2	SO_2	SO_2	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
	1 hr	8 hr	1 hr	Annual	1 hr	24 hr	Annual	24 hr	24 hr	Annual
	H1H	H1H	H8H	Max	H4H	H1H	Max	H6H	H8H	Max
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
New DWB boilers	33.4	20.5	28.6	3.5	0.0	0.0	0.0	1.4	1.2	0.3
Flare	93.9	49.3	14.9	0.3	12.7	4.4	0.2	0.9	0.5	0.1
Diesel generators	250.9	31.4	26.9	10.9	39.9	2.1	1.5	1.9	0.3	0.0
OCB boiler	16.6	7.7	14.5	0.4	0.4	0.1	0.0	1.3	0.9	0.2
NMB boiler	29.5	15.9	6.2	0.4	0.2	0.1	0.0	0.8	0.7	0.2
All units together running simultaneously	253.2	57.2	35.1	11.6	39.9	4.4	1.5	2.3	1.2	0.3
Background	1.5	0.4	41.7	8.9	3.7	1.7	0.4	14.7	17.7	7.3
Total	255	58	77	20	44	6.1	1.9	16.9	19	7.7
NAAQS	40,000	10,000	188	100	196	365	78	150	35	12
Percentage of standard	0.6%	0.6%	41%	20%	22%	2%	2.4%	11%	54%	64%

H1H: high–1st-high
H4H: high–4th-high
H6H: high–6th-high
H8H: high–8th-high
µg/m³: micrograms per cubic meter

Table 10. Iteration 2: Renovate Existing Dewatering Building

	Boiler stack heights are above existing DWB rooftop; flare is at ground level south of thickening/dewatering									
	CO	CO	NO_2	NO_2	SO_2	SO_2	SO_2	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
	1 hr	8 hr	1 hr	Annual	1 hr	24 hr	Annual	24 hr	24-hr	Annual
	H1H	H1H	H8H	Max	H4H	H1H	Max	H6H	H8H	Max
	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Flare	47.2	40.9	47.0	7.7	0.0	0.0	0.0	2.9	2.4	0.6
Boilers	63.7	34.7	8.4	0.2	8.2	1.8	0.2	0.6	0.4	0.0
Diesel generators	250.9	31.4	26.9	10.9	39.9	2.1	1.5	1.9	0.3	0.0
OCB boiler	16.6	7.7	14.5	0.4	0.4	0.1	0.0	1.3	0.9	0.2
NMB boiler	29.5	15.9	6.2	0.4	0.2	0.1	0.0	0.8	0.7	0.2
All units together running simultaneously	253.2	57.9	47.7	11.5	39.9	3.1	1.5	3.1	2.7	0.7
Background	1.5	0.4	41.7	8.9	3.7	1.7	0.4	14.7	17.7	7.3
Total all	255	58	89	20	44	4.8	1.9	17.8	20	8.0
NAAQS	40,000	10,000	188	100	196	365	78	150	35	12
Percentage of standard	0.6%	0.6%	48%	20%	22%	1%	2.4%	12%	58%	67%

H1H: high–1st-high
H4H: high–4th-high
H6H: high–6th-high
H8H: high–8th-high
µg/m3: micrograms per cubic meter

Appendix A Emission Calculations

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Arllington County
Biosolids Gas Utilization - SA2
Current Facility PTE Calculation

All values in tons per year

Pollutant	Existing Faclity		Post-Project Total	NSR Major Source Threshold	NSR Major?	Title V Major Source Threshold	Title V Major?
	Engines [1]	Other [2]					
PM	7.7	0.3	8.0	250	NO	100	NO
PM_{10}	7.7	0.3	8.0	250	NO	100	NO
$PM_{2.5}$	7.7	0.3	8.0	250	NO	100	NO
NO_x	23.1	3.2	26.3	100	NO	100	NO
SO_2	6.1	0.02	6.1	250	NO	100	NO
CO	31.2	1.37	32.6	250	NO	100	NO
VOC	3.9	0.2	4.1	50	NO	50	NO
CO_2e [3]	59,748	4,086	63,834			100,000	NO

[1] With the exception of CO_2e, values obtained from facility registration number 70026 dated October 30, 2009 (amended July 2, 2012). CO2e emissions were estimated based on permitted engine limites and GHG emission factors obtained from 40 CFR Part 98.

Arllington County
Biosolids Gas Utilization - SA2
Post-Project PTE Calculation

All values in tons per year

Pollutant	Project			Existing Faclity		Post-Project Total	Title V Threshold	Title V Major?
	Boiler 1	Boiler 2	Flare	Engines [1]	Other [2]			
PM	0.12	0.12	1.23	7.7	0.10	9.3	100	NO
PM_{10}	0.48	0.48	1.23	7.7	0.10	10.0	100	NO
$PM_{2.5}$	0.48	0.48	1.23	7.7	0.10	10.0	100	NO
NO_x	6.31	6.31	5.18	23.1	1.19	42.1	100	NO
SO_2	0.04	0.04	3.3	6.1	0.008	9.5	100	NO
CO	5.30	5.30	22.9	31.2	0.51	65.2	100	NO
VOC	0.35	0.35	1.59	3.9	0.07	6.25	50	NO
CO_2e [3]	7,549	7,549	9,171	59,741	1,527	85,537	100,000	NO

[1] With the exception of CO_2e, values obtained from facility registration number 70026 dated October 30, 2009 (amended July 2, 2012). CO2e emissions were estimated based on permitted engine limites and GHG emission factors obtained from 40 CFR Part 98.

[2] Reflects decommissioning of the Kewanee L3W-150G-LE boiler located in the Dewatering Building.

Arllington County
Biosolids Gas Utilization - SA2
Project PTE Calculation

All values in tons per year

Pollutant	Boiler 1	Boiler 2	Flare	Project Total	NSR/PSD Threshold	PSD/NSR Major?	VDEQ Minor NSR Threshold	Minor NSR Triggered?
PM	0.12	0.12	1.23	1.47	250	NO	15	NO
PM_{10}	0.48	0.48	1.23	2.19	250	NO	10	NO
$PM_{2.5}$	0.48	0.48	1.23	2.19	250	NO	6	NO
NO_x	6.31	6.31	5.18	17.8	100	NO	10	YES
SO_2	0.04	0.04	3.3	3.4	250	NO	10	NO
CO	5.30	5.30	22.9	33.5	250	NO	100	NO
VOC	0.35	0.35	1.59	2.28	50	NO	10	NO
CO_2e	7,549	7,549	9,171	24,269				

Arllington County
Biosolids Gas Utilization - SA2
Boilers
PTE Calculation

Manufacturer:	Hurst	350 BHP, Series 300
Fuel:	Natural Gas/Digester Gas	
Digester Gas Heat Content:	580	Btu/cf (Design basis)
Heat Input Rating:	14.70	MMBtu/hr
Design Digester Gas Usage:	422	scfm (Calculated)
Annual Operating Hours:	8,760	

		Natural Gas				
		Emission Factor			PTE	
Pollutant	CAS	Value	Units	Source	lb/hr	ton/yr
PM [1]		0.002	lb/MMBtu	A	0.03	0.12
PM_{10} [2]		0.007	lb/MMBtu	A	0.11	0.48
$PM_{2.5}$ [2]		0.007	lb/MMBtu	A	0.11	0.48
NO_x	10102-44-0	0.10	lb/MMBtu	A	1.44	6.31
SO_2	7446-09-5	0.0006	lb/MMBtu	A	0.009	0.04
CO	630-08-0	0.08	lb/MMBtu	A	1.21	5.30
VOC		0.005	lb/MMBtu	A	0.08	0.35
CO_2e					1,721	7,539
CO_2					1,720	7,532
Combustion		53.06	kg/MMBtu	B	1,720	7,532
Pass Through						
N_2O	10024-97-2	0.0001	kg/MMBtu	B	0.003	0.01
CH_4	74-82-8	0.001	kg/MMBtu	B	0.03	0.14
Hydrogen Sulfide	7783-06-4					
Lead	7439-92-1	4.90E-07	lb/MMBtu	A	7.21E-06	3.16E-05
Arsenic	7440-38-2	2.0E-07	lb/MMBtu	A	2.88E-06	1.26E-05
Benzene	71-43-2	2.1E-06	lb/MMBtu	A	3.03E-05	1.33E-04
Beryllium	7440-41-7	<1.2E-08	lb/MMBtu	A	1.73E-07	7.57E-07
Cadmium	7440-43-9	1.1E-06	lb/MMBtu	A	1.59E-05	6.94E-05
Chromium	7440-47-3	1.4E-06	lb/MMBtu	A	2.02E-05	8.84E-05
Cobalt	7440-48-4	8.2E-08	lb/MMBtu	A	1.21E-06	5.30E-06
Formaldehyde	50-00-0	7.4E-05	lb/MMBtu	A	1.08E-03	4.73E-03
Hexane	110-54-3	1.8E-03	lb/MMBtu	A	2.59E-02	1.14E-01
Manganese	7439-96-5	3.7E-07	lb/MMBtu	A	5.48E-06	2.40E-05
Mercury	7439-97-6	2.5E-07	lb/MMBtu	A	3.75E-06	1.64E-05
Naphthalene	91-20-3	6.0E-07	lb/MMBtu	A	8.79E-06	3.85E-05
Nickel	7440-02-0	2.1E-06	lb/MMBtu	A	3.03E-05	1.33E-04
POM	Sum of individual POM				1.01E-05	4.41E-05
2-Methylnaphthalene	91-57-6	2.4E-08	lb/MMBtu	A	3.46E-07	1.51E-06
3-Methylchloranthrene	56-49-5	<1.8E-09	lb/MMBtu	A	2.59E-08	1.14E-07
7,12-Dimethylbenz(a)anthracene	57-97-6	<1.6E-08	lb/MMBtu	A	2.31E-07	1.01E-06
Acenaphthene	83-32-9	<1.8E-09	lb/MMBtu	A	2.59E-08	1.14E-07
Acenaphthylene	208-96-8	<1.8E-09	lb/MMBtu	A	2.59E-08	1.14E-07
Anthracene	120-12-7	<2.4E-09	lb/MMBtu	A	3.46E-08	1.51E-07
Benz(a)anthracene	56-55-3	<1.8E-09	lb/MMBtu	A	2.59E-08	1.14E-07
Benzo(a)pyrene	50-32-8	<1.2E-09	lb/MMBtu	A	1.73E-08	7.57E-08
Benzo(b)fluoranthene	205-99-2	<1.8E-09	lb/MMBtu	A	2.59E-08	1.14E-07
Benzo(g,h,i)perylene	191-24-2	<1.2E-09	lb/MMBtu	A	1.73E-08	7.57E-08
Benzo(k)fluoranthene	207-08-9	<1.8E-09	lb/MMBtu	A	2.59E-08	1.14E-07
Chrysene	218-01-9	<1.8E-09	lb/MMBtu	A	2.59E-08	1.14E-07
Dibenzo(a,h)anthracene	53-70-3	<1.2E-09	lb/MMBtu	A	1.73E-08	7.57E-08
Fluoranthene	206-44-0	2.9E-09	lb/MMBtu	A	4.32E-08	1.89E-07
Fluorene	86-73-7	2.7E-09	lb/MMBtu	A	4.04E-08	1.77E-07
Indeno(1,2,3-cd)pyrene	193-39-5	<1.8E-09	lb/MMBtu	A	2.59E-08	1.14E-07
Phenanathrene	85-01-8	1.7E-08	lb/MMBtu	A	2.45E-07	1.07E-06
Pyrene	129-00-0	4.9E-09	lb/MMBtu	A	7.21E-08	3.16E-07
Selenium	7782-49-2	<2.4E-08	lb/MMBtu	A	3.46E-07	1.51E-06
Toluene	108-88-3	3.3E-06	lb/MMBtu	A	4.90E-05	2.15E-04
Total HAP	Sum of Individual HAP				0.0272	0.1191

[1] Includes filterable particulate matter only.
[2] Includes both filterable and condensable particulate matter.

NOTES:
A - Fifth Edition AP-42, Section 1.4 (7/98).
B - See H_2S, SO_2 and CO_2 Emission Factors tab.
C - 40 CFR pt. 98 - Mandatory Greenhouse Gas Reporting, Table C -1 and C -2, reflecting the update effective January 1, 2014.

Greenhouse Gas	GWP
CO_2	1
N_2O	298
CH_4	25

Description:	Flare	Varec 244E
	500	cfm (Anaerobic digester system design)
Maximum Design Digester Gas Flow:	30,000	ft^3/hr (Calculated)
	16,500	ft^3 methane/hr (assume 55% methane)
Digester Gas Heat Content:	580	Btu/cf (Design basis)
Digester Gas Heat Input:	17.4	MMBtu/hr (Calculated)
Annual Hours of Operation:	8,760	hr/yr

		Emission Factor			Potential Emissions	
Pollutant	**CAS**	Number	Units	Source	lb/hr	ton/yr
PM		17	lb/MMft^3 methane	A	0.28	1.23
PM_{10}		17	lb/MMft^3 methane	A	0.28	1.23
$PM_{2.5}$		17	lb/MMft^3 methane	A	0.28	1.23
NO_x	10102-44-0	0.068	lb/MMBtu	B	1.18	5.18
SO_2	7446-09-5	2.53E-05	lb/ft^3 gas	C	0.76	3.3
CO	630-08-0	0.30	lb/MMBtu	B	5.22	22.9
VOC		12.10	lb/MMft^3 gas	D	0.36	1.59
CO_2e					2,094	9,171
CO_2					2,084	9,126
Combustion		52.07	kg/MMBtu	E	1,997	8,749
Pass Through		5.22E-03	lb/dcf	C	86	377
N_2O	10024-97-2	6.3E-04	kg/MMBtu	E	0.02	0.11
CH_4	74-82-8	3.2E-03	kg/MMBtu	E	0.12	0.54
Hydrogen Sulfide	7783-06-4	2.69E-07	lb/dcf	C	0.008	0.04
Lead	7439-92-1	0.0005	lb/MMft^3 gas	F	0.0000	0.0001
Arsenic	7440-38-2	2.0E-04	lb/MMft^3 gas	F	0.0000	0.0000
Benzene	71-43-2	2.1E-03	lb/MMft^3 gas	F	0.0001	0.0003
Beryllium	7440-41-7	<1.2E-05	lb/MMft^3 gas	F	0.0000	0.0000
Cadmium	7440-43-9	1.1E-03	lb/MMft^3 gas	F	0.0000	0.0001
Chromium	7440-47-3	1.4E-03	lb/MMft^3 gas	F	0.0000	0.0002
Cobalt	7440-48-4	8.4E-05	lb/MMft^3 gas	F	0.0000	0.0000
Formaldehyde	50-00-0	7.5E-02	lb/MMft^3 gas	F	0.0023	0.0099
Hexane	110-54-3	1.8E+00	lb/MMft^3 gas	F	0.0540	0.2365
Manganese	7439-96-5	3.8E-04	lb/MMft^3 gas	F	0.0000	0.0000
Mercury	7439-97-6	2.6E-04	lb/MMft^3 gas	F	0.0000	0.0000
Naphthalene	91-20-3	6.1E-04	lb/MMft^3 gas	F	0.0000	0.0001
Nickel	7440-02-0	2.1E-03	lb/MMft^3 gas	F	0.0001	0.0003
POM	Sum of individual POM				0.0000	0.0001
2-Methylnaphthalene	91-57-6	2.4E-05	lb/MMft^3 gas	F	0.0000	0.0000
3-Methylchloranthrene	56-49-5	<1.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
7,12-Dimethylbenz(a)anthracene	57-97-6	<1.6E-05	lb/MMft^3 gas	F	0.0000	0.0000
Acenaphthene	83-32-9	<1.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
Acenaphthylene	208-96-8	<1.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
Anthracene	120-12-7	<2.4E-06	lb/MMft^3 gas	F	0.0000	0.0000
Benz(a)anthracene	56-55-3	<1.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
Benzo(a)pyrene	50-32-8	<1.2E-06	lb/MMft^3 gas	F	0.0000	0.0000
Benzo(b)fluoranthene	205-99-2	<1.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
Benzo(g,h,i)perylene	191-24-2	<1.2E-06	lb/MMft^3 gas	F	0.0000	0.0000
Benzo(k)fluoranthene	207-08-9	<1.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
Chrysene	218-01-9	<1.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
Dibenzo(a,h)anthracene	53-70-3	<1.2E-06	lb/MMft^3 gas	F	0.0000	0.0000
Fluoranthene	206-44-0	3.0E-06	lb/MMft^3 gas	F	0.0000	0.0000
Fluorene	86-73-7	2.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
Indeno(1,2,3-cd)pyrene	193-39-5	<1.8E-06	lb/MMft^3 gas	F	0.0000	0.0000
Phenanathrene	85-01-8	1.7E-05	lb/MMft^3 gas	F	0.0000	0.0000
Pyrene	129-00-0	5.0E-06	lb/MMft^3 gas	F	0.0000	0.0000
Selenium	7782-49-2	<2.4E-05	lb/MMft^3 gas	F	0.0000	0.0000
Toluene	108-88-3	3.4E-03	lb/MMft^3 gas	F	0.0001	0.0004
Total HAP	Sum of Individual HAP				0.0566	0.2480

A - Obtained from Fifth Edition AP-42, Table 2.4-5.

B - Vendor guarantee.

C - See H_2S, SO_2 and CO_2 Emission Factors tab.

D - SDAPCD emission factors for biogas flares, accessed at http://www.sdapcd.org/content/dam/sdc/apcd/PDF/Misc/EFT/Gas_Combustion/APCD_Flares_Digester_Gas_Fired_Enclosed.pdf in November 2017.

E - 40 CFR pt. 98 - Mandatory Greenhouse Gas Reporting, Table C -1 and C -2, reflecting the update effective January 1, 2014, corresponding to Biomass Fuels - Gaseous.

Greenhouse Gas	GWP
CO_2	1
N_2O	298
CH_4	25

F - Fifth Edition AP-42, Section 1.4 (7/98).

Arllington County
Biosolids Gas Utilization - SA2
Digester Gas H_2S, SO_2 and CO_2 Emission Factors

Gas Law Inputs & Conversions

Pressure	1	atmosphere
Temperature	60	F =
Gas Constant	0.08206	lit-atm/mol deg K
Mol. Wt. H_2S	34.0819	grams/mol
Mol. Wt. SO_2	64.0628	grams/mol
Mol. Wt. CO_2	44.01	grams/mol
1 ft^3 =	28.316	liters
1 lb=	453.6	grams

$$m = \frac{p * V * MW}{R * T}$$

	H_2S Concentration (ppm)	H_2S Emission Factor (lb/dcf) ***	SO_2 Emission Factor (lb/dcf)
Raw Digester Gas	150 *	2.69E-07	2.53E-05
Treated Digester Gas	15 **	2.69E-08	2.53E-06

	CO_2 Concentration (ppm)	CO_2 Emission Factor (lb/dcf)
Digester Gas	45,000 ****	5.22E-03

* Design basis.

** Design basis achieved using an iron sponge.

*** Assumes a minimum of 98% of the H_2S is converted to SO_2 during combustion.

**** Assumes 55% of the biogas is methane and the remainder is CO_2.

Arllington County
Biosolids Gas Utilization - SA2
Air Toxics Ambient Impact Evaluation [a]

lb/hr

TAP	CAS	Boiler 1		Boiler 2		Flare		Facility Total		Exemption Emission Rate *		Further Review?	
		lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Arsenic	7440-38-2	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.000	0.0132	0.029	NO	NO
Benzene	71-43-2	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.00	2.112	4.64	NO	NO
Beryllium	7440-41-7	0.00	0.00	0.00	0.00	0.00	0.00	0.000001	0.00000	0.000132	0.00029	NO	NO
Cadmium	7440-43-9	0.00	0.00	0.00	0.00	0.00	0.00	0.0001	0.00028	0.0033	0.00725	NO	NO
Chromium	7440-47-3	0.00	0.00	0.00	0.00	0.00	0.00	0.0001	0.00036	0.0033	0.00725	NO	NO
Cobalt	7440-48-4	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00002	0.0033	0.00725	NO	NO
Formaldehyde	50-00-0	0.00	0.00	0.00	0.00	0.00	0.01	0.0044	0.019	0.0825	0.174	NO	NO
Hexane	110-54-3	0.03	0.11	0.03	0.11	0.05	0.24	0.106	0.46	11.616	25.52	NO	NO
Lead	7439-92-1	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00013	0.0099	0.02175	NO	NO
Manganese	7439-96-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.33	0.725	NO	NO
Mercury	7439-97-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00002	0.00007	0.00066	0.00145	NO	NO
Methanol	67-56-1							0.000	0.00	10.824	37.99	NO	NO
Naphthalene	91-20-3	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.00	2.607	7.54	NO	NO
Nickel	7440-02-0	0.00	0.00	0.00	0.00	0.00	0.00	0.0001	0.0005	0.0066	0.0145	NO	NO
POM		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Selenium	7782-49-2	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0000	0.0132	0.0290	NO	NO
Toluene	108-88-3	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.001	18.645	54.665	NO	NO

* Obtained from VDEQ document titled "VDEQ Toxics_Spreadsheet.xlsx", accessed at https://www.deq.virginia.gov/home/showpublisheddocument/5546/637516769161600000 in July 2021.

Arllington County
Biosolids Gas Utilization - SA2
Existing Equipment Emission Rates

Emission Source	Short-term Emission Rates (g/s) NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	Emission Rate Basis
Diesel Generator A	0.75	0.81	0.16	0.2	0.2	0.1	Permit Limits
Diesel Generator B	0.75	0.81	0.16	0.2	0.2	0.1	Permit Limits
Diesel Generator C	0.75	0.81	0.16	0.2	0.2	0.1	Permit Limits
Operations Control Building (OCB) Boiler[1]	0.0189	0.0151	0.000371	0.00469	0.00469	0.0034	CO, SOx, PM and VOC from AP-42 emission factors;(1) based on maximum rated heat input capacity; 20 ppm low NOx burner, emission rate calculated for NOx
New Maintenance Building (NMB) Boiler[1]	0.00612	0.0208	0.000148	0.00188	0.00188	0.00136	CO, SOx, PM and VOC from AP-42 emission factors;(1) based on maximum rated heat input capacity; 20 ppm low NOx burner, emission rate calculated for NOx

Emission Source	Long-term Emission Rates (g/s) NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	Emission Rate Basis
Diesel Generator A	0.75	0.36	0.08	0.1	0.1	0.05	2016 Emissions Inventory worst-case for each generator
Diesel Generator B	0.75	0.36	0.08	0.1	0.1	0.05	2016 Emissions Inventory
Diesel Generator C	0.75	0.36	0.08	0.1	0.1	0.05	2016 Emissions Inventory
Operations Control Building (OCB) Boiler[1]	0.0189	0.0151	0.000371	0.00469	0.00469	0.0034	2016 Emissions Inventory, AP-42 emission factors; 20ppm low NOx burner
New Maintenance Building (NMB) Boiler[1]	0.00612	0.0208	0.000148	0.00188	0.00188	0.00136	2016 Emissions Inventory, AP-42 emission factors; 20ppm low NOx burner

[1] Emission factors from U.S. EPA Compilation of Air Pollutant Emission Factors (AP-42). https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

Source: CDM Smith, 2017

Appendix B Isopleth Figures

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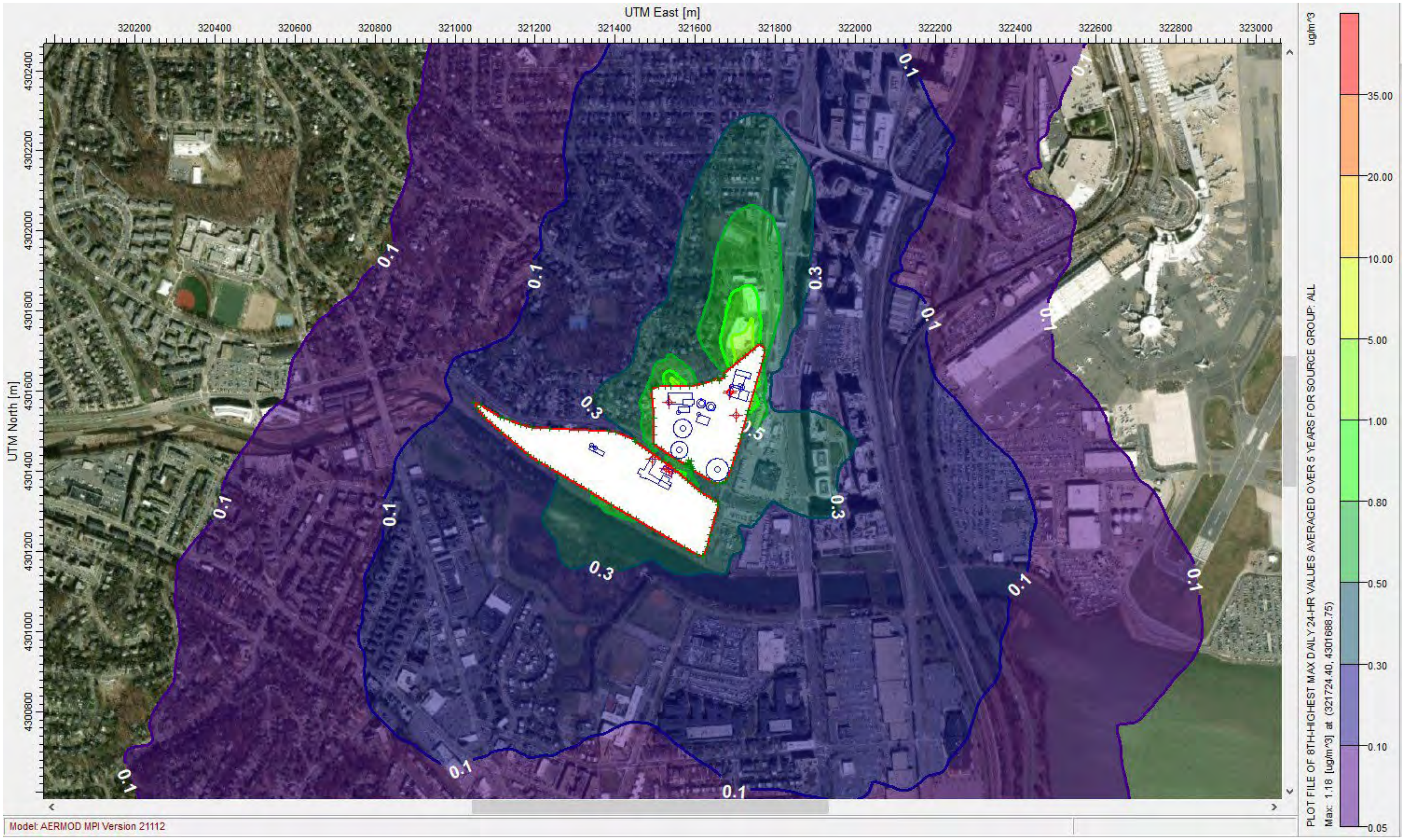
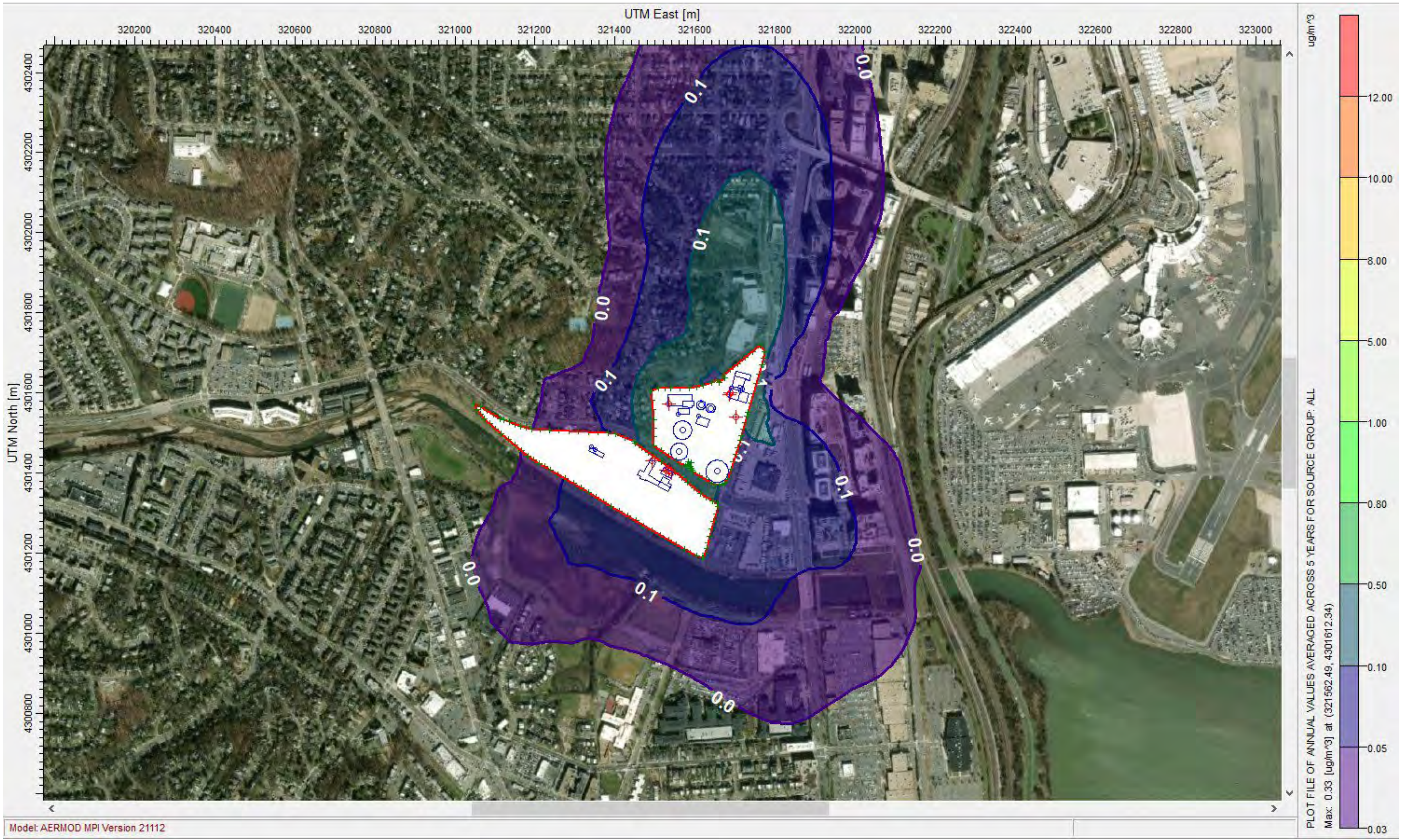
Iteration 1 – Decommission Existing Dewatering Building

PM2.5 24HR – All Sources



Iteration 1 – Decommission Existing Dewatering Building

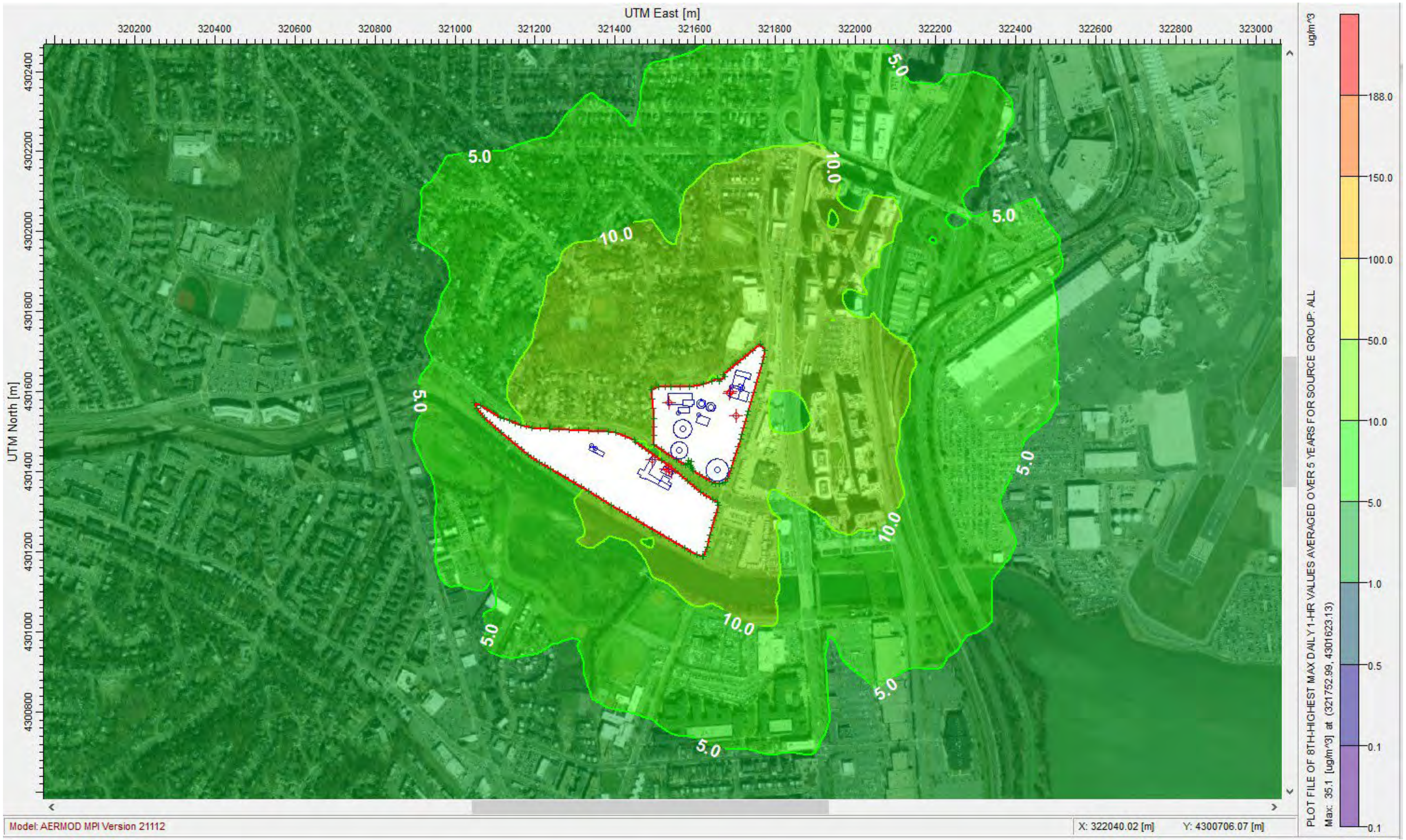
$PM_{2.5}$ Annual – All Sources



Appendix B – Isopleths

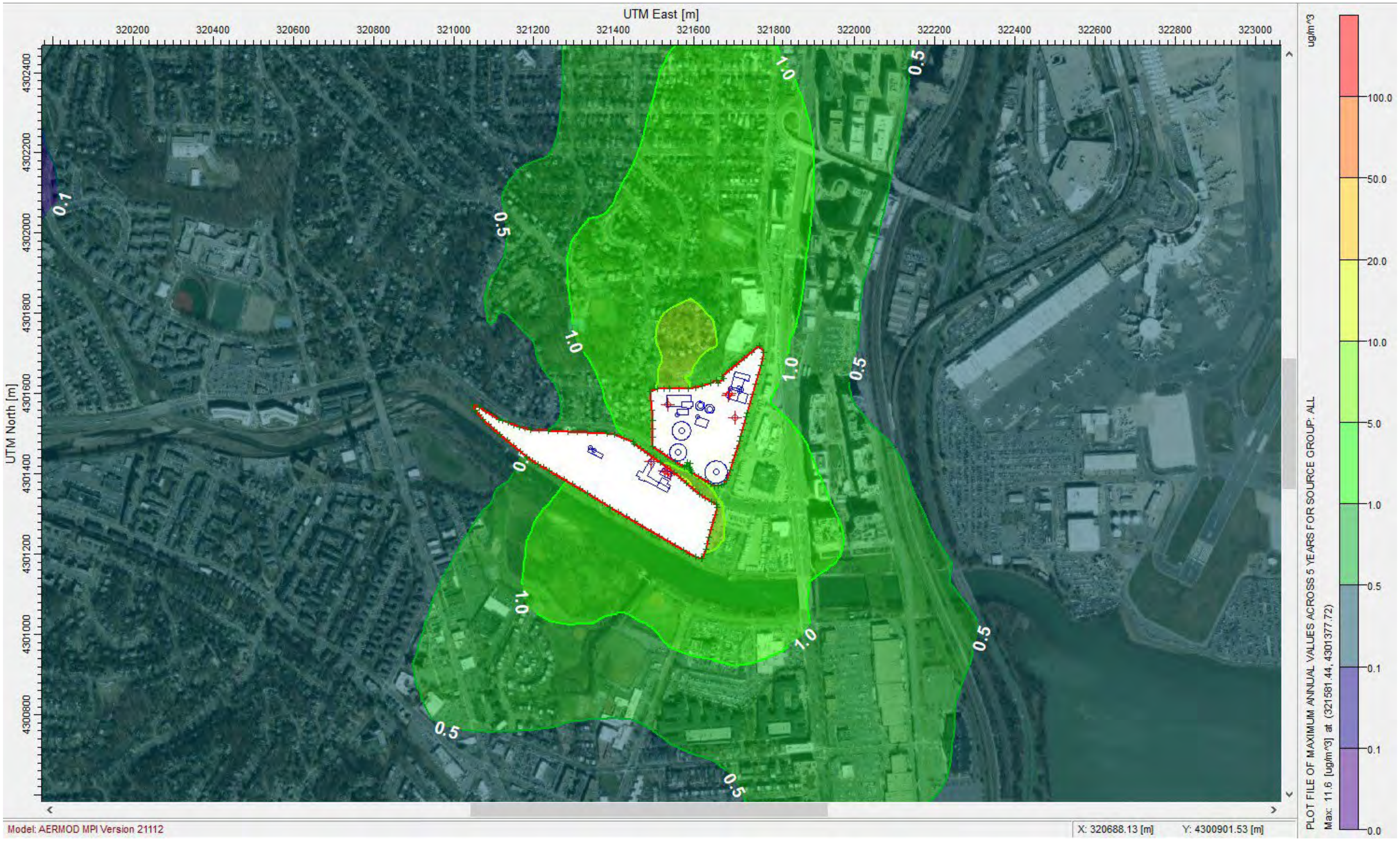
Iteration 1 – Decommission Existing Dewatering Building

NO$_2$ 1HR – All Sources



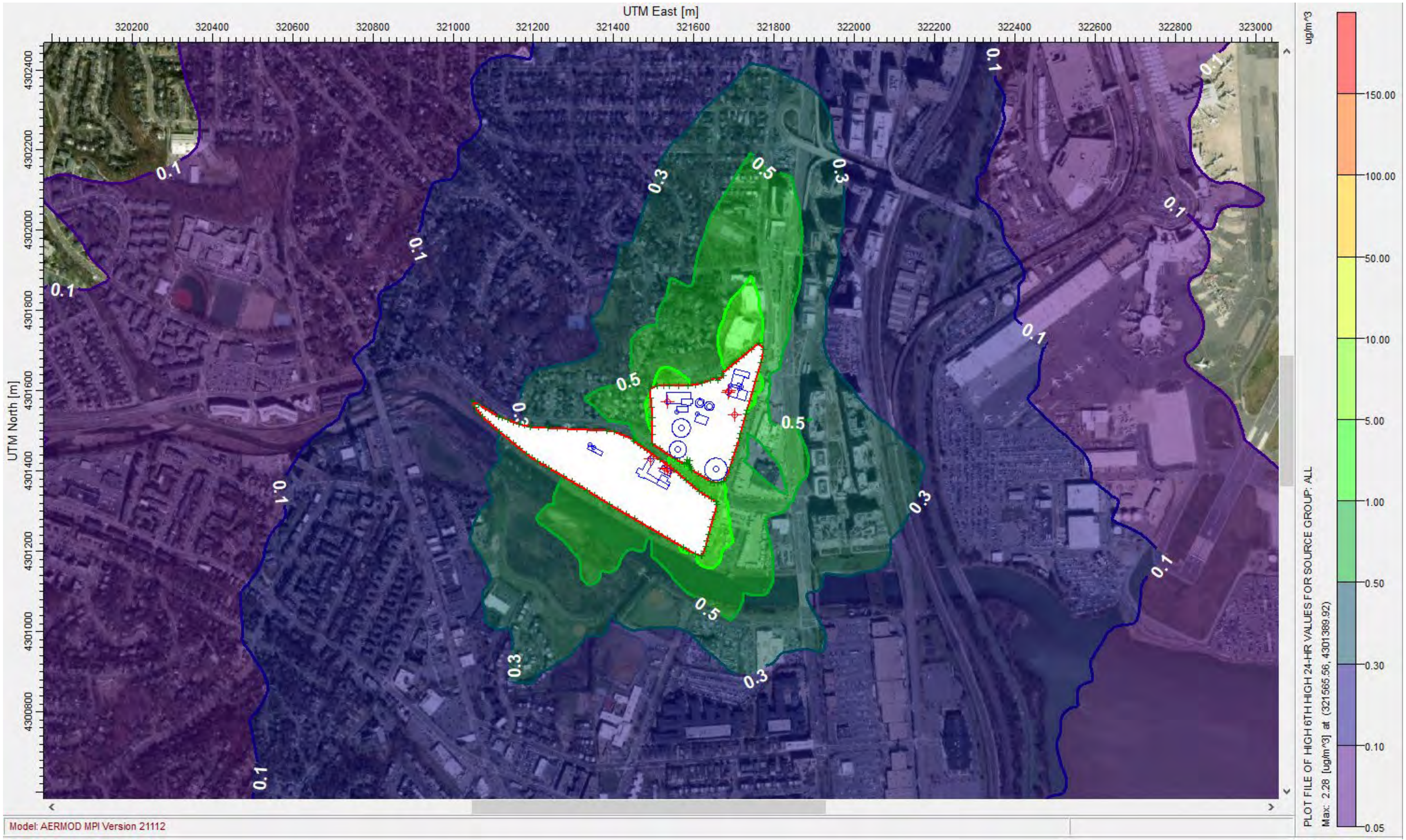
Iteration 1 – Decommission Existing Dewatering Building

NO_2 Annual – All Sources



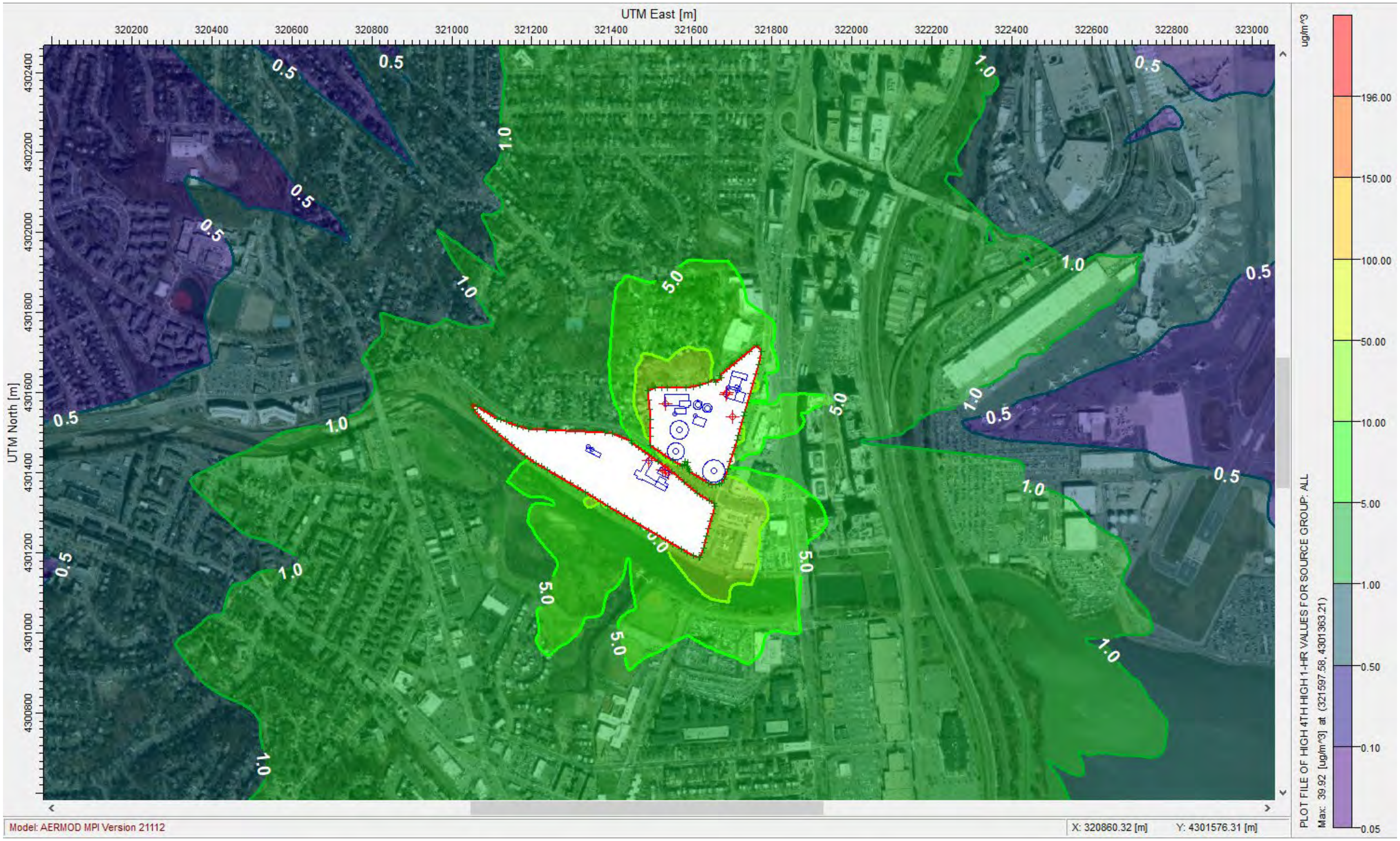
Iteration 1 – Decommission Existing Dewatering Building

PM10 24HR – All Sources



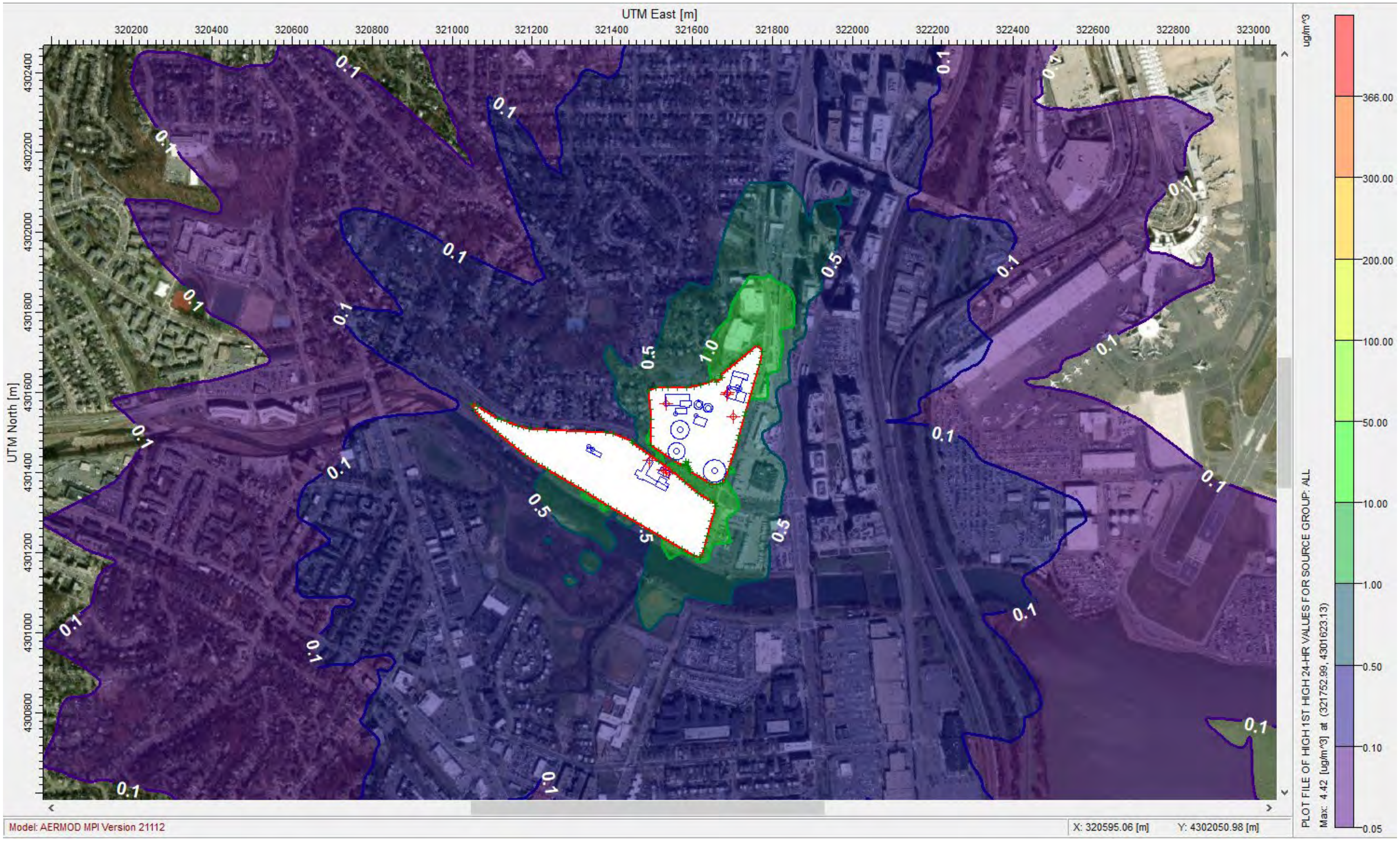
Iteration 1 – Decommission Existing Dewatering Building

SO_2 1HR – All Sources



Iteration 1 – Decommission Existing Dewatering Building

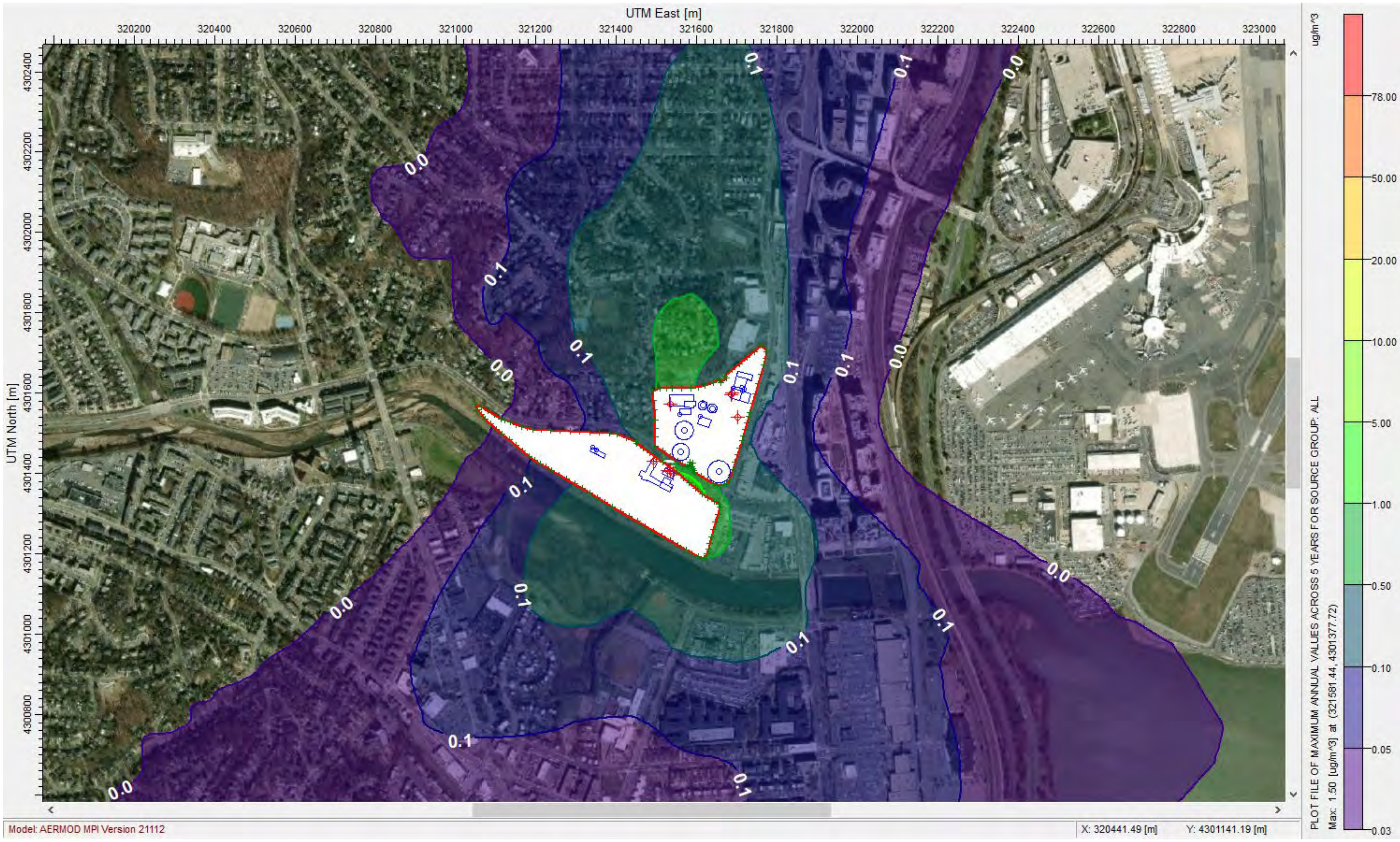
SO2 24HR – All Sources



Appendix B – Isopleths

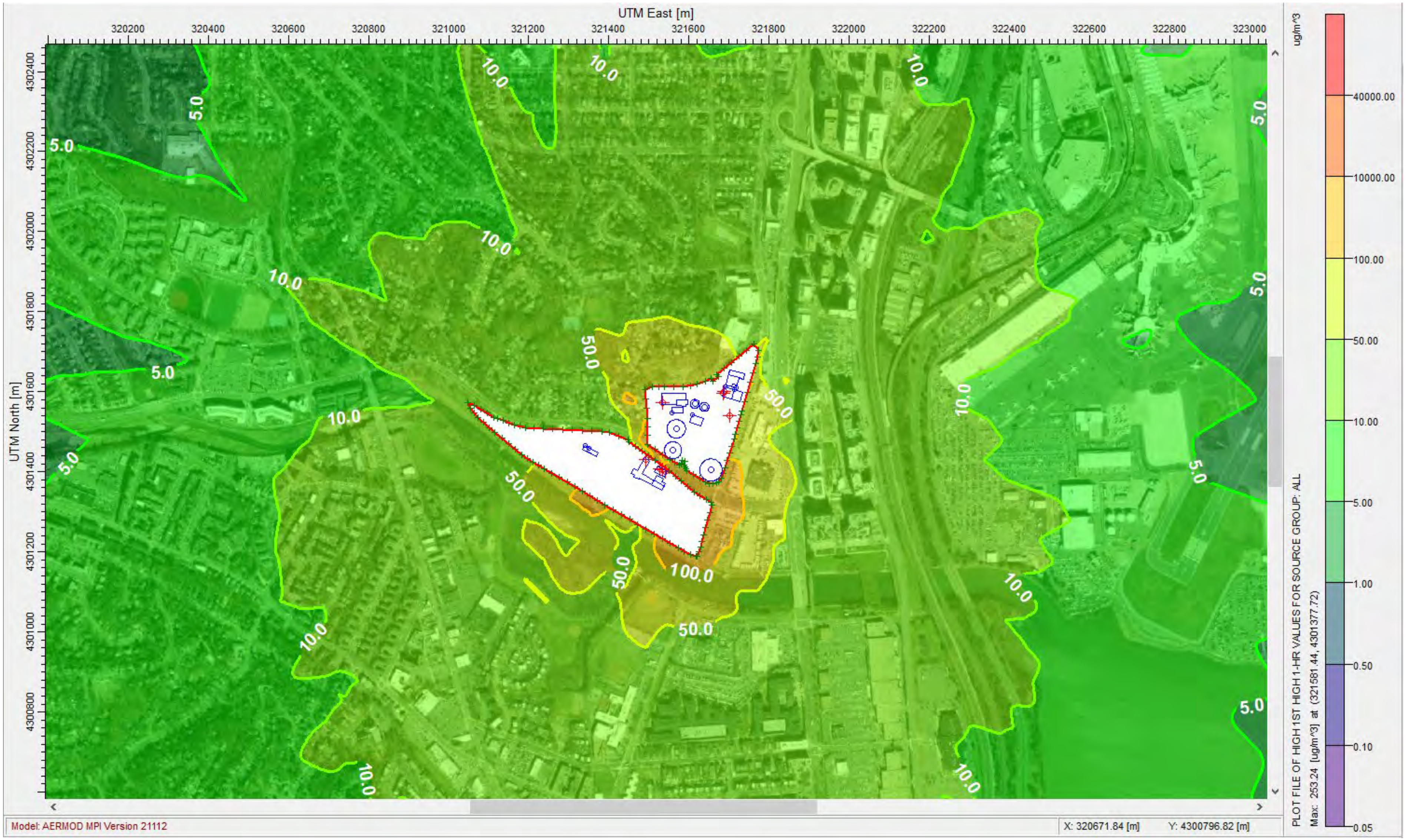
Iteration 1 – Decommission Existing Dewatering Building

SO₂ Annual – All Sources



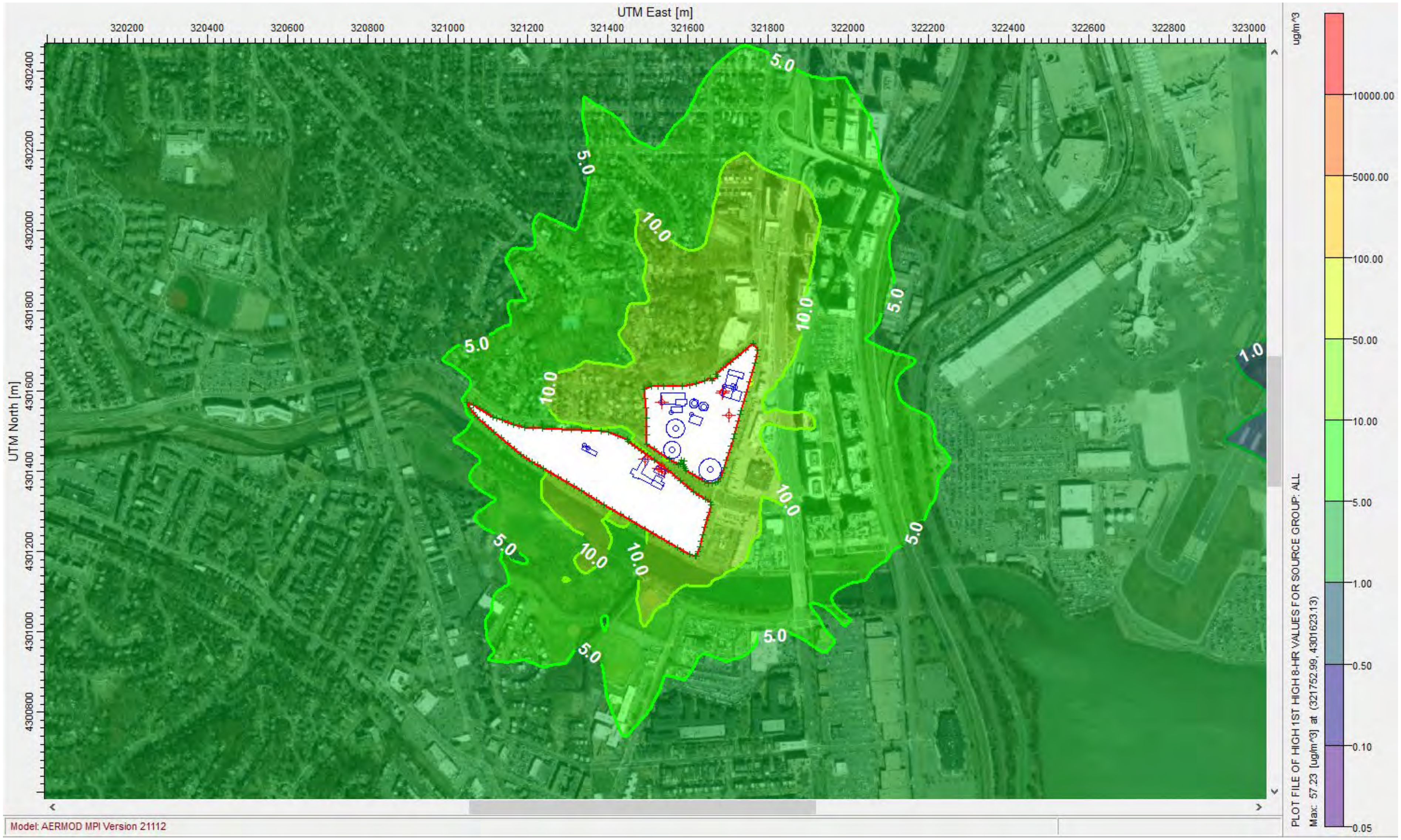
Iteration 1 – Decommission Existing Dewatering Building

CO 1HR – All Sources



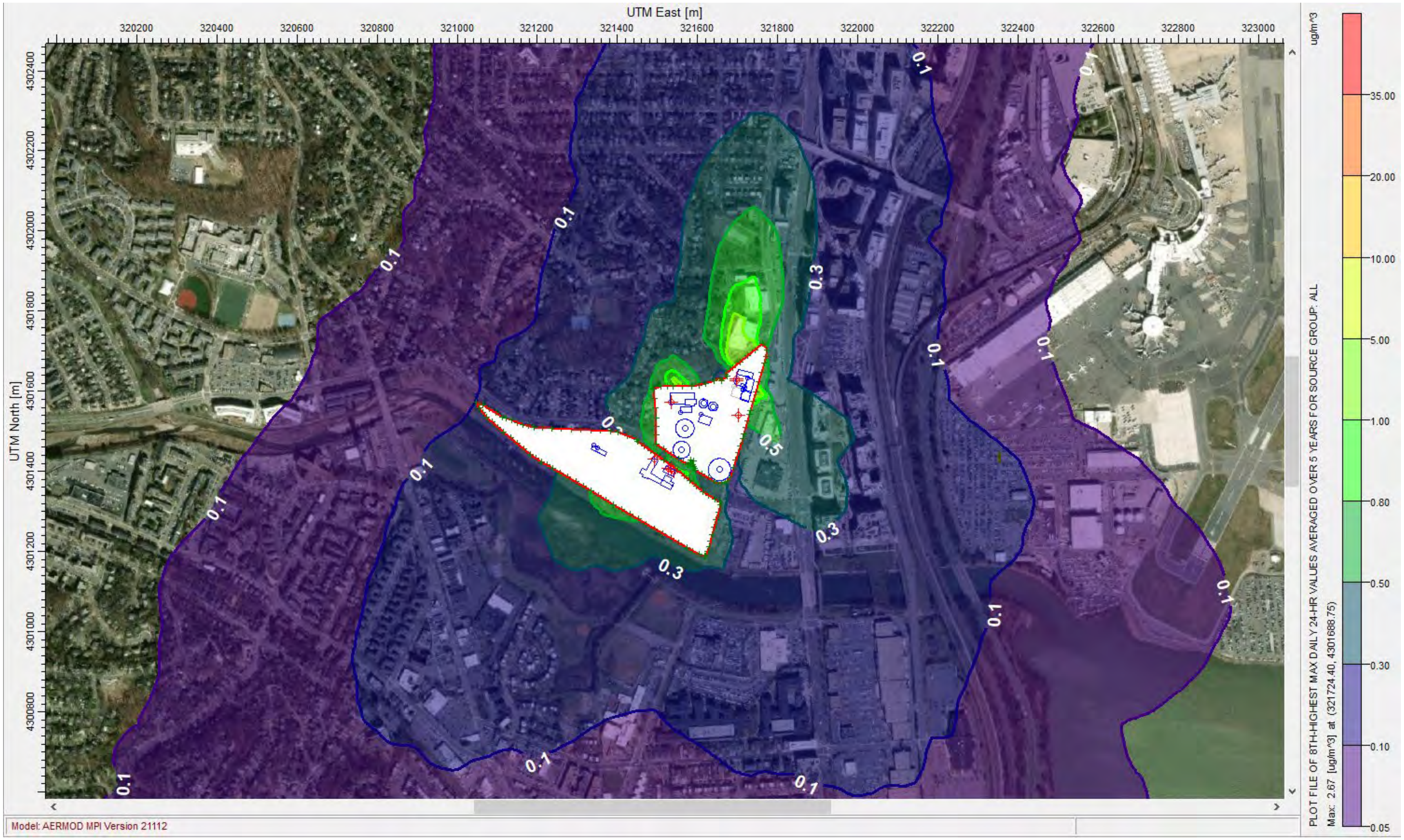
Iteration 1 – Decommission Existing Dewatering Building

CO 8HR – All Sources



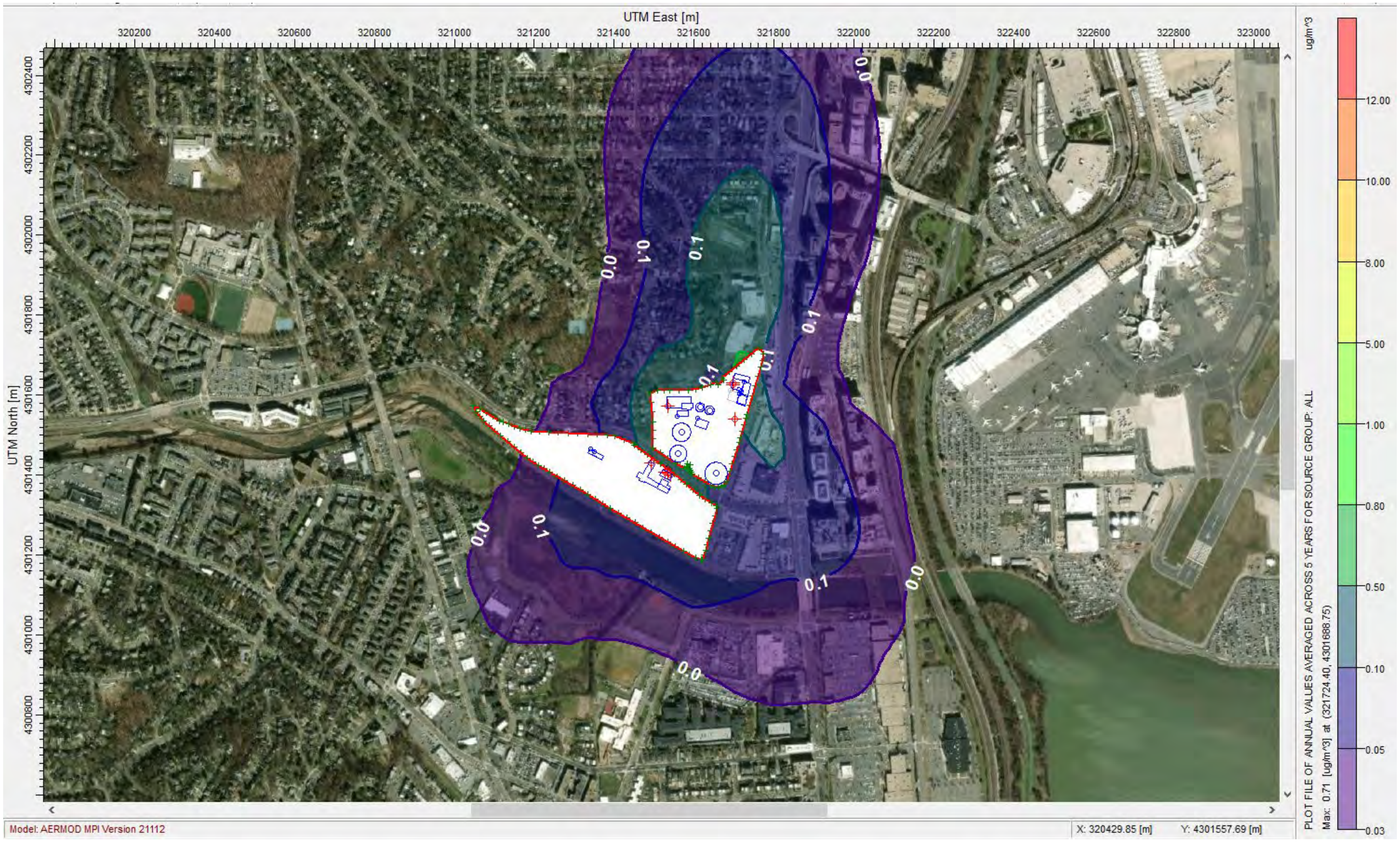
Iteration 2 – Renovate Existing Dewatering Building

PM2.5 24HR – All Sources



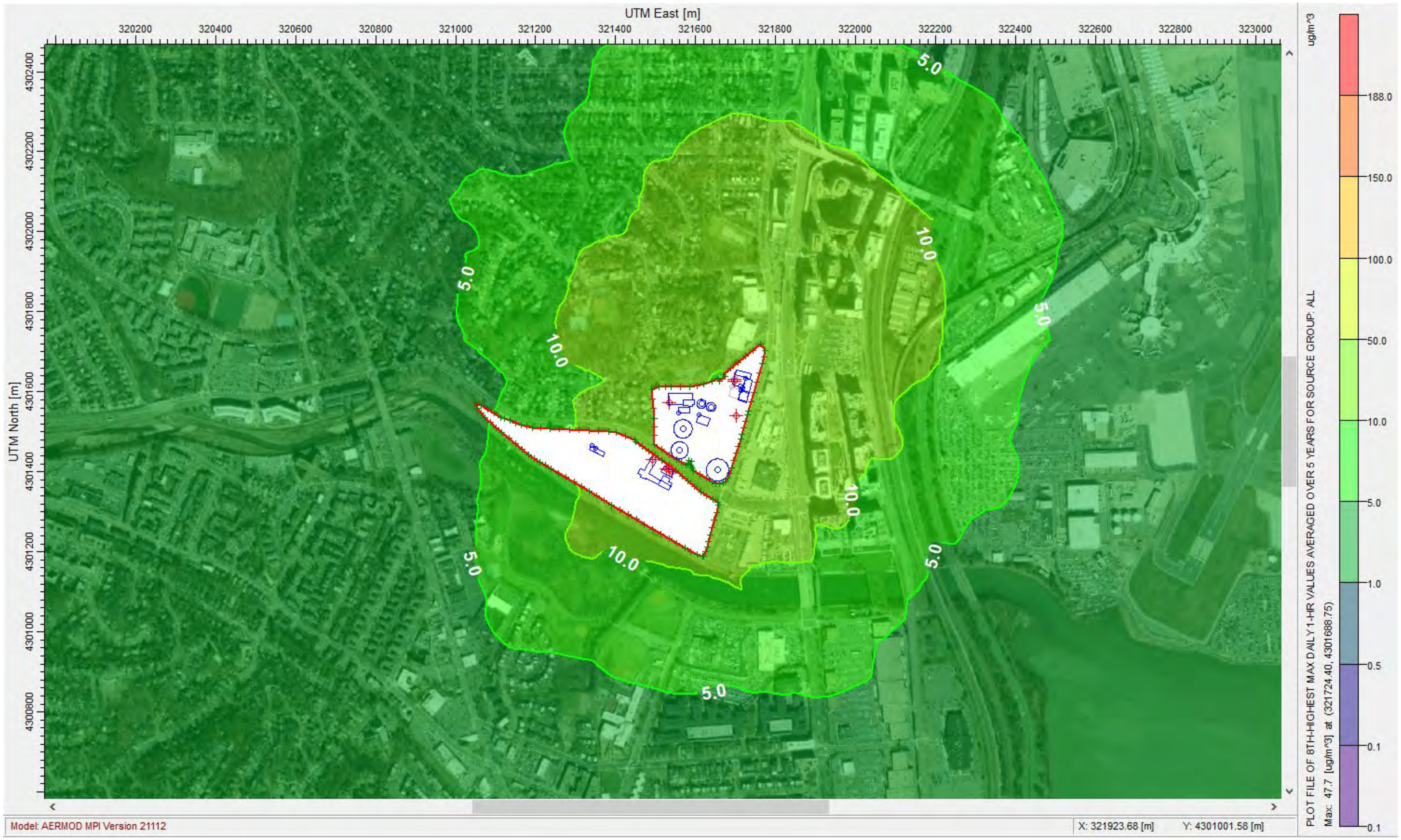
Iteration 2 – Renovate Existing Dewatering Building

PM2.5 Annual – All Sources



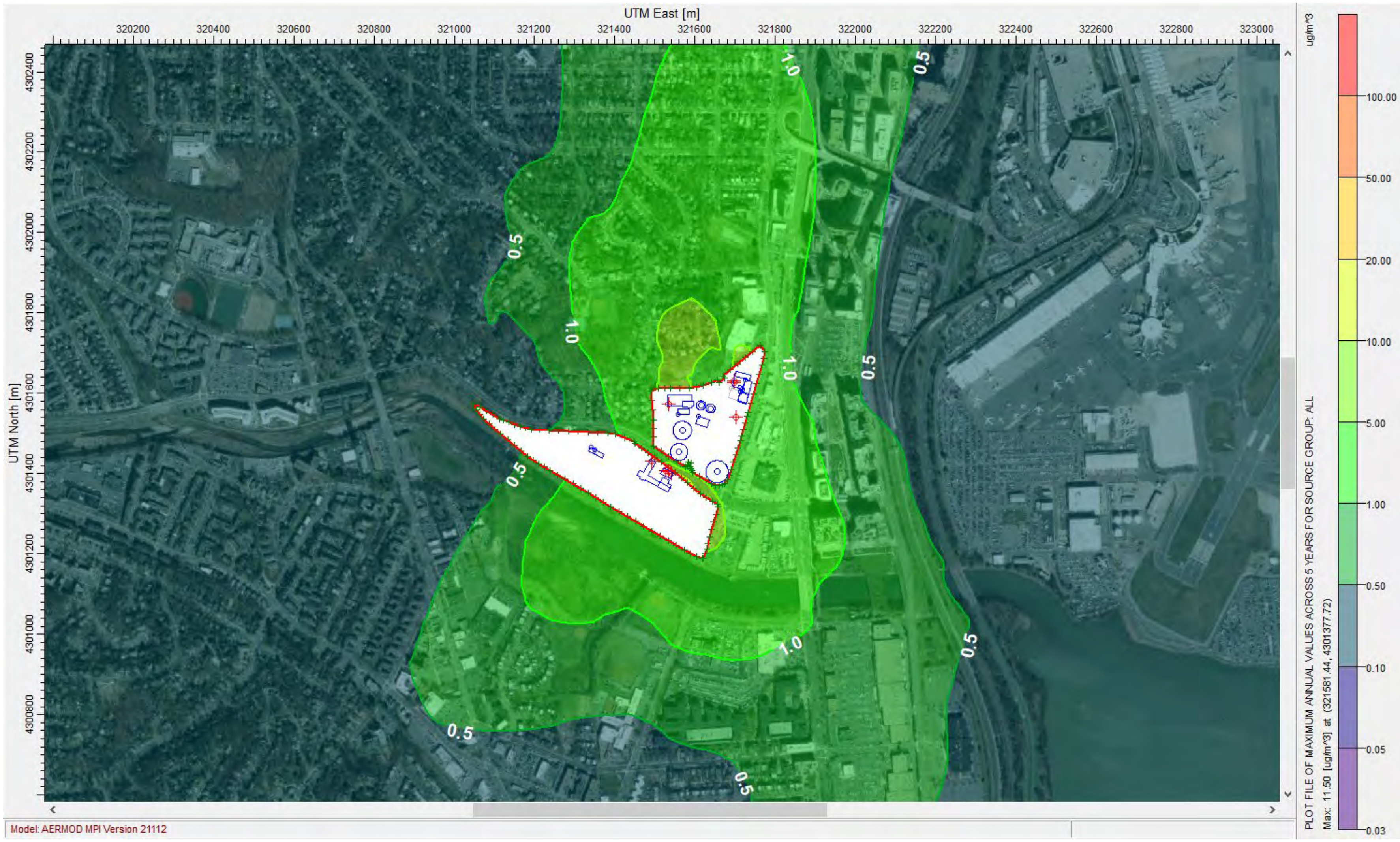
Iteration 2 – Renovate Existing Dewatering Building

NO_2 1HR – All Sources



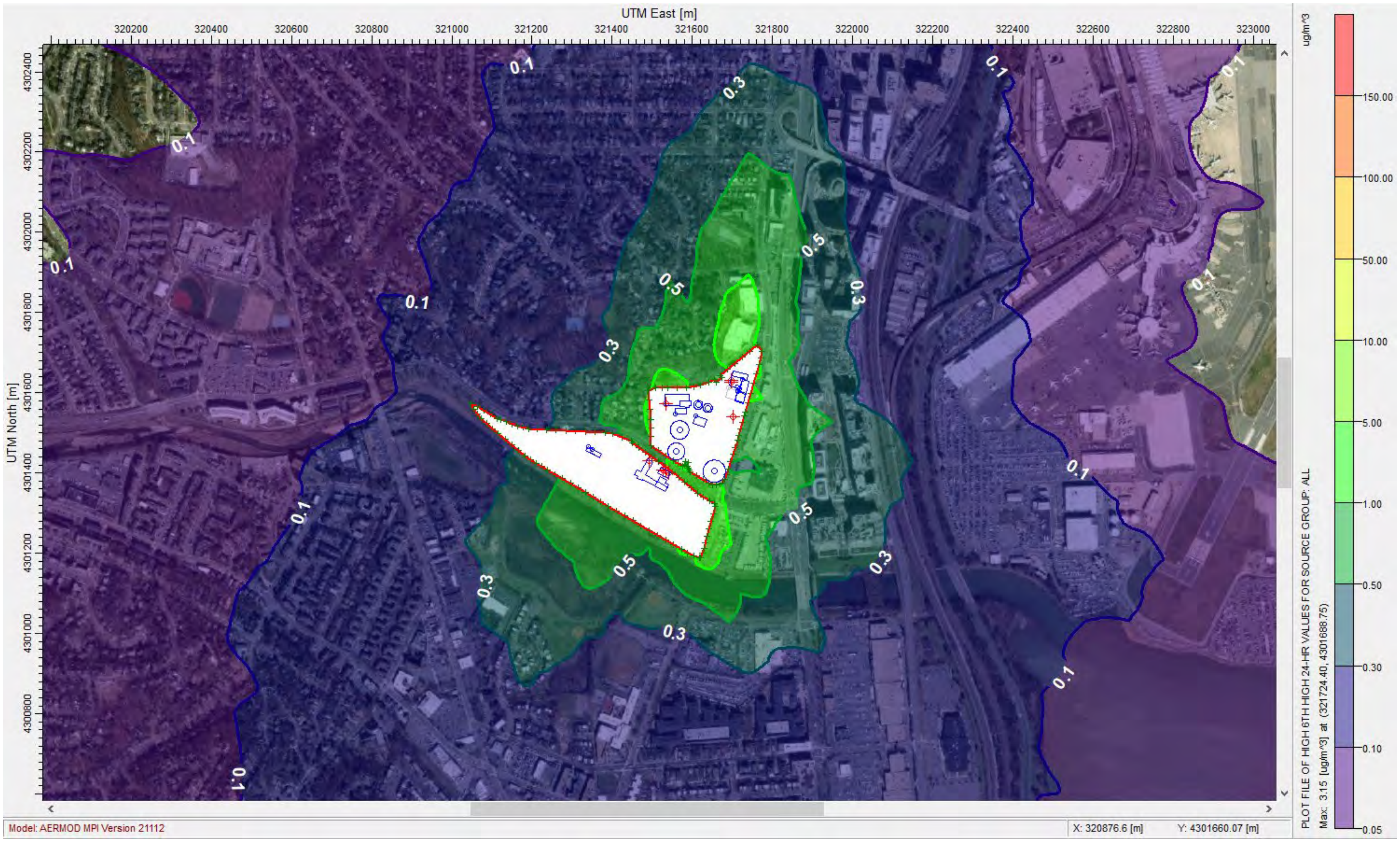
Iteration 2 – Renovate Existing Dewatering Building

NO_2 Annual – All Sources



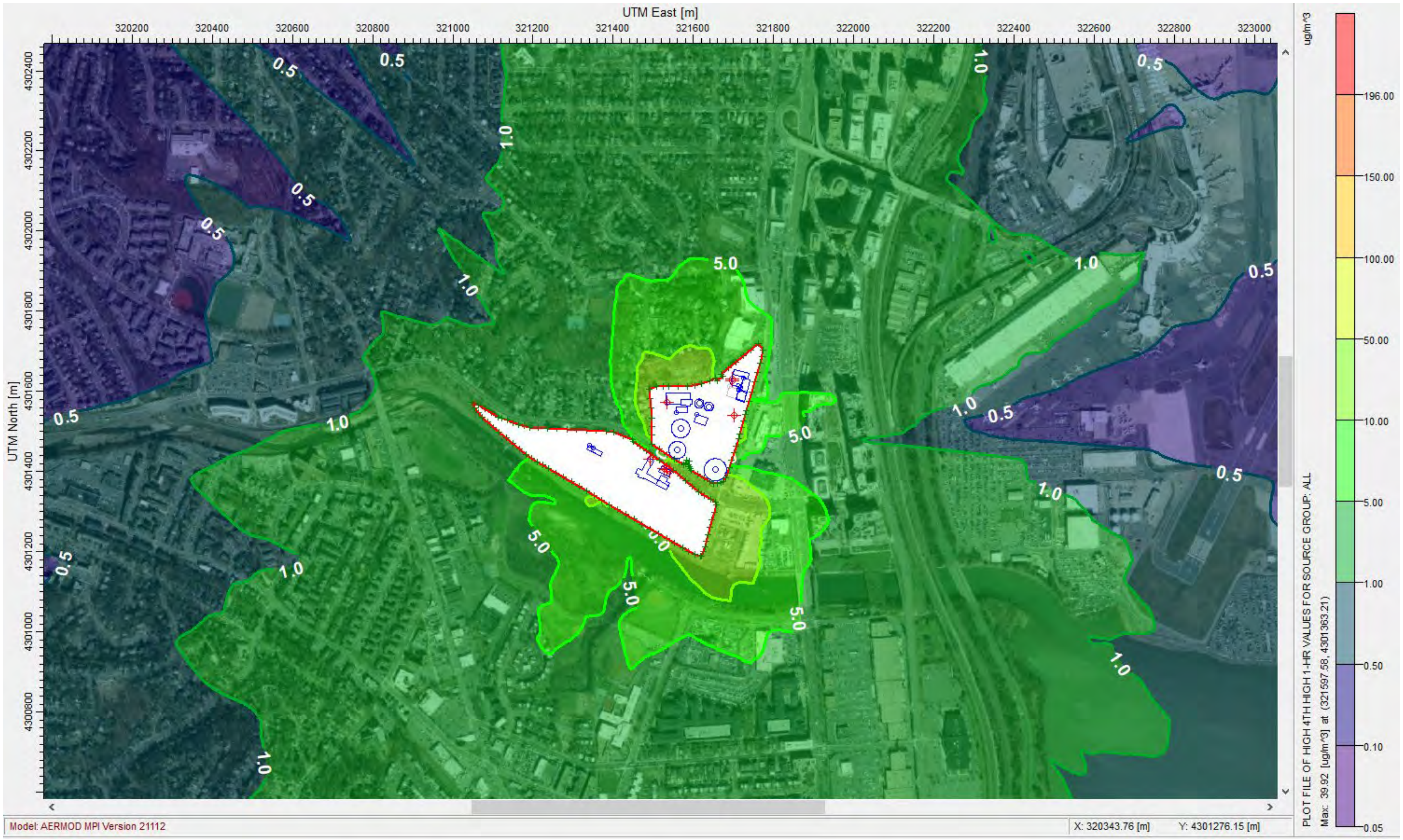
Iteration 2 – Renovate Existing Dewatering Building

PM_{10} 24HR – All Sources



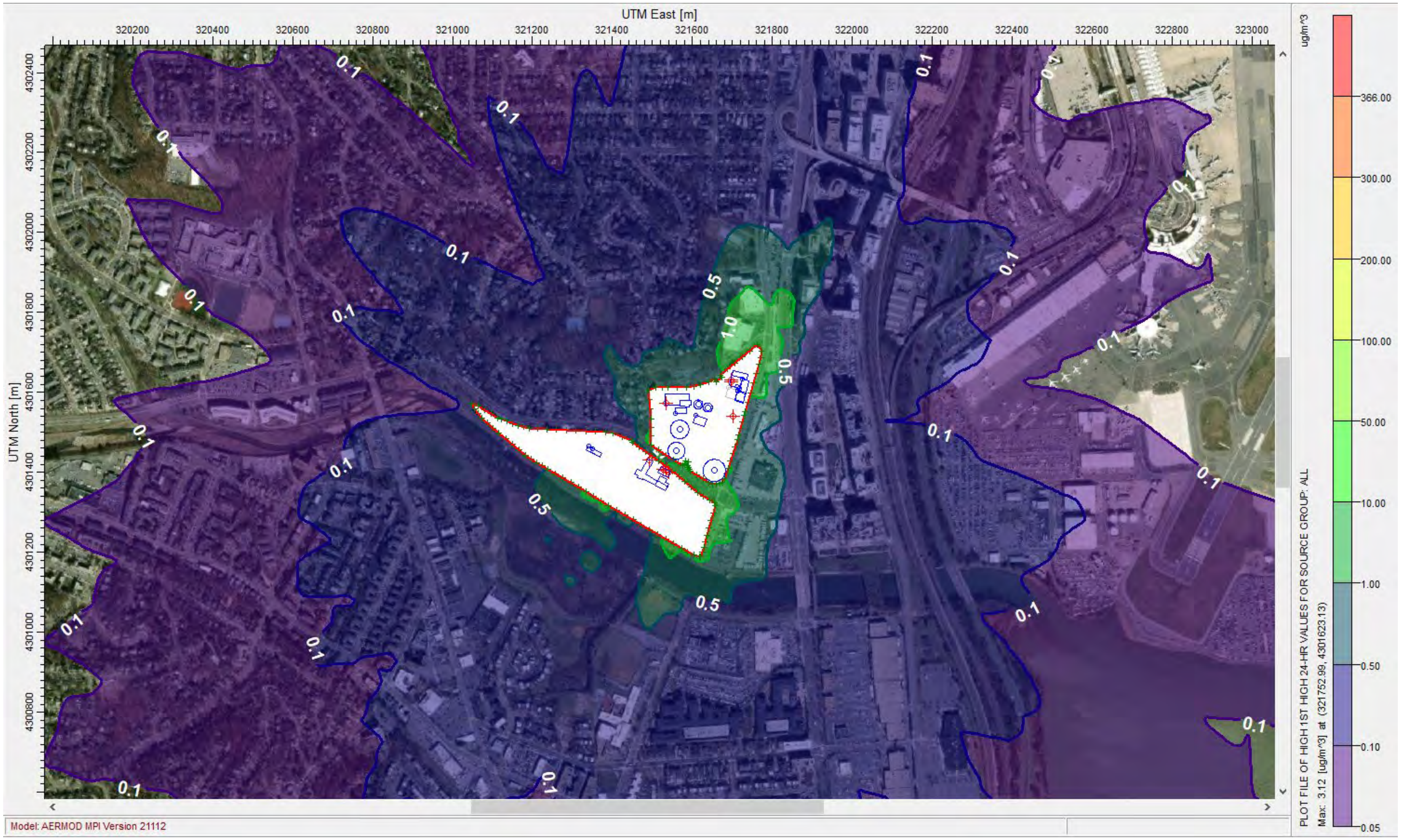
Iteration 2 – Renovate Existing Dewatering Building

SO₂ 1HR – All Sources



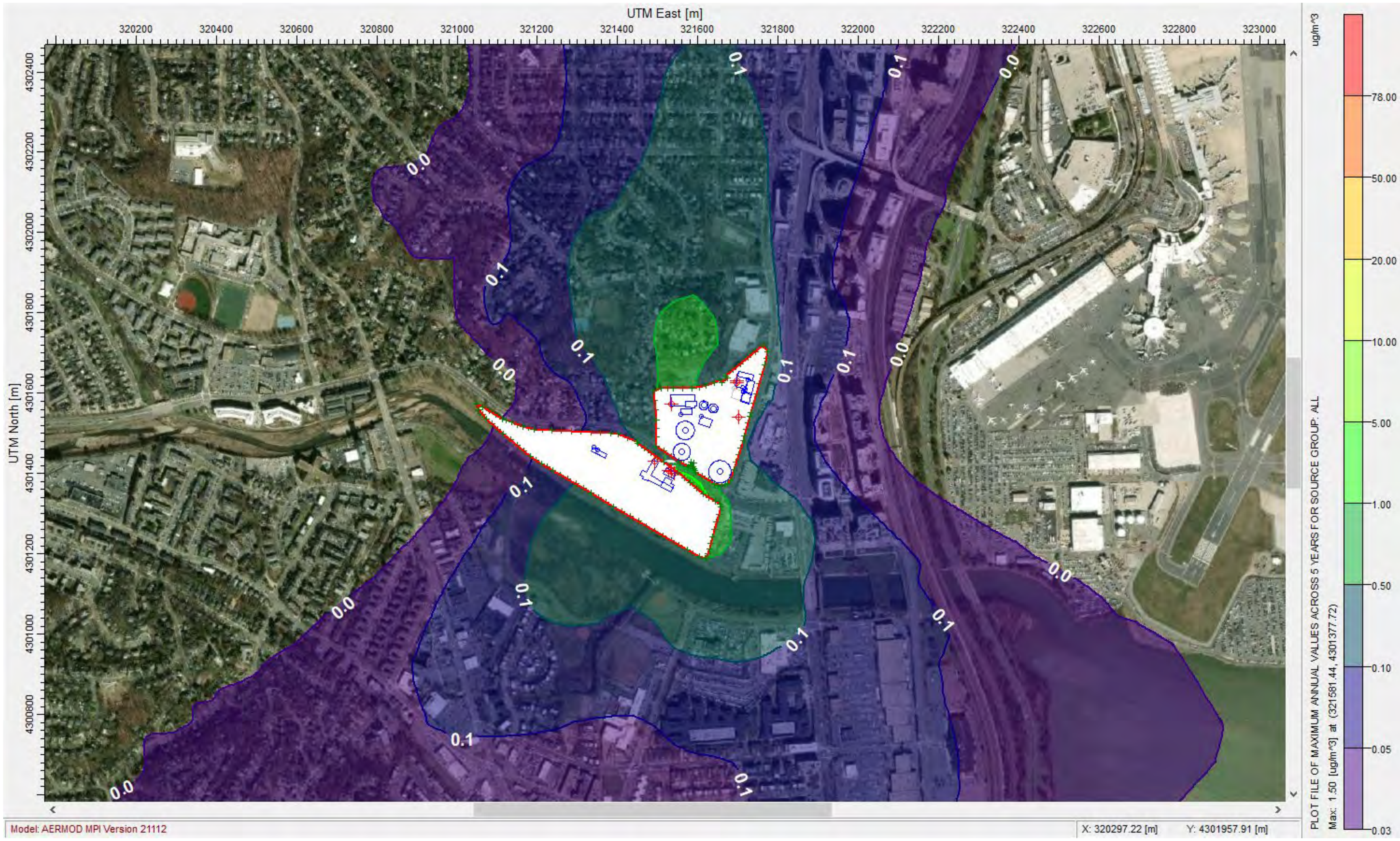
Iteration 2 – Renovate Existing Dewatering Building

SO_2 24HR – All Sources



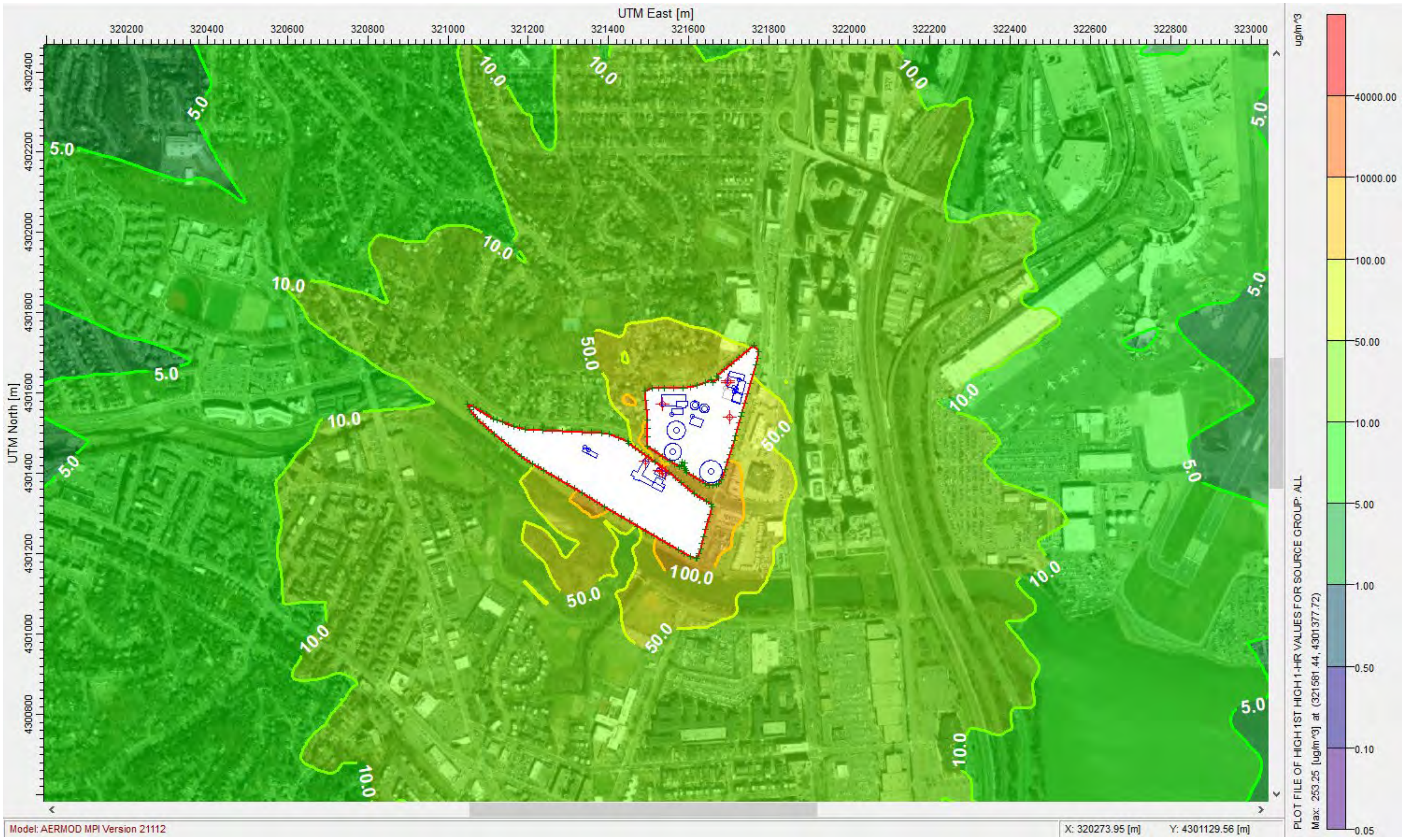
Iteration 2 – Renovate Existing Dewatering Building

SO₂ Annual – All Sources



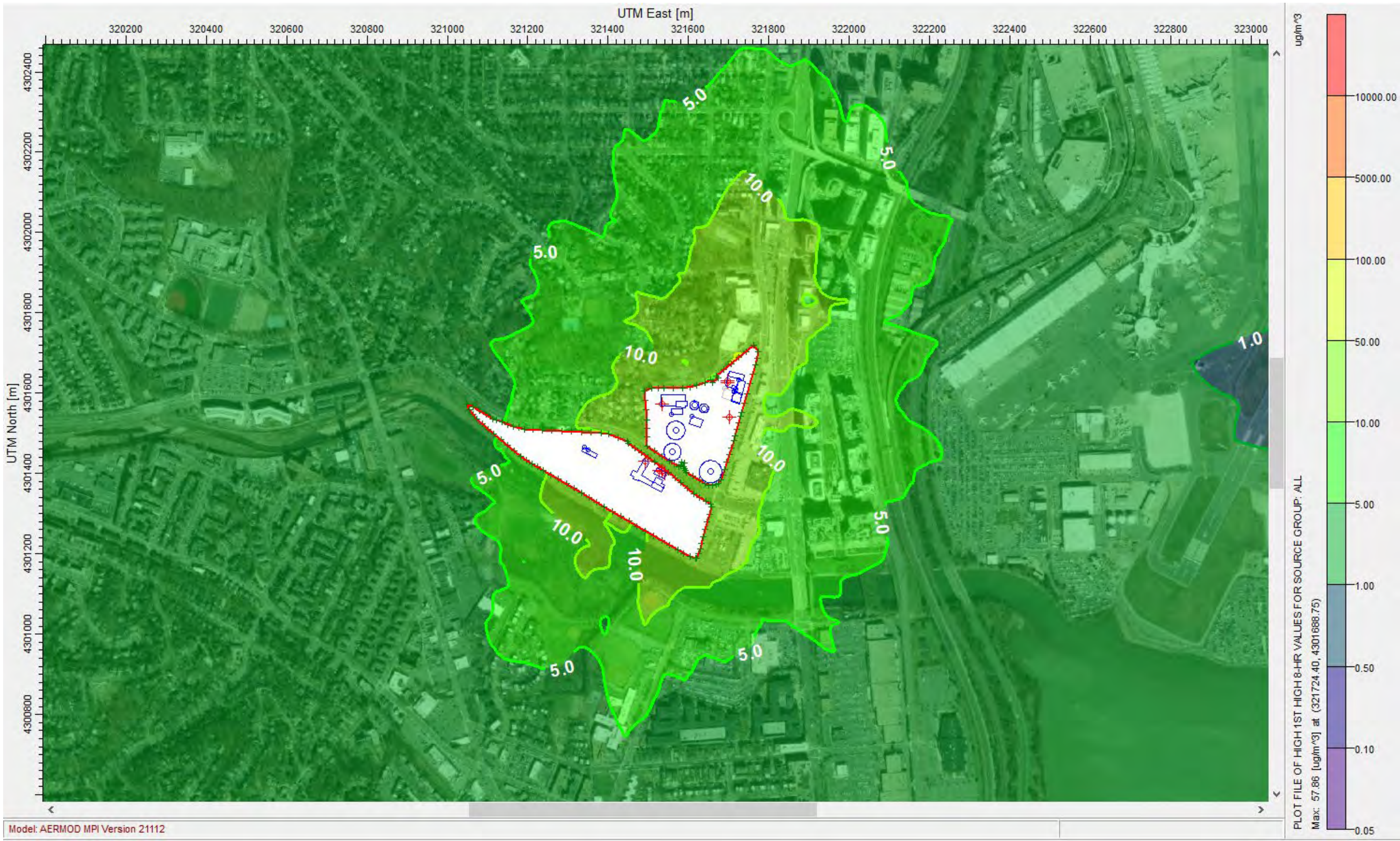
Iteration 2 – Renovate Existing Dewatering Building

CO 1HR – All Sources



Iteration 2 – Renovate Existing Dewatering Building

CO 8HR – All Sources



Appendix C Preliminary Screening of Alternative Gas Utilization Scenarios

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1.0 Introduction

HDR Engineering, Inc.'s (HDR's) analysis began with a preliminary screening of emissions and impacts from various potential biogas utilization alternatives. To develop the alternatives for evaluation, the following potential uses were considered feasible, either alone or in combination:

- On-site use for process and building heating
- Producing electrical power and recovering wasted heat (combined heat and power [CHP])
- Production of renewable natural gas (RNG) for use as vehicle fuel

Use of either internal-combustion engines or gas turbines was identified as viable for the alternatives including CHP.

Based on these potential biogas uses the following seven major alternatives were developed (note that all alternatives include a flare):

- **Alternative 1:** process and building heating
- **Alternative 2A:** CHP with engines, boilers
- **Alternative 2B:** CHP with gas turbine, boilers
- **Alternative 3:** RNG, boilers
- **Alternative 4A:** RNG, CHP with engines, boilers
- **Alternative 4B:** RNG, CHP with gas turbine, boilers

Between the five major alternatives, four main equipment types were identified as sources of emissions: CHP turbines, boilers, CHP engines, and waste gas flaring. Alternative 1 was the baseline and was not considered as a viable option for implementation. Alternatives 4A/B were eliminated from consideration because of cost and complexity. Of the remaining alternatives, CHP (2A/B) had the most emissions. For the CHP alternative, engines were determined to be a worst-case selection for equipment based on levels of emissions and dispersion modeling characteristics. Typically, engines generate equal or higher rates of pollutants, on a pounds (lb) per megawatt (MW) basis, than turbines and have a lower exhaust temperature, which results in worse dispersion characteristics. Therefore, turbines were not specifically evaluated in this initial screening because impacts are anticipated to be lower than those of engines.

2.0 Proposed Project Equipment

Potential emissions were evaluated from different categories of proposed equipment based on anticipated vendor guarantees and U.S. Environmental Protection Agency (EPA) default emission factors obtained from AP-42, Fifth Edition Compilation of Air Pollutant Emissions Factors, Volume 1: Stationary Point and Area Sources.

2.1 Potential to Emit

The emissions listed in Table C-1 below represent the annual total in tons per year of each major criterion pollutant that is regulated by the Clean Air Act (CAA). Each unit is represented as operating at maximum load capacity for all hours of the year with no limitations (commonly referred to as the "potential to emit" [PTE]). This is not intended to be reflective of actual levels of operations and emissions, but accounts for a worst-case scenario based on equipment design. In reality, these units would be limited in hours of operation based on available biogas and/or Arlington Water Pollution Control Plant (WPCP) needs.

Table C-1. Project Potential to Emit (tons per year)

Pollutant	Proposed Equipment				
	CHP Engine 1	CHP Engine 2	Boiler 1	Boiler 2	Flare
PM	1.70	1.70	0.12	0.12	1.23
PM_{10}	1.70	1.70	0.48	0.48	1.23
$PM_{2.5}$	1.70	1.70	0.48	0.48	1.23
NO_x	2.27	2.27	6.31	6.31	5.18
SO_2	0.14	0.14	0.04	0.04	3.3
CO	28.4	28.4	5.30	5.30	22.9
VOC	6.5	6.5	0.35	0.35	1.59
CO_2e	4,143	4,143	7,549	7,549	9,171
Total hazardous air pollutants (HAP)	1.1848	1.1848	0.1191	0.1191	0.2480
Total reduced sulfur (TRS) (including H_2S)	0.002	0.002	0.00005	0.00005	0.04

Post-project WPCP-wide emissions were calculated for both of the identified alternatives discussed above. Alternatives 2A and 2B would provide CHP via either engines or turbines operating on site, and of those two equipment types, engines are the larger source of emissions and impacts. Alternatives 2A, 2B, and 3 would all use natural gas-fired boilers as part of the solids treatment process, with a flare to handle any excess waste gas for safety and control of the biogas system.

From an air permitting standpoint, the CHP engines would push the carbon monoxide (CO) emissions for the WPCP above the CAA Title V major source threshold, which would trigger additional regulatory review and potentially a more restrictive air permit for WPCP operations. Alternately, operational limits could be developed to keep the WPCP's CO potential to emit below the major source threshold.

Table C-2. Post-Project WPCP Potential to Emit (tons per year)

Pollutant	Existing Facility Minus Existing DWB [a]	Project Emissions: CHP Engines (Alternative 2A)	Project Emissions: RNG Production (Alternative 3)	Post Project Total (Alternative 2A)	Post Project Total (Alternative 3)	Title V Major Source Threshold
$PM/PM_{10}/PM_{2.5}$	7.8	5.6	2.2	13.4	10.0	100
NO_x	24.3	22.3	17.8	46.6	42.1	100
SO_2	6.1	3.7	3.4	9.8	9.5	100
CO	31.7	90.2	33.5	121.9[c]	65.2	100
VOC	4.0	1.6	2.3	19.4	6.3	50 [b]
CO_2e	61,268	32,556	24,269	93,824	85,537	100,000

a. Values reflect removal of the dewatering building (DWB) and associated boilers.
b. Per the 9 VAC5-80-2010.C definition of major stationary source for facilities located in the Ozone Transport Region. The applicability of these thresholds will be verified with VDEQ as part of the permit application process.
c. This value exceeds the Title V major source permitting threshold of 100 tons per year.

3.0 Initial Dispersion Modeling

This section describes initial dispersion modeling analyses that were performed to help characterize the impact of WPCP layout on ambient air quality impacts.

3.1 Proposed Layouts

Differences in the potential gas utilization alternatives also led to development of multiple WPCP layout concepts. Two preliminary options included reuse of the existing dewatering building (DWB), or demolition of dewatering and replacing the building with new digesters and a new central digester building. Those two layouts are shown in Figure C-1 and Figure C-2.

Figure C-1. Preliminary Design Option 1

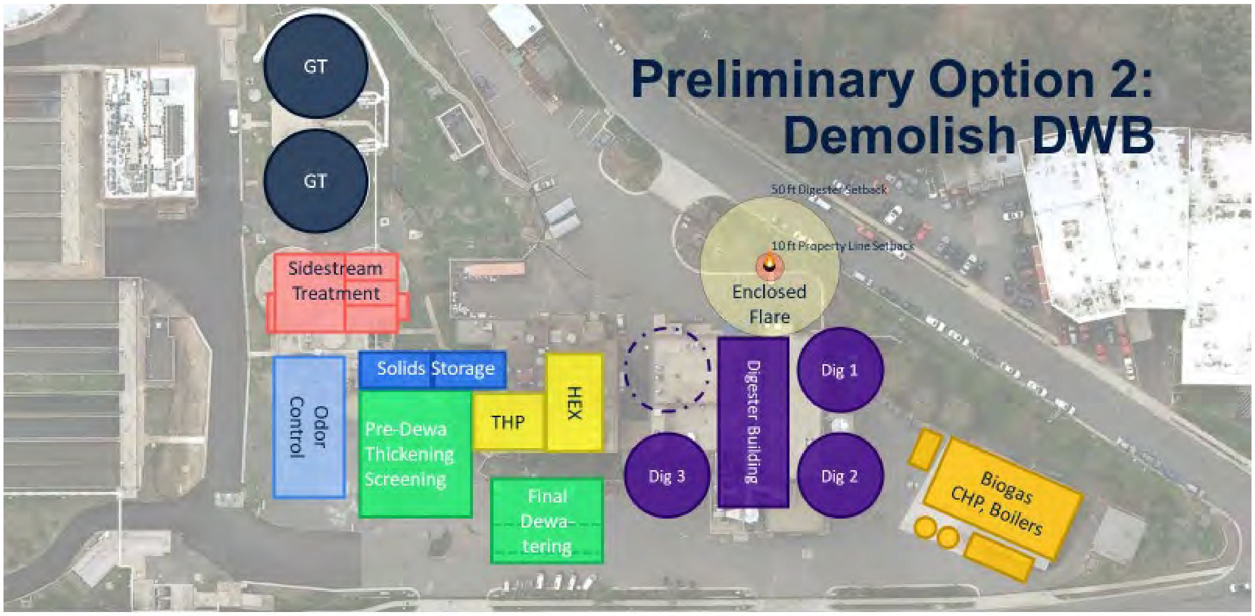

Figure C-2. Preliminary Design Option 2

For either option, all emission units (aside from the flare) would be located at the far northern side of the WPCP in a power block structure that would be roughly 20 feet tall.

3.2 Worst-Case Pollutant Analysis

To help narrow down the scope of the modeling analysis, a "first cut" dispersion analysis was performed with worst-case assumptions. All proposed units were modeled as operating simultaneously, at maximum capacity (PTE), and were located in the northern corner of the WPCP with the lowest expected stack heights.

For all modeled pollutants except nitrite (NO_2), the proposed engines would be a larger source of emissions than the proposed boilers. For NO_2, the boilers would be higher based on the lack of specific nitrogen oxide (NO_x) controls such as low NO_x burners, ultra-low NO_x burners, or selective catalytic reduction (SCR). Emissions from the proposed engines were assumed to have SCR systems installed to provide a 90 percent control efficiency, as described in New Source Performance Standards (NSPS) Subpart JJJJ emissions limits. Even with the overly conservative assumptions outlined above, only one pollutant had modeled impacts that were significant when compared with the relevant ambient air quality standards: particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$). For the remainder of this analysis, $PM_{2.5}$ is the pollutant of interest, with the assumption that any design changes made to improve dispersion of $PM_{2.5}$ would also improve dispersion of all other pollutants.

3.3 Building Downwash Investigation

Prevailing winds at the WPCP are from the south, creating a large downwash cavity on the north side of the WPCP as the wind comes across the tall existing dewatering structures (or proposed digester structures). Building downwash can increase ground-level concentrations of pollutants that become entrained in the resultant eddy as shown in Figure C-3 below.

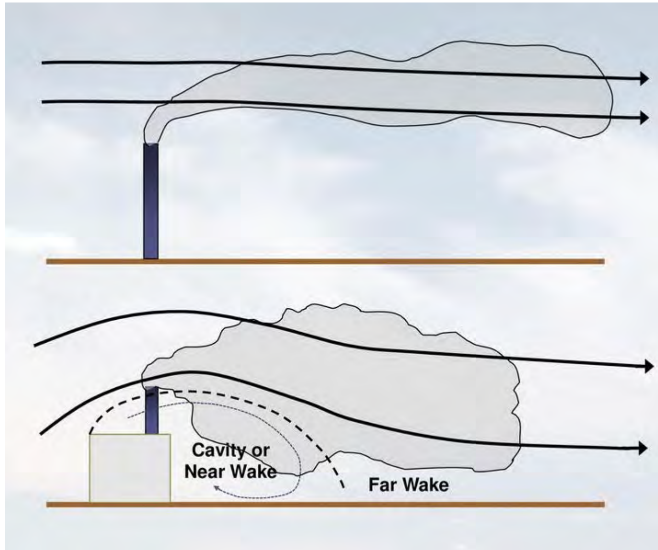

Figure C-3. Building Downwash Cavity

In each of the proposed layouts, the power block building is sited on the northern side of the WPCP, which would be affected by this downwash cavity. To illustrate the differences in impacts caused by building downwash, an alternate location for the power block structure was modeled farther to the south of the digester structures, which represent a worst-case scenario as they are larger than the existing DWB. Comparisons were done for emissions of $PM_{2.5}$ as the pollutant of interest. Figure C-4 and Figure C-5 show these two proposed configurations of equipment and the comparative ambient air impacts from each, with all other modeled parameters remaining equal. Because of differences in $PM_{2.5}$ emission rates, and exhaust stack characteristics, results from each major equipment type (engines or boilers) are presented separately. Because of the prevailing wind from the south (left sides of Figure C-4 and Figure C-5), pollutant concentrations increase when emission sources are placed at the north side of the WPCP (right sides of Figure C-4 and Figure C-5) and are better dispersed (i.e., result in lower impacts) when the power block structure is moved upwind of the main dewatering facilities. This spatial change improves dispersion and lessens air quality impacts to the surrounding area without relying on operational constraints or added control technologies.

These figures also demonstrate the difference in magnitude between emissions generated by the proposed engines and emissions generated by the proposed boilers. For all modeled pollutants except NO_2, the proposed engines are a larger source of emissions than the proposed boilers.

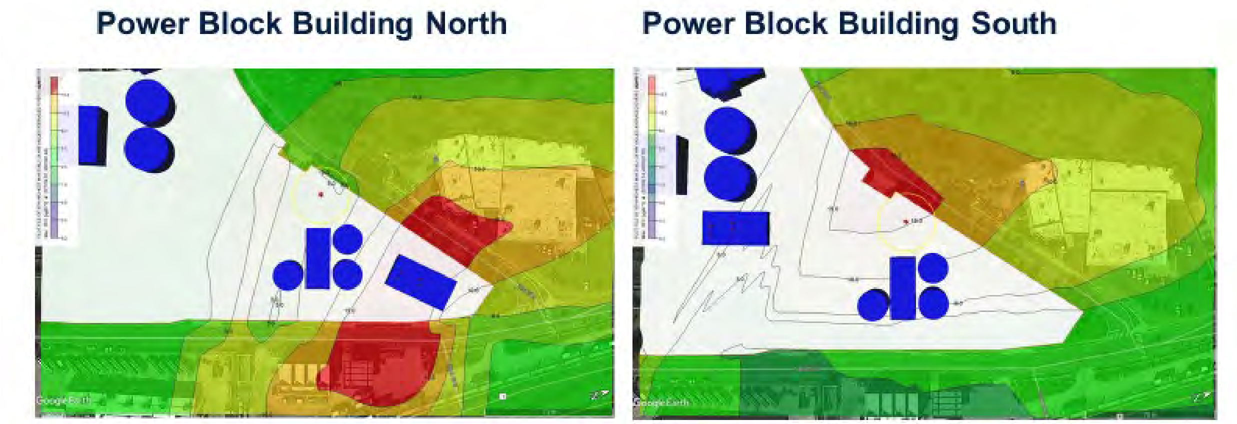

Figure C-4. Building Downwash Comparison: Engines Only

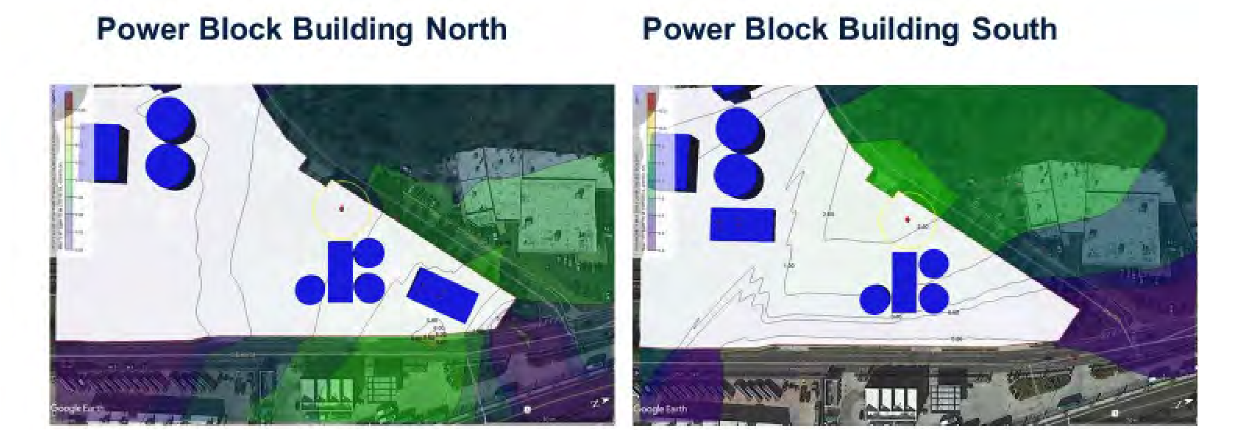

Figure C-5. Building Downwash Comparison: Boilers Only

Overall, the preferred location for the power block structure is central to the WPCP, rather than the northern corner of the WPCP. It should also be noted that for $PM_{2.5}$, the CHP engines are more significant sources of modeled impacts than the boilers.

3.4 Iterative Modeling Analysis

Focusing on $PM_{2.5}$ as the pollutant of interest, four modeling iterations were performed to illustrate the differences in impacts to ambient air quality as driven by changes to buildings, location of emission units, and changes to stack heights.

3.4.1 Spatial Layouts and Stack Parameters

Iterations 1 through 4 had the model layout selections shown in Table C-3.

Table C-3. Modeling Iteration Descriptions

Iteration	WPCP Design Option	Location of Power Block Building	Stack Heights of Boilers/Engines
1	Existing DWB	North	30 feet (10 feet above building rooftop)
2	Existing DWB	North	50 feet (30 feet above building rooftop)
3	Demolish DWB/build digesters	North	30 feet (10 feet above building rooftop)
4	Existing DWB	South	30 feet (10 feet above building rooftop)

For all iterations, the proposed waste gas flare was located near the northern WPCP fence line (west of the DWB) with a stack height of 25 feet above ground level. In all iterations, the power block building that houses both the engines and boilers was assumed to be 20 feet tall.

3.4.2 Operating Scenarios

Based on design for gas utilization scenarios, the boilers and engines would not typically be fired with fuel simultaneously, as heat from the engines would be recovered to create the steam necessary for THP. Similarly, the waste gas flare would only be operational with the boilers as there would be excess biogas generated that would need to be flared. The flare would not be necessary for the scenario including engines as all of the biogas would be utilized in the engines. In the iterative modeling analysis, these emission units were split by those operational scenarios:

- Only engines, each operating 8,760 hours per year
- Only boilers and flaring, each operating 8,760 hours per year

3.4.3 Background Concentrations

To help understand the existing air quality in the region, ambient air monitoring data were identified for $PM_{2.5}$ from nearby monitors in the EPA Air Quality Monitor Network. Concentrations were included from the most recent 3 years of data available from the monitor located at the intersection of S 18th and Hayes Streets in Arlington. For the 24-hour averaging period, a background concentration of 17.7 $\mu g/m^3$ of $PM_{2.5}$ was derived. For the annual averaging period, a background concentration of 7.3 $\mu g/m^3$ of $PM_{2.5}$ was derived.

3.4.4 Comparison with National Ambient Air Quality Standards

Modeled impacts from the project equipment were added to background concentrations for comparison with the National Ambient Air Quality Standards (NAAQS) to provide context for the impact of the evaluated gas utilization alternatives. Emissions were modeled at maximum PTE, operating for all hours of the year, with a period of 5 years of meteorological data. Results are presented in Table C-3 below. The maximum values reported below may or may not occur at the same receptor location or during the same 24-hour or annual period, so the individual source maximums should not be summed to estimate total impacts. Total modeled impacts from all units operating simultaneously are provided as a separate maximum in Table C-4 below.

Table C-4. Iterative Modeling Results: $PM_{2.5}$

	Iteration 1 - North of Existing DWB Stack heights at 30 feet; power building at 20 feet; flare at 25 feet (WORST-CASE LAYOUT)		Iteration 2 - North of Existing DWB Stack heights at 50 feet; power building at 20 feet; flare at 25 feet		Iteration 3 - North of Proposed DWB/Digesters Stack heights at 30 feet; power building at 20 feet; flare at 25 feet		Iteration 4 - South of Existing DWB Stack heights at 30 feet; power building at 20 feet; flare at 25 feet	
	24HR ug/m3	Annual ug/m3	24HR ug/m3	Annual ug/m3	24HR ug/m3	Annual ug/m3	24HR ug/m3	Annual ug/m3
FLARE	2.3	0.34	2.3	0.34	9.7	1.6	2.2	0.27
BOILERS	5.5	0.96	2.1	0.30	6.4	0.99	3.1	0.78
ENGINES	38	12	30	8.5	38	6.6	20	5.7
BOILERS + FLARE	5.5	0.98	2.6	0.44	9.8	1.8	3.1	0.8
ALL UNITS TOGETHER	41.9	12.7	30.6	8.8	41.9	7.6	23	6.4
BACKGROUND	17.7	7.3	17.7	7.3	17.7	7.3	17.7	7.3
TOTAL ENGINES	55.7	19.6	47.3	15.8	55.6	13.9	38	13
NAAQS	35	12	35	12	35	12	35	12
PERCENT OF STANDARD	159%	163%	135%	132%	159%	116%	108%	108%
TOTAL BOILERS + FLARE	23.1	8.3	20.3	7.8	27.5	9.1	20.7	8.1
NAAQS	35	12	35	12	35	12	35	12
PERCENT OF STANDARD	66%	69%	58%	65%	79%	76%	59%	68%

4.0 Conclusions

Based on iterative modeling analysis, the recommended location for the power block structure would be south of the DWB. The waste gas flare is not expected to have a significant impact on ambient air quality, especially considering that flaring would be far less than 8,760 hours per year. Design for CHP engines would need to be developed further to minimize impacts through enhanced dispersion techniques or limitation of operation if it remains a viable alternative. As discussed previously, impacts from turbines would likely be less than those from engines; however, the effect of moving the location of the power block structure may not be enough to reduce the emission impacts below the NAAQS for those units and would require further design and analysis.

Technical Memorandum No. 11

Date:	December 14, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Digestion Facilities Evaluation

Contents

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Tables

Figures

1.0 Introduction

This introductory section presents the background and purpose of this project and the digestion facilities evaluation approach.

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary solids (PS) and waste activated solids (WAS) thickening, dewatering, and Class B lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a Class A thermal hydrolysis process (THP) and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The purpose of this digester evaluation is to assess and compare digester alternatives. The results of this evaluation will inform and validate a final decision on the digester type, configuration, and covers for the Facilities Plan.

1.2 Evaluation Approach

A suite of alternatives was developed for digester tank types, sizing, configuration, mixing systems, and digester covers. Conceptual footprints and costs were prepared for each alternative. Alternatives were presented and reviewed at several project workshops with the County. Workshop participants screened and selected a short list of preferred alternatives, as described in later sections of this technical memorandum (TM).

In this evaluation, the shortlisted alternatives are further evaluated and compared based on the following criteria:

- Site layout and space requirements
- Constructability
- Energy efficiency and electrical requirements
- Operations and maintenance (O&M) demands
- Operational flexibility
- Capital costs
- Net present value (capital plus O&M costs)
- History of installations at THP facilities

2.0 Summary of Facilities and Processing

The existing biosolids processes consist of thickening, dewatering, and lime stabilization. Gravity-thickened PS and dissolved air flotation-thickened secondary solids are blended in solids storage tanks and dewatered using centrifuges. Lime is added to the dewatered solids to achieve Class B pathogen and vector attraction reduction. Lime-stabilized biosolids are hauled off site for beneficial use through bulk land application.

The proposed biosolids processes will consist of thickening, pre-dewatering, THP, anaerobic digestion, and dewatering. In this process, thickened PS and unthickened secondary solids would be sent to pre-dewatering and be fed to the THP. Hydrolyzed solids would be pumped through cooling heat exchangers and fed to the primary digesters. A secondary digester would provide storage of solids and biogas from the primary digesters. The gas would be cleaned and used as vehicle fuel or renewable natural gas injection with excess gas sent to either the boiler or the boiler and waste gas burner. Class A stabilized biosolids will be hauled off site for beneficial use. A process flow diagram is provided in Figure 1.

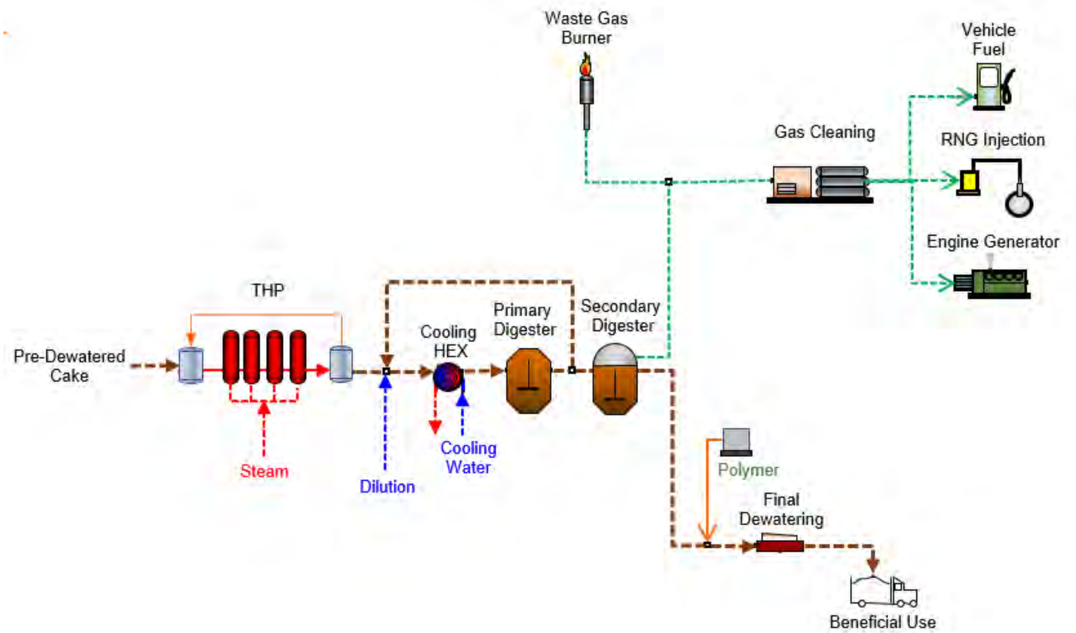


Figure 1. Future Process Flow Diagram

3.0 Design Criteria

The following three design loading conditions were considered for digester equipment evaluation:

- **23 million gallons per day (mgd)—current conditions:** annual average loading was considered for "minimum" operating conditions and as a baseline for annual O&M costs
- **30.8 mgd—2052 projected conditions:** used as the basis for equipment sizing and number of units required for the Facilities Plan
- **40 mgd—buildout conditions:** used to establish total footprint requirements and facility sizing, with space reserved for future tanks and equipment

The proposed process consists of mesophilic digesters in a primary/secondary configuration. Hydrolyzed solids from the THP will be fed to two or three primary digesters (in parallel), and the digested solids from the primary digesters will be fed to the secondary digester. The system will be designed to provide a minimum solids residence time (SRT) in the primary digesters; the volume of the secondary digester is not included in the SRT calculations.

Typically, anaerobic digesters are sized for 15-day SRT to meet U.S. Environmental Protection Agency (EPA) requirements for Class B pathogen reduction. However, because THP meets the requirements for Class A pathogen reduction, the proposed digesters for this project can be sized for a lower SRT. THP pilot testing recently performed by Virginia Tech using solids generated at Arlington WPCP evaluated digester performance at 10.0-, 12.5-, and 15.0-day SRTs; digester performance was determined to be acceptable at the lower SRTs. A **12-day SRT** target at peak 14-day loading will be used to size the primary digesters. The possibility of operating the digesters at a 10-day SRT can be evaluated in the future, but the project team selected 12 days as a more conservative basis of design. In addition, all configurations were checked to make sure peak volatile solids (VS) loading rates were lower than 0.4 pound volatile solids per cubic foot (lb-VS/ft^3) per day and that predicted ammonia concentrations in the digesters were below 3,000 mg/L. These parameters are important to maintain digester health.

The project team selected a minimum **4 days of storage** downstream of the primary digesters. This value was based on the County's preference to have the flexibility to not operate the dewatering system for 4 consecutive days, for operational or maintenance reasons or for intermittent interruptions in the hauling of final dewatered cake. The digested sludge storage can also help mitigate disruptions that prevent biosolids from being hauled from the WPCP, such as inclement weather or scheduling issues with the biosolids hauling contractor.

The option to provide digested sludge storage tanks (DSSTs) was considered and eliminated in preliminary evaluations. Instead, the project team opted for a secondary digester downstream of the primary digesters, as the volume, equipment, and energy requirements were similar to DSSTs. In addition to providing digested sludge storage, a secondary digester provides operational flexibility of being able to function as a primary if one of the other digesters is out of service. Furthermore, using a similar shape and dimensions for the secondary digester as the other tanks is anticipated to reduce the complexity and cost of construction. The secondary digester will capture any residual biogas that was not released in the primary digesters, although this volume is not heated so it is not counted toward the SRT and volatile solids reduction (VSR) calculations.

4.0 Digester Alternatives

Digester alternatives are described in this section, including digester shape and construction, configuration and sizing, covers, and mixing.

4.1 Digester Shape and Construction

Three digester shapes were considered: conventional cylindrical, silo, and egg-shaped. A comparison of the different types of configurations is shown in Table 1.

Table 1. Comparison of Digester Shape and Construction Options

Evaluation Consideration	Conventional	Silo	Egg-Shaped
Compatible mixing options	Draft tube mixers Gas and pump mixing Top-mounted mixers	Draft tube mixers Gas and pump mixing	Draft tube mixers
Mixing efficiency	Medium	High	Highest
Tank material options	Concrete or steel	Concrete	Steel
Cover options	All options	Fixed concrete	Steel
Relative cleanout frequency	Frequent or routine 5–10 years	Moderate 10–15 years	Minimum 10–20 years
Relative capital cost	Low	Medium	High
Relative operating cost	High	Medium	Low
Ability to store biogas in tank	Yes	No	No

Conventional cylindrical digesters have a digester height-to-diameter ratio between 1:1 and 1:2. Of the three options considered, a conventional shape is least costly to construct and offers the greatest flexibility for mixing systems, covers, and materials of construction. It also provides the largest headspace surface area, which makes them better suited to provide biogas storage and mitigate a potential rapid volume expansion caused by a process upset. The main disadvantage of the conventional shape is the reduced mixing efficiency, which results in higher energy and maintenance requirements to prevent accumulation of grit and scum because of the shallow floor slope, as compared to the other two configurations.

Silo digesters have a height-to-diameter ratio greater than 1:1, reducing the footprint required compared to conventional digesters. Mixing efficiency is also better because silo digesters are taller than they are wide, reducing the surface area available for grit and scum accumulation. They typically have a steeply sloped floor to further discourage grit accumulation on the floor, which in turn reduces the frequency required to take the tank out of service for cleaning. Silo digesters are more expensive to construct than conventional digesters and have fewer options for mixing and cover systems. The reduced surface area also reduces the ability to contain a volume expansion event. Additionally, the taller height of a silo digester might be objectionable to adjacent neighborhoods.

Egg-shaped digesters are known to have the highest mixing efficiency but are also the most expensive to build. They have the fewest mixing and cover options. They require the least cleaning of the three configurations because of the mixing efficiency combined with a steep floor slope. Because of the limited headspace, overflows are more likely; therefore, downstream storage tanks are necessary. The project team determined that egg-shaped digesters would negatively affect the viewshed.

Given the preference to reduce construction costs and minimize impacts to the viewshed, a conventional cylindrical configuration with a 1:1 height-to-diameter ratio was selected. This ratio balances footprint and height and aligns with the recommendations of the THP supplier. To reduce the cost and complexity of construction, a gradual floor slope of 1:6 (2 inches per foot [ft]) was selected.

Cylindrical digesters can be constructed of concrete or steel. Steel is not recommended for a project of this size. The following two methods of American Water Works Association (AWWA) D110 concrete construction were considered:

- **Type III** tanks use precast concrete walls with an embedded steel diaphragm. The tank wall is placed in permanent compression with horizontal prestressing.
- **Type I** tanks use a cast-in-place concrete wall, horizontal strand prestressing, and vertical post-tensioning. The tank wall is placed in permanent compression with horizontal prestressing, like the Type III tanks.

No recommendation is being made at this time for the construction method. There is value in an early pre-selection because of the need to keep manufacturers closely involved in the design process. The type of construction can be further evaluated at a later stage of design.

4.2 Digester Configuration and Sizing

Digester sizing is determined by the design SRT and maximum allowable organic loading rate. Selected values for this project are presented in Table 2.

Table 2. Digester Sizing Design Criteria

Process Metric	Unit	Basis of Design at 14-day Peak Loads
Maximum organic loading rate	lb-VS/ft^3-digester-day	0.4
Minimum solids residence time (days)	Days	12
Maximum total ammonia-N concentration	mg-N/L	3,000

lb-VS/ft^3 = pounds volatile solids per cubic foot.
mg-N/L = milligrams nitrogen per liter.

To provide redundancy and comply with Virginia Sewage Collection and Treatment (SCAT) regulations, the digesters will be sized for a target SRT of 12 days at peak 14-day flows and loads with one digester out of service. As noted in Section 3.0, one of these digesters will be a secondary digester that can provide sludge storage or serve as a primary digester if another digester is out of service. Therefore, the dimensions are based on achieving a 12-day SRT with 2 primary digesters in service.

Four digester sizing configurations were considered, as listed below and presented in Figure 2. The metrics for each configuration are listed in Table 3.

- **Configuration 1:** three (2 primary + 1 secondary) 62-foot-diameter digesters sized for the 40 mgd buildout condition
- **Configuration 2:** four (3+1) 54-foot-diameter digesters sized for the 40 mgd buildout condition
- **Configuration 3:** three (2+1) 56-foot-diameter digesters sized for the 30.8 mgd (year 2052) condition
- **Configuration 4:** four (3+1) 49-foot-diameter digesters sized for the 30.8 mgd (year 2052) condition

As noted previously, a 1:1 height-to-diameter ratio was selected. The normal liquid operating level, also referred to as the side water depth (SWD), was assumed to be approximately 90 percent of the tank height, to provide 10 percent freeboard to accommodate fluctuations in liquid level. It should be noted that the design digester SRT does not need to be based off the permitted average daily flow of the plant.

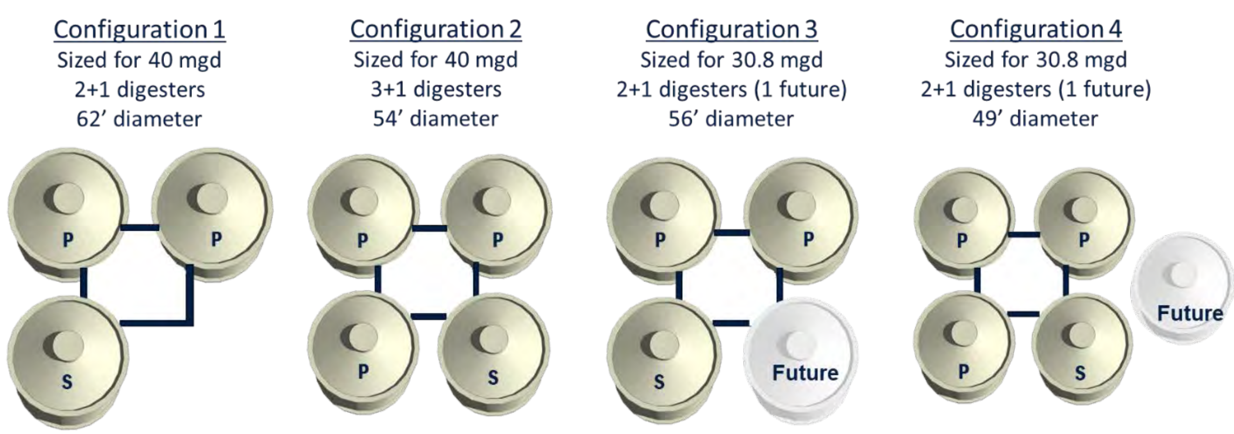


Figure 2. Digester Configurations

Table 3. Digester Configurations: Sizing Metrics

Process Metric	Configuration 1	Configuration 2	Configuration 3	Configuration 4
1. Basis of design	40 mgd—buildout conditions		30.8 mgd—2052 projected conditions	
2. Number of primary digesters	2	3	2	3
3. Number of secondary digesters	1	1	1	1
4. Diameter and height, ft	62	54	56	49
5. Side wall depth, ft	55	48	50	44
6. Volume including freeboard, MG	1.36	0.91	1.05	0.70
7. Liquid volume per digester, MG	1.22	0.81	0.94	0.62
8. SRT provided by one tank, days [a]				
30.8 mgd condition	7.8	5.2	6.0	4.0
40.0 mgd condition	6.0	4.0	4.6	3.1
9. Storage provided by one tank, days [b]				
30.8 mgd condition	7.0	4.7	5.4	3.6
40.0 mgd condition	5.4	3.6	4.1	2.8
10. Total primary digester volume, MG	2.43	2.43	1.87	1.87
11. SRT, all primary digesters, days				
Average loading at 30.8 mgd condition	22.2 (exceeds target)		17.1 (exceeds target)	
Peak 14-day load at 30.8 mgd condition	15.6 (exceeds target)		12.0 (meets target)	
12. SRT, all primary digesters, days				
Average loading at 40.0 mgd condition	17.1 (exceeds target)		13.2 (exceeds target)	
Peak 14-day load at 40.0 mgd condition	12.0 (meets target)		9.2 (below target)	
13. Total primary + secondary volume, MG	3.65	3.24	2.81	2.50
14. SRT, primary + secondary, days				
Peak 14-day load at 30.8 mgd condition	23	21	18	16
Peak 14-day load at 40.0 mgd condition	18	16	14	12
15. SWD in primary digesters for 12-day SRT at peak 14-day 30.8 mgd condition, ft (percentage of tank height)	42 (70%)	37 (70%)	50 (90%)	44 (90%)
16. Freeboard available when operating at SWD required for peak 14-day loads at 30.8 mgd, ft (percentage of tank height)	19 ft (30%)	17 ft (30%)	6 ft (10%)	5 ft (10%)
MG of freeboard	0.85	0.85	0.22	0.22
Volume expansion (ft freeboard ÷ SWD)	45%	45%	12%	12%
Equiv. days of storage at 14-day peak	5.5	5.5	1.4	1.4
17. SWD required to provide 4-day storage in one tank, ft (percentage of tank height) [b]				
Peak 14-day load at 30.8 mgd condition	28 (45%)	37 (70%)	34 (60%)	44 (90%) [b]
Peak 14-day load at 40.0 mgd condition	37 (60%)	48 (90%) [b]	44 (80%)	Inadequate

a. The SRTs shown in row 8 were calculated based on the liquid volume per digester, which is 90% of the total tank volume, to account for 10% freeboard.

b. The days of storage shown in row 9 were calculated based on 80% of the total tank volume because approximately 20% of the tank height must remain full to ensure proper mixing (height of a floor-mounted pump mix nozzle) and to maintain a liquid seal on piping to prevent biogas from entering sludge piping. For this reason, the SWD shown in row 17 must be no more than 80% of the tank height to ensure that 4 days' worth of storage volume is available above the minimum operating level.

Configurations 1 and 2 are sized for 40 mgd buildout conditions; therefore, the primary digesters could be operated at a lower liquid level in the near term. The larger freeboard would mitigate the risk of overflows caused by rapid volume expansions of the digester contents. Operating the primary digesters at a level that provides the target 12-day SRT for the 14-day peak 30.8 mgd condition (Table 3, row 15) provides enough freeboard to accommodate either a 45 percent volume expansion or 5.5 days of storage at peak 14-day flows (row 16).

Configurations 3 and 4 are sized for the 30.8 mgd (year 2052) design conditions. If one of the digesters is out of service, then the remaining digesters must operate as primary digesters at 90 percent of tank height to meet the 12-day SRT target at 14-day peak flows and loads (row 15). The only remaining space available to accommodate volume expansion or solids storage would be the 10 percent freeboard. Therefore, if a digester outage occurred in Configuration 3 or 4, the digester contents would have to be pumped out and dewatered continuously (7 days per week) to reduce the risk of over-filling the digesters.

Configurations 3 and 4 do not provide adequate primary digester volume to meet the 12-day SRT target at peak 14-day loads for the 40 mgd buildout conditions (row 11); however, they do provide adequate volume for the average loads at buildout (row 12). If operating at a lower SRT during peak loading is considered acceptable, addition of the future digester can be deferred.

The County would like to consider accepting fats, oils, and grease (FOG) in the future. Configurations 3 and 4 do not provide adequate primary digester volume to accept FOG at peak 14-day loads at 30.8 mgd conditions, but they are able to accept FOG at current peak conditions and future average conditions. Configurations 1 and 2 are able to accept FOG at peak 14-day loads at 30.8 mgd. Before implementing FOG receiving and processing, the County will need to consider all potential impacts of FOG, including impacts on THP, digestion, and value of renewable natural gas.

A minimum 4 days of digested sludge storage in the secondary digester is recommended for operational reliability, to accommodate the preferred dewatering schedule. The volume of each digester tank in Configurations 2 and 4 provides approximately 4 days of storage at 14-day peak loads in the 30.8 and 40.0 mgd conditions(Table 3, row 9). The volumes of each digester tank in Configurations 1 and 3 are 50 percent larger and provide approximately 6 days of storage at 30.8 and 40.0 mgd conditions. The liquid level required to provide 4 days of storage (row 17 of Table 3) must be no more than 80 percent of the tank height to ensure that 4 days' worth of storage volume is available above the minimum operating level that ensures mixing and maintaining a liquid seal to prevent biogas from entering sludge piping. The minimum level is currently assumed to be approximately 20 percent of the tank height, but this level constraint will become clearer during final design.

As noted in the paragraph above, the secondary digesters in Configurations 2 and 4 provide only the minimum 4 days of storage; therefore, additional volume should be considered to accommodate a rapid volume expansion. For Configuration 2, this volume can be provided by operating the digester at a lower level than the design SWD. For Configuration 4, an external containment tank may be recommended to accommodate overflow from a rapid volume expansion. Also note that the digester tanks are currently sized to have 12 percent freeboard to accommodate volume expansion.

The layout and location of the digesters depends on the selected option for the existing dewatering building. Three options are under consideration for the dewatering building: (1) renovation, (2) demolition, or (3) decommissioning. Figure 3 presents the preliminary footprints for all four digester configurations under the “renovate” option.

Figure 4 shows preliminary footprints under the “decommission” option for Configurations 1 and 3. Configurations 2 and 4 would not fit on the site unless the dewatering building is renovated and reused or demolished.

Figure 5 shows the preliminary footprint under the “demolition” option. For brevity, only Configuration 4 is shown (the other configurations are similar in appearance).

A high-level screening at the September 23, 2021, project workshop with the County eliminated Configurations 1 and 4. Configuration 1 was eliminated because the total digester volume was considered excessive: nearly double that required to provide 14-day SRT (3.65 million gallons [MG] of primary plus secondary volume provided versus 1.87 MG primary volume required). Configuration 4 was eliminated to avoid the need for a fifth digester in the future. Configurations 2 and 3 were carried forward for further evaluation.

A comparison of each digester configuration option is presented in Section 5.1.

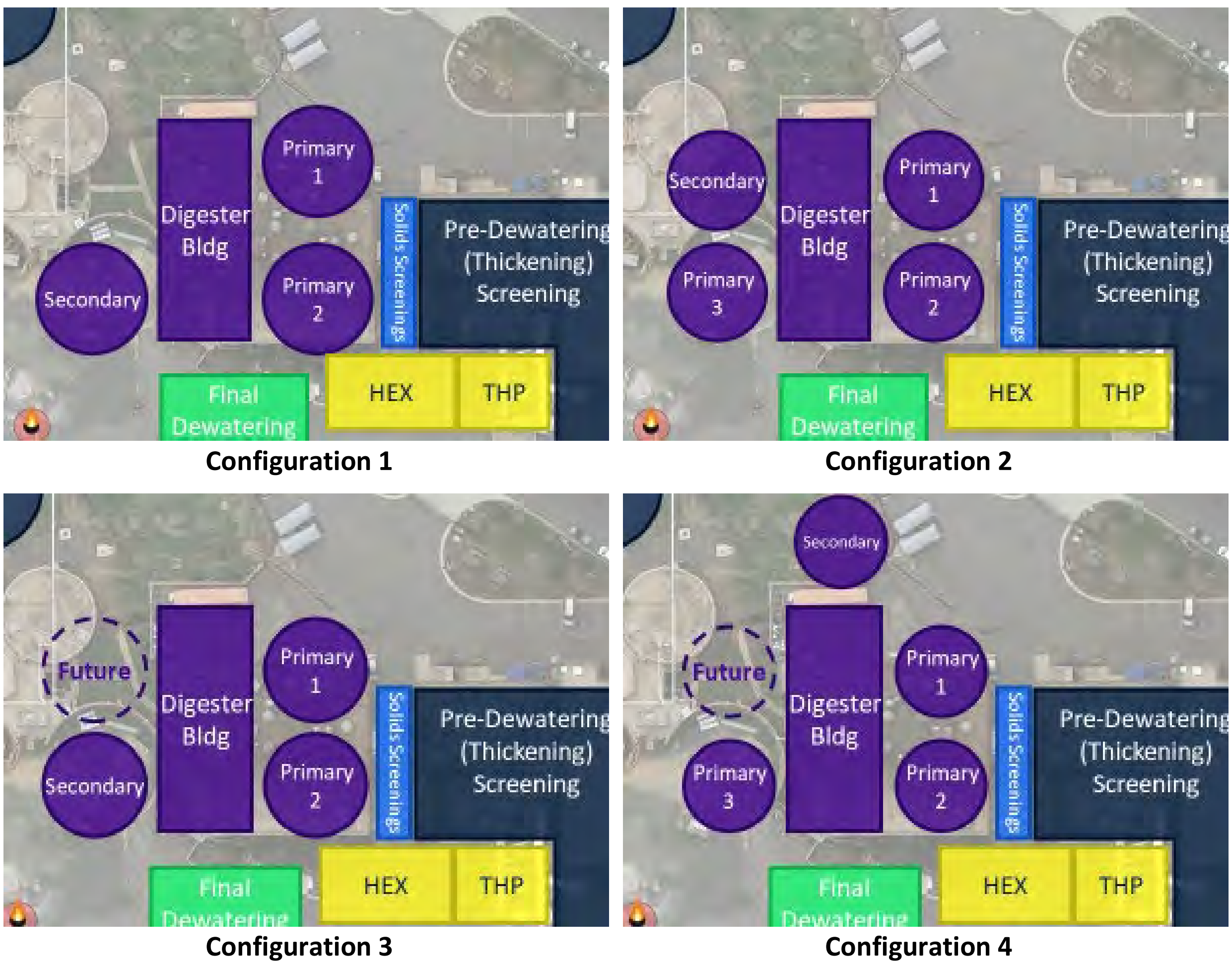
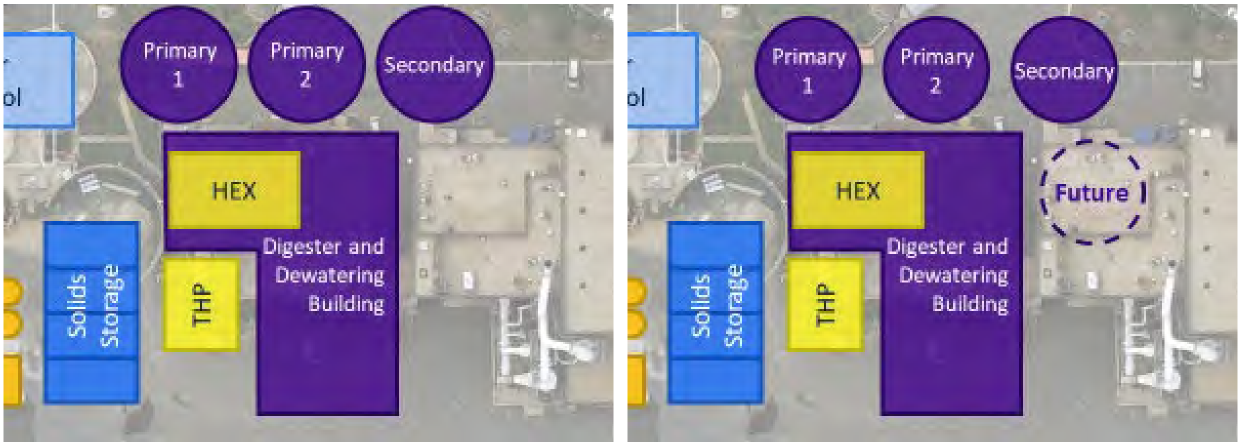


Figure 3. Preliminary Digester Facility Footprints: Renovate Dewatering Building Option



Configuration 1 **Configuration 3**

Figure 4. Preliminary Digester Facility Footprints: Decommission Dewatering Building Option

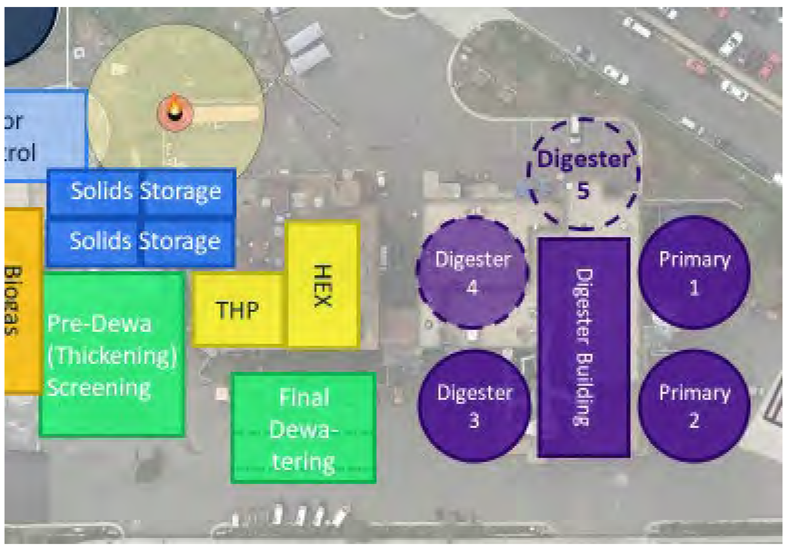


Figure 5. Preliminary Digester Facility Footprint: Demolish Dewatering Building Option

4.3 Digester Covers

Four types of digester covers were considered: floating, fixed, fixed submerged, and membrane. A high-level screening at the August 30, 2021, project workshop with the County eliminated floating covers and fixed submerged covers from further consideration and shortlisted fixed and membrane covers, as detailed later in this section.

The evaluation criteria for digester covers include the following:

- Ability to collect and convey digester gas
- Ability to contain digester foam, which can lead to nuisance, odor, and safety issues
- Ability to reduce fugitive odors
- Ability to accommodate a variety of mixing systems, including top-mounted equipment
- Ability to mitigate risks associated with tank overfilling and volume expansion

4.3.1 Floating Covers

Floating covers are the type of covers that were on the original Arlington WPCP digesters. These covers ride up and down on rails with the liquid surface. Floating gas holder covers ride up and down on both the liquid surface and the gas storage volume. The weight of a floating gas holder cover dictates the gas pressure. Floating covers were eliminated from further consideration for the following reasons:

- The gap between the cover and digester wall, which can allow fugitive odors
- The requirement of a flexible gas connection
- The fixed primary digester level
- The possibility of getting stuck in their tracks

4.3.2 Fixed Covers

Fixed covers are the most common type of covers used in THP applications. They are typically constructed of steel, but concrete fixed covers have become more common in the past few years. Fixed covers provide a large headspace, large surface area for gas release, the possibility of top-mounted mixers, and the ability to withdraw solids from the liquid surface via digester overflow piping. However, the underside is exposed to the corrosive atmosphere in the digester. Steel fixed covers are easier and less costly to install, but they require a side skirt and gas seal, which can be exposed to the corrosive tank atmosphere if the digester is operated at a low liquid level. Steel fixed covers require repainting approximately every 10 years. Concrete fixed covers are sealed regardless of liquid level and do not require periodic painting, but they are more costly and difficult to install.

4.3.3 Fixed Submerged Covers

Fixed submerged covers mimic the top of an egg-shaped digester, but for a cylindrical tank. These covers have limited headspace and only have a concrete construction option. Fixed submerged covers have limited surface exposed to the corrosive atmosphere and can have a top-mounted mixer. However, because of the limited headspace, the risk of overflows is higher. For these reasons, fixed submerged covers were eliminated from further consideration.

4.3.4 Membrane Gas Holder Covers

Membrane covers are inflatable hemispherical domes made of polyvinyl chloride (PVC)-impregnated fabric with the ability to store biogas. They typically consist of two membranes: the inner membrane contains the digester gas headspace, and the outer membrane provides structural support for the cover and is designed to resist wind and snow loads (Figure 6). Air at a fixed pressure is introduced and vented between the two membranes to regulate digester gas pressure. When more gas is being consumed than generated, the chamber is filled with air and the inner membrane deflates. When more gas is being generated than consumed, the chamber is vented and the inner membrane inflates.

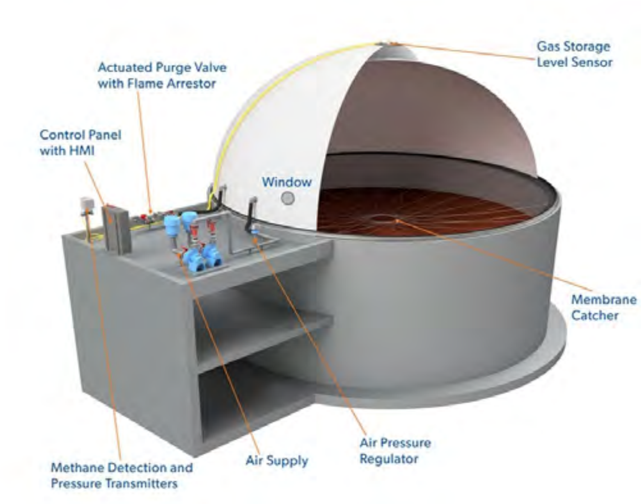


Figure 6. Membrane Gas Holder Cover

The main benefit of membrane covers is the variable headspace volume, which provides flexibility for biogas management and utilization. The most common mixing systems used with membrane covers are pumping or outboard draft tube systems. Membrane covers typically cannot be used with most types of roof-mounted mixers. Membrane covers typically have a life span of 10 to 20 years.

4.4 Digester Mixing

Digester mixing is intended to homogenize the contents of the digester, prevent settling of solids, prevent stratification, reduce short-circuiting, promote gas release, and prevent foaming. Mixing should minimize dead volume and distribute feed throughout the tank. Inadequate mixing can negatively impact digester performance (reduced volatile solids reduction and gas production), increase the risk of rapid volume expansions, and increase the frequency of tank cleaning.

The following five types of digester mixing systems were considered:

- Gas mixing
- Pump mixing
- Linear-motion mixing
- Mechanical draft tube mixing
- Slow-speed mechanical turbine mixing

A high-level screening at the August 30, 2021, project workshop with the County eliminated gas mixing, linear-motion mixing, and slow-speed mechanical turbine mixing from further consideration. The shortlisted alternatives were pump mixing and mechanical draft tube mixing.

4.4.1 Gas Mixing

Gas mixing operates by using compressors to withdraw biogas from the headspace and inject it back into the sludge using gas lances. This option was eliminated from further consideration because of the maintenance requirements associated with the gas compressors, the risk of foaming and scum accumulation, and lack of implementation with THP.

4.4.2 Pump Mixing

Pump mixing systems withdraw solids from the digester and discharge the sludge through nozzles located throughout the tank at a high velocity to maintain circulation and mixing in each digester. An example of a typical mixing pump and mixing nozzles is pictured in Figure 7.

Figure 7. Typical Pump Mixing System
Left: mixing pump Right: mixing nozzle

The main advantages of pump mixing systems are that there is no mechanical equipment within the digesters, it is compatible with all types of tank covers, and it does not require a minimum liquid level to operate. Redundancy can be provided by installing spare mixing pumps. Multiple manufacturers exist, so the system can be competitively bid to vendors.

The main disadvantage of pump mixing systems is the higher energy requirements compared to other options because of the head loss associated with pumping sludge through the mixing nozzles at high velocity. Additionally, gas entrainment or plugging of the pumps, nozzles, and piping can reduce system efficiency, further raising energy requirements to ensure adequate mixing. Because the pump suction and most of the discharge nozzles are in the lower portion of the tank, pump mixing has limited ability to fight stratification.

4.4.3 Linear-Motion Mixing

Linear-motion mixing consists of a paddle that moves up and down in the center of the tank. These mixers have low energy requirements and are relatively simple mechanically. This type of mixing minimizes retrofit costs, and mechanical maintenance can take place outside of the tank. This type of mixing works on fixed and floating covers. However, the mechanical equipment must be placed in the liquid, and no redundancy is provided. Linear-motion mixing is relatively new so there is not much information on mixer longevity and linear-motion mixing has not been implemented with THP. This mixing system can be challenging to operate with variable-level tanks because of the minimum level required for mixing. There is only one supplier of linear-motion mixers. For these reasons, linear-motion mixing was eliminated from further consideration.

4.4.4 Draft Tube Mixing

Mechanical draft tube mixers continuously transfer high volumes of sludge from the upper layer of the digester to the bottom using a propeller pump.

The main advantages of draft tube mixing systems are the lower energy requirements and better mixing performance compared to pump mixing. The propeller rotation can be reversed to change the direction of mixing and to free up rags that may have accumulated. Redundancy can be provided by installing additional draft tubes.

Draft tube mixers can be located either inside or outside the digester (Figure 8, top). External draft tube mixers are easier to maintain but typically cost 10 percent more than internal draft tube mixers because of the additional piping and maintenance platform. The motor for internal draft tube mixers can be mounted directly on a fixed digester cover. For digesters with membrane covers, the motor can be mounted on a platform on the inside edge of the tank; in this application, the sides of the mixer platform can be provided with walls that follow the slope of the membrane cover (Figure 9).

Figure 8. Typical Draft Tube Mixers
Left: internal roof-mounted draft tube Right: external draft tube

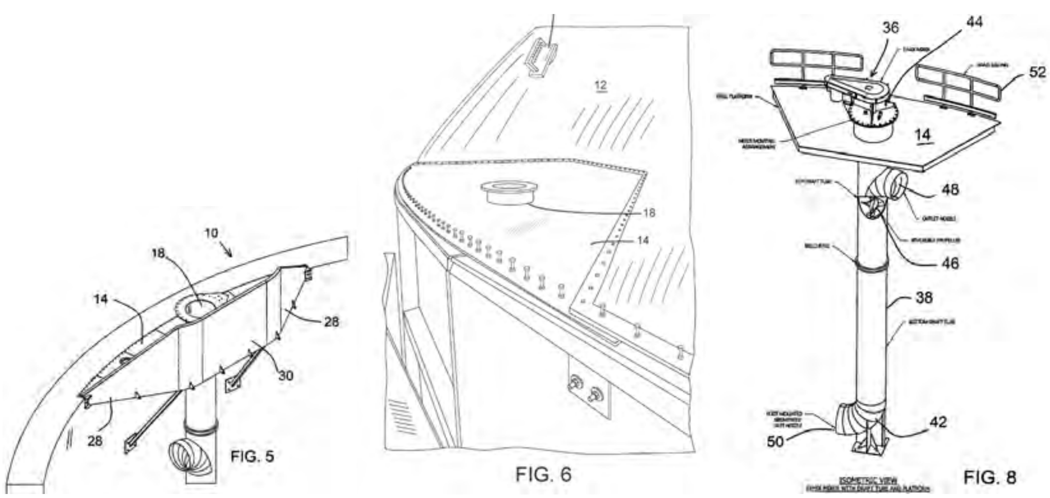


Figure 9. Draft Tube Mixer Design for Digesters with Membrane Covers

Draft tube mixing systems typically require a crane for removal and maintenance of the mixing propeller; however, maintenance of other components, such as the motor and gearbox, can generally be performed without a crane. Unlike pump mixing systems, draft tubes are sensitive to the liquid level and require a minimum level to operate effectively. Internal draft tubes are typically recommended for tanks with varying liquid levels.

4.4.5 Slow-Speed Mechanical Turbine Mixing

Slow-speed mechanical turbine mixing consists of a single roof-mounted turbine mixer in the center of the tank. This system has lower energy and maintenance requirements than other options. The mixer can be operated in forward or reverse. Mechanical equipment must be placed in the liquid, and no redundancy is provided. This mixing system is not compatible with membrane covers and has not been implemented with THP. Turbine mixers require a minimum liquid level and are not suitable for variable-level tanks. For these reasons, slow-speed mechanical turbine mixing was eliminated from further consideration.

5.0 Alternatives Comparison

This section presents a comparison of the relative advantages, disadvantages, and costs for the various digester alternatives evaluated.

5.1 Digester Configuration

A comparison of each digester configuration option is presented in Table 4. As noted in Section 4.2, Configurations 1 and 4 were eliminated at a previous workshop but are included in Table 4 for comparison.

Table 4. Comparison of Digester Configurations

Evaluation Consideration	Configuration 1	Configuration 2	Configuration 3	Configuration 4
Number of digesters (primary + secondary)	2 + 1	3 + 1	2 + 1	3 + 1
Compatible with site plan options? Renovate dewatering building Demolish dewatering building Decommission dewatering building	 ✓ ✓ ✓	 ✓ ✓ No	 ✓ ✓ ✓	 ✓ ✓ No
Able to meet target SRT at peak 14-day flows and loads at 30.8 mgd condition?	✓	✓	✓	✓
Excess digester volume to avoid 24/7 dewatering when one digester offline?	✓	✓	No	No
Total (primary + secondary) volume provided ÷ primary volume required for 30.8 mgd condition, MG	3.65 ÷ 1.87 195%	3.24 ÷ 1.87 173%	2.81 ÷ 1.87 150%	2.50 ÷ 1.87 133%
Sufficient capacity to accept FOG? Current (24.2 mgd) peak loads Average loading at 30.8 mgd condition Peak 14-day load at 30.8 mgd condition	 ✓ ✓ ✓	 ✓ ✓ ✓	 ✓ ✓ No	 ✓ ✓ No
Storage provided in secondary digester at 14-day peak load loads at 30.8 mgd, days (percentage of target 4 days)	7.0 (175%)	4.7 (116%)	5.4 (134%)	3.6 (90%)
Membrane volume, ft^3 per tank	62,000	41,000	46,000	31,000
Hours of gas storage at current average loading, assuming 10,000 gpd of FOG	2.6	1.8	2.0	1.4
Mitigation options to accommodate rapid volume expansion, between now and 30.8 mgd condition (estimated year 2052)	Operate primary digesters at lower level and/or use excess secondary digester volume	Operate primary digesters at lower level (~37 ft SWD).	Use excess secondary digester volume or divert overflow to external containment	Divert overflow to external containment
Able to meet target SRT at 40 mgd?	✓	✓	Only for average loads; a third primary digester is required for 14-day peak loads	Only for average loads; a fourth primary digester is required for 14-day peak loads

Of the shortlisted alternatives, Configuration 2 provides more volume, and thus offers more operational flexibility, especially at the design flow of 30.8 mgd. In order to construct Configuration 2 with the Decommission Dewatering Building option, it will be necessary to demolish the existing dewatering building as part of the Re-Gen program in order to construct the future 4th digester. Configuration 3 has lower initial construction costs and is easier to locate on site because of the fewer number of tanks and does not require the demolition of the existing Dewatering Building as part of the Re-Gen program for either the Renovate or Decommission Dewatering Building options. Configuration 3 would require that a fourth digester be built beyond the 30.8 mgd design condition. With the Renovate Dewatering Building option, all site work, prep, demolition, etc. will be completed for the 4th digester as part of the Re-Gen program. For the Decommission Dewatering Building option, the demolition of the existing dewatering building can be deferred to the later project at which time the 4th digester is to be constructed. Key differences between Configurations 2 and 3 are presented in the conclusion of this TM.

5.2 Digester Covers

Table 5 provides a side-by-side comparison of the relative advantages and disadvantages of each digester cover type. As noted in Section 4.3, floating and fixed submerged cover options were eliminated at a previous workshop but are included for comparison.

Table 5. Comparison of Digester Covers

Evaluation Consideration	Floating	Fixed Steel	Fixed Concrete	Fixed Submerged	Membrane
Odor containment	Poor	✓	✓	✓	✓
Maintenance requirements and mechanical reliability	Cover can get stuck on side tracks	Repaint ceiling every 10 years	✓ (Minimal)	✓ (Minimal)	Replace membrane every 10–20 years
Tanks can be designed to mitigate risk of overfilling	✓	✓	✓	No	✓
Compatible with top-mounted mixers	No	✓	✓	✓	Only draft tube
Allows sludge withdrawal from liquid surface	✓	✓	✓	No	✓
Ability to store digester gas	✓	No	No	No	✓

Fixed concrete covers are recommended for the primary digesters, as they provide more advantages over all other options, except for the ability to store gas. A membrane gas holder cover is recommended for the secondary digester to provide gas storage. The headspace of all digesters would be connected to allow gas to flow from the primary digesters to the gas storage.

5.3 Digester Mixing

Table 6 provides a side-by-side comparison of the relative advantages and disadvantages of each digester mixing system. As noted in Section 4.4, gas mixing, linear motion, and slow-speed mechanical turbine mixing systems were eliminated at a previous workshop but are included for comparison.

Table 6. Comparison of Digester Mixing Technologies

Evaluation Consideration	Gas Mixing	Pump Mixing	Draft Tube	Linear Motion	Turbine
Mechanical equipment located outside liquid	✓	✓	No	No	No
Low energy requirements	No	No	✓	✓	✓
Ability to prevent stratification	Poor	Limited	✓	✓	✓
Can be designed for redundancy	✓	✓	✓	No	No
Implemented with THP	No	✓	✓	No	No
Compatible with membrane covers	✓	✓	✓	No	No
Applicable for tanks with varying liquid levels	✓	✓	Medium	Poor	Poor
Common O&M challenges and other considerations	Gas compressors Scum layer Foaming	Air entrainment Nozzle plugging	Requires crane for mixer replacement	Single manufacturer (sole source)	

The energy requirements for pump mixing and draft tube mixing are compared for each shortlisted digester configuration in Table 7. Annual costs assume an electricity cost of $0.06 per kilowatt-hour (kWh).

Table 7. Shortlisted Alternatives Yearly Mixing Costs

Mixing Option	Digester Configuration 2: 3+1 54' digesters		Digester Configuration 3: 2+1 56' digesters	
	Total hp	Annual Electricity Cost	Total hp	Annual Electricity Cost
Pump Mixing	337	$132,000	283	$111,000
Draft Tube Mixing	91	$36,000	77	$30,000

Pump and draft tube mixing have the most advantages compared to the other three options. Pump mixing systems are generally easier to operate and maintain than draft tube mixing, especially for tanks with varying liquid levels, but they are not as effective at preventing stratification and require nearly four times as much energy as draft tube mixing systems. The type of mixing system will be further evaluated at a later stage of design.

5.4 Cost Comparison

Planning-level opinions of capital costs were prepared for each alternative based on preliminary quotes from vendors, with added multipliers for installation, contingencies, and other construction costs as shown in Table 8. Quoted costs of tanks and equipment provided by equipment suppliers are presented in Table 9.

Table 8. General Percentages for Cost Preparation

Parameter	Percentage
Sitework	15%
Electrical	20%
Instrumentation and controls	8%
Large and specialty pipe	5%
Geotechnical (piles)	7%
Project contingency	20%
Contractor mobilization/staging	5%
Contractor bonds/insurance	3%
Contractor overhead and profit	15%

Table 9. Tank and Equipment Costs

Item	Cost	Notes
54' diameter concrete tanks, each	$ 1,900,000	Precast construction (AWWA D110 Type III) Includes foundation, walls, and concrete cover Assumes deep foundations are required Cost is similar for concrete tank with open top
56' diameter concrete tanks, each	$ 2,100,000	
Membrane cover, each	$ 371,000	Similar cost is assumed for 56' and 54' diameter
Pump mixing system, per digester	$ 189,000	Similar cost is assumed for 56' and 54' diameter
External draft tube mixer, per digester	$ 481,000	For primary digesters with fixed covers
Internal draft tube mixer, per digester	$ 435,000	For primary digesters with fixed covers (provided for reference only, not used in capital costs)
Internal draft tube mixer, per digester	$ 535,000	For secondary digester with membrane cover

Preliminary 20-year costs (capital + 20-year O&M costs) were developed for both shortlisted digester configurations with both shortlisted pumping options and are presented in Table 10 and Table 11. Membrane replacement and pump mixing system maintenance are not included in the O&M costs, as they were assumed to apply equally to all alternatives.

Table 10. 20-Year Costs for Shortlisted Digester Configurations with Pump Mixing

Cost Item	Configuration 2 with Pump Mixing	Configuration 3 with Pump Mixing
Equipment Costs		
Tanks	$ 7,600,000	$ 6,300,000
Membrane cover	$ 371,000	$ 371,000
Mixing system	$ 759,000	$ 569,000
Equipment costs subtotal	$ 8,730,000	$ 7,240,000
Construction Costs		
Sitework	$ 1,310,000	$ 1,086,000
Electrical	$ 1,746,000	$ 1,448,000
Instrumentation and controls	$ 698,000	$ 579,000
Large and specialty pipe	$ 437,000	$ 362,000
Geotechnical (piles)	$ 611,000	$ 507,000
Project contingency	$ 1,746,000	$ 1,448,000
Contractor mobilization/staging	$ 437,000	$ 362,000
Contractor bonds/insurance	$ 262,000	$ 217,000
Contractor overhead and profit	$ 1,310,000	$ 1,086,000
Construction costs subtotal	$ 8,557,000	$ 7,095,000
O&M Costs		
20 years of mixing energy costs	$ 2,640,000	$ 2,220,000
O&M costs subtotal	$ 2,640,000	$ 2,220,000
Total 20-year cost (sum of subtotals above)	**$ 19,927,000**	**$ 16,555,000**

Table 11. 20-Year Costs for Shortlisted Digester Configurations with Draft Tube Mixing

Cost Item	Configuration 2 with draft tube mixing	Configuration 3 with draft tube mixing
Equipment Costs		
Tanks	$ 7,600,000	$ 6,300,000
Membrane cover	$ 371,000	$ 371,000
Mixing system	$ 1,978,000	$ 1,497,000
Equipment costs subtotal	$ 9,949,000	$ 8,168,000
Construction Costs		
Sitework	$ 1,492,000	$ 1,225,000
Electrical	$ 1,990,000	$ 1,634,000
Instrumentation and controls	$ 796,000	$ 653,000
Large and specialty pipe	$ 497,000	$ 408,000
Geotechnical (piles)	$ 696,000	$ 572,000
Project contingency	$ 1,990,000	$ 1,634,000
Contractor mobilization/staging	$ 497,000	$ 408,000
Contractor bonds/insurance	$ 298,000	$ 245,000
Contractor overhead and profit	$ 1,492,000	$ 1,225,000
Construction costs subtotal	$ 9,748,000	$ 8,004,000
O&M Costs		
20 years of mixing energy costs	$ 720,000	$ 600,000
O&M costs subtotal	$ 720,000	$ 600,000
Total 20-year cost (sum of subtotals above)	**$ 20,417,000**	**$ 16,772,000**

6.0 Summary and Conclusions

The following digester alternatives were shortlisted for further consideration:

- **Digester shape and construction:** Conventional concrete with a 1:1 height-to-diameter ratio.
  - The type of construction (precast AWWA D110 Type III or cast-in-place AWWA D110 Type I) will be evaluated as the design progresses.
- **Digester configuration and sizing:**
  - Primary digesters sized for 12-day target SRT at peak 14-day flows and loads.
  - One secondary digester of identical size, with ability to operate as a primary digester if one digester is out of service.
  - Shortlisted configurations:
    - **Configuration 2:** four (3+1) 54-foot-diameter digesters sized for the 40 mgd buildout condition
    - **Configuration 3:** three (2+1) 56-foot-diameter digesters sized for the 30.8 mgd (year 2052) condition
- **Digester covers:** Fixed concrete for primary digesters, membrane gas holder for secondary digester.
- **Digester mixing:** Pump and draft tube mixing systems.

- For the draft tube option, external mixers are recommended for the primary digesters, for ease of maintenance; internal mixers are recommended for the secondary digester, to accommodate variations in liquid level.

Key differences between the shortlisted digester configurations are presented in Table 12
Digester Configuration 3 is recommended, as capital costs are anticipated to be 20 percent lower than Configuration 2 (approximately $1.5 million lower cost). Configuration 3 is also compatible with all site plan alternatives, while Configuration 2 is possible only if the existing dewatering building is renovated or demolished. Additionally, the slightly larger tanks of Configuration 3 provide more volume for storage of digested sludge or gas in the secondary digester.

Two digester mixing systems are recommended for further consideration. Pump mixing has lower equipment costs and is more adaptable to varying tank levels. On the other hand, draft tube mixing provides better mixing and requires less energy. When taking into account operating costs, draft tube mixing is anticipated to have lower life-cycle costs than a pumped mixing system. Further investigations are recommended to determine which option is better suited for this project. Both mixing options are compatible with the shortlisted digester and cover options.

As design progresses, the project team will also consider measures to mitigate the disadvantages of Configuration 3. Because it provides less total volume, an emergency overflow tank or detailed operating procedures may be required to manage digester levels in the event of a tank outage or rapid volume expansion. Additionally, Configuration 3 is limited in the ability to accept FOG at peak 14-day loads under 30.8 mgd design conditions; however, it will likely be able to accept FOG at peak loads under current (24.2 mgd) conditions as well as average loads at 30.8 mgd conditions.

Finally, it should be noted that Configuration 3 would likely require an additional digester to provide a 12-day SRT at 14-day peak loads for 40 mgd buildout conditions; however, based on current projections, those conditions are unlikely to occur within the next few decades.

Table 12. Comparison of Shortlisted Digester Alternatives

Parameter	Configuration 2	Configuration 3
Design condition	40 mgd (buildout)	30.8 (year 2052)
Number of digesters (primary + secondary)	3 + 1	2 + 1
Capital cost with pump mixing system	$ 8.6 million	$ 7.1 million
Capital cost with draft tube mixing	$ 9.8 million	$ 8.0 million
20-year cost with pump mixing system	$ 19.9 million	$ 16.6 million
20-year cost with draft tube mixing	$ 20.4 million	$ 16.8 million
Compatible with all site plan options?	Not compatible with "decommission dewatering building"	✓
Digester volume adequate to avoid 24/7 dewatering when one digester offline?	✓	24/7 dewatering may be necessary at 30.8 mgd conditions when one digester is out of service
Sufficient capacity to accept FOG at 30.8 mgd?	✓	Only at average loads
Storage provided in secondary digester at 14-day peak load at 30.8 mgd, days	4.7	5.4
Membrane volume, ft^3 per tank	41,000	46,000
Mitigation options to accommodate rapid volume expansion, between now and 30.8 mgd condition (estimated year 2052)	Operate primary digesters at lower level (~37 ft SWD)	Use excess secondary digester volume or divert overflow to external containment
Able to meet target 12-day SRT at 40 mgd?	✓	Only for average loads; additional digester required for 14-day peak loads

Technical Memorandum No. 12

Date:	November 29, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Cooling Technologies Evaluation

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1.0 Introduction

This introductory section presents the background and purpose of this project and the thermal hydrolysis process (THP) pre-digester cooling evaluation, followed by a description of the evaluation approach.

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary solids (PS) and waste activated solids (WAS) thickening, dewatering, and Class B lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a Class A THP and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The purpose of this THP pre-digester cooling evaluation is to further assess and compare pre-digester sludge cooling alternatives following the workshop at which the options were presented. The results of this evaluation will inform and validate a final decision on which technology will be chosen for THP pre-digester cooling for inclusion in the Facilities Plan.

1.2 Evaluation Approach

A range of alternatives using various cooling technologies was developed for the THP pre-digester cooling. Conceptual process conditions, configurations, cooling technology sizing, and conceptual operating costs were prepared and then presented and reviewed at the September 23, 2021, project workshop with the County. Workshop participants screened and selected a short list of preferred technologies. In this evaluation, the shortlisted technologies are further evaluated and compared based on budgetary capital equipment costs, conceptual operating cost estimates, and non-cost considerations including space requirements and noise. A 20-year life-cycle cost analysis was completed to compare the shortlisted technologies.

2.0 Summary of THP and Cooling

A process flow diagram for the proposed THP process and pre-digester cooling is shown in Figure 1. After the hydrolyzed solids leave the THP flash tank at approximately 221 degrees Fahrenheit (°F), pathogen-free dilution water is added allowing the solids concentration to be reduced to approximately 0.09 pound total solids per pound sludge (lb-TS/lb-sludge) (9 percent). Digested sludge recycle is subsequently added to the stream to promote fluid flow, which also lowers the sludge temperature before entering the cooling heat exchangers (HEXs). The HEXs cool the sludge further to the mesophilic digestion design temperature of 98°F. There will be two primary digesters and one secondary digester that could act as a primary during maintenance. Each primary digester will have a HEX available and both HEXs will be piped to the secondary digester to provide the required redundancy when the secondary digester is acting as a primary. The THP process and downstream cooling is expected to operate continuously. The equipment evaluations for the HEX and cooling water, indicated in the blue dashed area in Figure 1, are included in this technical memorandum (TM).

All the cooling technology options presented in this TM include a similar style and configuration of HEX but differ in size, how cooling water is provided, and what happens to the cooling water after it has been used.

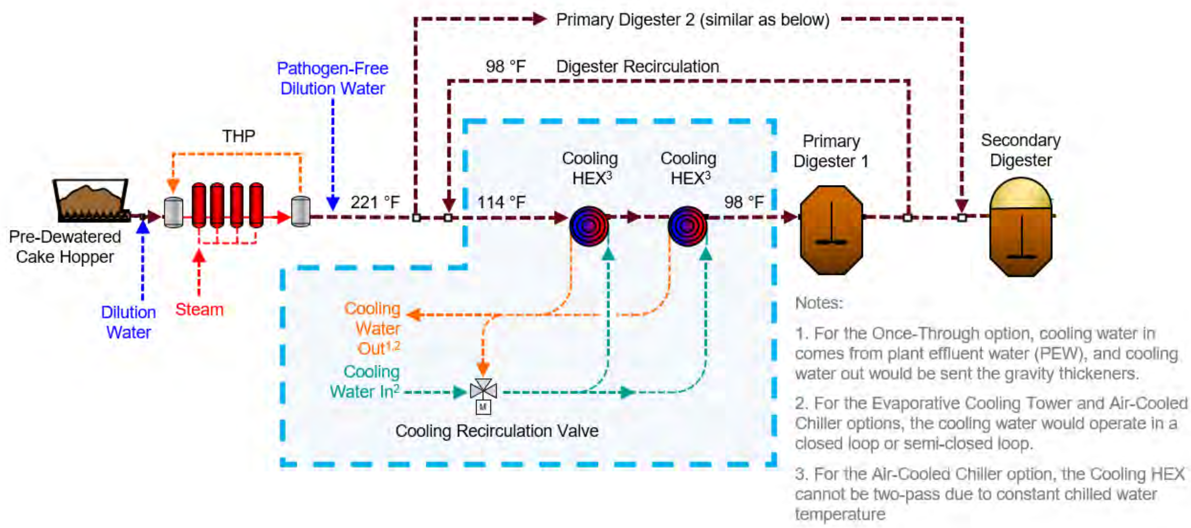

Figure 1. THP and Pre-Digester Cooling Process Flow Diagram

3.0 Design Criteria

This section presents the design criteria for the cooling technologies considered, including cooling demand and controls.

3.1 Cooling Demand

Concept engineering for cooling options is dependent on the required thermal load reduction of the mixed sludge through the HEX. The design conditions for the cooling HEX sizing and cooling water technologies were based on the WPCP peak 3-day loadings using 30.8-million-gallon per day (mgd) flow as detailed in *TM No. 1 Solids Production and Design Criteria.* The amount of heat transfer required to lower the mixed sludge temperature from 114°F to 98°F is given by the following equation and detailed in Table 1 below. The following assumes a specific heat (Cp) of 1.0 for the sludge:

$$\frac{MMBtu}{hr} = \frac{\Delta T \left(GPM * 60\ \frac{min}{hr}\right)\left(8.34\frac{lb}{gal}\right)\left(1.0\ \frac{BTU}{lb - {}^\circ F}\right)}{1{,}000{,}000}$$

Table 1. Digester Feed Sludge Process Design Conditions

Parameter	Design
Total mixed sludge flow from THP (gpm)	568
Mixed sludge flow per digester (gpm)	284
Mixed sludge temperature post-dilution/recycle (°F)	114
Mixed sludge viscosity (cP)	25.0
Mixed sludge density (lbm/ft^3)	61.3
Target digester feed temperature (°F)	98
Total cooling demand (MMBtu/hr)	4.4
Cooling demand per digester (MMBtu/hr)	2.2

3.2 Heat Exchanger Sizing and Design Conditions

One HEX is required for each primary digester under all cooling options described in this TM. The type and size of HEX will vary based on the cooling technology selected. Sizing of the HEX depends on the cooling flow temperature, mass flow rate, and specific temperatures of the HEX material and fluids. As the temperature difference increases across the HEX, the surface area required to maintain the same heat transfer rate decreases.

The material choice for the HEX tubes depends on the cooling liquid properties for each respective cooling option. Historically, THP installations have installed 316L stainless steel HEX for cooling the thermally hydrolyzed solids (THS). However, at the first THP installation in the United States, at the DC Water Blue Plains Advanced Wastewater Treatment Plant (WWTP), the installed 316 cooling HEXs exhibited pinhole leaks on the water side, which has been attributed to a high manganese content of the plant effluent cooling water. It was determined that the leaks were most likely from microbial-induced corrosion (MIC) from manganese consuming bacteria among other factors. Based on this experience, similar occurrences at Arlington when PEW has been used in HEXs, and the uncertainty associated with long-term corrosion resistance of 316 stainless steel with sludge cooling operations using plant effluent water (PEW) as the cooling liquid, Super Duplex 2507 alloy is recommended for the HEX tubes. This higher alloy material provides exceptional resistance to MIC. For the evaporative cooling tower and air-cooled chiller options, the cooling water will be a municipal-supplied treated closed loop, significantly less corrosive than PEW. The municipal water would be treated with a custom chemical treatment plan typically consisting of biocides such as bromine and sodium hypochlorite as well as anti-scalant and corrosion inhibitors. Therefore, 316 stainless steel is recommended for the cooling HEX material for these cooling options, as the treated cooling water has a substantially reduced risk of MIC.

The HEXs will be concentric steel tube, counterflow design (Figure 2), and will have two sludge and two water passes in series. The two-pass design allows flow to bypass one or both sections, allowing each pass to operate independently of the other during low-flow operating conditions or during maintenance operations where one pass can be taken offline (typically during winter months when the HEX cooling load can be met with less HEX area). The two-pass design will also allow a lower pressure drop for the sludge and water sides, lowering pumping costs.

Figure 2. Concentric-Tube Heat Exchanger

Figure 3 shows a simplified process flow diagram for a two-pass design with both HEXs operating to provide the full design cooling duty.

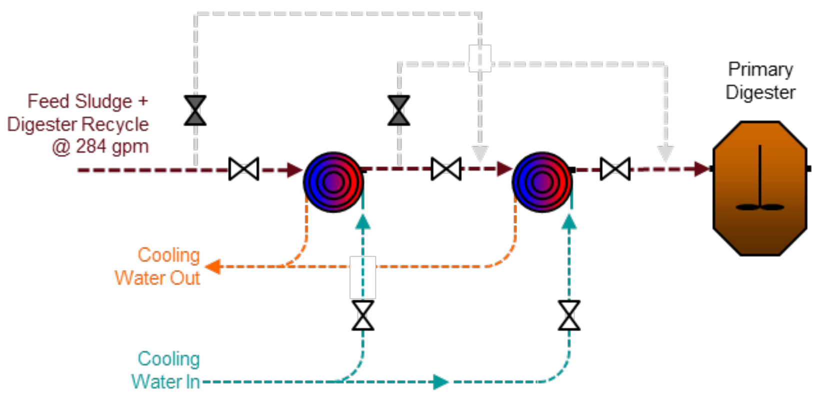

Figure 3. Two-Pass HEX Process Flow Diagram: Normal Conditions

Figure 4 shows a simplified process flow diagram for one of the two passes being isolated to handle the entire cooling duty.

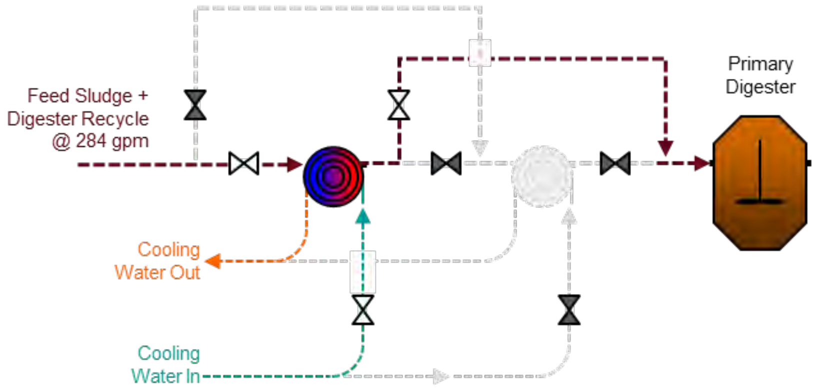

Figure 4. Two-Pass HEX Process Flow Diagram: Maintenance/Low Flow Conditions

3.3 Controls

The cooling water system controls the temperature of the cooled solids feed to the digester. This is accomplished primarily by modulating the cooling water flow rate. Cooling water temperature can also be controlled to a limited degree by recirculating a controlled water flow from HEX water effluent back to the HEX water influent. Cooling water temperature control has the added benefit of preheating cooling water during cold weather, minimizing the chances of fats, oils, and grease (FOG) from condensing on the HEX piping.

To have precise control over digester temperature and to prevent cycles of undershooting and overshooting the digester temperature set point, it is recommended that several tuning features be incorporated in the temperature control programming. These include, but are not limited to:

- Signal conditioning: adjustable time averages
- Adjustable set point dead bands
- Adjustable temperature correction rates
- Closed-loop control

The cooling water flow control should be programmed to use the flows and inlet and outlet temperatures to calculate heat exchange rate and efficiency and warn of fouling. Additionally, inlet and outlet pressures can be compared against expected head loss to warn of potential clogging.

In addition to control programming features, physical design elements can increase the stability and precision of the digester temperature control. These include selecting feedback signals that respond quickly to control changes. One example would be to control the cooling water flow based on feedback from HEX sludge outlet temperature rather than temperature in the digester (the latter of which would take many hours to reflect a temperature change resulting from a change in cooling water flow and could result in a choppy on/off control of water). Another physical recommendation is to place temperature-sensing devices in a flow stream; for example, placing digester temperature sensing on mixing pump suction, not on the digester itself.

4.0 Cooling Technology Evaluation

Five cooling water alternatives were reviewed at the September 16, 2021, project workshop with the County:

- Once-through cooling with PEW
- Mechanical draft evaporative cooling tower
- Air-cooled chiller
- Water-cooled chiller
- Air-cooled HEX (radiator)

The water-cooled chiller is an indoor unit that uses a refrigeration cycle to produce chilled water with heat rejected by the water loop to a cooling tower. This option was ruled out because of the high equipment costs and system complexity.

The air-cooled HEX, otherwise known as an air cooler or radiator, uses fans to force ambient air over tubes containing the water being used for the HEX cooling. This option was ruled out because of its inability to provide the amount of cooling required on the warmest days.

The once-through cooling, evaporative cooling tower, and air-cooled chiller cooling options were shortlisted following the workshop and are presented below with additional context on design criteria, space requirements, equipment costs, and annual operating cost estimates.

4.1 Once-Through Cooling

Using the existing site PEW in a once-through cooling design would provide the least complex option because no additional mechanical equipment would be required to cool the water. PEW would provide the necessary cooling through the concentric-tube HEX and then be sent to the gravity thickeners (GTs) to provide elutriation water to be confirmed during detailed design. Additionally, a new pump would be required in the PEW recirculation line to provide warm HEX water effluent back to water influent to control the HEX inlet temperature.

The PEW temperature varies throughout the year depending on outdoor ambient temperature conditions. Three years of temperature data were given and the monthly average, maximum, and minimum temperatures were extracted and are presented in Figure 5 and Table 2 below. The hottest effluent temperature recorded (84.3°F) was used as the design condition for sizing the HEX.

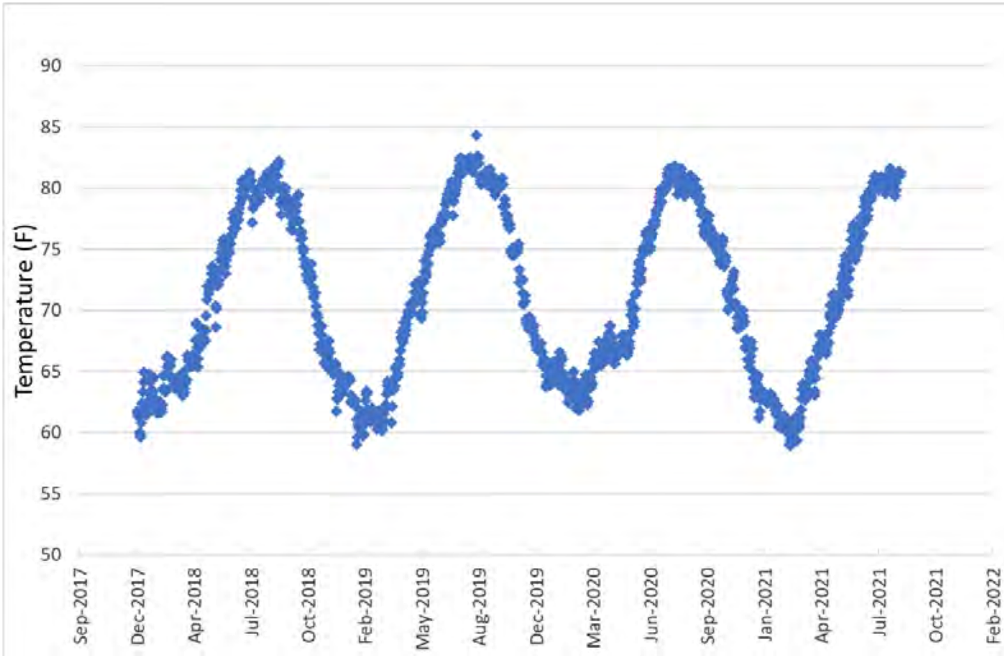

Figure 5. Plant Effluent Water Historical Temperatures, 2018–2021

Table 2. Plant Effluent Water Monthly Temperature Data, 2018–2021

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effluent average (°F)	62.9	62.1	63.8	67.2	71.4	76.3	80.2	80.8	79.4	75.8	69.7	65
Effluent maximum (°F)	66.6	66.2	67.4	70.6	76.2	79.5	82.5	84.3	82.2	80.8	73.8	67.6
Effluent minimum (°F)	59.1	58.9	59.4	63.1	66.3	73.4	77.2	78.9	76.1	71.2	65.4	61.2

The lower effluent temperatures in the winter reduce the required flow through a flow control valve to the HEXs, allowing one pass of the HEX to be taken offline for maintenance. The average effluent winter temperature of 64.3°F was used to size the HEX so that the winter-temperature effluent could handle the entire cooling duty with one pass. This eliminates the need to provide a redundant third HEX that would serve both primary digesters, and maintenance can be performed on the out-of-service portion of the HEX during winter months.

Water chemistry of the WPCP effluent may cause MIC in HEXs, even those made of stainless steel, thus requiring Super Duplex 2507 alloy to reduce that risk. The PEW also presents a higher risk of HEX fouling than using treated municipal water. The higher amount of fouling may require more periodic cleanings to take place than the other options. In addition, the relatively warm temperatures of the WPCP effluent would require larger HEX surface areas than the other options, leading to the most expensive HEXs of all the options.

This type of HEX typically requires low maintenance because it has no moving parts. Tube cleaning will be required when the pressure drop is abnormally high based on typical operating conditions or if HEX efficiency has decreased. Cleaning can typically be done with a pressure washer, stainless-steel tube brush, or pigging system; however, a maintenance schedule is not known at this time and will be based off specific site sludge and cooling water conditions. Feedback from a HEX supplier indicated that coupling gaskets may require maintenance attention if return bends are not properly removed and reinstalled during maintenance operation. The HEX supplier provided no indication that other THP installations have seen major HEX reliability issues.

The existing PEW pumps were assumed to be able to handle the additional system pressure head of pumping to and from the new HEXs. A hydraulic model will need to be completed to confirm this assumption. Table 3 below shows once-through cooling preliminary design criteria.

Table 3. Once-Through Cooling Preliminary Design Criteria

Parameter	Once-Through HEX	Unit
Total heat transfer capacity	4.4	MMBtu/hr
Heat transfer per digester	2.2	MMBtu/hr
Heat transfer per HEX pass	1.1	MMBtu/hr
PEW maximum inlet temperature	84.3	°F
PEW maximum outlet temperature	102.5	°F
PEW minimum inlet temperature	64.3	°F
PEW minimum outlet temperature	99.0	°F
HEX space required (L × W) per HEX	24 × 7 (qty. 2)	ft
Maximum PEW demand per HEX	250	gpm
Minimum PEW demand per HEX	105	gpm
Recirculation pump size per HEX	5	hp

Approximate sizes of the two HEXs are shown in Figure 6 and Figure 7 below with the dashed line indicating the pull space required for HEX maintenance.

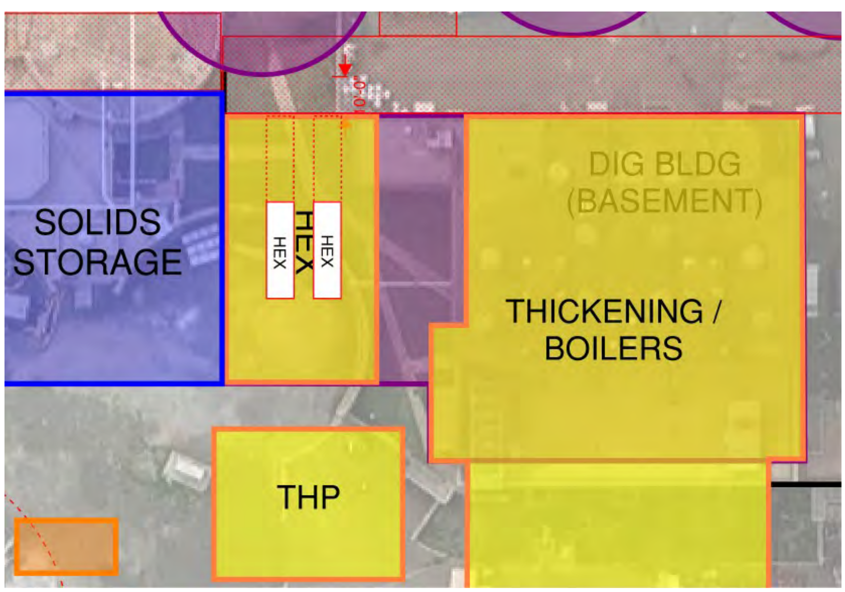

Figure 6. Once-Through Cooling: Equipment Plan View—Decommission Dewatering Building Option

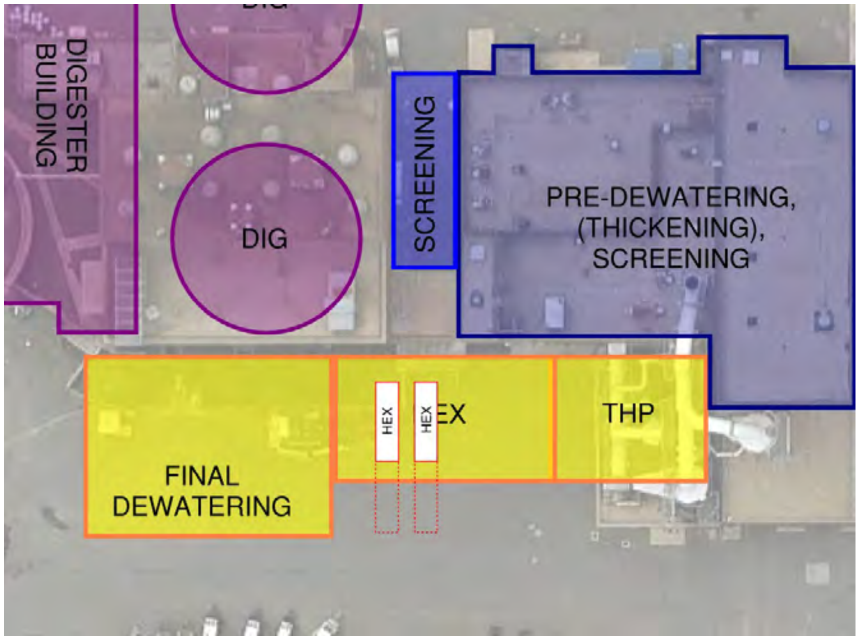

Figure 7. Once-Through Cooling: Equipment Plan View—Renovate Dewatering Building Option

The relative advantages and disadvantages of the once-through cooling option are listed in Table 4.

Table 4. Once-Through Cooling Advantages and Disadvantages

Advantages	Disadvantages
No additional cooling equipment required (beyond HEX)	Largest HEX required compared to other options
Smallest electrical load and simplest equipment complexity	More HEX maintenance because of PEW fouling
Fewer moving parts, low noise	Potential for corrosion: suggest high alloy steel HEX material
Small footprint	PEW would need to be recycled and retreated (optional if not sent to GTs)

4.2 Evaporative Cooling Tower

The concept for evaporative cooling towers is to cool the HEX discharge water through an evaporation process. Cooling water would be pumped through the HEX to the top of the cooling tower and sprayed onto a packed fill media, falling to the bottom basin. To maximize evaporative cooling capacity, fans would be used to pull a countercurrent stream of dry, cooler air through the packed fill media, evaporating some of the cooling water and providing the cooling effect. In winter, the cooling tower outlet water temperature would decrease and a portion of the flow would need to bypass the HEX to maintain the correct sludge temperatures. A continuous amount of treated municipal-supplied makeup water would be required to replenish the water lost through evaporation and the periodic blowdowns required to maintain the proper water chemistry in the cooling loop. A typical evaporative cooling tower is shown in Figure 8.

Figure 8. Evaporative Cooling Tower: Typical Unit

In the colder months of the year, the moisture from the sprayed water within the packed fill media would be absorbed in the air and condense in the cold, humid air. This condensate would be visible and create a “plume,” which the project team considers to be an unacceptable visual impact to the neighboring community. This problem can be mitigated by a plume abatement feature that typically works by equipping the tower with an additional section of coils near the exhaust air discharge. The hot process water piped through this section would heat the air before it contacts the cold ambient air outside of the tower. By discharging the air/water vapor mixture at a warmer temperature, the amount of water condensed after contacting the cold ambient air would be limited, and the visible plume would be reduced or eliminated. Additional pumping power would be required compared to a tower without plume abatement because of the additional pressure loss of sending the hot water through the heating coils. Figure 9 shows a cooling tower with and without plume abatement.

Figure 9. Evaporative Cooling Tower Example: Left Side Operating with Plume Abatement Off, Right Side Operating with Plume Abatement On

The climatic design temperatures for ambient air-cooled options were taken from the 2017 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) design standards for Ronald Reagan Washington National Airport (see Table 5). The 0.4 percent design conditions are commonly used in cooling tower design, signifying that the given temperatures are exceeded only 0.4 percent of hours in a year.

Table 5. ASHRAE 2017 Reagan National Airport Design Conditions

Monthly Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry bulb average	37.2	39.4	47.1	57.4	66.3	75.4	80	78.4	71.3	59.9	49.4	40.9

Table 6 shows the evaporative cooling design conditions taken from ASHRAE. The 0.4 percent ambient wet bulb temperature was used as the design condition for the evaporative cooling tower.

Table 6. ASHRAE 2017 Reagan National Airport Cooling Tower Design Conditions

Cooling Design Data	0.4% Design Condition
Ambient air dry bulb, °F	94.7
Ambient air wet bulb, °F	78.4

To provide redundancy for the system, the cooling tower would consist of two cells, each independently capable of handling 100 percent of the design conditions. A single cooling tower would provide the cooling requirements for both HEXs. The fans would be outfitted with a variable-frequency drive (VFD) to control motor speed. During maximum cooling load operation, the towers would each operate at half capacity, and during maintenance or unplanned outages, a single unit would operate at full capacity. A second cooling water pump would also be required as a redundant unit that could run in parallel at part load or be used in a standby capacity.

In the colder months, the cooling tower can produce outlet water temperatures much below those that the tower was sized for. To lower energy usage, the cooling tower equipment can include fan VFDs to control “free cooling” benefits where the fan speed is lowered to reduce the amount of cooling. To maintain a set cooling water temperature into the HEX, a controlled cooling tower bypass line could be incorporated, but considerations would need to be made for minimum flow requirements through the cooling tower. For plume abatement, a minimum flow would be required through the heating coils, which would limit the controllability of the HEX inlet water temperature.

HDR contacted two cooling tower manufacturers as representative suppliers for this type of equipment, Baltimore Aircoil (BAC) and SPX Cooling Technologies, for information and cost proposals. For both manufacturers, plume abatement is not available at the required size; therefore, the unit would be oversized for the application to include plume abatement. A preliminary estimate showed the cooling capacity of a plume-abated tower meeting the design criteria to be 50 percent oversized compared to a standard tower with plume (increasing the cost by approximately $250,000). A minimum hot water flow would be required through the cooling tower that would require additional bypass around the HEX.

Preliminary design criteria, shown in Table 7, are based on these vendor proposals.

Table 7. Evaporative Cooling Tower Preliminary Design Criteria

Parameter (per Tower)	Evaporative Cooling Tower (Plume Abatement)	Evaporative Cooling Tower (No Plume Abatement)	Unit
Number of fans	2	2	Qty.
Fan power	20	15	hp
Hot water inlet temperature	96	96	°F
Cooling water outlet temperature	86	86	°F
Cooling water flow	1,180	940	gpm
Total cooling tower space required (includes maintenance clearances) (L × W × H)	23 × 24 × 26	17 × 18 × 12	ft
HEX space required (L × W) per HEX	24 × 7 (qty. 2)	24 × 7 (qty. 2)	ft
Equipment operating weight (2-cell tower)	96,000	31,000	lb
Minimum cooling demand to tower	1,180	N/A	gpm
Water demand (makeup)	14	10	gpm
Power requirement	15	11	kW
Noise	86	86	dB(A) at 5 ft

Approximate sizes of the HEXs and cooling tower are shown in Figure 10 and Figure 11 below with the dashed line indicating the pull space required for HEX maintenance.

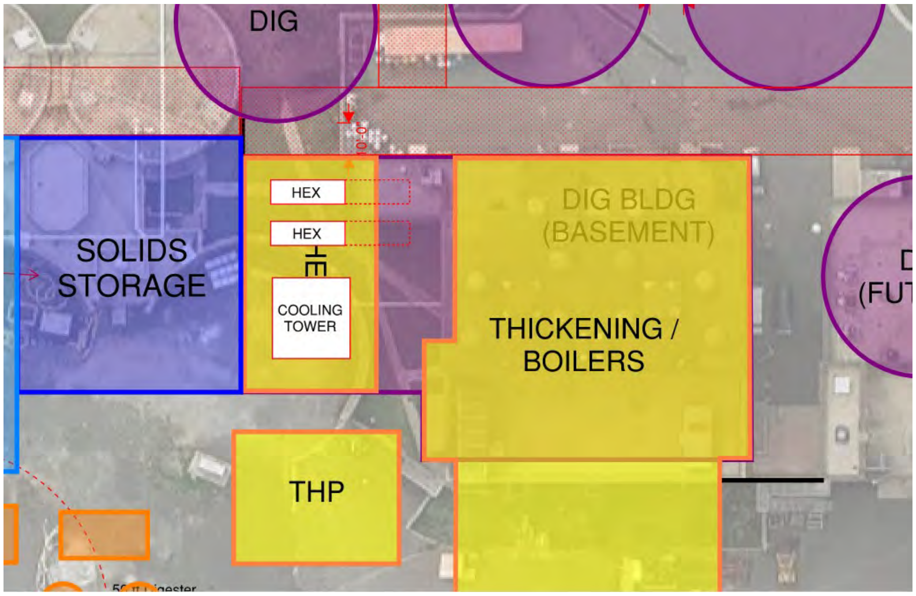

Figure 10. Evaporative Cooling Tower (Plume Abatement): Equipment Plan View—Decommission Dewatering Building Option

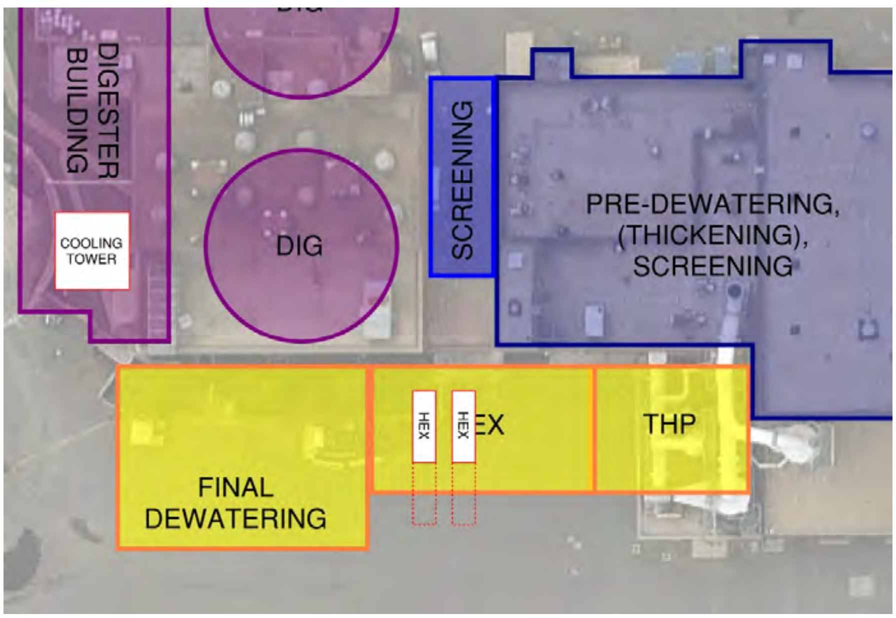

Figure 11. Evaporative Cooling Tower (Plume Abatement): Equipment Plan View—Renovate Dewatering Building Option

The relative advantages and disadvantages of the evaporative cooling tower option are listed in Table 8.

Table 8. Evaporative Cooling Tower Advantages and Disadvantages

Advantages	Disadvantages
Closed-loop system with treated municipal-supplied water: HEX less likely to have fouling, corrosion, and scaling	Cooling tower located outdoors: plume abatement may be required (higher cost)
316L stainless-steel material acceptable	Unit physical height may cause aesthetic concern
Reduced size of HEX compared with once-through HEX	Requires treated water makeup source
	Additional noise for fan operation
	Minimum allowable cooling water temperature to the HEX and minimum cooling water flow required for plume abatement option may complicate operation and control of the system

4.3 Air-Cooled Chiller

Mechanical air chillers make use of the vapor-compression refrigeration cycle to remove heat from a propylene glycol liquid stream and reject it to a warmer heat sink. Operation of a mechanical chilling cycle requires the use of an electrically driven compressor. The major advantage of this technology is that it can achieve lower cooling temperatures than both the once-through and cooling tower options, which are limited by the PEW temperatures and ambient air temperature, respectively. The lower temperatures would reduce the required size of the HEX. However, air-cooled chillers typically operate at a constant chilled water temperature, which does not make a design case for a single-pass isolation redundancy method feasible. A third redundant two-pass HEX is used as the basis for design for the air-cooled chiller cooling option.

In the colder months when the ambient air temperature is less than the target cooling temperature, an air-cooled chiller can be outfitted with a water-side economizer that can use “free cooling.” In this configuration, ambient air is used to directly remove heat from the cooling water, reducing the load on the refrigeration cycle, thereby reducing the compressor electrical load. The fan’s speed can also be modulated with a VFD to save on power when the required cooling load is reduced.

A single chiller would provide the cooling requirements for both HEXs. To provide redundancy, a second chiller would be required that can provide the full design cooling load. A second cooling water pump would also be required as a redundant unit that could run in parallel at part load or be used in a standby capacity. A typical air-cooled chiller is shown in Figure 12. Table 9 shows air-cooled chiller preliminary design criteria.

Figure 12. Air-Cooled Chiller: Typical Unit

Table 9. Air-Cooled Chiller Preliminary Design Criteria

Parameter (Per Chiller)	Air-Cooled Chiller	Unit
Cooling load	396	Tons cooling
Number of fans	20	Qty.
Water inlet temperature	85	°F
Chilled water outlet temperature	65	°F
Cooling water flow	500	gpm
Chiller space required (L × W × H): per chiller	38 × 8 x 8	ft
HEX space required (L × W) per HEX	24 × 7 (qty. 3)	ft
Equipment operating weight: per chiller	22,000	lb
Water demand	Closed cycle	-
Max power	410	kW
Noise	101	dB(A) at 30 ft

Approximate sizes of the HEXs and air-cooled chillers are shown in Figure 13 and Figure 14 below with the dashed line indicating the pull space required for HEX maintenance.

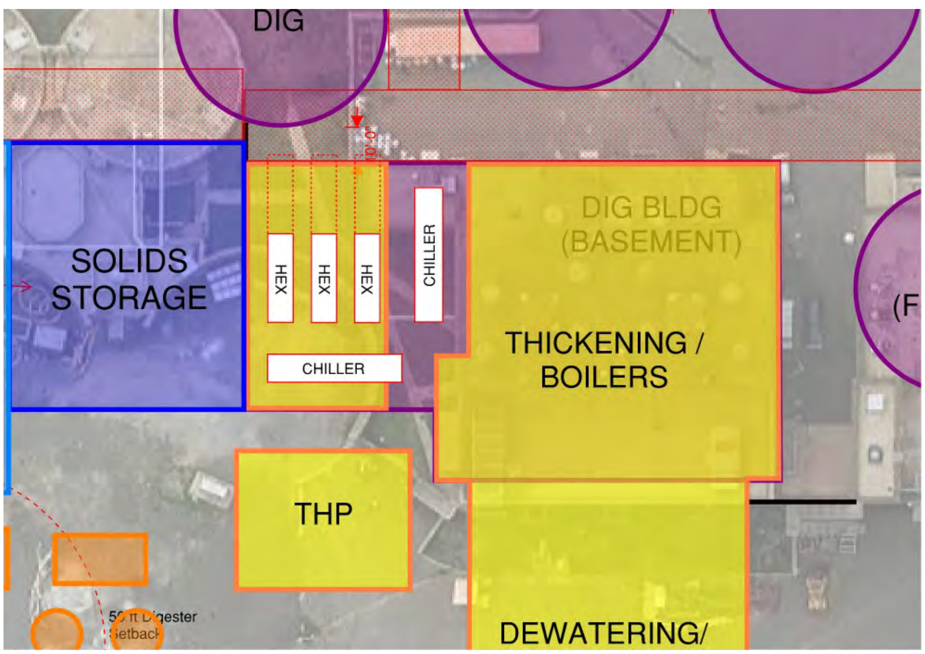

Figure 13. Air-Cooled Chiller: Equipment Plan View—Decommission Dewatering Building Option

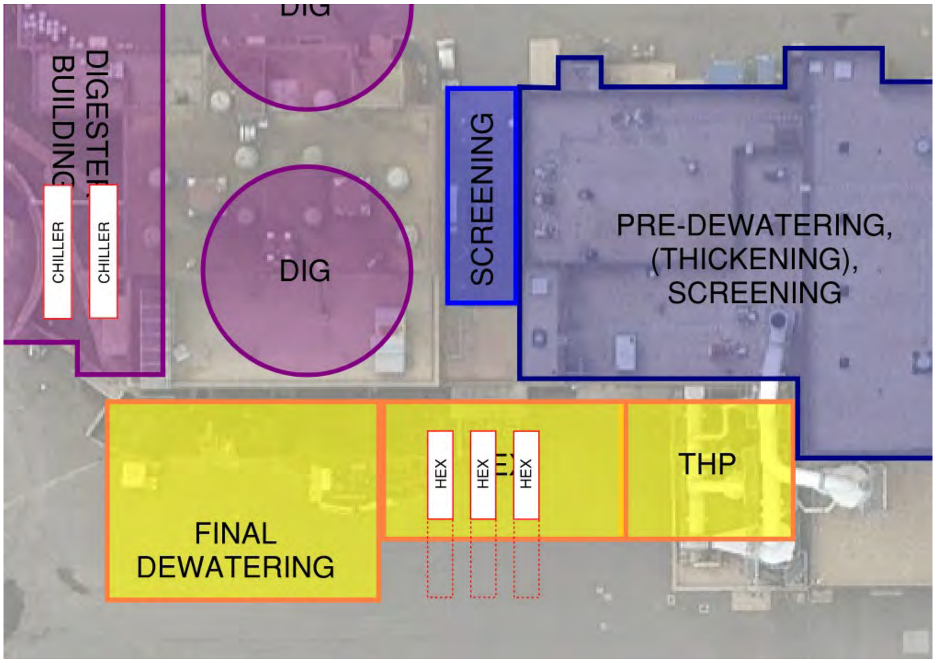

Figure 14. Air-Cooled Chiller: Equipment Plan View—Renovate Dewatering Building Option

The relative advantages and disadvantages of the air-cooled chiller are listed in Table 10.

Table 10. Air-Cooled Chiller Advantages and Disadvantages

Advantages	Disadvantages
Closed-loop system with treated municipal-supplied water: HEX less likely to have fouling, corrosion, and scaling	Redundancy requires additional chiller and chilled water pump
316L stainless-steel material acceptable	Located outside: aesthetics and impact of weather on performance and equipment degradation
Reduced surface area per HEX	High operating costs for electricity consumption
	Additional noise for fan/compressor operation

5.0 Technology Comparison

This section presents a side-by-side comparison of the relative advantages and disadvantages, design criteria, and equipment costs for the cooling technologies evaluated. It also identifies and compares operating costs for the shortlisted technologies.

5.1 Market Comparison

A market analysis was completed looking at current facilities with THP installed or in construction in the United States. All the facilities shown in Table 11 below use once-through technologies with plant effluent or evaporative cooling towers. No THP facility in the United States uses an air-cooled chiller technology.

Table 11. Cooling Technologies Implemented at North American THP Facilities

Agency	Site	Project Status	Cooling Technology
DC Water, Washington, DC	Blue Plains Advanced WWTP	Started up in 2014	Once-through with plant effluent
Medina, Ohio	Holtz WWTP	Started up in 2018	Once-through with plant effluent
HRSD, Virginia	Atlantic WWTP	Started up in 2020	Once-through with plant effluent
Trinity River Authority (Dallas, Texas)	Central Regional Wastewater System	In construction; startup in 2021	Evaporative cooling tower
City of Raleigh, North Carolina	Neuse River RRF Bioenergy Recovery Project	In construction; startup in 2022	Evaporative cooling tower
WSSC, Maryland	Piscataway WRRF Bioenergy Facility	In construction; startup in 2023	Once-through with plant effluent
Kansas City, Missouri	Blue River Biosolids Facility	In design	Evaporative cooling tower (tentative)

5.2 Advantages/Disadvantages Comparison of Technologies

Table 12 provides a side-by-side comparison of the relative advantages and disadvantages of each technology. Design criteria are compared in Table 13 for the different cooling technologies.

Table 12. Cooling Technology Advantages and Disadvantages Comparison

Advantages/ Disadvantages	Once-Through	Evaporative Cooling Tower	Air-Cooled Chiller
Advantages	+ No additional cooling equipment required + Smallest electrical load and simplest equipment complexity + Fewer moving parts, low noise + Small footprint + Commonly used with THP	+ Closed-loop system with treated municipal-supplied water: HEX less likely to have fouling, corrosion, and scaling + Stainless-steel material acceptable + Reduced size of HEX + Has been implemented with THP	+ Closed-loop system with treated municipal-supplied water: HEX less likely to have fouling, corrosion, and scaling + Stainless-steel material acceptable + Reduced size of HEX
Disadvantages	- Largest HEX required compared to other options - More HEX maintenance because of PEW fouling - Potential for corrosion: suggest high alloy steel HEX material - PEW would need to be recycled and retreated (optional if not sent to GTs)	- Cooling tower located outdoors: plume abatement has higher capital costs - Unit physical height may cause aesthetic concern - Requires treated water makeup source - Additional noise for fan operation - Minimum allowable cooling water temperature to the HEX and minimum cooling water flow required for plume abatement may complicate operation and control of the system	- Redundancy requires additional chiller and chilled water pump - Located outside: aesthetics and impact of weather on performance and equipment degradation - High operating costs for electricity consumption - Additional noise for fan/compressor operation - No known THP installations

Table 13. Cooling Technology Design Criteria Comparison

Parameter	Once-Through	Evaporative Cooling Tower (Plume Abatement)	Evaporative Cooling Tower (No Plume Abatement)	Air-Cooled Chiller	Unit
Cooling equipment quantity	N/A	2 (cells)	2 (cells)	2	Qty.
HEX inlet water temperature	84.3	86.0	86.0	65.0	°F
Max cooling water flow	250 (per HEX)	1,180 (total)	940 (total)	500 (total)	gpm
Min cooling water flow	105 (per HEX)	1,180 (total)	470 (total)	500 (total)	gpm
HEX outlet water temperature	98.5	90.3	90.3	80.7	°F
HEX heat transfer area (per HEX)	2,100	1,500	1,500	700	ft^2
HEX sludge velocity	6.4	6.4	6.4	6.4	ft/s
HEX water velocity	3.1	4.5	4.5	3.1	ft/s
Mixed sludge pressure drop	79	48	48	21	psi
Cooling water pressure drop	16	25	25	4	psi
Total cooling equipment space required (L x W x H)	N/A	23 × 24 × 26 552	17 × 18 × 12 306	38 × 20 × 8 760	ft ft^2 (total)
Cooling equipment operating weight	N/A	96,000	31,000	22,500 45,000	lb per unit lb total weight
Maximum water demand	500 (PEW)	14 (makeup)	10 (makeup)	N/A	gpm
Cooling water pump configuration	4 × 5 hp (recirculation)	2 × 30 hp	2 x 25 hp	2 × 15 hp	
Max cooling equipment power requirement (excluding pumps)	N/A	15	11	410	kW total
Used with existing THP sites	Yes	Yes	Yes	No	

5.3 Operating Cost Assumptions

Annual and 20-year operating costs were estimated at the design average WPCP flow of 30.8 mgd, and the 3-day peaking factor as detailed in *TM No. 1 Solids Production and Design Criteria*. The annual and 20-year operating costs were calculated based on a constant THP sludge flow of 568 gallons per minute (gpm). Operating costs included cooling water pump electricity, cooling tower fans, makeup water pump electricity, and municipal water supply costs.

5.3.1 Once-Through Cooling Operating Costs

For the once-through cooling method, the maximum PEW temperatures shown in Table 2 above were used to calculate the mass flow rate of PEW required to meet the cooling demand. The total PEW cooling demand for both digesters was calculated to range between approximately 200 gpm in the colder months and 500 gpm in the hotter months. The existing PEW pumps were assumed to be capable of handling the additional system pressure head of pumping to and from the new HEX. A hydraulic model is required to confirm this assumption. A recirculation pump preliminarily sized at 5 horsepower (hp) per HEX is operating throughout the year to provide temperature control of the PEW into each HEX.

The recirculation pump will be variable speed and will modulate the PEW recirculation to maintain a constant temperature into the HEXs.

It is assumed that the PEW can be used as elutriation water for the GTs, thus not requiring any additional operating costs for retreatment. In the operating scenario where the PEW would need to bypass the GTs, a retreatment cost of $0.50/1,000 gallons should be applied to the PEW flow that accounts for pumping costs to and from the PEW source.

5.3.2 Cooling Tower Operating Costs

The cooling tower operating costs were based on a two-cell tower, each sized for 100 percent of the design cooling load. Only one fan is required to operate at full load, and the fan is equipped with a VFD to reduce the fan speed and electrical load in the colder months. For the plume abatement option, the fan was assumed to operate between its rated power of 20 hp in the summer months and 5 hp in the colder months. For the non-plume abatement option, the rated fan power is 15 hp in the summer months and 5 hp in the colder months.

The selected model of cooling tower with plume abatement required a minimum flow through the tower of 1,180 gpm. Using an assumed design system head of 75 feet (includes static lift of cooling tower, pressure drop through HEX, and piping friction losses), the circulating water pump size is estimated to be 30 hp. This pump was assumed to operate at a constant speed throughout the year. For the non-plume abatement option, the circulating water pump size was estimated at 25 hp because of the lower flow rate requirements.

It was assumed that the makeup water was supplied by the municipal source at a pressure capable of meeting the cooling tower requirements. Further analysis needs to be completed to verify that a makeup water pump is not required.

Municipal water chemical treatment costs were assumed to be negligible for this analysis. The municipal water will need to be periodically tested and may need a biocide and chemical treatment for scaling and corrosion prevention in the tower. The costs for this testing and chemical addition were assumed to be negligible for this analysis.

5.3.3 Air-Cooled Chiller Operating Costs

Based on the outside ambient temperature, an air-cooled chiller equipped with variable-speed fans, variable-speed compressor, and free cooling can be modulated, saving electricity costs. As the ambient temperature decreases, a chiller can use the free cooling capabilities and reduce the compressor power, decreasing the power from around 410 kilowatts (kW) to around 30 kW during the coldest days. The total compressor and fan power was modeled as an average monthly usage based on the average ambient dry-bulb temperature shown in Table 5 above.

The required flow through both HEXs using 65°F chilled water was approximately 500 gpm to meet the full cooling load. Using an assumed design system head of 75 feet (includes pressure drop through chiller, pressure drop through HEX, and piping), a 15 hp pump was chosen that would operate at a constant speed throughout the year.

5.4 Cost Comparison for Shortlisted Technologies

Conceptual equipment and construction costs were prepared for each alternative based on preliminary equipment quotes from vendors and general percentages for site work, contingencies, and general contractor costs as shown in Table 14.

Table 14. General Percentages for Cost Preparation

Parameter	Percentage
Contractor mechanical and installation	50%
Contractor mobilization/staging	5%
Contractor bonds/insurance	3%
Contractor overhead and profit	15%
Project contingency	20%

Annual and 20-year present-value operating costs were estimated for the shortlisted cooling technologies. Operating cost estimates considered the following annual costs:

- Power at $0.06 per kilowatt-hour [kWh]
- Retreatment of WPCP effluent at $0.50/1,000 gallons (for retreatment operating condition—not included in base option)
- Municipal supply makeup water at $4.91/1,000 gallons

Present-value costs were calculated for the 20-year analysis period using a nominal interest rate of 4.0 percent. Cooling option costs are compared in Table 15. A 20-year present value of costs for each option is presented for comparison.

Table 15. Capital and Operating Costs: Annual and 20-Year Present Value

Parameter	Once-Through Cooling	Evaporative Cooling Tower (Plume Abatement)	Evaporative Cooling Tower (No Plume Abatement)	Air-Cooled Chiller
Capital Costs				
Cooling equipment	$0	$420,000	$155,000	$650,000
Pumps	$10,000	$40,000	$36,000	$30,000
HEX	$1,540,000	$1,150,000	$1,150,000	$666,000
Subtotal equipment cost	*$1,550,000*	*$1,610,000*	*$1,341,000*	*$1,346,000*
Contractor cost	$775,000	$805,000	$671,000	$673,000
Mobilization and bonds	$124,000	$129,000	$108,000	$108,000
Contractor overhead and profit	$233,000	$242,000	$202,000	$202,000
Contingency	$310,000	$322,000	$269,000	$270,000
Total capital cost	*$2,992,000*	*$3,108,000*	*$2,591,000*	*$2,599,000*
Annual Operating Costs				
Cooling equipment electricity	$0	$6,000	$4,000	$95,000
Pump electricity	$4,000	$12,000	$10,000	$6,000
Makeup water costs	$0	$37,000	$26,000	$0
Water treatment costs	$0	$0	$0	$0
Total annual operating cost	$4,000	*$55,000*	*$40,000*	*$101,000*
20-year Present-Worth Operating Costs				
Cooling equipment electricity	$0	$70,000	$53,000	$1,290,000
Pump electricity	$60,0000	$160,000	$140,000	$80,000
Makeup water costs	$0	$500,000	$360,000	$0
Water treatment costs	$0	$0	$0	$0
Total 20-year present-worth operating costs	*$60,000*	*$730,000*	*$553,000*	*$1,370,000*
Total 20-year Present Value of Costs	**$3,052,000**	**$3,838,000**	**$3,144,000**	**$3,969,000**

As part of the once-through cooling option, the annual and 20-year present-value operating costs were analyzed in the scenario where the WPCP effluent from the HEX could not be sent as elutriation for the GTs and instead, to drain. Using the approximate cost of $0.50/1,000 gallons, the estimated annual cost based on the maximum PEW demand at design conditions would be approximately $90,000 and approximately $1.2 million for a 20-year present value basis, resulting in a total 20-year cost of $4.2 million.

6.0 Summary and Conclusions

The cooling tower option with plume abatement presented the highest capital costs primarily because of the increased cooling tower size and the additional piping needed for plume abatement. The once-through design option had the next-highest costs because it required the largest HEX surface area and because of the high cost of the upgraded HEX alloy to prevent corrosion. The air-cooled chiller option had the next-highest capital costs primarily because of the low chilled water temperature, reducing the required HEX size and cost. The evaporative cooling tower option without plume abatement had the lowest capital costs because of the much cheaper tower compared to the plume abatement option as well as the smaller stainless-steel HEX compared to the once-through option.

The air-cooled chiller option had the highest operating costs because of the high compressor electricity loads. The savings from the smaller HEX did not pay for the high operating costs compared to the other three options. The options with the next-highest operating costs were the cooling tower options because of the fan power, pumping costs for the cooling water, and the cost of the municipal-supplied makeup water needed for evaporation losses and periodic blowdown. The operating costs were very low for the WPCP effluent option because the water can be used as elutriation for the GTs and would not need to be retreated, leaving only a small electrical pumping load because of recirculation of the effluent for temperature control.

The cooling tower could be placed on a roof or on the ground; however, pumping costs would increase as the height of the cooling tower water inlet is increased. The overall footprint would be lower for the cooling tower than for the chiller; however, the approximate 26-foot height of the cooling tower with plume abatement could pose an aesthetic issue for the site.

Although not included at this stage of the quantitative analysis, replacement and maintenance costs for the cooling tower and chiller equipment should be considered because of the added mechanical complexity and moving parts. This equipment can be assumed to have a life expectancy of 20 years.

HDR recommends including the once-through cooling with PEW as the basis for costs and design in the Facilities plan. The evaporative cooling tower options could be considered for the final design should any design parameters or equipment costs significantly change.

Next steps required to confirm the design of the cooling system should include analysis of the following items:

1. PEW/cooling tower pumping total dynamic head (TDH) analysis including preliminary piping model
2. Minimum cooling water temperature for the cooling HEX to prevent FOG buildup
3. Water quality analysis on PEW to confirm suitability of materials and fouling potential.
4. Effect of warm effluent for GT elutriation
5. Impact of a cooling tower plume on community aesthetics

Technical Memorandum No. 13

Date:	December 14, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Odor Control Facility Evaluation

Contents

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1.0 Introduction

This introductory section presents the background and purpose of this project and the odor control facilities evaluation, followed by a description of the evaluation approach.

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary solids (PS) and waste activated solids (WAS) thickening, dewatering, and lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a thermal hydrolysis process (THP) and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The purpose of this odor control facilities evaluation is to assess and compare alternatives for establishing permanent odor control facilities for the new solids processes. The results of this evaluation will inform decisions on overall site planning and utility requirements for inclusion in the Facilities Plan.

1.2 Evaluation Approach

Four odor control alternatives were developed for comparison based on preliminary design criteria established through:

- Estimated foul-air exhaust rates for the potential odor sources
- Estimated peak and average concentrations of odorants in combined foul-air exhaust flows
- Identified odor treatment system design parameters
- Identified odor collection and treatment system arrangement and redundancy requirements

For each odor control alternative, conceptual odor control facility layouts and life-cycle costs were developed.

2.0 Summary of Existing Facilities

There are three existing odor control systems at the WPCP: the south, north, and dewatering building (DWB) odor control systems.

The south odor control system currently serves the following areas:

- Four Mile Run Pump Station
- Preliminary treatment building (PTB)
- Dissolved air flotation thickener (DAFT)
- Gravity thickeners (GTs)
- Sludge storage tanks (SSTs)

The north odor control system primarily serves the equalization (EQ) tanks, the primary clarifier effluent channel, the backup screens and various flow structures. The DWB odor control system serves the entire DWB including multiple process points within the building and the truck bays.

The locations of the three scrubber systems and facilities served are shown in Figure 1.

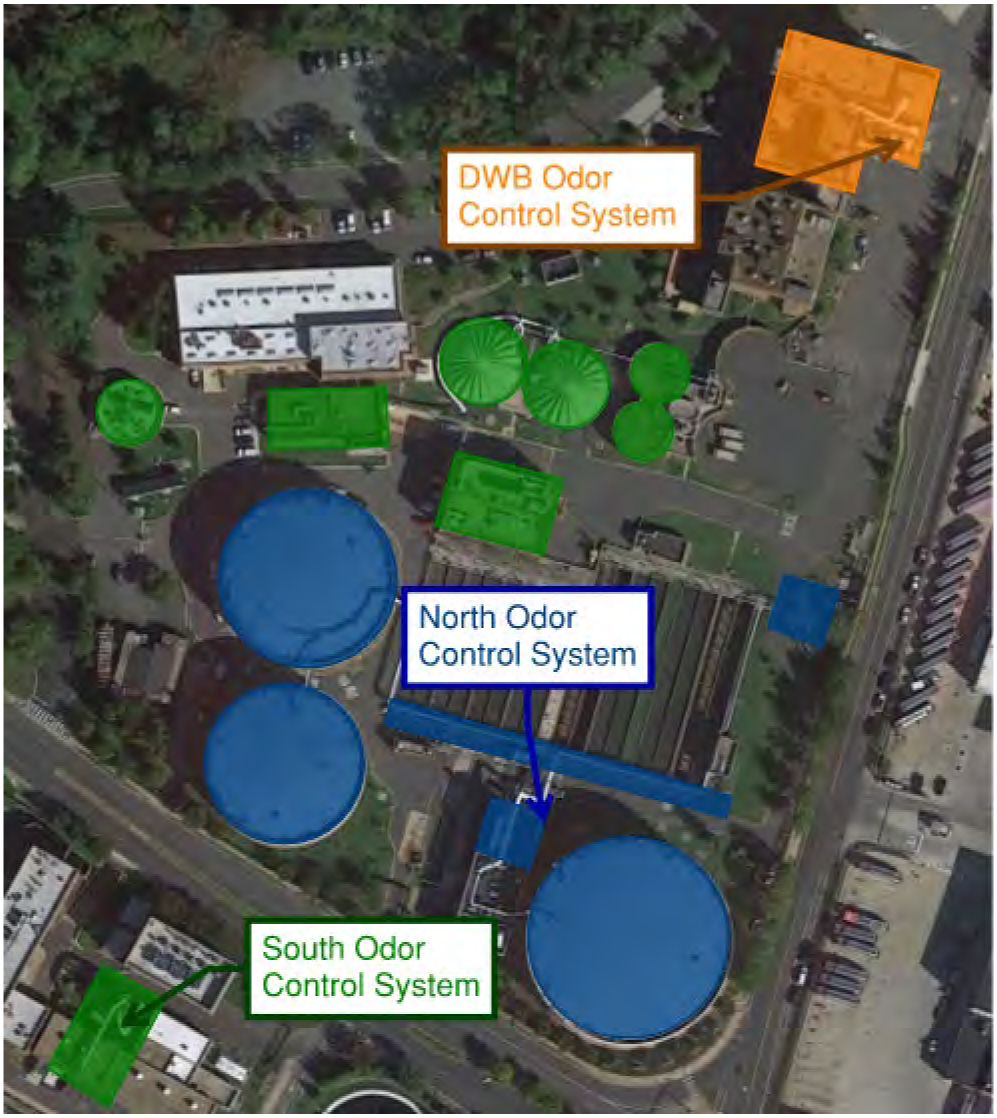

Figure 1. Locations of Existing Odor Control Facilities

The south odor control system includes a two-stage packed-tower scrubber for removal of hydrogen sulfide (H_2S) and low molecular weight organic sulfur compounds, also referred to as organic reduced sulfur compounds (orgS). This system has a capacity of approximately 31,000 cubic feet per minute (cfm). Many recent studies have been completed to review the design and capacity of the south and DWB odor control systems, including the *Foul Air Study for Preliminary Treatment Building and Dewatering Building* (CDM Smith 2017) and the *Preliminary Treatment Upgrades (WPB2) Phase 9B Odor Control Alternatives Ventilation System Evaluation and Recommendations* (CDM Smith 2019).

The design for the Preliminary Treatment Upgrades (WPB2) Phase 9B (PTB Upgrades) includes new ventilation for the PTB. Odor control for this new ventilation will be provided by directing the PTB airflow through the GTs, and then on to the south odor control system. The expected odor control ventilation rates to the south odor control system subsequent to the PTB Upgrades is provided in Table 1. All areas served by South Odor Control have dedicated four air fans exhausting from the source.

Table 1. Expected Exhaust to the South Odor Control System Following WPB2 PTB Upgrades

Source	Flow (cfm)	Notes
PTB	23,000	Directed through GTs
GTs	20,000	Captures PTB airflow
DAFTs	5,300	
Four Mile Run Pump Station	4,800	
SSTs	700	
Minor sources	450	
Total to south odor control	**34,250**	Airflow from PTB not additive as it goes through GTs

The north odor control system treats odors from flow equalization tanks and primary effluent channel in a two-stage packed-tower scrubber for removal of H_2S and orgS. The system is designed to treat up to 39,000 cubic feet per minute. No modifications to the north odor control system are expected as part of the Arlington Re-Gen Program.

The DWB odor control system treats odors collected from the existing DWB in a multistage process: packed-tower scrubbers with acid to remove ammonia (NH_3) followed by two-stage packed-tower scrubbers with sodium hypochlorite (NaOCl) to remove H_2S and a wide range of organic sulfur compounds. The two ammonia scrubbers are designed to operate in parallel and provide treatment capacity up to 17,660 cubic feet per minute (4,350 and 13,310 cubic feet per minute respectively). The sulfide scrubbers are designed to operate in series and provide treatment capacity up to 41,830 cubic feet per minute.

Rehabilitation of the existing DWB or construction of the new solids processing building will result in replacement of all existing processes, requiring new takeoffs and ductwork. The existing DWB chemical scrubber process mechanical equipment is approaching the end of its useful life and it is recommended that a new odor control system be designed and new equipment be provided.

3.0 Summary of Future Facilities

The following new facilities will generate odors that should be collected and treated as part of the Arlington Re-Gen Program:

- WAS EQ storage tanks
- Solids screens
- Thickened solids storage tanks
- Screw conveyors
- Pre-dewatering centrifuges
- Pre-dewatered cake bins
- Final dewatering centrifuges
- Final dewatered cake bins
- Truck bay
- Future facilities

It is assumed that screenings from the solids screens will be bagged using a continuous bagging system prior to discharge into the screenings dumpsters and the screenings dumpsters will not generate odors.

Future odor control needs may include future WAS thickening; future fats, oils, and grease (FOG) receiving; etc.

While definitive information on the character of odors from the new potential sources will not be available until construction is complete and operation is underway, experience can provide an idea of what is likely.

Wastewater treatment processes are capable of producing a range of odors, including the following:

- H_2S
- OrgS:
    - Mercaptans
    - Dimethyl sulfide
    - Dimethyl disulfide
- Amines:
    - NH_3
- Volatile organic compounds (VOCs):
    - Ketones
    - Aldehydes
    - Organic acids
    - Alcohols

Most wastewater treatment processes will typically produce some H_2S and, to a lesser degree, methyl mercaptan. Generally, H_2S dominates in preliminary and primary treatment; for aeration tanks and solids processing, orgS (e.g., methyl mercaptan, dimethyl sulfide, dimethyl disulfide) tend to become more pronounced. Following heating (i.e., THP) and/or pH elevation, sludge cake can also emit amines, whereNH_3 typically dominates. Long-chain amines are uncommon.

Odors produced by future facilities will likely consist mostly of H_2S, orgS, and NH_3. Exhaust flow from solids processing as far downstream as the pre-dewatered cake storage hoppers would be expected to have H_2S and orgS but no NH_3. The most significant sulfur odors will likely be produced by the pre-dewatered raw cake prior to THP. Exhaust flow from the final dewatering centrifuges, final dewatered cake storage hoppers, and truck bay will likely have a strong NH_3 odor but diminished sulfur odor. Odor from the truck bay is expected to be strong but intermittent, primarily driven by NH_3 and some orgS (i.e., only when the truck bay is in use).

4.0 Odor Control Technology Review

This section provides a review of the following three odor control technologies considered for use at the WPCP:

- Packed-tower chemical scrubbers
- Biological systems
- Activated carbon adsorption

All three of these are gas-phase treatment technologies, requiring effective capture and ventilation of odors to contain them and convey the odorous air for treatment.

4.1 Packed-Tower Chemical Scrubbers

Packed-tower chemical scrubbers are included in the odor control technology evaluation because they can be very effective for the types of odors observed with the solids handling process and Arlington County is familiar with the equipment. Figure 2 provides a schematic and photo of packed-tower chemical scrubbers.

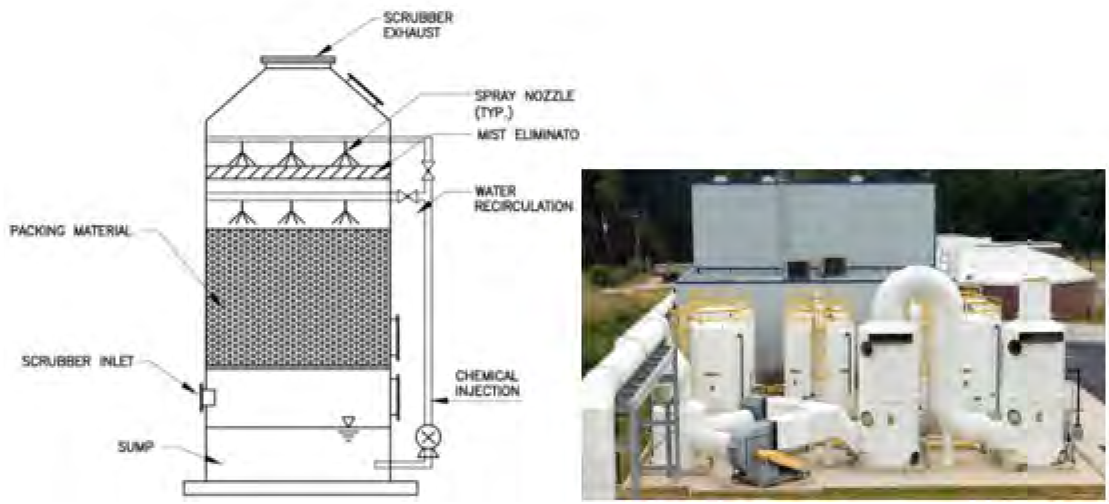

Figure 2. Packed-tower Chemical Scrubbers Schematic and Photo

Packed-tower chemical scrubbers have been used extensively to control odors at wastewater treatment plants and are classified as wet scrubbers because they use a scrubbing solution to remove odor-causing compounds from odorous air streams.

System configurations for packed-tower scrubbers range from single-stage systems that may or may not use oxidants to two-stage systems that typically use both absorption and oxidation to remove odorous air contaminants. The packed-tower chemical scrubber system chemistries are selected and designed specifically for the types of odorous compounds being treated. These systems can be effective at removing a wide range of odorants, including H_2S, orgS, and NH_3-based compounds. As noted previously, Arlington County currently has three packed-tower chemical scrubber systems at the WPCP.

Advantages of packed-tower chemical scrubbers include the following:

- Can achieve high levels of H_2S and other odorous compound removal over a wide range of airflow rates
- Low required contact time allows for smaller scrubber vessel volumes
- Proven technology with a long track record
- Scrubber systems can be turned on and off at will, or throttle down or up if the odor load changes
- WPCP staff have experience with chemical scrubbers

Disadvantages of packed-tower chemical scrubbers include the following:

- Cost and risk of handling potentially challenging chemicals such as caustic (NaOH), sodium hypoclorite (NaOCl), and sulfuric acid (H_2SO_4).
- Produce a continual flow of contaminant scrubbing solution known as blowdown. Scrubber system blowdown flows are a waste product that needs to be managed. Depending on the chemicals used in the scrubber, the blowdown can often be discharged to the WPCP drain.
- High capital costs associated with chemical pumping, piping, and containment.
- Require periodic cleaning of the media by acid washing.

4.2 Biological Systems

Like chemical treatment, biological treatment relies on absorption of odorants into solution and subsequent liquid-phase processes. Unlike chemical treatment, it relies on biomass, rather than chemical dosing, for ultimate removal of the odorants.

In the same way that chemical treatment of foul air containing H_2S, orgS, and NH_3 requires the use of multiple chemicals, biological treatment requires the growth of different types of bacteria depending on the odorants. The bacteria most suited to consuming H_2S are autotrophic and thrive in low-pH conditions; the bacteria most effective at treating orgS are heterotrophic and can survive only in neutral pH conditions. Biological treatment does not directly treat NH_3 and amine odors. However, biological treatment can treat NH_3 and amines indirectly through the same acid-base chemistry of a packed-tower chemical scrubber.

Two types of systems are used for biological treatment: biofilters and biotowers.

4.2.1 Biofilters

Biofilters consist of solid media where bacteria and other organisms form and biologically consume the odor-causing compounds. Figure 3 provides a schematic and photo of a biofilter system.

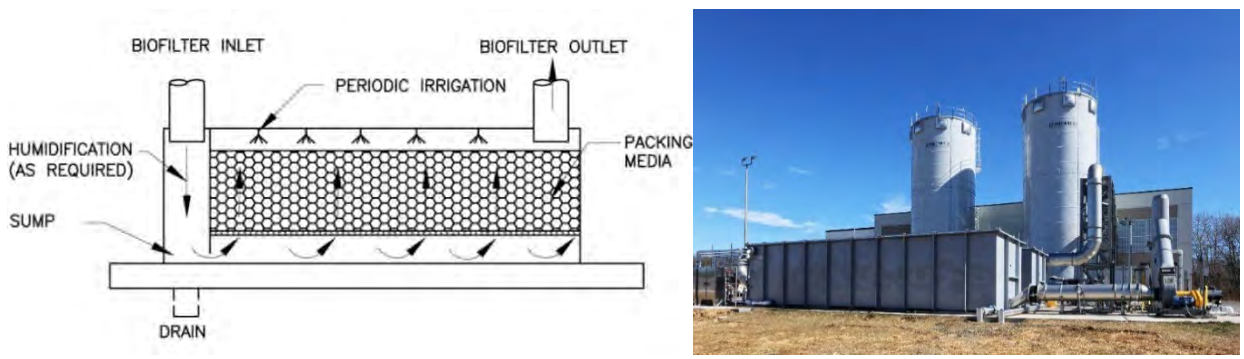

Figure 3. Biofilter Schematic and Photo

Biofilter systems—particularly the media used—have evolved over time. The older biofilter systems were made with bark mulch style media that would gradually decay and compact, which required regular media replacements. The older biofilter systems also required larger footprints because of longer empty-bed contact time (EBCT) requirements of at least 60 seconds. More recently, long-life media biofilter systems have been developed that do not decay and compact and come with 10-year warranties. Some of these long-life biofilter systems have been in proven service for more than 10 years.

These long-life biofilter systems also require less EBCT because the manufactured media achieves a better performance. Although the EBCT is lower on the newer systems, further decreasing the overall sizing requirements of the biofilter footprint, it still has a large footprint compared to other treatment options. Biofilters generally operate at a near-neutral pH.

Advantages of biofilter systems include the following:

- They are proven technologies for treating a wide range of compounds including H_2S, methyl mercaptan, and other orgS (dimethyl sulfide, dimethyl disulfide, etc.).
- They have relatively low maintenance requirements.
- Biofilters do not require any chemical storage or handling other than small nutrient addition systems.

Disadvantages of biofilter systems include the following:

- They have larger footprints because of long EBCT requirements.
- Biofilters are living systems that require initial acclimation of the biology and they must stay in service to keep the biology alive.
- Biofilters have an upper reasonable limit for inlet H_2S. Sustained long-term levels above 50 parts per million (ppm) are not desirable as they can overload the media with sulfur deposits and acid by-product attack. This is likely not anticipated as an issue for the WPCP.
- Because the systems are biological, consideration must be given to cooler winter conditions, and the inlet air temperature from the odor sources. Sustained odorous air temperatures below 40 degrees Fahrenheit are not desirable. This is not considered a serious limitation for Arlington, given the lowest typical winter weather and the lowest historical wastewater temperatures.

4.2.2 Biotowers

Biotowers are odor control treatment technologies that also consist of solid media for bacteria to grow. Figure provides a schematic and photo of a biotower system.

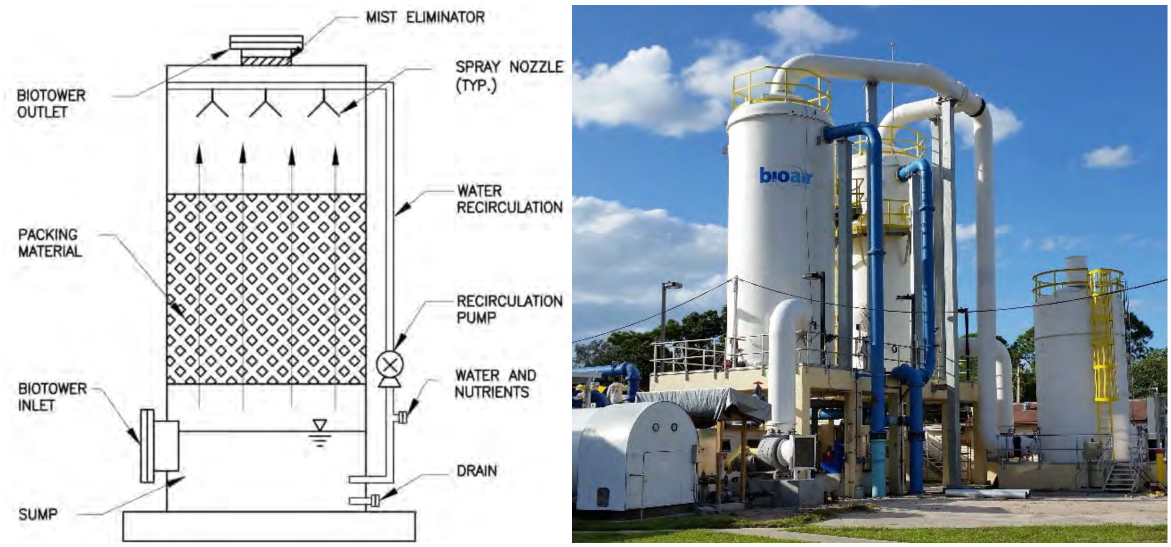

Figure 4. Biotower Schematic and Photo

The key differences between biofilters and biotowers are the EBCT and the biology being grown. Biofilters typically rely on heterotrophic organisms that remove multiple odorous compounds, whereas biotowers typically rely on autotrophic organisms targeting H_2S removal. Biotower media is completely inert and resistant to decay and compaction. For that reason, nutrient addition (such as trace organics, nitrogen, phosphorus, and potassium) is required for the biology and is added to biotower systems with spray water. Typically, the spray water consists of plant effluent water; however, it may be supplemented with dilute fertilizer injected into the spray water.

Advantages of biotower systems include the following:

- Biotowers have much shorter EBCTs (typically 10 to 15 seconds) compared to biofilters, and the media can be stacked much higher. These result in much smaller footprint requirements.
- Because the media in biotowers is inert, it has a very long bed life and likely requires little, if any, media replacement.
- The system likely does not require any significant chemical addition (potential for some nutrient addition) or safety concerns.

Disadvantages of biotower systems include the following:

- Biotowers are better suited to removing H_2S than other odorous compounds and can be less effective at removing orgS (dimethyl sulfide, dimethyl disulfide, etc.).
- Biotowers produce a continual flow of contaminant solution known as blowdown or leachate that is very acidic (H_2SO_4). Biotower blowdown flows are a waste product that needs to be managed.

- Biotowers work best at high H_2S loading rates (averaging more than 20 ppm).

4.3 Activated Carbon Adsorption

Activated carbon adsorption treats odor by adsorbing select odorants to its surface as foul air passes across it. Figure 5 provides a photo of a carbon adsorption system.

Figure 5. Carbon Adsorption System

Odorous air is passed through a bed of media composed of carbon-based adsorbents that adhere to or chemically react with odorous gases. As the gas-phase odor contaminants pass through the media, they contact and collide with the internal surfaces and are removed via adsorption from the air stream exiting the system. As the gas-phase odor contaminants accumulate on the internal surface area of the carbon (adsorbent), the carbon becomes exhausted, and the media must be regenerated or replaced. This can be a downside to this technology because replacing the carbon can be expensive and labor-intensive.

When H_2S concentrations are low (below 5 ppm), and NH_3 is not present at high concentrations, carbon-adsorption systems typically have lower capital costs compared to other gas-phase treatment systems (such as chemical scrubbers and biological systems) because odors can be removed with a much shorter contact time. The height of activated carbon systems is limited, so airflows above 10,000 cfm typically require multiple vessels. When concentrations of H_2S or NH_3 are higher, or when other odor species are present besides H_2S, carbon systems become uncompetitive because of the costs of replacing the media (high H_2S) and/or need for additional media types. There have also been case studies where odor sources with varying odor species (orgS, etc.) have been treated with carbon systems and resulted in desorption or chemical reactions, leaving more of these compounds in the effluent air.

Advantages of activated carbon adsorption systems include the following:

- Typically, carbon adsorption systems have lower initial capital costs compared to other treatment technologies.
- The systems do not require any chemical handling or storage.
- The systems can have a smaller footprint because of the short contact time requirements.
- The systems can be used as a polishing step for treated odorous air.

Disadvantages of activated carbon adsorption systems include the following:

- Exhausted carbon media replacements are costly and labor-intensive. If not replaced timely, spent carbon can result in off-site odor excursions.
- Influent loads with odor sources with varying odor species (organic sulfides, etc.) can result in effluent air with higher organic sulfur compound formation.
- The systems are not recommended for systems with very high odor concentrations.

4.4 Comparison of Treatment Technologies

The advantages and disadvantages of the four odor treatment systems are discussed above. An expanded summary comparison of the four treatment systems is presented in Table 2.

Table 2. Comparison of Odor Technologies

Technology	Packed Tower	Biotower	Biofilter	Carbon Adsorption
Removal of H_2S	99%+	99%+, works best at higher loadings (>20 ppm)	95%+, works best at lower loadings (<50 ppm)	99%+, 0% after carbon is spent
Removal of orgS	With the right chemistry	Research is ongoing but original design concept for biotowers was for H_2S removal only	Effective at low inlet concentrations	Can be designed for organic sulfur removal, but some research has shown desorption, leading to odor issues
Adjustment period	None required	Can take 2–3 weeks to acclimate during initial start, typically a polishing unit is provided	Faster acclimation than biotower but can still take several days to acclimate	None required
Footprint	Lowest contact time required	Vertical vessels for contact time, but still requires ~10-second EBCT	Shallower depth than others with ~30-second EBCT	Low contact time required, vessels limited in height
Capital cost	Moderate: has multiple ancillary systems (pumping, chemicals, containment)	Moderate: larger footprint and vessels than packed towers	Typically highest because of large space requirements	Typically lowest because of small space requirements and simplicity of system
Operating cost	Moderate because of chemical costs, generally low water use	Little to no chemical costs, can have high water use	Little to no chemical costs, moderate water use	Limited O&M costs but frequent carbon replacement can be expensive
O&M burden	Generally low day to day, but have added burden of chemical handling	Very low: monitor pH and nutrient addition chemicals	Very low: make sure irrigation is functioning as intended	Very low day to day but high when carbon replacement is required
Health and safety concern	Chemical handling concerns	No major concerns	No major concerns	Low risk of fires in carbon bed

The information presented in Table 2 is included to provide a sense of how each technology performs, relative to the other technologies; differences between technologies on one factor (e.g., operating cost) should not be viewed as being as significant as differences listed on other factors (e.g., capital cost or footprint). For example, with the types and concentrations of odors expected at the WPCP, differences in annual operating cost between a packed-tower scrubber system and a biofilter are unlikely to outweigh the differences in footprint or capital costs.

5.0 Design Criteria

To guide development of the new odor control alternatives, preliminary design criteria were established. The design criteria consist of the following:

- Estimated foul-air exhaust rates for potential odor sources
- Estimated peak and average concentrations of odorants in combined foul-air exhaust flows
- Identified odor collection and treatment system arrangement and redundancy requirements

The preliminary design criteria are discussed in the following sections.

5.1 Odor Collection

Establishing design criteria for odor source ventilation requires delineating odor source spaces (e.g., tank headspaces, gravity belt thickener [GBT] enclosures, etc.) in terms of fixed volumes and then defining one or more of the following factors to be maintained within those volumes (i.e., ventilation bases):

- Minimum air changes per hour (ACH)
- Minimum vacuum (i.e., negative pressure)
- Maximum concentration of specific odor species

The latter two factors are directly related to physical processes. Maintaining a relative vacuum within an odor source establishes a pressure gradient from the outside in and prevents the uncontrolled flow of foul air into otherwise non-odorous spaces. Maintaining a maximum concentration of, for example, H_2S, can prevent corrosion. Determining the ventilation (i.e., exhaust) rate necessary to maintain some negative pressure and/or some maximum concentration of a specific odorant in source volumes, however, typically requires more detail (e.g., leakage area and odorant flux rate, respectively) than is available ahead of detailed design or even odor sampling. The other ventilation basis, maintenance of some number of ACH, can be used to estimate required ventilation in lieu of having some of these data. Estimating the ventilation rate on an ACH basis only requires defining the minimum allowable ACH and estimating the volume of the odor source to be ventilated.

Table 3 presents the estimated exhaust rates for the processes and facilities to potentially be treated by the new odor control. Ventilation of buildings will be in accordance with other standards, including National Fire Protection Association (NFPA) 820 requirements. Odor collection will be based on point-source collection within the buildings and room air will be ventilated separately. Odorous gases from the THP will be cooled and condensed at the THP equipment skid before being conveyed directly to the digesters for treatment, and is not considered in this evaluation. Staff will need to follow proper procedures for preventing odor release during maintenance of the thermal hydrolysis system (such as flushing vessels and piping before exposing to the atmosphere). These procedures will be documented separately.

Foul-air takeoff rates for the potential odor sources were estimated based on the following:

- 12 ACH applied to the headspace of the existing GTs in accordance with industry standards for enclosed areas directly exposed to wastewater with entry requirements.

- 12 ACH applied to the total estimated hopper volume of the new cake storage hoppers based on experience at other similar facilities.
- 6 ACH applied to the total room volume (first floor only) of the new truck bay, consistent with industry standards for similar areas. Takeoffs should be located directly above the maximum filled truck trailer elevation expected, in order to focus ventilation on the actual source of odor.
- 2 ACH applied to the total tank volume (empty) of the SSTs.
- According to manufacturer-recommended rates based on maintaining negative pressure for similar equipment (i.e., GBTs, sludge screens, screw conveyors, pre-dewatering centrifuges, and final dewatering centrifuges) installed elsewhere.

Table 3. Estimated Foul-Air Takeoff Rates

Source	Criterion	Basis	Number of Units	Rate, Unit (cfm)	Rate, Total (cfm)
GTs	12	ACH	2	10,000	20,000
Storage tank (WAS EQ)	2	ACH	1	1,050	1,050
Future GBTs (WAS thickening)	-	Mfr.	2	600	1,200
Storage tanks (thickened and screened sludge)	2	ACH	3	1,050	3,150
Sludge screens	-	Mfr.	3	200	600
Screw conveyors	-	Mfr.	2	100	200
Pre-dewatering centrifuge cake	-	Mfr.	4	100	400
Pre-dewatering centrifuge centrate	-	Mfr.	4	100	400
Pre-dewatered cake storage	12	ACH	2	950	1,900
Final dewatering centrifuge cake	-	Mfr.	3	100	300
Final dewatering centrifuge centrate	-	Mfr.	3	100	300
Final dewatering cake storage	12	ACH	1	1,100	1,100
Truck bay	6	ACH	1	5,500	5,500
Total					**36,100**

The values listed in Table 3 are preliminary for initial sizing purposes and will change based on the final configuration designed by the delivery teams. For design, it is recommended that the estimates be revisited and the design rates be coordinated with manufacturers, to ensure that exhaust rates will both maintain vacuum (i.e., a maximum of -0.1 inch water column [w.c.] pressure) in odor spaces and avoid wasting treatment capacity with over-generous ventilation. The design will also need to evaluate if a single induced draft fan at the odor control system is sufficient or if multiple booster fans will be required.

The 20,000 cfm listed for the GTs represents ventilating both GTs simultaneously. At present, the WPCP operates only a single GT. Consideration could be given to not continuously ventilating the GT that is not in service.

5.2 Design Criteria for Odor Treatment

At this preliminary stage, instead of establishing design peak and average odorant loading to treatment, several combinations of foul-air gas flows from different potential odor sources were developed and design peak and average concentrations of H_2S, orgS, and NH_3 were assigned to each.

The three combined exhaust flows are listed in Table 4.

Table 4. Properties of Combined Exhaust Flows

Combined Exhaust	Source	Source Description
GTs	GTs	Potential for low levels of H_2S and methyl mercaptan Potential for lower levels of other orgS High ventilation rates lead to lower concentrations
Sludge storage and pre-dewatering	Storage tank (WAS EQ)	Potential for moderate levels of H_2S Potential for moderate levels of orgS
	GBTs	
	SSTs	
	Sludge screens	
	Screw conveyors	
	Pre-dewatering centrifuge cake	
	Pre-dewatering centrifuge centrate	
	Pre-dewatered cake storage	
Final dewatering	Final dewatering centrifuge cake	Potential for lower levels of H_2S Potential for lower levels of orgS Potential for moderate levels of NH_3
	Final dewatering centrifuge centrate	
	Final dewatering cake storage	
	Truck bay	

The flow rate and peak and average design odorant concentrations associated with each combined exhaust flow are indicated in Table 5. The design concentrations reflect HDR Engineering, Inc. (HDR) experience at other sites; however, the concentrations are subject to significant uncertainty. Actual concentrations will be a function of site-specific factors including liquid-phase wastewater chemistry and operating conditions and design criteria should be validated with the delivery teams.

Table 5. Basis of Design for Foul-Air Loading

Exhaust	Airflow (cfm)	H_2S (ppm)		orgS (ppm)		NH_3 (ppm)	
		Average	Peak	Average	Peak	Average	Peak
GTs	20,000[a]	1.0	10.0	0.5	2.0	0.0	0.0
Sludge storage and pre-dewatering	8,900	5.0	25.0	2.0	10.0	0.0	0.0
Final dewatering	7,200	1.0	10.0	1.0	5.0	10.0	50.0

a. 10,000 cfm if only one GT is in operation at any given time.

6.0 Odor Control Alternatives

Odor control alternatives were developed by evaluating the full range of potential treatment sequencing options in the context of each combined exhaust flow.

For each pairing, the following were determined:

- Minimum required stages and packing/media depth of each stage to achieve the following:
  - 99 percent removal of H_2S
  - 90 percent removal of orgS
  - 99 percent removal of NH_3
- Minimum number of trains in parallel to satisfy industry-standard, treatment-specific constraints on vessel area, airflow velocity, and gas loading rate

Conceptual construction costs were prepared for each alternative based on preliminary equipment quotes from vendors and cost-capacity curves for blowers, packed-tower scrubbers, biotowers, biofilters, and carbon scrubbers; cost per cubic yard for concrete treatment facility slabs; and general percentages for ancillary facilities, site work, contingencies, and general contractor costs shown in Table 6. A built-up estimate for mechanical and treatment-facility-slab structural work is provided. Percentage cost adders are applied to these built-up estimates to determine the final conceptual costs, as shown in Table 6. Percentage cost adders and estimates for the four alternatives are developed further in the following section.

Table 6. General Assumptions for Opinions of Probable Construction Costs

Parameter	Percentage
Base subtotal: Mechanical and structural/architectural	Built-up estimate
Sitework	15% of base subtotal
Electrical	20% of base subtotal
Instrumentation and controls	8% of base subtotal
Large and specialty pipe	5% of base subtotal
Geotechnical	7% of base subtotal
Subtotal	*Subtotal*
Project contingency	20% of subtotal
Contractor mobilization/staging (percentage of subtotal and project contingency)	5% of subtotal plus
Contractor bonds/insurance (percentage of subtotal and project contingency)	3%
Contractor overhead and profit (percentage of subtotal and project contingency)	15%
Total construction cost	**Total**

The conceptual costs are only rough order-of-magnitude costs to use for relative comparisons between the various alternatives. The conceptual costs presented herein are not for budgeting purposes.

Operating costs were estimated based on irrigation/makeup water, H_2SO_4, sodium hydroxide (NaOH), and NaOCl required to treat average loading, assumed activated carbon replacement frequency, and power required by blowers and recirculation pumps for continuous duty. To estimate the annual operating cost of each developed alternative, the unit costs in Table 7 were assumed.

Table 7. Assumed Unit Costs of Site Water, Chemical, Carbon, and Power

Demand	Cost ($/gal)
PEW	$0.0005
H_2SO_4 (97.0%)	$0.66
NaOH (25.0%)	$2.66
NaOCl (12.5%)	$0.50
Activated carbon	$4.00[a]
Power	$0.06[b]

a. $ per pound
b. $ per kilowatt-hour.

Finally, as a single point of comparison, a net present value (NPV) for each odor control alternative was estimated based on the capital and operating costs. It was assumed that all capital costs are paid during year 0; operating costs were assumed to continue over a 20-year period. A discount rate of 3 percent was assumed.

Each alternative includes rerouting exhaust from the existing GTs to new odor control. In concert with the decommissioning of the DAFTs, migrating the odor load of the existing GTs and SSTs to new odor control would reduce existing design flow to the south odor control system by 23,000 cfm. That freed-up capacity could theoretically be allocated for ventilation and treatment of the PTB.

The effect of decommissioning the DAFTs and migrating load from the existing GTs and SSTs from the south odor control system to new odor control is illustrated in Table 8.

Table 8. Impact of Contemplated Changes on Design Flow to the South Odor Control System

Source	Current Design Flow (cfm)	Potential Future Design Flow (cfm)
GTs	20,000	-
PTB	-	23,000
DAFTs	5,300	-
Four Mile Pump Station	4,800	4,800
SSTs	700	-
Minor sources	450	450
Total	31,250	28,250

Four alternatives were developed using these treatment options:

- Alternative 1: Combined Treatment of Gravity Thickener Exhaust
- Alternative 2: Dedicated Treatment of GT Exhaust Flow via Biotower and Activated Carbon Adsorption Polishing
- Alternative 3: Dedicated Treatment of GT Exhaust via Biofilter and Activated Carbon Adsorption Polishing
- Alternative 4: Dedicated Treatment of GT Exhaust via Activated Carbon Adsorption

All four alternatives include two-stage packed-tower scrubbers (both for sulfur removal) for the combined sludge storage and pre-dewatering odor load and separate treatment of the combined final dewatering odor load via two-stage packed-tower scrubbers (one for NH_3 and one for sulfur) activated carbon adsorption for polishing. Packed-tower scrubbers are considered the best available technology for dealing with moderate levels of ammonic and organic sulfur compounds, and thus the reason they are included in all alternatives. The alternatives differ only in how the GT exhaust is treated.

The four alternatives are described further below.

6.1 Alternative 1: Combined Treatment of Gravity Thickener Exhaust

Under Alternative 1, there would be two treatment schemes: one to treat exhaust flow from final dewatering sources and one to treat combined exhaust flow the GTs and sludge storage and pre-dewatering sources. The latter scheme is not expected to contain any NH_3 while the former is.

The combined exhaust flow from final dewatering sources would be treated for NH_3 odor via a first-stage packed-tower scrubber using H_2SO_4 then treated for sulfur odor via a second-stage packed-tower scrubber with NaOH and NaOCl. The scrubbers would be followed by activated carbon adsorption polishing. The combined exhaust flow from the GTs, sludge storage, and pre-dewatering sources would be expected to need treatment only for sulfur odor and would be treated via two-stage packed-tower scrubber using NaOH and NaOCl.

6.1.1 Summary of Odor Control Facility Sizing and Estimated Performance

The design parameters for the treatment stages are listed in and Table 9 and Table 10.

Table 9. Treatment Parameters under Alternative 1 for Treating Final Dewatering Exhaust

Parameter	Unit	Stage 1	Stage 2	Stage 3
Target odor		NH_3	Sulfur	Sulfur
Treatment unit		Packed tower	Packed tower	Activated carbon adsorption
Chemical		H_2SO_4	NaOH + NaOCl	
Size	ft	5'-0"	5'-0"	12'-0"
Gas loading	cfm	7,200	7,200	7,200
Liquid loading	gpm	250	250	-
Packing/media depth	ft	12	12	6
Makeup water	gpd	360	9,000	-
H_2SO_4 dose	gpd	1.4	0.0	-
NaOH dose	gpd	0.0	14.3	-
NaOCl dose	gpd	0.0	31.0	-

Table 10. Treatment Parameters under Alternative 1 for Treating Combined GT and Sludge Storage and Pre-dewatering Exhaust

Parameter	Unit	Stage 1	Stage 2
Target odor		Sulfur	Sulfur
Treatment unit		Packed tower	Packed tower
Chemical		NaOH + NaOCl	NaOH + NaOCl
Size	ft	10'-0"	10'-0"
Gas loading	cfm	28,900	28,900
Liquid loading	gpm	700	700
Packing/media depth	ft	12	12
Makeup water	gpd	1,008	1,008
NaOH dose	gpd	4.7	1.8
NaOCl dose	gpd	144	21.9

6.1.2 Odor Control Facility Layout

Both odor treatment systems can be located on the same pad. It is estimated that the pad would need to be a minimum of 50 feet wide by 75 feet long to fit the requisite vessels, equipment, and ductwork. A plan view showing one potential arrangement is provided as Figure 6. Chemical storage and feed would be located in a separate building.

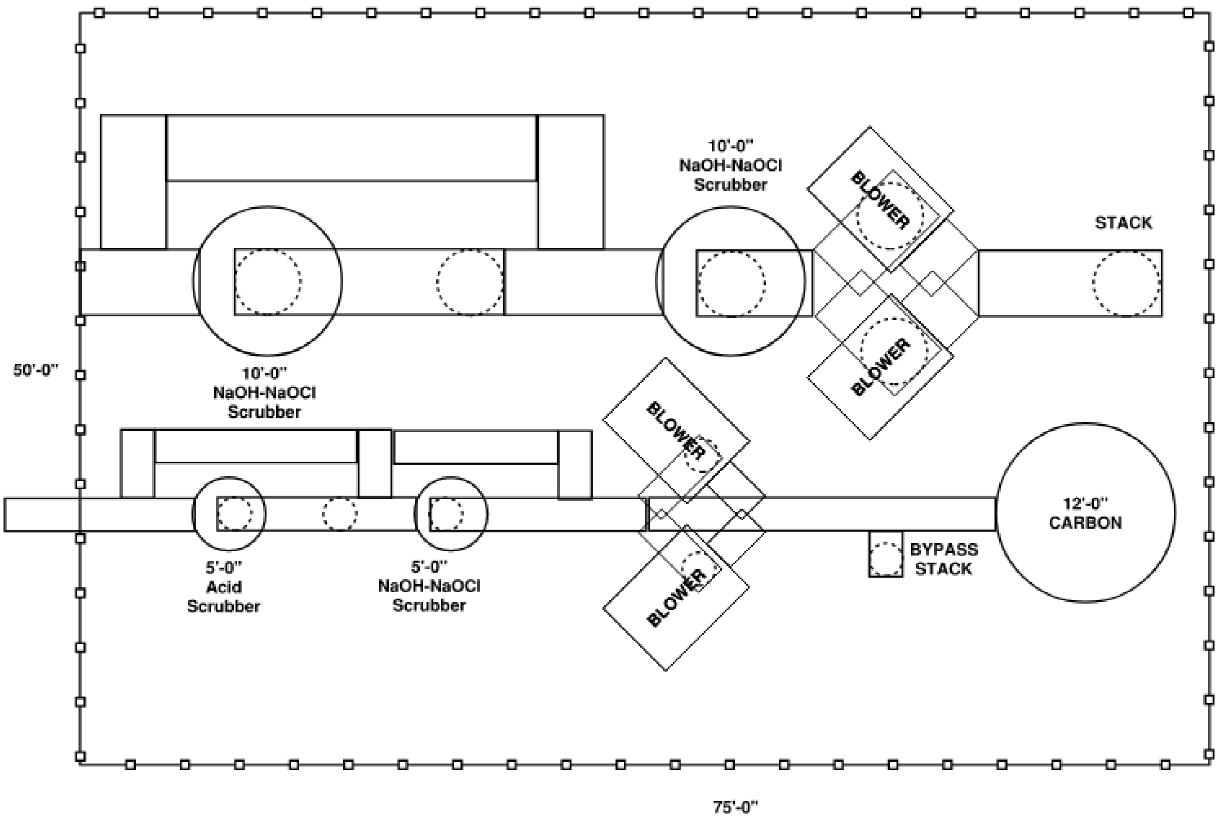

Figure 6. Layout of Pad for Odor Treatment Systems under Alternative 1

6.1.3 Summary of Conceptual Costs

A summary of the conceptual cost estimate and estimated annual operating costs is provided in Table 11 and Table 12, respectively.

Of note, the lone carbon scrubber will be used for polishing. As a result, the media will likely only need to be replaced every 3 to 5 years, in accordance with the carbon manufacturer's standard recommended minimum changeout frequency. Each carbon replacement would cost roughly $120,000. At a changeout frequency of 3 years, the annualized operating cost of carbon replacement is estimated as $40,000.

Table 11. Conceptual Cost Estimate for Alternative 1

Parameter	Percentage	Cost
Structural		$90,000
Mechanical		$1,360,000
Base Subtotal		**$1,450,000**
Sitework	15%	$220,000
I&C/SCADA	8%	$120,000
Electrical	20%	$290,000
Large and specialty piping	5%	$80,000
Geotechnical	7%	$110,000
Subtotal		**$2,270,000**
Contingency	20%	$460,000
Subtotal		**$2,730,000**
Contractor mobilization, staging, and security	5%	$140,000
Contractor bonds and insurance	3%	$90,000
Subtotal		**$2,960,000**
Contractor overhead and profit	15%	$450,000
Total		**$3,410,000**

Table 12. Summary of Estimated Annual Operating Costs for Alternative 1

Parameter	Cost ($/year)
Water	$2,080
Chemical	$37,200
H_2SO_4	$350
NaOH	$20,100
NaOCl	$16,750
Carbon	$40,000
Power	$32,260
Blowers	$23,630
Recirculation pumps	$8,630
Total	**$111,540**

Over a 20-year period and assuming a discount rate of 3 percent, the NPV of Alternative 1 would be $5,070,000.

6.2 Alternative 2: Dedicated Treatment of GT Exhaust Flow via Biotower and Activated Carbon Adsorption Polishing

Under Alternative 2, there would be three treatment schemes: one to treat exhaust flow from final dewatering sources, one to treat exhaust flow the sludge storage and pre-dewatering sources, and one to treat exhaust flow from the GTs.

Exhaust flow from final dewatering sources would be treated as in Alternative 1. The combined exhaust flow from sludge storage and pre-dewatering sources would be treated for sulfur odor via two-stage packed-tower scrubber using NaOH and NaOCl. The third exhaust flow from the GTs is expected to contain relatively little organic sulfur, and would be treated via a biotower followed by activated carbon adsorption polishing. Because the system would treat only GT exhaust flow and would be located in close proximity to the GTs, and given that, at present, the WPCP operates only a single GT, the system would be sized to ventilate and treat only 10,000 cfm, the estimated exhaust rate for a single GT.

6.2.1 Summary of Odor Control Facility Sizing and Estimated Performance

The design parameters for the treatment stages are listed in Table 13, Table 14, and Table 15.

Table 13. Treatment Parameters under Alternative 2 for Treating Final Dewatering Exhaust

Parameter	Unit	Stage 1	Stage 2	Stage 3
Target odor		NH_3	Sulfur	Sulfur
Treatment unit		Packed tower	Packed tower	Activated carbon adsorption
Chemical		H_2SO_4	NaOH + NaOCl	
Size	ft	5'-0"	5'-0"	12'-0"
Gas loading	cfm	7,200	7,200	7,200
Liquid loading	gpm	250	250	-
Packing/media depth	ft	12	12	6
Makeup water	gpd			
H_2SO_4 dose	gpd	1.4	0.0	-
NaOH dose	gpd	0.0	14.3	-
NaOCl dose	gpd	0.0	31.0	-

Table 14. Treatment Parameters under Alternative 2 for Treating Sludge Storage and Pre-dewatering Exhaust

Parameter	Unit	Stage 1	Stage 2
Target odor		Sulfur	Sulfur
Treatment unit		Packed tower	Packed tower
Chemical		NaOH + NaOCl	NaOH + NaOCl
Size	ft	6'-0"	6'-0"
Gas loading	cfm	8,900	8,900
Liquid loading	gpm	170	170
Packing/media depth	ft	12	12
Makeup water	gpd	245	245
NaOH dose	gpd	0.8	0.4
NaOCl dose	gpd	74.9	5.6

Table 15. Treatment Parameters under Alternative 2 for Treating Gravity Thickener Exhaust

Parameter	Unit	Stage 1	Stage 2
Target odor		Sulfur	Sulfur
Treatment unit		Biotower	Activated carbon adsorption
Chemical		[Nutrient]	
Size	ft	8'-0"	14'-0"
Gas loading	cfm	10,000	10,000
Liquid loading	gpm	50	-
Packing/media depth	ft	8	6
Makeup water	gpd	72,000	-

6.2.2 Odor Control Facility Layout

The two odor treatment systems treating exhaust from sludge storage and pre-dewatering sources and exhaust from final dewatering sources can be located on the same pad. It is estimated that the pad would need to be a minimum of 45 feet wide by 65 feet long, slightly smaller than the single pad associated with Alternative 1, to fit the requisite vessels, equipment, and ductwork. A plan view showing one potential arrangement is provided as Figure 7. Chemical storage and feed facilities would be located in a separate building.

A second pad for the system treating the GT exhaust would also be needed. It is estimated that the pad would need to be a minimum of 45-feet-wide by 65-feet-long. A plan view showing one potential arrangement is provided as Figure 8.

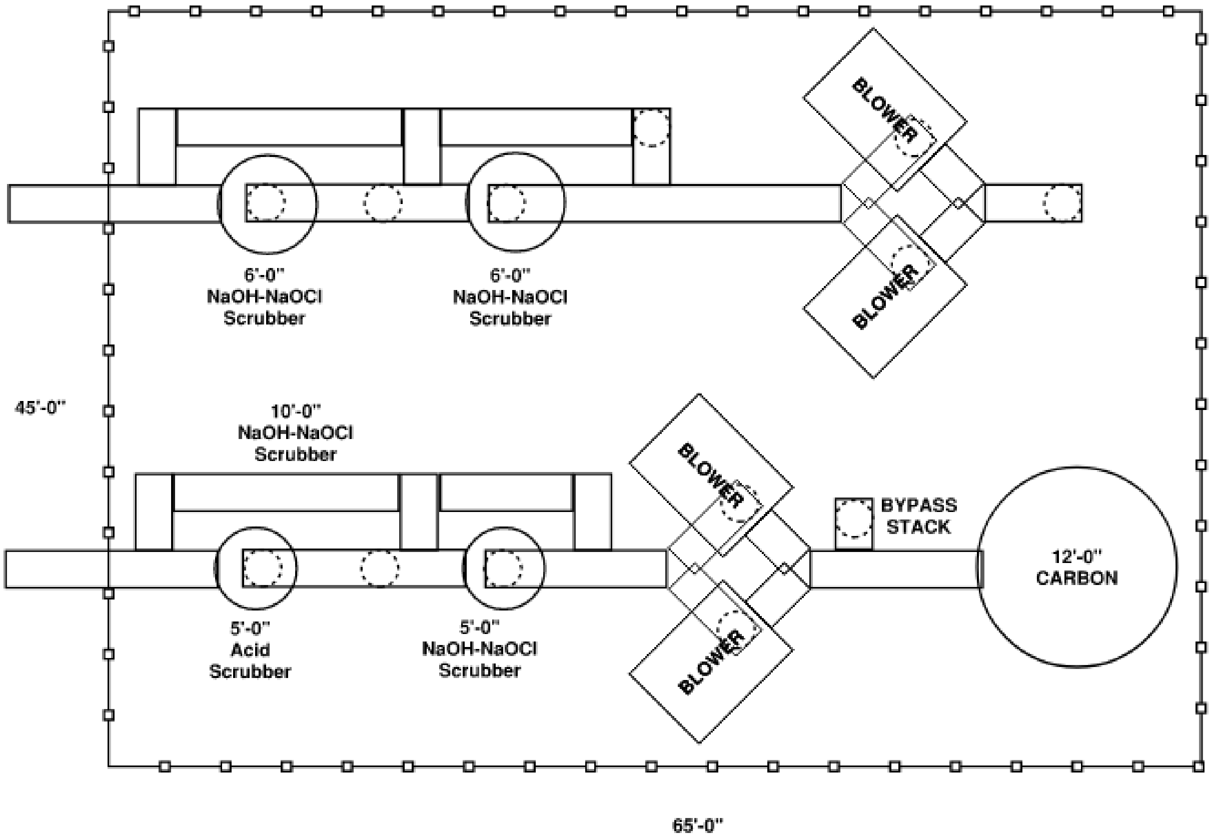

Figure 7. Layout of Pad for Odor Treatment Systems Treating Exhaust from Sludge Storage and Pre-dewatering Sources and Exhaust from Final Dewatering Sources under Alternative 2

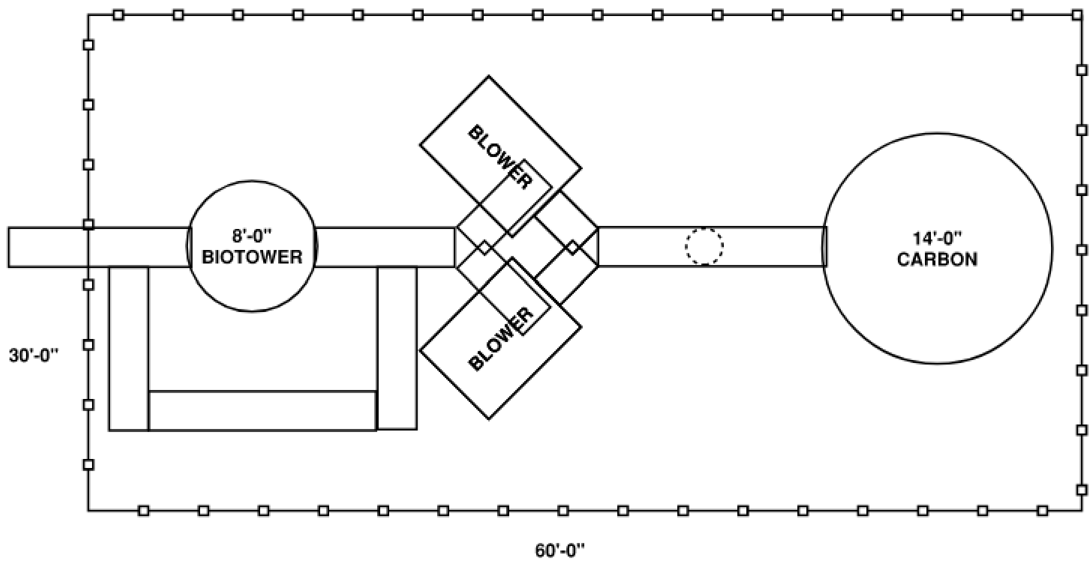

Figure 8. Layout of Pad for Odor Treatment Systems Treating Exhaust from Gravity Thickeners under Alternative 2

6.2.3 Summary of Costs

A summary of the conceptual cost estimate and estimated annual operating costs is provided in Table 16 and Table 17, respectively.

Of note, both carbon scrubbers will be used for polishing. As a result, the media in each vessel will likely only need to be replaced every 3 to 5 years, in accordance with the carbon manufacturer's standard recommended minimum changeout frequency. Each carbon replacement in the 12-ft-diameter vessel would cost roughly $120,000; each in the 14-ft-diameter vessel would cost roughly $150,000. At a changeout frequency of 3 years for both vessels, the annualized operating cost of carbon replacement is estimated as $90,000.

Table 16. Alternative 2 Conceptual Cost Estimate

Parameter	Percentage	Cost
Structural		$110,000
Mechanical		$2,030,000
Base Subtotal		**$2,140,000**
Sitework	15%	$330,000
I&C/SCADA	8%	$180,000
Electrical	20%	$430,000
Large and specialty piping	5%	$110,000
Geotechnical	7%	$150,000
Subtotal		**$3,340,000**
Contingency	20%	$670,000
Subtotal		**$4,010,000**
Contractor mobilization, staging, and security	5%	$210,000
Contractor bonds and insurance	3%	$130,000
Subtotal		**$4,350,000**
Contractor overhead and profit	15%	$660,000
Total		**$5,010,000**

Table 17. Summary of Estimated Annual Operating Costs for Alternative 2

Parameter	Cost ($/year)
Water	$14,940
Chemical	$29,050
H_2SO_4	$350
NaOH	$16,660
NaOCl	$12,040
Carbon	$90,000
Power	$30,060
Blowers	$26,210
Recirculation pumps	$3,850
Total	**$164,050**

Over a 20-year period and assuming a discount rate of 3 percent, the NPV of Alternative 2 would be $7,460,000.

6.3 Alternative 3: Dedicated Treatment of GT Exhaust via Biofilter and Activated Carbon Adsorption Polishing

Under Alternative 3, like under Alternative 2, there would be three treatment schemes: one to treat exhaust flow from final dewatering sources, one to treat exhaust flow from the sludge storage and pre-dewatering sources, and one to treat exhaust flow from the GTs. The only difference from Alternative 2 is that the GT exhaust would be treated through a biofilter followed by carbon adsorption instead of a biotower followed by carbon adsorption.

6.3.1 Summary of Odor Control Facility Sizing and Estimated Performance

The design parameters for the treatment stages are listed in Table 18, Table 19, and Table 20.

Table 18. Treatment Parameters under Alternative 3 for Treating Final Dewatering Exhaust

Parameter	Unit	Stage 1	Stage 2	Stage 3
Target odor		NH_3	Sulfur	Sulfur
Treatment unit		Packed tower	Packed tower	Activated carbon adsorption
Chemical		H_2SO_4	NaOH + NaOCl	
Size	ft	5'-0"	5'-0"	12'-0"
Gas loading	cfm	7,200	7,200	7,200
Liquid loading	gpm	250	250	-
Packing/media depth	ft	12	12	6
Makeup water	gpd			
H_2SO_4 dose	gpd	1.4	0.0	-
NaOH dose	gpd	0.0	14.3	-
NaOCl dose	gpd	0.0	31.0	-

Table 19. Treatment Parameters under Alternative 3 for Treating Sludge Storage and Pre-dewatering Exhaust

Parameter	Unit	Stage 1	Stage 2
Target odor		Sulfur	Sulfur
Treatment unit		Packed tower	Packed tower
Chemical		NaOH + NaOCl	NaOH + NaOCl
Size	ft	6'-0"	6'-0"
Gas loading	cfm	8,900	8,900
Liquid loading	gpm	170	170
Packing/media depth	ft	12	12
Makeup water	gpd	245	245
NaOH dose	gpd	0.8	0.4
NaOCl dose	gpd	74.9	5.6

Table 20. Treatment Parameters under Alternative 3 for Treating Gravity Thickener Exhaust

Parameter	Unit	Stage 1	Stage 2
Target odor		Sulfur	Sulfur
Treatment unit		Biofilter	Activated carbon adsorption
Chemical			
Size	ft	30'-0" × 30'-0"	14'-0"
Gas loading	cfm	10,000	10,000
Liquid loading	gpm	5	-
Packing/media depth	ft	6	6
Makeup water	gpd	7,200	-

6.3.2 Odor Control Facility Layout

The two odor treatment systems treating exhaust from sludge storage and pre-dewatering sources and exhaust from final dewatering sources can be located on the same pad. As with Alternative 2, it is estimated that the pad would need to be a minimum of 45 feet wide by 65 feet long.

A second pad for the system treating the GT exhaust would also be needed. It is estimated that the pad would need to be a minimum of 40 feet wide by 85 feet long, significantly larger than that associated with Alternative 2 because of the relative large size of the biofilter. A plan view showing one potential arrangement is provided as Figure 9.

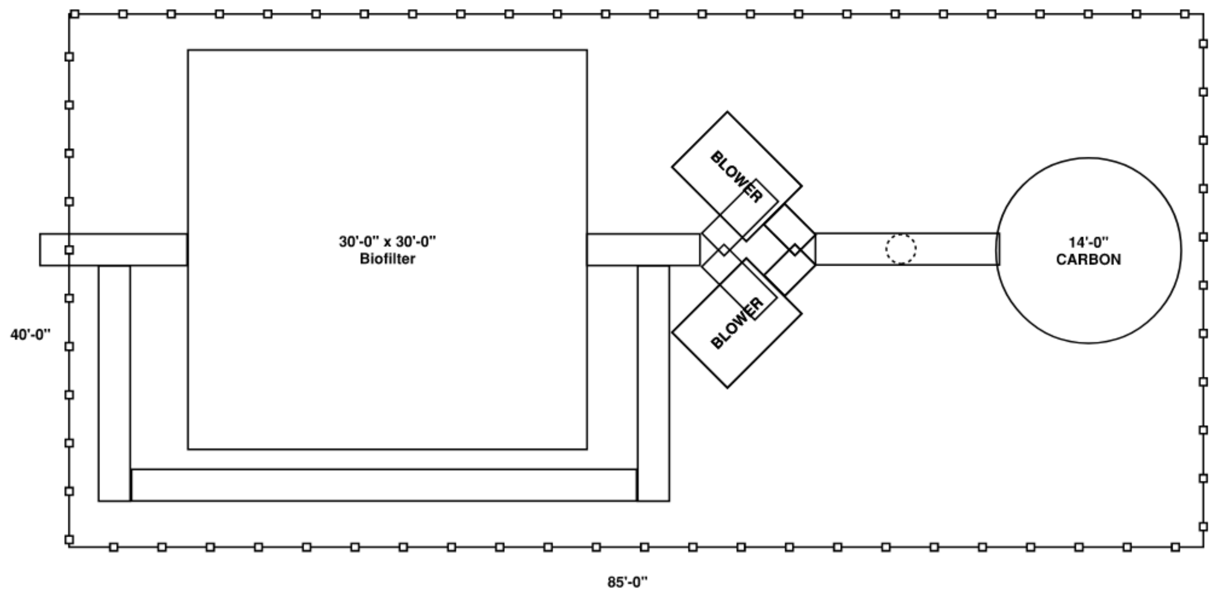

Figure 9. Layout of Pad for Odor Treatment Systems Treating Exhaust from Gravity Thickeners under Alternative 3

6.3.3 Summary of Costs

A summary of the conceptual cost estimate and estimated annual operating costs is provided in Table 21 and Table 22, respectively.

Of note, both carbon scrubbers will be used for polishing. As a result, the media in each vessel will likely only need to be replaced every 3 to 5 years, in accordance with the carbon manufacturer's standard recommended minimum changeout frequency. Each carbon replacement in the 12-ft-diameter vessel would cost roughly $120,000; each in the 14-ft-diameter vessel would cost roughly $150,000. At a changeout frequency of 3 years for both vessels, the annualized operating cost of carbon replacement is estimated as $90,000.

Table 21. Alternative 3 Conceptual Cost Estimate

Parameter	Percentage	Cost
Structural		$150,000
Mechanical		$2,530,000
Base Subtotal		**$2,680,000**
Sitework	15%	$410,000
I&C/SCADA	8%	$220,000
Electrical	20%	$540,000
Large and specialty piping	5%	$140,000
Geotechnical	7%	$190,000
Subtotal		**$4,180,000**
Contingency	20%	$840,000
Subtotal		**$5,020,000**
Contractor mobilization, staging, and security	5%	$260,000
Contractor bonds and insurance	3%	$160,000
Subtotal		**$5,440,000**
Contractor overhead and profit	15%	$820,000
Total		**$6,260,000**

Table 22. Summary of Estimated Annual Operating Costs for Alternative 3

Parameter	Cost ($/year)
Water	$3,120
Chemical	$29,050
H_2SO_4	$350
NaOH	$16,660
NaOCl	$12,040
Carbon	$90,000
Power	$30,060
Blowers	$26,210
Recirculation pumps	$3,850
Total	**$152,230**

Over a 20-year period and assuming a discount rate of 3 percent, the NPV of Alternative 3 would be $8,530,000.

6.4 Alternative 4: Dedicated Treatment of GT Exhaust via Activated Carbon Adsorption

Under Alternative 4, as under the previous two alternatives, there would be three treatment schemes: one to treat exhaust flow from final dewatering sources, one to treat exhaust flow the sludge storage and pre-dewatering sources, and one to treat exhaust flow from the GTs. The difference is that standalone carbon adsorption would be used for the GT exhaust in lieu of biological systems followed by carbon adsorption for polishing.

For this alternative to be considered, a rigorous field sampling program would be recommended to validate H_2S concentrations in the existing GT exhaust, followed by carbon selection and a full life-cycle assessment including cost of carbon replacement based on the measured H_2S concentrations.

6.4.1 Summary of Odor Control Facility Sizing and Estimated Performance

The design parameters for the treatment stages are listed in Table 23, Table 24, and Table 25.

Table 23. Treatment Parameters under Alternative 4 for Treating Final Dewatering Exhaust

Parameter	Unit	Stage 1	Stage 2	Stage 3
Target odor		NH_3	Sulfur	Sulfur
Treatment unit		Packed tower	Packed tower	Activated carbon adsorption
Chemical		H_2SO_4	NaOH + NaOCl	
Size	ft	5'-0"	5'-0"	12'-0"
Gas loading	cfm	7,200	7,200	7,200
Liquid loading	gpm	250	250	-
Packing/media depth	ft	12	12	6
Makeup water	gpd			
H_2SO_4 dose	gpd	1.4	0.0	-
NaOH dose	gpd	0.0	14.3	-
NaOCl dose	gpd	0.0	31.0	-

Table 24. Treatment Parameters under Alternative 4 for Treating Sludge Storage and Pre-dewatering Exhaust

Parameter	Unit	Stage 1	Stage 2
Target odor		Sulfur	Sulfur
Treatment unit		Packed tower	Packed tower
Chemical		NaOH + NaOCl	NaOH + NaOCl
Size	ft	6'-0"	6'-0"
Gas loading	cfm	8,900	8,900
Liquid loading	gpm	170	170
Packing/media depth	ft	12	12
Makeup water	gpd	245	245
NaOH dose	gpd	0.8	0.4
NaOCl dose	gpd	74.9	5.6

Table 25. Treatment Parameters under Alternative 4 for Treating Gravity Thickener Exhaust

Parameter	Unit	Stage 1
Target odor		Sulfur
Treatment unit		Activated carbon adsorption
Chemical		
Size	ft	14'-0"
Gas loading	cfm	10,000

6.4.2 Odor Control Facility Layout

The packed-tower odor control system layout would be the same as for Alternatives 2 and 3. A separate pad for the system treating the GT exhaust would also be needed. It is estimated that the pad would need to be a minimum of 30 feet wide by 45 feet long, slightly smaller than that associated with Alternative 2. A plan view showing one potential arrangement is provided as Figure 10.

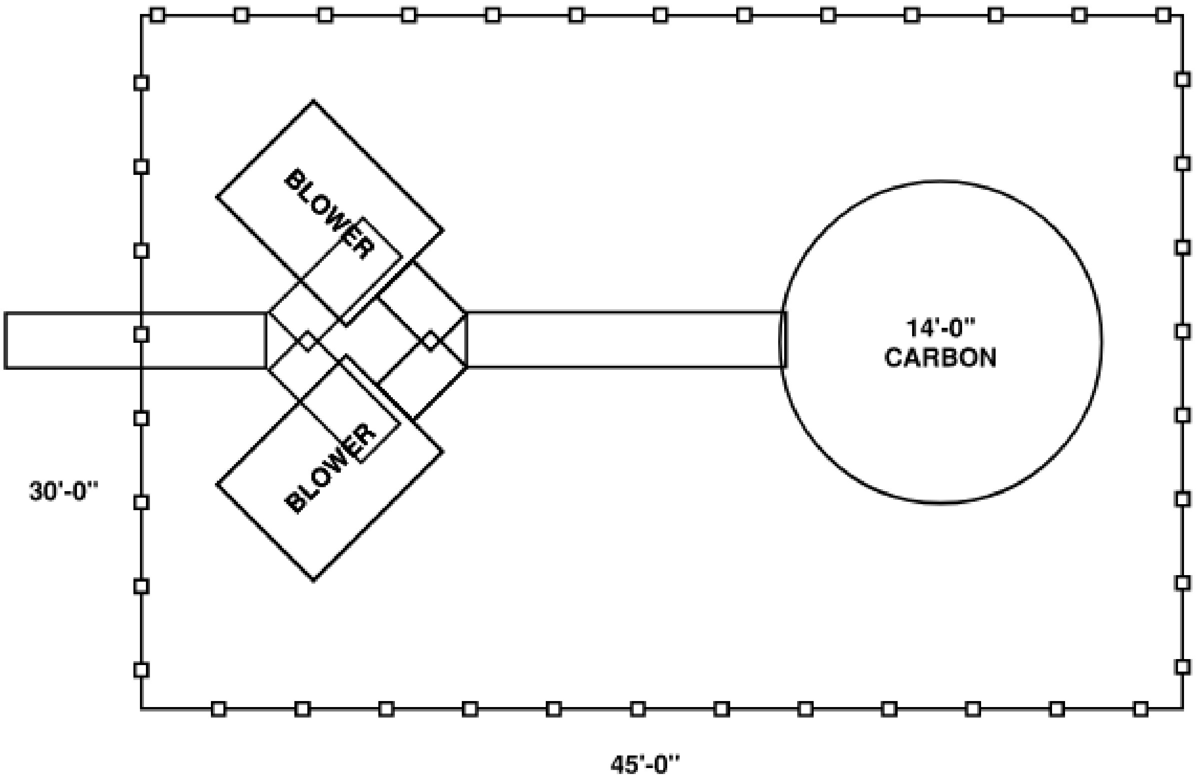

Figure 10. Layout of Pad for Odor Treatment Systems Treating Exhaust from Gravity Thickeners under Alternative 4

6.4.3 Summary of Costs

A summary of the conceptual cost estimate and estimated annual operating costs is provided in Table 26 and Table 27, respectively.

Of note, while the 12-ft-diameter scrubber will be used for polishing, the larger 14-ft-diameter scrubber will be used for primary treatment. The media in the latter will likely need to be replaced more frequently. At a changeout frequency of 1 year for the carbon scrubber treating gravity thickener exhaust and a changeout frequency of 3 years for the other scrubber, the annualized operating cost of carbon replacement is estimated as $190,000.

Table 26. Alternative 4 Conceptual Cost Estimate

Parameter	Percentage	Cost
Structural		$150,000
Mechanical		$1,440,000
Base Subtotal		**$1,590,000**
Sitework	15%	$240,000
I&C/SCADA	8%	$130,000
Electrical	20%	$320,000
Large and specialty piping	5%	$80,000
Geotechnical	7%	$120,000
Subtotal		**$2,480,000**
Contingency	20%	$500,000
Subtotal		**$2,980,000**
Contractor mobilization, staging, and security	5%	$150,000
Contractor bonds and insurance	3%	$90,000
Subtotal		**$3,220,000**
Contractor overhead and profit	15%	$490,000
Total		**$3,710,000**

Table 27. Summary of Estimated Annual Operating Costs for Alternative 4

Parameter	Cost ($/year)
Water	$1,800
Chemical	$29,050
H_2SO_4	$350
NaOH	$16,660
NaOCl	$12,040
Carbon	$190,000
Power	$25,500
Blowers	$21,650
Recirculation pumps	$3,850
Total	**$246,350**

Over a 20-year period and assuming a discount rate of 3 percent, the NPV of Alternative 4 would be $7,380,000.

7.0 Comparison of Alternatives and Recommendation

The alternatives can be evaluated and compared based on the following:

- Estimated treatment effectiveness
- Estimated conceptual costs
- Estimated space required
- Operations and maintenance (O&M) familiarity with the requisite odor control technologies
- O&M responsibilities
- Health and safety concerns (unrelated to exposure to odorous emissions)

All four alternatives have similar levels of treatment effectiveness. All also have some level of chemical treatment including multiple chemicals. Therefore, the evaluation is driven primarily by NPV costs and site constraints.

A summary of conceptual costs is provided in Table 28.

Table 28. Comparison of Estimated Conceptual Costs

	Alternative Description	Combined Treatment of GT Exhaust	Dedicated Treatment of GT Exhaust via Biotower and Activated Carbon Polishing	Dedicated Treatment of GT Exhaust via Biofilter and Activated Carbon Polishing	Dedicated Treatment of GT Exhaust via Activated Carbon Adsorption
Cost	**Alternative No.**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Capital cost	$	$3,410,000	$5,010,000	$6,260,000	$3,710,000
Operating cost	$/year	$111,540	$164,050	$152,230	$246,350
NPV	$	$5,070,000	$7,460,000	$8,530,000	$7,380,000

Alternatives 2, 3 and, 4 would all have a significantly higher cost than Alternative 1 and would require additional space requirements on a tight site. Although these alternatives would reduce chemical consumption, some chemical treatment would still be required. Therefore, Alternatives 2, 3, and 4 are not recommended for implementation.

Based on discussions with the County, Alternative 1 has the following advantages over other alternatives and is thus recommended for implementation as part of the Re-Gen Program:

- Lowest capital cost and NPV
- Consolidated footprint on a tight site
- No concern about carbon media life
- Proven technology for hard-to-remove odorants
- Familiar technology for WPCP staff

Technical Memorandum No. 14

Date:	November 12, 2021
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Tom Broderick Lisa Racey
From:	HDR
Subject:	Program Delivery Recommendation

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1.0 Purpose and Project Background

The Arlington County (County) Water Pollution Control Bureau (WPCB) is implementing new solids handling processes at the Arlington Water Pollution Control Plant (WPCP), an advanced wastewater treatment plant located on S Glebe Road with capacity to treat up to 40 million gallons per day (mgd). The WPCP provides wastewater treatment for a service area that includes most of Arlington County plus areas of Falls Church, Alexandria, and Fairfax County.

Due to the age and condition of the existing facilities as well as opportunities to increase sustainability and reliability, it is necessary to replace the solids handling processes at the WPCP. Nearly all the solids handling processes at the WPCP will require upgrades or replacement.

This Technical Memorandum contains project background information and a detailed discussion of the recommendation to use the Design-Build delivery method for project implementation.

1.1 Current Solids Handling Process

The WPCP uses a combination of physical, chemical, and biological processes to treat wastewater. Solids removed from the treatment processes receive additional treatment before being hauled off site by trucks. Solids are thickened and dewatered prior to lime stabilization. Approximately 36,000 wet tons of lime-stabilized biosolids are hauled annually by truck from the site for beneficial use as Class B biosolids in bulk land application, which equates to about 30 dry tons per day. The current solids handling processes are shown schematically on Figure 1.

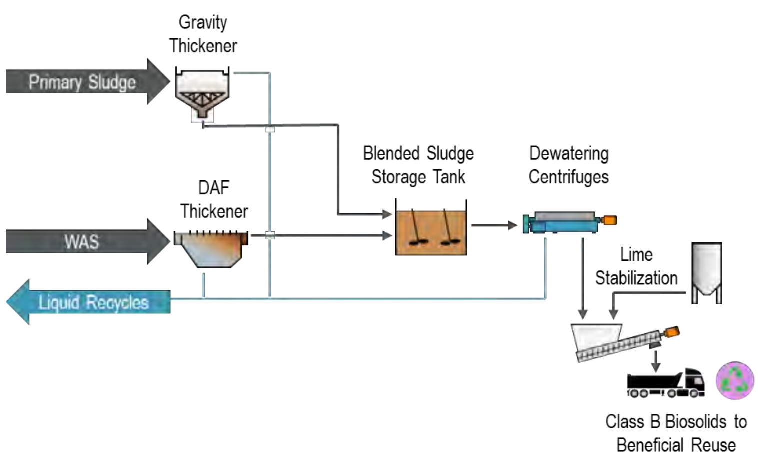

Figure 1. Existing Solids Handling Processes at the Arlington WPCP

The existing solids handling processes, which were constructed between the 1950s and 1990s, are well beyond their 20-year equipment life. Many need replacement because of high operation and maintenance costs, sub-optimal performance, or non-operational status.

1.2 Solids Master Plan

In 2015, the WPCB initiated a comprehensive Solids Master Plan (Master Plan) to address the long-term needs of the WPCB. The goals of the Master Plan included the following:

- Replacing failing and end-of-life equipment

- Mitigating the risk of potential future regulatory changes to the current practice of recycling Class B biosolids through application to agricultural land
- Providing a solution that reduces the energy and greenhouse-gas footprint of the WPCP
- Furthering County-wide sustainability goals
- Developing a solids management strategy that offers long-term reliability
- Establishing an implementation plan compatible with County capital improvement program (CIP) funding

The Master Plan recommended processes include the thermal hydrolysis process (THP) followed by anaerobic digestion (AD), which will recover energy and nutrient resources. The Class A biosolids product generated can be both land-applied, used in the community, and will provide resilience against potential future regulatory changes. The methane generated through the process will be beneficially used as renewable natural gas or to generate electricity and heat on the WPCP site. The proposed processes are shown schematically on Figure 2.

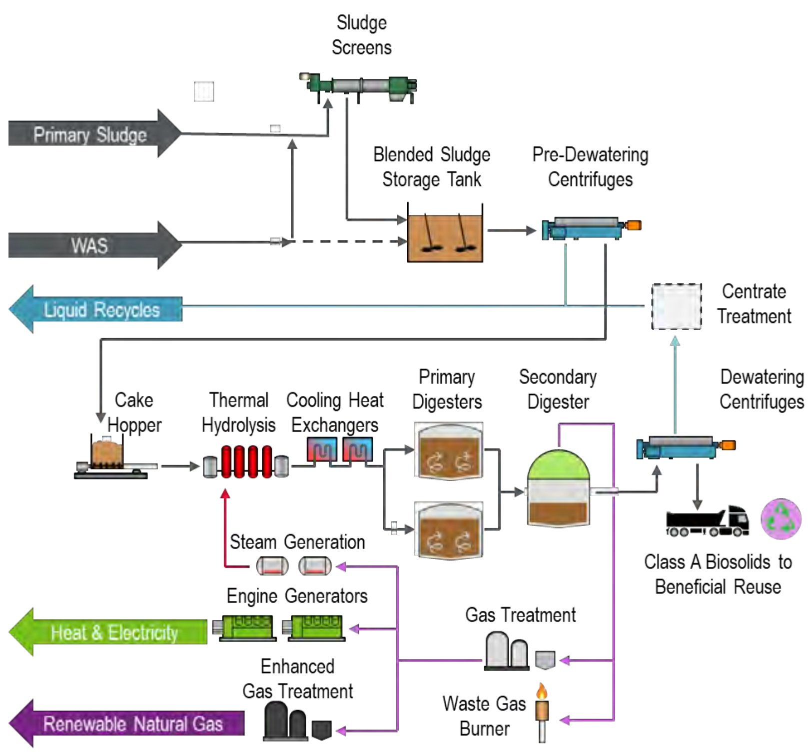

Figure 2. Proposed Solids Handling Processes at the Arlington WPCP

The Master Plan was adopted by the County Board concurrent with the fiscal year (FY) 2019–2028 CIP, with a total value of $155 million.

1.3 Current Program Status

In 2020, the County hired HDR Engineering, Inc. (HDR) as Program Manager to assist with the development and execution of the improvements identified in the Master Plan (collectively, the Program). Initial efforts under the Program include development of a Facilities Plan to further define the scope of the improvements, and an evaluation of project packaging, and delivery methods for implementation.

2.0 Delivery Method Risks

To facilitate the evaluation of project packaging and delivery methods for implementation, HDR and the WPCB completed a thorough risk review of the Program elements in a series of interactive workshops. The top Program delivery risks identified by the WPCB team are shown in in Table 1 below.

Table 1. Project Delivery Risks

Risk	Risk Description
Startup	The new facilities include multiple integrated facilities that need to work together seamlessly, requiring collaboration between the County, Engineer, and Contractor.
Constructability	The site available for construction is tight and construction will impact the ability to maintain operations. Constructability and temporary operations decisions that impact costs and schedule will need to be made during design.
Process performance	There is responsibility of both the Engineer and the Contractor on ensuring performance meets the requirements of the County to make a successful project.
Budget	There is significant uncertainty in pricing in the current market, and decisions made during design can have a large impact on the overall budget.
Scope Uncertainty	Engineering errors or omissions and scope gaps could impact cost and schedules.
Quality	The new facilities will need to be designed and constructed to maintain the expected quality of the final product.
Collaboration and County Input	Collaboration is desired between all parties to minimize other project risks.
Schedule	Schedule delays could impact overall cost and result in failures of existing equipment.

Through the risk analysis and discussion of potential delivery approaches, the WPCB determined that the traditional competitive sealed bidding approach (Design-Bid-Build) does not adequately address key project risks, as identified in Table 2 below. Additionally, risk ownership of these key risks remains solely with the County.

Table 2. Risks Associated with Competitive Sealed Bidding

Risk	Risk Ownership	Potential Issue	Cost Impacts	Schedule Impacts
Startup	County	Lack of coordination between the contractor and engineer on critical sequencing and startup procedures for the complex facilities leads to schedule delays and conflict during execution.	✓	✓
Site utilization	County	Lack of contractor input during design leads to uninformed decisions on site utilization, site layout, and temporary operations, leading to added costs and schedule delays during construction.	✓	✓
Process performance	County	Lack of coordination and execution of performance guarantees to prove process performance leads to added costs, schedule delays, and conflict during execution.	✓	✓
Budget	County	Lack of price certainty until the project bids leads to budget overruns and schedule delays if additional funding is required.	✓	✓
Scope uncertainty	County	Conflicts, errors, and omissions identified during construction lead to budget overruns and schedule delays.	✓	✓

Due to the inability of the competitive sealed bidding to adequately address the risks and the potential impacts on cost and schedule, the WPCB believes that the use of competitive sealed bidding is not practicable for implementation of the Program.

3.0 Recommendation for Use of Design-Build

The WPCB recommends use of the design-build (DB) delivery method through competitive negotiations for delivery of the major portions of the Program, as authorized by the Arlington County Purchasing Resolution (July 2021), Section 4-102(3)D. The primary advantages to the WPCB of the DB delivery method for this Program are as follows:

- Single point of responsibility for design and construction, including startup and performance requirements
- Contractor input during design, both to inform the design and to allow the contractor to be more informed to accurately price the work
- Decision making informed through real-time pricing discussions
- Deliberate teaming of design and construction partners in a collaborative manner

The WPCB has determined that the DB delivery method mitigates many of the risks identified in Table 1 that are associated with competitive sealed bidding. These mitigation strategies are described in Table 3. Using the DB delivery method, the risk is assigned to the most appropriate entity and is not the sole responsibility of the County.

Table 3. Risk Mitigation through Design Build Delivery

Risk	Risk Ownership	Risk Mitigation
Startup	Design-builder	Design-builder is fully responsible for coordination and startup of complex, integrated facilities as a single point of accountability.
Site utilization	Design-builder and County	Design-builder offers input during design phase, including risk analysis, constructability, and site utilization planning, prior to final pricing being set. County maintains risk for uncontrollable conditions.
Process performance	Design-builder	Design-builder is fully responsible for process performance as a single point of accountability.
Budget	County	While County maintains risk ownership, detailed cost estimates during design process can inform County decisions on scope and scope changes.
Scope uncertainty	Design-builder	Design-builder is fully responsible for foreseeable conflicts, errors, and omissions identified during construction. In addition, design-builder maintains responsibility during design for identifying potential conflicts.

The project team understands that there are risks associated with the DB delivery method. Working in partnership with HDR and the County's Purchasing Agent, the project team will actively monitor and manage the risks before they become problematic and work with the delivery team to address them. Three key areas of focus will be:

- Owner involvement: HDR will facilitate County design reviews to identify areas for the County review team to focus on and confirm critical aspects of the review. In addition, HDR will perform independent design reviews focused on constructability, operability, and maintainability of the new facilities.

- Quality during construction: HDR will provide independent onsite quality assurance during construction to confirm quality procedures are being properly followed.
- Performance: Prior to issuance of the DB RFP, the program team will agree on performance guarantees needed for ultimate project success. The selected DB Team will be responsible for proven performance against the performance guarantees.

The County will continue to use HDR as the Program Manager to assist the County with preparation of procurement documents and to facilitate the County review of proposals received. A tentative schedule of the DB procurement is provided below:

- Issue Request for Qualifications: March 2022
- Statement of Qualifications due: April 2022
- Issue Request for Proposals: May 2022
- Technical proposals due: August 2022
- Interviews: September 2022
- Recommendation for negotiations: October 2022
- Recommendation for award: January 2023
- Board recommendation: February 2023

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Technical Memorandum No. 15

Date:	December 2, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Envision Rating System Recommendations

Contents

Appendices

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1.0 Background

Arlington County (County) has initiated the implementation of the Arlington Re-Gen Biosolids Upgrade Program (Program) for the next generation of biosolids management facilities at the Arlington County Water Pollution Control Plant (WPCP). A comprehensive Program will be developed and managed by the Program Team for the engineering, design, construction, maintenance, startup, and operation necessary to add sustainable equipment and systems to effectively recover the County's renewable resources, produce a Class A biosolids product, and most efficiently utilize the biogas. The new solids handling processes (Facilities) will entail upgrades to or replacement of nearly all existing solids handling facilities at the WPCP. A thermal hydrolysis process (THP) followed by anaerobic digestion (AD) form the backbone of the new treatment train. A marketable Class A biosolids product and biogas utilization system to clean and make use of recovered biogas gas either on or off site are also envisioned. The completed Program will enhance operating conditions and reliability of the Facilities while continuing to meet all permit requirements and ensure an unrelenting commitment to environmental stewardship.

Mission Statement: *Upgrade resource recovery facilities to produce Class A biosolids and renewable energy, maximizing sustainability and community acceptance. Collaborate with team members to select and implement processes that are safe, reliable, and financially responsible throughout planning, design, construction, operations and maintenance.*

The Arlington County Facility Sustainability Policy for New Construction and Major Renovation (Green Building Policy, April 30, 2019) requires that "all County buildings and public facilities shall strive to incorporate the highest environmental performance standards using the LEED, International Living Futures Institute (ILFI), or Viridiant's EarthCraft Virginia green building rating system." Further, the policy notes that all eligible new construction must achieve at least Leadership in Energy and Environmental Design (LEED) Silver certification "to demonstrate and communicate comprehensive sustainability to the public, including management of energy, water, materials, indoor environment, and sustainable sites."

Because of the industrial, process-oriented nature of the Program, it would be difficult for the facility to meet several of the LEED prerequisites. The Envision® V3 Sustainable Infrastructure Framework (Envision) was created by a strategic alliance of the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure (ISI) to foster "the dramatic and necessary improvement in the sustainable performance and resiliency of physical infrastructure."[1] Whereas LEED is intended to evaluate interior spaces with the primary purpose of human occupancy, Envision covers projects in broad civil infrastructure. Refer to Appendix A for more background on Envision and representative water and wastewater infrastructure projects that are Envision Verified. The WPCP can use the Envision framework to improve sustainable performance, as a project guide, and to pursue Envision verification.

The purpose of this technical memorandum (TM) is to provide context to the Envision framework and provide comparisons between the Envision and LEED rating systems to assist with the approval process to use the Envision program for the Program.

[1] https://sustainableinfrastructure.org/wp-content/uploads/EnvisionV3.9.7.2018.pdf

2.0 Comparison of Envision to Arlington County's Green Building Policy and LEED

This section presents a comparison between Envision and Arlington County's Green Building Policy and LEED.

2.1 Envision Sustainability Infrastructure Framework Comparison to Existing Policies

The Program team reviewed the County's Green Building Policy and found that it aligns well with the Envision framework, as shown in Appendix B. Table B1 provides a direct comparison between the Green Building Policy and Envision. Table B2 provides a list of Envision topics not explicitly covered by the Green Building Policy.

2.2 Envision Sustainability Infrastructure Framework Comparison to LEED

Given the County's LEED requirement, the Program team compared and contrasted Envision and LEED, specifically related to the Program.

Envision is similar in structure to the LEED rating system. While LEED is intended to be used for buildings, Envision provides industry-wide sustainability metrics for all infrastructure types, including industrial facilities such as the WPCP. Envision provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects, giving recognition to those projects that use transformational, collaborative approaches to assess the sustainability indicators over the course of a project's life cycle. Similar to LEED, Envision has multiple levels of verification, depending on the number of points achieved: Verified, Silver, Gold, or Platinum.

Appendix C provides additional information on the Envision/LEED comparison. Table C1 provides a high-level comparison of the LEED and Envision rating systems. Table C2 shows how LEED credits correlate to Envision credits. Table C3 shows how Envision credits correlate to LEED credits, noting how closely they correlate using green, yellow, and red dots. Table C4 provides detail on LEED v4.1 Prerequisite Credits and their criteria, showing which Envision credits correlate with the prerequisites, if the project would anticipate pursing those credits, the anticipated level of achievement (LOA), and the credit criteria or requirements for the anticipated LOA.

Together, these comparisons provide support for use of Envision in place of LEED Program.

3.0 LEED/Envision Energy

LEED and Envision both have credits that focus on energy use and emissions.

The LEED v4.1 Energy and Atmosphere category includes four prerequisites and six credits as follows:

- Energy and Atmosphere prerequisites:
  - Fundamental Commissioning and Verification
  - Minimum Energy Performance
  - Building-Level Energy Metering
  - Fundamental Refrigerant Management
- Energy and Atmosphere credits:

- Enhanced Commissioning
- Optimize Energy Performance
- Advanced Energy Metering
- Grid Harmonization
- Renewable Energy
- Enhanced Refrigerant Management

The Envision Resource Allocation category includes four credits focused on energy, and the Climate and Resilience category includes three credits related to emissions. There are no prerequisites.

- Resource Allocation credits:
  - RA2.1 Reduce Operational Energy Consumption
  - RA2.2 Reduce Construction Energy Consumption
  - RA2.3 Use Renewable Energy
  - RA2.4 Commission & Monitor Energy Systems
- Climate and Resilience credits:
  - CR1.1 Reduce Net Embodied Carbon
  - CR1.2 Reduce Greenhouse Gas Emissions
  - CR1.3 Reduce Air Pollutant Emissions

Details about Envision's energy- and emissions-related credits are outlined in Appendix D. Table D1 lists Envision credits, the LOA at which they are anticipated to be pursued, and rationale as to why credits cannot be pursued at the highest LOA, if applicable. Appendix D also includes excerpts of the Envision Guidance Manuals showing the energy and emissions-related credits.

Another approach for tracking energy efficiency is the EnergyStar program, which provides energy efficiency metrics and ratings for a range of applications. Most commonly found on commercial appliances, the EnergyStar program has also been applied to commercial buildings with the same principles: buildings that are designed to require fewer resources and less energy are rated accordingly.

Some wastewater treatment facilities have also been evaluated with the EnergyStar program and given a score based on their relative use of purchased power and other operational metrics compared against a database compiled from survey information of other wastewater treatment facilities across the country. From there, a facility can be assigned a rank within the database, which then corresponds to an assigned EnergyStar score.

Comparing the energy use of the Program to other wastewater treatment facilities is not recommended, as the EnergyStar rating system is intended to be used for entire wastewater treatment facility operations, rather than specific portions, such as biosolids processing. The rating system also does not account for vast differences in treatment requirements at various wastewater treatment facilities. This difference in treatment requirements can mean that significantly more energy is needed to achieve treatment, and some facility designs are inherently more energy intensive. Therefore, it is not recommended to use an EnergyStar rating as another tracking tool for energy efficiency.

4.0 Envision Assessment

An Envision assessment was completed for the Program to:

- Evaluate the Program's alignment with Envision criteria (sustainable performance), in the context of planning and design decisions made up to this point
- Identify areas for future/further consideration as opportunities to improve the Program's sustainable performance

To evaluate the Program, the team worked with HDR's Envision specialist to conduct an initial review of the Program's preliminary conceptual facilities related to each of the 64 Envision credits and associated criteria. Preliminary research was also conducted to review County plans and their relationship to the Program and Envision. This review was done to:

- Evaluate each credit for relevance
- Conduct initial analysis into the potential level of achievement (LOA)
- Discuss potential documentation sources
- Identify potential opportunities for incremental improvements in sustainable performance
- Note areas for improvement or efforts that may push the program to achieve higher LOAs

On September 30, 2021, an Envision workshop was held with the Program's Sustainability Workgroup. The purpose of the workshop was to:

- Continue to build understanding of Envision and what is needed to document the Program for verification
- Discuss 13 credits identified as needing additional input from the Sustainability Workgroup to try to determine if they will be pursued and, if so, at which LOA

A high-level overview of the assessment results, including potential LOA targets or ranges, is included in Appendix E. Some credits are shown with an LOA range. The low LOA indicates the level the Program might attain with the current preliminary concepts. Ranges indicate a potential for increased LOA depending on decisions made in the future throughout detailed design and construction that might improve the Program's sustainable performance. Refer to TM No. 17: *Envision Assessment Summary* for a detailed analysis of the preliminary assessment of the Program's sustainable performance, estimated credit LOA, and recognition level likely to be achieved by the Program.

This assessment represents an early review of Envision for the Program, including a review of the Program's sustainable attributes and County's sustainable practices. At this stage, some credits are difficult to gauge because related design decisions have not yet been made. This is a limitation for the Envision review but offers opportunities for the team to improve sustainable performance in some areas. In addition, Envision includes five construction-specific credits. These credits would require guidance to and monitoring of the contractor during the construction phase. The team has made some assumptions about the LOA for these five credits.

5.0 Recommendation

Based on the initial evaluation, the Arlington Re-Gen Biosolids Upgrade Program is well-suited to pursue credits that could result in an Envision verification, provided that the required supporting documentation is compiled. The Program currently demonstrates that it can achieve a Silver verification goal, which aligns with the Green Building Policy's requirement for LEED Silver certification. There may be sufficient points to target a Gold verification when submitted.

As the nature of the Arlington Re-Gen Biosolids Upgrade Program is a broad and complex civil infrastructure project, it is recommended that the Program proceed with the Envision verification system as a means to achieve a more sustainable Program while fulfilling the intent of the Arlington County Green Building Policy.

To assist with the concerns with omitted credits between LEED and Envision, is it recommended that all Envision credits that correlate to LEED prerequisites be included, with the exception of those discussed above, as shown in the preliminary Envision scorecard.

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Appendix A. Envision Overview

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ENVISION™

Envision® v3 Sustainable Infrastructure Framework

The framework provides a **flexible system of criteria and performance objectives** to aid decision makers and help project teams identify sustainable approaches during planning, design, and construction that will carry forward throughout the project's operations and maintenance and end-of-life phases.

Envision Benefits

Economic
- Consideration of future expansion
- Extend useful life of project
- Lower heating bills
- Lower O&M costs
- Reduce energy and water costs
- Reduce wastewater fees
- Return on investment

Societal
- Create more livable communities
- Demonstrating good governance to voters, taxpayers, or ratepayers
- Develop durable infrastructure, with less maintenance
- Improve/increase local job market
- Improve business environment
- Improve community safety, mobility, recreational opportunities
- Increase community/stakeholder involvement in process
- Integrate into the local environment
- Preserve community culture/history
- Reduce construction impacts
- Reduce environmental impacts
- Reduce noise

Environmental
- Conserve energy and water
- Optimize resource efficiency
- Preserve greenfields/redevelop brownfields
- Reduced air pollution
- Reduce greenhouse gas emissions
- Reduce light pollution
- Reduce stormwater runoff
- Reduce waste sent to landfills
- Source local materials
- Use materials more efficiently
- Use recycled materials

Other
- Calibrate internal assessment against a common set of sustainability criteria
- Demonstrate commitment to environmental stewardship and social responsibility
- Improve public perception
- Strengthen inter-agency and project team collaboration

PURPOSE OF ENVISION

The purpose of Envision is to foster the dramatic and necessary improvement in the sustainable performance and resiliency of physical infrastructure by helping owners, planners, engineers, communities, contractors, and other infrastructure stakeholders to implement more cost-effective, resource-efficient and adaptable long-term infrastructure investments.

ENVISION BACKGROUND

Institute for Sustainable Infrastructure

Envision was created by a strategic alliance of the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure (ISI). ISI is a not-for-profit education and research organization, dedicated to developing and maintaining a civil infrastructure rating system, and was formed by the American Council of Engineering Companies, the American Public Works Association and the American Society of Civil Engineers.

WHERE DOES ENVISION APPLY?

- Designed as a holistic framework for all types and sizes of both public and private infrastructure
- Covers project in energy, water, waste, transportation, landscape, information and other civil infrastructure
- Not intended to evaluate interior, conditioned, buildings with the primary purpose of human occupation
- Has been applied extensively throughout the U.S. and Canada but is applicable, and has been used, all over the world
- Used by infrastructure owners, design teams, community groups, environmental organizations, constructors, regulators and policy makers

STRUCTURE

Credit Categories & Subcategories

1| Quality of Life – Wellbeing, Mobility, Community

2 | Leadership – Collaboration, Planning, Economy

3 | Resource Allocation – Materials, Energy, Water

4 | Natural World – Siting, Conservation, Ecology

5 | Climate and Resilience – Emissions, Resilience

Levels of Achievement

1 | Improved – Performance that is above conventional.

2 | Enhanced – Sustainable performance that is on the right track.

3 | Superior – Sustainable performance at a very high level.

4 | Conserving – Performance that has achieved essentially zero negative impact.

5 | Restorative – Performance that restores natural or social systems.

Innovation Points

Potential points awarded in each category for methods that advance sustainable infrastructure practices or show exceptional performance beyond expectations.

VERIFICATION

Registration and Verification Fees

Registration: $2,000

Verification: Fees based on project size, membership and verification pathway. HDR is a member of ISI and can register client project's to receive member pricing.

Verification Pathways

Projects may pursue verification either after:

- The design phase (at or after 95% design completion)
- The construction phase (at or after 95% construction completion).

Projects pursuing verification after the design phase will be required to complete an additional post-construction review follow-up.

The post-construction review is required to maintain the Envision award earned after the design phase. The purpose of the post-construction review is to validate that commitments made in the planning and design stages of the project were carried through during construction

Project Award Levels

To receive recognition, projects must achieve a minimum percentage of the total applicable Envision points. Projects can be recognized at four levels.

- Verified: 20%
- Silver: 30%
- Gold: 40%
- Platinum: 50%

ENVISION v3 POINTS TABLE

			Improved	Enhanced	Superior	Conserving	Restorative
QUALITY OF LIFE	PURPOSE	QL1.1 Improve Community Quality of Life	2	5	10	20	26
		QL1.2 Enhance Public Health and Safety	2	7	12	16	20
		QL1.3 Improve Construction Safety	2	5	10	14	-
		QL1.4 Minimize Noise and Vibration	1	3	6	10	12
		QL1.5 Minimize Light Pollution	1	3	6	10	12
		QL1.6 Minimize Construction Impacts	1	2	4	8	-
	WELLBEING	QL2.1 Improve Community Mobility and Access	1	3	7	11	14
		QL2.2 Encourage Sustainable Transportation	-	5	8	12	16
		QL2.3 Improve Access and Wayfinding	1	5	9	14	-
	COMMUNITY	QL3.1 Advance Equity and Social Justice	3	6	10	14	18
		QL3.2 Preserve Historic and Cultural Resources	-	2	7	12	18
		QL3.3 Enhance Views and Local Character	1	3	7	11	14
		QL3.4 Enhance Public Space and Amenities	1	3	7	11	14
					Maximum QL Points	200*	
LEADERSHIP	COLLABORATION	LD1.1 Provide Effective Leadership and Collaboration	2	5	12	18	-
		LD1.2 Foster Collaboration and Teamwork	2	5	12	18	-
		LD1.3 Provide for Stakeholder Involvement	3	6	9	14	18
		LD1.4 Pursue Byproduct Synergies	3	6	12	14	18
	PLANNING	LD2.1 Establish a Sustainability Management Plan	4	7	12	18	-
		LD2.2 Plan for Sustainable Communities	4	6	9	12	16
		LD2.3 Plan for Long-Term Monitoring and Maintenance	2	5	8	12	-
		LD2.4 Plan for End-of-Life	2	5	8	14	-
	ECONOMY	LD3.1 Stimulate Economic Prosperity and Development	3	6	12	20	-
		LD3.2 Develop Local Skills and Capabilities	2	4	8	12	16
		LD3.3 Conduct a Life-Cycle Economic Evaluation	5	7	10	12	14
					Maximum LD Points	182*	
RESOURCE ALLOCATION	MATERIALS	RA1.1 Support Sustainable Procurement	3	6	9	12	-
		RA1.2 Use Recycled Materials	4	6	9	16	-
		RA1.3 Reduce Operational Waste	4	7	10	14	-
		RA1.4 Reduce Construction Waste	4	7	10	16	-
		RA1.5 Balance Earthwork On Site	2	4	6	8	-
	ENERGY	RA2.1 Reduce Operational Energy Consumption	6	12	18	26	-
		RA2.2 Reduce Construction Energy Consumption	1	4	8	12	-
		RA2.3 Use Renewable Energy	5	10	15	20	24
		RA2.4 Commission and Monitor Energy Systems	3	6	12	14	-
	WATER	RA3.1 Preserve Water Resources	3	5	7	9	12
		RA3.2 Reduce Operational Water Consumption	4	9	13	17	22
		RA3.3 Reduce Construction Water Consumption	1	3	5	8	-
		RA3.4 Monitor Water Systems	1	3	6	12	-
					Maximum RA Points	196*	
NATURAL WORLD	SITING	NW1.1 Preserve Sites of High Ecological Value	2	6	12	16	22
		NW1.2 Provide Wetland and Surface Water Buffers	2	5	10	16	20
		NW1.3 Preserve Prime Farmland	-	2	8	12	16
		NW1.4 Preserve Undeveloped Land	3	8	12	18	24
	CONSERVATION	NW2.1 Reclaim Brownfields	11	13	16	19	22
		NW2.2 Manage Stormwater	2	4	9	17	24
		NW2.3 Reduce Pesticide and Fertilizer Impacts	1	2	5	9	12
		NW2.4 Protect Surface and Groundwater Quality	2	5	9	14	20
	ECOLOGY	NW3.1 Enhance Functional Habitats	2	5	9	15	18
		NW3.2 Enhance Wetland and Surface Water Functions	3	7	12	18	20
		NW3.3 Maintain Floodplain Functions	1	3	7	11	14
		NW3.4 Control Invasive Species	1	2	6	9	12
		NW3.5 Protect Soil Health	-	3	4	6	8
					Maximum NW Points	232*	
CLIMATE & RESILIENCE	EMISSIONS	CR1.1 Reduce Net Embodied Carbon	5	10	15	20	-
		CR1.2 Reduce Greenhouse Gas Emissions	8	13	18	22	26
		CR1.3 Reduce Air Pollutant Emissions	2	4	9	14	18
	RESILIENCE	CR2.1 Avoid Unsuitable Development	3	6	8	12	16
		CR2.2 Assess Climate Change Vulnerability	8	14	18	20	-
		CR2.3 Evaluate Risk and Resilience	11	18	24	26	-
		CR2.4 Establish Resilience Goals and Strategies	-	8	14	20	-
		CR2.5 Maximize Resilience	11	15	20	26	-
		CR2.6 Improve Infrastructure Integration	2	5	9	13	18
					Maximum CR Points	190*	
		Maximum TOTAL Points	1,000*				

*Not every credit has a restorative level. Therefore totals include the maximum possible points for each credit whether conserving or restorative.

Envision Context – Water and Wastewater Treatment

110 **Verified**, publicly announced, projects

49 **Water** projects

- **19** Wastewater
- **7** Drinking Water
- **23** Water Resources

4 Projects in Virginia


Figure 1: Verified Water Sector Projects; ISI website 1/14/2022


Figure 2: Verified Wastewater Treatment Projects; ISI website 1/14/202

Figure 3: Verified Regional Wastewater Treatment Projects; ISI website 1/14/2022

Water and Wastewater Envision Project Examples

Envision benefits can often best be illustrated through project examples. The following are a few of the Envision verified wastewater projects, which illustrate the benefits of sustainable infrastructure and use of the Envision framework. HDR projects are marked with an *. Information for other examples was referenced on ISI's website (sustainableinfrastructure.org).

*Little Patuxent Water Reclamation Plant Biosolids Processing Facilities Improvement Project, Howard County, MD**

Envision Silver, September 2021

Key factors contributing to the project earning Envision Silver include:

- Stimulating sustainable growth and development. This project implements new process methods into the overall wastewater solids treatment process.
- Finding beneficial uses for waste products. A detailed biosolids market study was conducted to research potential end uses for the new Class A dried biosolids waste product.
- Use of recycled and regionally sourced materials – over 50% recycled materials by weight, over 90% locally or regionally sources.
- More than 80 percent of excavated materials were kept onsite in stockpiles with the intent to reuse for topsoil and fill.

"Participating in this project has truly been a pleasure thanks to the collaboration of HDR Engineering as designer and Clark Construction as Construction Manager at Risk. The Little Patuxent Water Reclamation Plant has been a leader in our industry and region with the highest levels of treatment performance, especially as it pertains to nutrients in discharged effluent water. The improved biosolids product we are now producing is another example of our ability to produce a high-quality product that can be beneficially reused in various markets and minimize impacts to the Chesapeake Bay watershed and the environment in general. We are very pleased that ISI has awarded this project a silver award and appreciate all of the efforts put forth by the entire design and construction teams." Robert Hindt, Plant Manager

*Big Dry Creek Wastewater Treatment Facility, Solids Dewatering and Campus Wide Improvements Project, Westminster, CO**

Envision Bronze, June 2021

Key factors contributing to the project earning Envision Bronze include:

- Improving efficiencies and saving costs – By reducing the water content of biosolids and allowing more material to be applied to the same acreage
- Extending the life of the project
- Reducing the number of hauling trips by two-thirds
- Holistic facility design, in conjunction with efficient coordination of on-site design elements with off-site elements
- Providing flexibility to meet current needs and projected future needs
- Enhancing nitrogen removal to improve biosolids quality

"Using the Envision certification process has helped the City become a better fiscal, social and environmental steward. Sustainability and safe, reliable service are top priorities for our residents and will be a continued focus of our strategic infrastructure investments." Max Kirschbaum, City of Westminster's Public Works and Utilities Director

Water and Wastewater Envision Project Examples

AlexRenew, Nutrient Management Facility (NMF), Alexandria, VA

Image from ISI website 1/14/2022: sustainableinfrastructure.org/project-awards/nutrient-management-facility

Envision Platinum, November 2016

The Nutrient Management Facility includes 18 million gallons in tank capacity with associated pumps, chemical analysis equipment, and an extensive odor control system. It also includes a lit, regulation athletic field located on top of the process tanks, created as a community amenity. The NMF stores wastewater to balance the amount of nitrogen that goes into AlexRenew's biological treatment process.

Key factors contributing to the project earning Envision Platinum include:

- Removed 85,000 cubic yards of contaminated soil from the site and selected only native plant species with high habitat value that require no pesticides, herbicides, and fertilizers for the site's landscaping
- Many considerations to improve community quality of life were incorporated, including a multi-purpose lit athletic field, built on top of the NMF.
- Acres of impervious surface were replaced with vegetated areas to restore infiltration and water quality functions. A fish and sediment barrier was removed, which improved aquatic habitat connectivity, and a crucial wooded riparian buffer was expanded, enhancing the natural habitat.

Grand Bend Area Wastewater Treatment Facility, Ontario, Canada

Image from Stantec website 1/14/2022: www.stantec.com/en/projects/canada-projects/g/grand-bend-area-wwt-facility

Envision Platinum, February 2015

Converted one of four existing lagoons into an extended aeration mechanical treatment facility and wetland nature reserve. The facility prevents effluent discharges from adversely impacting surface and groundwater quality and allows for responsible community development.

Key factors contributing to the project earning Envision Platinum include:

- Key design features enhance its durability, flexibility, and resiliency. The facility can be reconfigured and/or expanded to meet new demands, and respond to changing sewage inflows through the use of flow equalization to prevent sewage bypass events.
- Construction of wetland provided an opportunity to reuse excavated soils on-site and significantly reduced the need for imported fill and associated costs.
- Habitat was created through the design of the constructed wetland and restoration of a tallgrass prairie on-site. The project team worked with local conservation groups, volunteers, and municipal staff to develop a plan that supports the elimination of invasive species.
- The project design addresses projected changes in population and service area growth and increases in frequency and severity of extreme rainfall events in southern Ontario.

Water and Wastewater Envision Project Examples

Noman M. Cole, Jr. Pollution Control Plant (NMCPCP), Fairfax Disinfection Improvements, Fairfax County, VA

Image from ISI website 1/14/2022: sustainableinfrastructure.org/project-awards/fairfax-disinfection-improvements

Envision Gold, October 2019

The project includes a UV facility, an auxiliary chemical storage and feed facility, separate disinfection for water reuse/plant water purposes, reuse water pump station, plant water pump station, filter backwash storage and pumping, a new outfall pipe and associated electrical improvements.

Key factors contributing to the project earning Envision Gold include:

- Conducted a thorough analysis of water requirements for the project and found many ways to reduce potable water use for plant operations, thereby protecting the availability of freshwater resources in the area.
- UV disinfection process eliminates two major chemical uses at the NMCPCP: sodium hypochlorite for disinfection and sodium bisulfite for dechlorination.
- Eliminating chemical uses reduces the number of truck deliveries required to transport liquid chemicals and subsequently related greenhouse gas emissions.
- Modifying the hydraulic grade line of the facility allowed for the complete elimination of a pump station resulting in operational energy savings and reduced greenhouse gas emissions.

"We are honored that this is the second Envision award achieved by Fairfax County DPWES. Wastewater utilities projects, although might not be visible to the communities they serve, actively create more livable and resilient communities. We have always been driven by the principles of sustainability throughout our project planning and implementation and we are fortunate to provide environmental, social, and economic benefits to the community. Working alongside community partners who value sustainability and support efforts like this have increased the positive impact on our local waterways."
Guiying Xiao, Project Manager, Fairfax County Department of Public Works and Environmental Services (DPWES)

Northeast Ohio Regional Sewer District (NEORSD) Southerly Wastewater Treatment Plant, Cleveland, OH

Image from ISI website 1/14/2022: sustainableinfrastructure.org/project-awards/neorsd-southerly-plant

Envision Silver, January 2018

Key factors contributing to the project earning Envision Silver include:

- Facilitating economic growth and development, including college assistance program and training opportunities
- The facility expands educational opportunities by offering introductory level workshops about the history and future of sewer systems, water quality, and sustainability in the region.
- The recently completed Renewable Energy Facility (REF) at the plant uses sludge, septage, and grease from both the Southerly and Easterly plants to generate energy. Construction of the REF, along with the decommissioning of the Southerly Plant's Biosolids Thermal Conditioning System, contributes to a reduction in natural gas usage by approximately 137,000 mcf per year.

Water and Wastewater Envision Project Examples

San Antonio River Authority, Martinez IV Wastewater Treatment Plant, Saint Hedwig, TX

Image from ISI website 1/14/2022: sustainableinfrastructure.org/project-awards/martinez-iv-wastewater-treatment-plant

Envision Silver, September 2019

This is a new facility built to accommodate the significant projected population growth of the surrounding communities. Without this facility, the increased raw sewage would need to be pumped and hauled by truck on a daily basis to other facilities for treatment, causing significant impacts to soil, watershed quality, air pollution, and carbon dioxide emissions.

Key factors contributing to the project earning Envision x include:

- Onsite renewable solar energy provides 41.5% of energy for process equipment.
- Invasive species were removed from the site and it was re-vegetated with several native species.
- Plant positioned beyond the 500-year floodplain to reduce risks from flooding.

"The San Antonio River Authority is committed to safe, clean, and enjoyable creeks and rivers, so the decision to provide the community with sustainable infrastructure and pursue an Envision rating for the Martinez IV Project is in line with our vision and mission." Amy Middleton, San Antonio River Authority Utilities Manager and Martinez IV Project Manager

Water Treatment Plant Residuals Management Facility, Red Deer, Alberta, CA

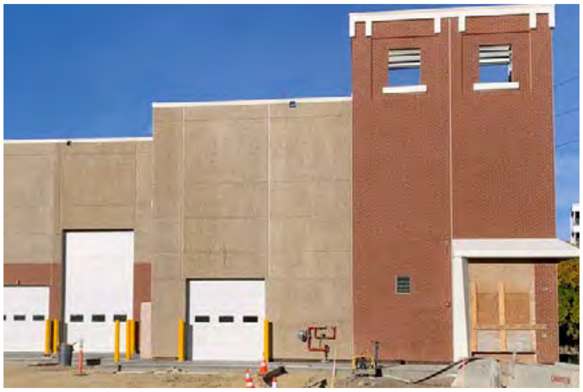

Image from ae.ca website 1/14/2022: www.ae.ca/ae-today/latest-updates/details/blog/2021/10/07/red-deers-water-treatment-plant-residuals-management-facility-will-reduce-environmental-impacts-associated-with-treating-water

Envision Bronze, July 2021

Key factors contributing to the project earning Envision x include:

- Minimizing noise and vibration from plant operations
- Reducing operational energy consumption by 23.6% compared to industry norms.
- Developing a comprehensive plan for long-term monitoring and maintenance.
- Supporting sustainable procurement practices by aligning procurement with the City's Environmental Sustainability Policy which encourages staff to minimize the environmental impact of the city's infrastructure and employ environmentally sound operational practices.
- Preventing surface and groundwater contamination by including several features and monitoring systems into the project's design.

"It is an honour for ISI to recognize the City of Red Deer Water Treatment Plant Residuals Management Facility project as a leader in sustainable infrastructure. Our drinking water and our environment are high priorities for the City. The project is not only a proactive step in our ongoing upgrades to our water treatment plant but also demonstrates the City's environmental leadership and commitment to achieving environmental sustainability. The City worked closely with its Engineering Consultant, General Contractor and regulators: Alberta Environment and Parks, Fisheries and Oceans Canada, Transport Canada, Alberta Public Lands, and Alberta Culture and Tourism to make the project a reality."
Kingsford Amoah, City of Red Deer's Environmental Planning Engineer and ENV SP Lead

Appendix B. Comparison Tables: Envision and the Arlington County Green Building Policy

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Table B1. Comparison of Arlington County Facility Sustainability Policy: for New Construction and Major Renovation (Green Building Policy) to the Envision Sustainable Infrastructure Framework

Green Building Policy	Envision Framework
This policy was developed to support Arlington County's mission of sustainability and to support the County's overall greenhouse gas reduction goals.	
Purpose: • To reduce operating costs through energy and water efficiency • To achieve high-performing, durable, and efficient buildings that are easy to operate and maintain • To invest in healthy indoor environments for staff and visitors • To demonstrate Arlington's commitment to environmental, economic, and social stewardship • To set a community standard of sustainable building practices	**Purpose:** To foster the dramatic and necessary improvement in the sustainable performance and resilience of physical infrastructure by helping owners, planners, engineers, communities, contractors, and other infrastructure stakeholders to implement more cost-effective, resource-efficient, and adaptable long-term infrastructure investments
Guiding Principles	**Envision Alignment/Related Credits**
1. **Function:** Achieve **high-performing and efficient building operations** with systems and components that are easy to use and **maintain**. Ensure that the building operates as intended and **reduce long-term operating costs**: • Prioritize simple, passive solutions over mechanical solutions for **energy use reduction** and **stormwater management** • Minimize use of complicated sensor and control systems • Design and locate building systems for **ease of access and maintenance** • Ensure that building systems are compatible with the building programming, are fully functional, and operate as intended before the building is accepted • As new facilities are acquired or built, facilities maintenance budgets should be reassessed and planned	LD2.3 Plan for Long-Term Monitoring & Maintenance LD2.4 Plan for End-of-Life RA1.3 Reduce Operational Waste RA2.1 Reduce Operational Energy Consumption RA2.4 Commission & Monitor Energy Systems RA3.2 Reduce Operational Water Consumption RA3.4 Monitor Water Systems NW2.2 Manage Stormwater CR2.3 Evaluate Risk & Resilience CR2.4 Establish Resilience Goals and Strategies CR2.5 Maximize Resilience
2. **Energy:** Use integrated design and passive strategies to **minimize heating, cooling, and lighting loads and reduce long-term operating costs**: • Prioritize the building thermal envelope and right-size mechanical equipment • Use building orientation and daylight devices to evenly distribute daylight • Avoid elements that are solely aesthetic that increase energy use • Optimize solar photovoltaic exposure and vegetated roof space • Incorporate efficient space utilization	RA2.1 Reduce Operational Energy Consumption RA2.3 Use Renewable Energy RA2.4 Commission & Monitor Energy Systems
3. Human Experience: Support occupant health and well-being with: • Fresh air and ventilation • Humidity control • Selection of low-toxicity materials • Evenly distributed daylight and minimal glare	QL1.1 Improve Community Quality of Life QL1.2 Enhance Public Health & Safety QL1.3 Improve Construction Safety QL1.4 Minimize Noise and Vibration QL1.5 Minimize Light Pollution QL1.6 Minimize Construction Impacts QL2.1 Improve Community Mobility and Access QL2.2 Encourage Sustainable Transportation QL2.3 Improve Access and Wayfinding QL3.1 Advance Equity and Social Justice QL3.2 Preserve Historic & Cultural Resources QL3.3 Enhance Views and Local Character QL3.4 Enhance Public Space and Amenities CR1.2 Reduce Greenhouse Gas Emissions

	CR1.3 Reduce Air Pollutant Emissions
4. **Durability:** Select quality materials, systems, and equipment to **reduce maintenance, operations, and replacement costs**: • County buildings and facilities should be built to last and be flexible in their design to support occupant and community needs as they change over time • Select materials that are easy to maintain and durable for the intended use and expected life of the building • Commission all building systems starting at the design phase and test the building enclosure for air and water infiltration	LD2.3 Plan for Long-Term Monitoring & Maintenance LD2.4 Plan for End-of-Life RA1.2 Use Recycled Materials RA2.4 Commission & Monitor Energy Systems RA3.4 Monitor Water Systems CR2.2 Assess Climate Change Vulnerability CR2.3 Evaluate Risk & Resilience CR2.4 Establish Resilience Goals and Strategies CR2.5 Maximize Resilience
Minimum Sustainability Targets	Envision Alignment/Related Credits
1. New County buildings, additions, and major renovations shall be designed and constructed to **reduce energy use intensity (EUI)** below 28 kBtu/ft²/yr and optimize solar exposure to be "Net Zero Energy Ready." A power purchase agreement may be used to install on-site solar equipment necessary to achieve Net Zero Energy certification through the International Living Futures Institute. Renewable Energy Credits (RECs) should remain on site, if possible.	RA2.1 Reduce Operational Energy Consumption RA2.2 Reduce Construction Energy Consumption RA2.3 Use Renewable Energy RA2.4 Commission & Monitor Energy Systems *RA2.3 Use Renewable Energy: Projects may only count RECs purchased or under contract at the time of assessment. Nonbinding commitments for future REC purchases cannot be counted toward achievement in this credit. Purchased RECs must be annualized over the life of the project. For example, if a project with a 20-year life purchases RECs for 100% of its energy consumption for one year, this would translate to 5% of its overall energy consumption.*
2. Net Zero Energy Ready goals may be waived, as described in item 6 below, if analysis shows sufficient technical constraints such as high density or inherently high energy intensity uses such as aquatic centers or other constraint. If determined that the project will not pursue Net Zero Energy Ready goals, then new County buildings, additions, and major renovations will be designed and constructed to operate at or below a site EUI based on building type in kBtu/ft²/yr.	
3. New County buildings, additions, and major renovations eligible for LEED for New Construction certification must achieve **at least LEED Silver certification** to demonstrate and communicate comprehensive sustainability to the public, including **management of energy, water, materials, indoor environment, and sustainable sites**. Projects may achieve Viridiant's EarthCraft Commercial or Residential certification as applicable in lieu of LEED Silver certification.	The Arlington Re-Gen Biosolids Upgrade Program is contractually obligated to reach at least a Silver level of Envision verification, but will likely target a Gold level of Envision verification. Like LEED, Envision's verification levels are based on points earned: • LEED-certified buildings can earn a total of 110 points. A project must earn 50–59 points for Silver and 60–79 points for Gold. • The Envision framework has a total of 1,000 potential points. To earn an Envision verification, the threshold for Silver is 30% of applicable points and Gold is 40% of applicable points.
4. Buildings to be constructed or renovated with less than 5,000 ft² gross floor area (GFA), buildings leased by the County with less than 8,000 ft² GFA or an initial lease term 8 years or less, and buildings without climate-control systems may be exempt from these Policy Standards but will follow the Guiding Principles.	See Envision alignment with Guiding Principles on pages 9–10.
5. If analysis shows that a major renovation does not include the scope of work necessary to pursue the **Net Zero Energy Ready goal**, the target EUI, and/or is ineligible for LEED or EarthCraft certification, then it shall be determined that this policy has been met if applicable Guiding Principles have been incorporated.	See Envision alignment with Guiding Principles on pages 9–10.

6. Each County project will be evaluated on a case-by-case basis. Waiver of **Net Zero Energy Ready goals** will be determined by the Director of Environmental Services or designee. Unless the County Manager determines that the application of this policy to a particular building or facility is not in the County's best interest (for example, because of time urgency or lack of funding), all County buildings and facilities will be constructed or renovated in accordance with this policy.	
Procedures and Responsibilities	**Envision Alignment/Related Credits**
1. The directors of all County departments whose responsibilities include planning, designing, developing, constructing, renovating, managing, and decommissioning County-owned and -leased buildings and facilities shall be responsible for **ensuring that facilities and buildings comply with this policy**.	LD1.1 Provide Effective Leadership & Commitment LD1.2 Foster Collaboration & Teamwork
2. Budget planning should include **life-cycle cost analysis** (LCCA) to support implementation of this policy.	LD3.3 Conduct a Life-Cycle Economic Evaluation The life-cycle economic evaluation prompts a comprehensive assessment to better understand the tradeoffs of upfront capital costs and the longer-term anticipated operational savings that may accrue from sustainable design. It can also measure and value community, environmental, and societal benefits, which are typically assessed qualitatively. In the Arlington WPCP Solids Master Plan, annual costs and 20-year life-cycle costs were developed using annual projections of solids for years 2021–2040. The Program has also used an LCCA to compare components for gas utilization.
3. Include stakeholders in the scoping, design, and construction process to effectively implement this policy, including a post-occupancy survey to identify lessons learned.	13 Envision credits include a stakeholder engagement component: QL1.1 Improve Community Quality of Life QL1.4 Minimize Noise and Vibration QL1.6 Minimize Construction Impacts QL2.1 Improve Community Mobility and Access QL3.1 Advance Equity & Social Justice QL3.2 Preserve Historic & Cultural Resources QL3.3 Enhance Views & Local Character QL3.4 Enhance Public Space & Amenities **LD1.3 Provide for Stakeholder Involvement** LD2.4 Plan for End of Life LD3.2 Develop Local Skills & Capabilities CR2.3 Evaluate Risk & Resilience CR2.4 Establish Resilience Goals & Strategies
4. When selecting design teams, include a competitive preference for design and construction professionals experienced in ultra-low energy buildings.	
5. Agencies shall include in their calculations for maintenance costs for new or renovated buildings an adjustment in cost per square foot to support new buildings.	
6. County staff must have LEED and building science training appropriate for their level of involvement in the project(s).	

Table B2. Envision Credits That Cover Topics Not Included in the Arlington Green Building Policy

Credit	Intent
LD1.4 Pursue Byproduct Synergies	Critically reconsider whether traditional waste streams can be beneficially reused
LD2.1 Establish a Sustainability Management Plan	Create a project sustainability management plan that can manage the scope, scale, and complexity of a project seeking to improve sustainable performance
LD2.2 Plan for Sustainable Communities	Incorporate sustainability principles into project selection/identification to develop the most sustainable project for the community
LD3.1 Stimulate Economic Prosperity & Development	Support economic prosperity and sustainable development, including job growth, capacity building, productivity, business attractiveness, and livability
RA1.1 Support Sustainable Procurement Practices	Develop sustainable procurement policies and programs to source materials and equipment from manufacturers and suppliers that implement sustainable practices
RA1.4 Reduce Construction Waste	Divert construction and demolition waste streams from disposal to recycling and reuse
RA1.5 Balance Earthwork On Site	Minimize the movement of soils and other excavated materials off site to reduce transportation and environmental impacts
RA3.1 Preserve Water Resources	Assess and reduce the negative net impact on freshwater availability, quantity, and quality at a watershed scale to positively impact the region’s water resources
RA3.3 Reduce Construction Water Consumption	Reduce potable water consumption during construction
NW1.1 Preserve Sites of High Ecological Value	Avoid placing the project and temporary works on a site that has been identified as being of high ecological value
NW1.2 Provide Wetland & Surface Water Buffers	Protect, buffer, enhance, and restore wetlands, shorelines, and water bodies by providing natural buffer zones, vegetation, and soil-protection zones
NW1.3 Preserve Prime Farmland	Identify and protect soils designated as prime farmland, unique farmland, or farmland of importance
NW1.4 Preserve Undeveloped Land	Conserve undeveloped land by locating projects on previously developed land
NW2.1 Reclaim Brownfields	Locate projects on sites classified as brownfields
NW2.3 Reduce Pesticide & Fertilizer Impacts	Reduce nonpoint-source pollution by reducing the quantity, toxicity, bioavailability, and persistence of pesticides and fertilizers
NW2.4 Protect Surface & Groundwater Quality	Preserve water resources by preventing pollutants from contaminating surface water and groundwater and monitoring impacts during construction and operations
NW3.1 Enhance Functional Habitats	Preserve and improve the functionality of terrestrial (land) habitats
NW3.2 Enhance Wetland & Surface Water Functions	Maintain and restore the ecosystem functions of streams, wetlands, water bodies, and their riparian areas
NW3.3 Maintain Floodplain Functions	Preserve floodplain functions by limiting development and impacts of development in the floodplain
NW3.4 Control Invasive Species	Use appropriate non-invasive species, and control or eliminate existing invasive species
NW3.5 Protect Soil Health	Preserve the composition, structure, and function of site soils
CR1.1 Reduce Net Embodied Carbon	Reduce the impacts of material extraction, refinement/manufacture, and transport over the project life
CR2.1 Avoid Unsuitable Development	Minimize or avoid development on sites prone to hazards

Appendix C. Comparison Tables: Envision and LEED

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Table C1. Envision/LEED Alignment and Comparison

	LEED® BD+C (V4)	Envision (v3)
Basics	• Most recognizable sustainable certification available for **building projects** • Rigorous set of clearly defined standards that encourage improve building performance and occupant well-being • Prerequisite requirements must be met if a project is to be considered for certification • Building rating systems (BD+C, ID+C, O&M) for occupied buildings • LEED Zero available for all LEED projects certified under the BD+C or O+M rating systems that have net zero goals in carbon and/or resources	• Holistic view of **infrastructure development** • Recognized and rapidly growing program • Dual pathways allow projects to be submitted for verification either after design reaches 95% with a follow-up at construction completion, or at 95% construction completion • No prerequisites—not required to pursue all credits, but a certain number of credit points must be approved for a project to achieve verification • If used in conjunction with LEED, complements building rating system to inform project elements outside building and direct site; LEED documentation can be used to support some Envision credits
Description	Green building certification program and the globally recognized standard for the design, construction, and operation of high-performance green buildings and neighborhoods	Sustainable best practices and rating system for planning, designing, building, and maintaining civil infrastructure. Provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects.
Managing body	Green Business Certification, Inc. (GBCI) gbci.org U.S. Green Building Council (USGBC) usgbc.org LEED website	Institute for Sustainable Infrastructure (ISI) sustainableinfrastructure.org
Geography	International	International
Intended for	New buildings, existing buildings, renovations, interior fit-outs (also modules for Neighborhood Development [ND] and Cities)	New and existing infrastructure; new and existing buildings that are primarily process focused
Applicable project phase(s)	Design and construction: LEED Building Design and Construction (BD+C) and LEED Interior Design and Construction (ID+C) Operations and maintenance: LEED Building Operations and Maintenance (O&M)	Planning and design, construction, and operations and maintenance in one framework
Categories	• Location & Transportation • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Innovation • Regional Priority	• Quality of Life • Leadership • Resource Allocation • Natural World • Climate and Resilience
# Credits/ prerequisites	57 credits/12 prerequisites	64 credits/no prerequisites
Registration cost	$1,500 ($1,200 if Silver, Gold, and Platinum Level Member)	$2,000
Certification cost	Based on building square footage Precertification: $5,000 ($4,000 if Silver, Gold, and Platinum Level Member)	Based on project cost ($M), membership status of the project team pursuing verification; verification pathway
Rating scale	Certified, Silver, Gold, Platinum	Verified, Silver, Gold, Platinum

Table C2. Envision/LEED Alignment and Comparison

Envision	Related LEED V4 BD+C Credits
Quality of Life	
QL1.1 Improve Community Quality of Life	LT: High-Priority Site (Option 2) ~SS: Site Assessment
QL1.2 Enhance Public Health and Safety	~EQ: Construction Indoor Air Quality Management Plan SS Prerequisite: Construction Activity Pollution Prevention
QL1.3 Improve Construction Safety	
QL1.4 Minimize Noise and Vibration	EQ: Acoustic Performance EQ Prerequisite: Minimum Acoustic Performance?
QL1.5 Minimize Light Pollution	SS: Light Pollution Reduction
QL1.6 Minimize Construction Impacts	
QL2.1 Improve Community Mobility and Access	LT: Surrounding Density and Diverse Uses LT: Access to Quality Transit LT: Bicycle Facilities ~LT: Reduced Parking Footprint?
QL2.2 Encourage Sustainable Transportation	LT: Surrounding Density and Diverse Uses LT: Access to Quality Transit LT: Bicycle Facilities ~LT: Reduced Parking Footprint?
QL2.3 Improve Access & Wayfinding	
QL3.1 Advance Equity & Social Justice	Pilot credits related to this
QL3.2 Preserve Historic & Cultural Resources	LT: High-Priority Site (Option 1)? MR: Building Life-Cycle Impact Reduction (Option 1)
QL3.3 Enhance Views & Local Character	EQ: Quality Views
QL3.4 Enhance Public Space & Amenities	SS: Open Space LT: Surrounding Density and Diverse Uses (public park, plaza) LT: Access to Quality Transit LT: Bicycle Facilities (access to bike network)
Leadership	
LD1.1 Provide Effective Leadership and Commitment	SS: Site Master Plan Prerequisite: Integrative Project Planning and Design IP: Integrative Process
LD1.2 Foster Collaboration and Teamwork	Credit: Integrative Process
LD1.3 Provide for Stakeholder Involvement	IP: Integrative Process?
LD1.4 Pursue Byproduct Synergies	MR: Prerequisite: Construction and Demolition Waste Management Planning MR: Construction and Demolition Waste Management
LD2.1 Establish a Sustainability Management Plan	~EA: Enhanced Commissioning
LD2.2 Plan for Sustainable Communities	
LD2.3 Plan for Long-Term Monitoring & Maintenance	~WE: Water Metering ~EA: Enhanced Commissioning ~EA: Advanced Energy Monitoring
LD2.4 Plan for End-of-Life	MR: Building Life Cycle Impact Reduction MR: Design for Flexibility
LD3.1 Stimulate Economic Prosperity & Development	LT: Surrounding Density and Diverse Uses ~MR: Building Life-Cycle Impact Reduction (Options 1 and 2)
LD3.2 Develop Local Skills & Capabilities	
LD3.3 Conduct a Life-Cycle Economic Evaluation	MR: Building Life-Cycle Impact Reduction
Resource Allocation	
RA1.1 Support Sustainable Procurement Practices	MR: Building Product Disclosure and Optimization-EPD MR: Building Product Disclosure and Optimization—Sourcing of Raw Materials MR: Building Product Disclosure Optimization—Material Ingredients MR: Construction and Demolition Waste Management (take back

	programs, Option 2 reduction of total waste material) EQ: Low-Emitting Materials
RA1.2 Use Recycled Materials	MR: Building Life-Cycle Impact Reduction MR: Building Product Disclosure and Optimization—Sourcing of Raw Materials MR: Construction and Demolition Waste Management
RA1.3 Reduce Operational Waste	MR Prerequisite: Storage and Collection of Recyclables MR: Building Life-Cycle Impact Reduction (Option 3) ~MR: Building Product Disclosure and Optimization-Sourcing of Raw Materials?
RA1.4 Reduce Construction Waste	MR Prerequisite: Construction and Demolition Waste Management Planning MR: Construction and Demolition Waste Management
RA1.5 Balance Earthwork On Site	SS: Site Development—Protect or Restore Habitat?
RA2.1 Reduce Operational Energy Consumption	EA Prerequisite: Minimum Energy Performance ~LT: Green Vehicles (Scope 3 of Envision Credit) EA: Optimize Energy Performance EA: Renewable Energy Production EA: Green Power and Carbon Offsets? EQ: Interior Lighting EQ: Daylight
RA2.2 Reduce Construction Energy Consumption	
Use renewable energy	EA: Renewable Energy Production EA: Green Power and Carbon Offsets
Commission and monitor energy systems	EA Prerequisite: Fundamental Commissioning and Verification EA Prerequisite: Building-Level Energy Metering EA: Enhanced Commissioning EA: Advanced Energy Monitoring
RA3.1 Preserve Water Resources	SS: Rainwater Management
RA3.2 Reduce Operational Water Consumption	WE: Prerequisite: Outdoor Water Use Reduction WE: Prerequisite: Indoor Water Use Reduction WE: Outdoor Water Use Reduction WE: Indoor Water Use Reduction WE: Cooling Tower Water Use
RA3.3 Reduce Construction Water Consumption	
RA3.4 Monitor Water Systems	WE: Prerequisite: Building-Level Water Metering WE: Water Metering
Natural World	
NW1.1 Preserve Sites of High Ecological Value	LT: Sensitive Land Protection SS: Site Assessment SS: Site Development- Protect or Restore Habitat
NW1.2 Protect Wetland and Surface Water Buffers	LT: Sensitive Land Protection SS: Rainwater Management
NW1.3 Preserve Prime Farmland	LT: Sensitive Land Protection ~LT: Reduced Parking Footprint
NW1.4 Preserve Undeveloped Land	LT: Sensitive Land Protection LT: High-Priority Site (Option 3)
NW2.1 Reclaim Brownfields	
NW2.2 Manage Stormwater	~LT: Reduce Parking Footprint? SS: Rainwater Management
NW2.3 Reduce Pesticide & Fertilizer Impacts	WE: Prerequisite: Outdoor Water Use Reduction WE: Outdoor Water Use Reduction (native and adaptive plants)
NW2.4 Protect Surface & Groundwater Quality	SS Prerequisite Construction Activity Pollution Prevention
NW3.1 Enhance Functional Habitats	LT: Sensitive Land Protection

NW3.2 Enhance Wetland & Surface Water Functions	~SS: Site Assessment
Maintain floodplain functions	LT: Sensitive Land Protection SS: Rainwater Management
NW3.4 Control Invasive Species	(Maybe Regional Priority Credits?)
NW3.5 Protect Soil Health	SS: Site Development—Protect or Restore Habitat
Climate and Resilience	
CR1.1 Reduce Net Embodied Carbon	MR: Life-Cycle Impact Reduction
CR1.2 Reduce Greenhouse Gas Emissions	LT: Green Vehicles EA Prerequisite: Minimum Energy Performance ~EA: Renewable Energy Production? EA: Green Power and Carbon Offsets MR: Building Life-Cycle Impact Reductions (Option 4)
CR1.3 Reduce Air Pollutant Emissions	LT: Green Vehicles LT: Access to Quality Transit MR: Building Life-Cycle Impact Reduction (Option 4) EA Prerequisite: Fundamental Refrigerant Management? EA Prerequisite: Minimum Energy Performance EA: Minimum Energy Performance EQ Prerequisite: Minimum Indoor Air Quality Performance? EQ: Indoor Air Quality Assessment
CR2.1 Avoid Unsuitable Development	SS: Site Assessment
CR2.2 Assess Climate Change Vulnerability	SS: Site Assessment EA Credit: Enhanced Refrigerant Management
CR2.3 Evaluate Risk and Resilience	
CR2.4 Establish Resilience Goals and Strategies	
CR2.5 Maximize Resilience	MR: Design for Flexibility
Improve infrastructure integration	LT: Access to Quality Transit LT: Bicycle Facilities ~LT: Reduced Parking Footprint EA: Renewable Energy Production

Table C3: LEED / Envision Credit Correlation

🟢 Substantial correlation
🟡 Minor correlation
🔴 No correlation

LEED V4 FOR NEW CONSTRUCTION AND MAJOR RENOVATION

		Points		Correlating Envision Credits	
LOCATION AND TRANSPORTATION	LEED for Neighborhood Development Location	16	🔴	N/A	
	Sensitive Land Protection	1	🟢	- NW1.1 Preserve Sites of High Ecological Value - NW1.2 Protect Wetland and Surface Water Buffers - NW1.3 Preserve Prime Farmland	- NW1.4 Preserve Undeveloped Land - NW3.1 Enhance Functional Habitats - NW3.3 Maintain Floodplain Functions
	High-Priority Site and Equitable Development	2	🟢	- LD3.1 Stimulate Economic Prosperity & Development - QL3.1 Advance Equity & Social Justice	- NW2.1 Reclaim Brownfields
	Surrounding Density and Diverse Uses	5	🟢	- QL2.1 Improve Community Mobility and Access - QL2.2 Encourage Sustainable Transportation	- QL3.4 Enhance Public Space & Amenities - LD3.1 Stimulate Economic Prosperity & Development
	Access to Quality Transit	5	🟢	- QL2.1 Improve Community Mobility and Access - QL2.2 Encourage Sustainable Transportation - QL3.4 Enhance Public Space & Amenities	- CR1.3 Reduce Air Pollutant Emissions - CR2.6 Improve infrastructure integration
	Bicycle Facilities	1	🟢	- QL2.1 Improve Community Mobility and Access - QL2.2 Encourage Sustainable Transportation	- QL3.4 Enhance Public Space & Amenities - CR2.6 Improve infrastructure integration
	Reduced Parking Footprint	1	🟢	- QL2.1 Improve Community Mobility and Access - QL2.2 Encourage Sustainable Transportation	- CR2.6 Improve infrastructure integration - CR0.0 Manage heat island effects
	Electric Vehicles	1	🟡	- QL2.2 Encourage Sustainable Transportation - CR1.2 Reduce Greenhouse Gas Emissions	- CR1.3 Reduce Air Pollutant Emissions - RA2.1 Reduce Operational Energy Consumption
		16			
SUSTAINABLE SITES	Construction Activity Pollution Prevention	Req	🟢	- QL1.6 Minimize Construction Impacts	- NW2.4 Protect Surface & Groundwater Quality
	Site Assessment	1	🟢	- QL1.2 Enhance Public Health & Safety - QL2.3 Improve Access & Wayfinding - QL3.2 Preserve Historic & Cultural Resources - QL3.3 Enhance Views & Local Character - NW1.1 Preserve Sites of High Ecological Value - NW1.2 Provide Wetland & Surface Water Buffers - NW1.3 Preserve Prime Farmland - NW1.4 Preserve Undeveloped Land	- NW2.1 Reclaim Brownfields - NW3.1 Enhance Functional Habitats - NW3.2 Enhance Wetland & Surface Water Functions - NW3.3 Maintain Floodplain Functions - NW3.4 Control Invasive Species - CR2.1 Avoid Unsuitable Development - CR2.2 Assess Climate Change Vulnerability
	Protect or Restore Habitat	2	🟢	- NW1.1 Preserve Sites of High Ecological Value - NW3.4 Control Invasive Species	- NW3.5 Protect Soil Health
	Open Space	1	🟢	- QL3.4 Enhance Public Space & Amenities	
	Rainwater Management	3	🟢	- NW1.2 Protect Wetland and Surface Water Buffers - NW2.2 Manage Stormwater	- NW3.3 Maintain Floodplain Functions
	Heat Island Reduction	2	🟢	- CR0.0 Manage heat island effects	
	Light Pollution Reduction	1	🟢	- QL1.5 Minimize light pollution	
		10			
WATER EFFICIENCY	Outdoor Water Use Reduction	Req	🟢	- RA3.2 Reduce Operational Water Consumption	- NW2.3 Reduce Pesticide & Fertilizer Impacts
	Indoor Water Use Reduction	Req	🟢	- RA3.2 Reduce Operational Water Consumption	
	Building-Level Water Metering	Req	🟢	- RA3.4 Monitor water systems	
	Outdoor Water Use Reduction	2	🟢	- RA3.2 Reduce Operational Water Consumption	- NW2.3 Reduce Pesticide & Fertilizer Impacts
	Indoor Water Use Reduction	6	🟢	- RA3.2 Reduce Operational Water Consumption	
	Cooling Tower Water Use	2	🟢	- RA3.2 Reduce Operational Water Consumption	
	Water Metering	1	🟢	- RA3.4 Monitor water systems	
		11			
ENERGY & ATMOSPHERE	Fundamental Commissioning and Verification	Req	🟢	- RA2.4 Commission and monitor energy systems	
	Minimum Energy Performance	Req	🟢	- RA2.1 Reduce Operational Energy Consumption	- CR1.2 Reduce Greenhouse Gas Emissions
	Building-Level Energy Metering	Req	🟢	- RA2.4 Commission and monitor energy systems	
	Fundamental Refrigerant Management	Req	🟡	- CR2.2 Assess Climate Change Vulnerability	- CR1.3 Reduce Air Pollutant Emissions
	Enhanced Commissioning	6	🟢	- LD2.3 Plan for Long-Term Monitoring & Maintenance	- RA2.4 Commission and monitor energy systems
	Optimize Energy Performance	18	🟢	- RA2.1 Reduce Operational Energy Consumption	- CR1.2 Reduce Greenhouse Gas Emissions
	Advanced Energy Metering	1	🟢	- RA2.4 Commission and monitor energy systems	- LD2.3 Plan for Long-Term Monitoring & Maintenance
	Grid Harmonization	2	🟢	- RA2.1 Reduce Operational Energy Consumption - RA2.3 Use renewable energy	- CR1.2 Reduce Greenhouse Gas Emissions - CR2.6 Improve infrastructure integration
	Renewable Energy	5	🟢	- RA2.3 Use renewable energy	
	Enhanced Refrigerant Management	1	🟡	- CR2.2 Assess Climate Change Vulnerability	- CR1.3 Reduce Air Pollutant Emissions
		33			
MATERIALS & RESOURCES	Storage and Collection of Recyclables	Req	🟢	- RA1.3 Reduce Operational Waste	
	Construction and Demolition Waste Management Planning	Req	🟢	- LD1.4 Pursue Byproduct Synergies - RA1.1 Support sustainable procurement practices	- RA1.2 Use recycled materials - RA1.4 Reduce Construction Waste
	Building Life-Cycle Impact Reduction	5	🟢	- LD2.4 Plan for End-of-Life - LD3.3 Conduct a Life-Cycle Economic Evaluation - CR1.1 Reduce Net Embodied Carbon - RA1.2 Use recycled materials	- RA1.3 Reduce Operational Waste - CR1.3 Reduce Air Pollutant Emissions - CR1.2 Reduce Greenhouse Gas Emissions
	BPDO - Environmental Product Declarations	2	🟢	- RA1.1 Support sustainable procurement practices	- RA1.2 Use recycled materials
	BPDO - Sourcing of Raw Materials	2	🟢	- RA1.1 Support sustainable procurement practices	- RA1.2 Use recycled materials
	BPDO - Material Ingredients	2	🟢	- RA1.1 Support sustainable procurement practices	- RA1.2 Use recycled materials
	Construction and Demolition Waste Management	2	🟢	- LD1.4 Pursue Byproduct Synergies - RA1.1 Support sustainable procurement practices	- RA1.2 Use recycled materials - RA1.4 Reduce Construction Waste
		13			
INDOOR ENVIRONMENTAL QUALITY	Minimum Indoor Air Quality Performance	Req	🟡	- CR1.3 Reduce Air Pollutant Emissions	
	Environmental Tobacco Smoke Control	Req	🔴	N/A	
	Enhanced Indoor Air Quality Strategies	2	🔴	N/A	
	Low-Emitting Materials	3	🟢	- RA1.1 Support sustainable procurement practices	
	Construction Indoor Air Quality Management Plan	1	🟢	- QL1.6 Minimize Construction Impacts	
	Indoor Air Quality Assessment	2	🟡	- CR1.3 Reduce Air Pollutant Emissions	
	Thermal Comfort	1	🔴	N/A	
	Interior Lighting	2	🟡	- RA2.1 Reduce Operational Energy Consumption	
	Daylight	3	🟡	- RA2.1 Reduce Operational Energy Consumption	
	Quality Views	1	🟢	- QL3.3 Enhance Views & Local Character	
	Acoustic Performance	1	🟡	- QL1.4 Minimize noise and vibration	
		16			
INNOVATION	Innovation	5	🟢	Innovation credits	
	LEED Accredited Professional	1	🟢	Project requirement: ENV SP on team	
		6			
	PROJECT TOTAL	110			

BPDO= Building Product Disclosure and Optimization

ENVISION CREDITS NOT CORRELATED TO LEED CREDITS:

- QL1.3 Improve Construction Safety
- LD2.2 Plan for Sustainable Communities
- LD3.2 Develop Local Skills & Capabilities
- RA1.5 Balance Earthwork On Site
- RA2.2 Reduce Construction Energy Consumption
- RA3.1 Preserve Water Resources
- RA3.3 Reduce Construction Water Consumption
- CR2.3 Evaluate Risk and Resilience
- CR2.4 Establish Resilience Goals and Strategies
- CR2.5 Maximize Resilience

Table C4: LEED v4.1 Prerequisite Credits/ Envision Credit Correlation

	LEED v4.1 Prerequisite Credits	LEED Criteria	Envision Correlation	Correlating Envision Credit(s)	Anticipate Pursuing for Re-Gen	Anticipated LOA or LOA Range (*indicates highest LOA)	Notes/ Explanation	Envision Credit Criteria or Requirements for the Anticipated LOA
SUSTAINABLE SITES	Construction Activity Pollution Prevention	Intent: To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust. Requirements: NC, CS, SCHOOLS, RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE Create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan must conform to the erosion and sedimentation requirements of the 2017 U.S. Environmental Protection Agency (EPA) Construction General Permit (CGP) or local equivalent, whichever is more stringent. Projects must apply the CGP regardless of size. The plan must describe the measures implemented.	●	QL1.6 Minimize Construction Impacts	Yes	Conserving*		A) The project team implements a construction management plan or policies to address the temporary inconveniences associated with construction. The plan or policies are informed by stakeholder engagement. (B, C, D, or E) The management plan addresses 1-**4** type(s) of construction impact: (B) noise, (C) safety/wayfinding, (D) access/mobility, or (E) lighting. (F) The construction management plan or policies include robust feedback mechanisms and performance monitoring and reporting for construction impacts.
				NW2.2 Manage Stormwater	No	-		Improved level of achievement: (A) Detain and treat 100% of the 85th percentile local 24-hour event. Ensure compliance with local requirements if stricter. (B) Do not exceed rate or quantity of runoff for the 2-year 24-hour rainfall event relative to the existing condition (greenfield, greyfield, or brownfield). (C) The project includes an erosion, sedimentation, and pollutant control plan for construction activities.
				NW2.4 Protect Surface & Groundwater Quality	Yes	Improved		(A) The project team determines potential impacts to surface water or groundwater quality, including temperature, during construction and operations. (B) The project includes spill and leak diversion systems, spill prevention plans, and cleanup. The project does not create new direct pathways for surface water and/or groundwater contamination
WATER EFFICIENCY	Outdoor Water Use Reduction	Intent: To reduce outdoor water consumption. Requirements: NC, CS, SCHOOLS, RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE Reduce outdoor water use through one of the following options. Nonvegetated surfaces, such as permeable or impermeable pavement, should be excluded from the landscape area calculations. Athletic fields and playgrounds (if vegetated) and food gardens may be included or excluded at the project team's discretion. Option 1. No Irrigation Required Show that the landscape does not require a permanent irrigation system beyond a maximum two-year establishment period. OR Option 2. Reduced Irrigation Reduce the project's landscape water requirement by at least 30% from the calculated baseline for the site's peak watering month. Reductions must be achieved through plant species selection and irrigation system efficiency, as calculated by the Environmental Protection Agency (EPA) WaterSense Water Budget Tool.	●	RA3.2 Reduce Operational Water Consumption	No	-	Upgraded facility will use more water than existing facility	(A) The project team conducts planning or design reviews to identify potable water reduction strategies during operation of the project. The team has considered using alternatives such as nonpotable water, reused water, recycled water, and stormwater. (B) The project reduces potable water use by at least __%. Improved: 25% - Enhanced: 50% - Superior: 75% - Conserving: 95% - Restorative: 100% (C) Overall water use (potable and nonpotable) is reduced by at least __%. Enhanced: 20%- Superior: 30% - Conserving: 40% - Restorative: 50% (D) The project not only reduces potable water consumption to zero, but also provides water that can be used by the community.
				NW2.3 Reduce Pesticide & Fertilizer Impacts	Yes	Conserving		(C) Landscaping is designed with plant species that do not require pesticides or fertilizers.
	Indoor Water Use Reduction	Intent: To reduce indoor water consumption. Requirements: NC, CS, SCHOOLS, NC-RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, NC-HOSPITALITY, HEALTHCARE Building Water Use For the fixtures and fittings listed in Table 1, as applicable to the project scope, reduce aggregate water consumption by 20% from the baseline. Base calculations on the volumes and flow rates shown in Table 1. All newly installed toilets, urinals, private lavatory faucets, and showerheads that are eligible for labeling must be WaterSense labeled. Appliance and Process Water Use Install appliances, equipment, and processes within the project scope that meet the requirements listed in the guidance document.	●	RA3.2 Reduce Operational Water Consumption	No	-	Upgraded facility will use more water than existing facility	See criteria noted for RA3.2 above.
	Building-Level Water Metering	Intent: To support water management and identify opportunities for additional water savings by tracking water consumption. Requirements: NC, CS, SCHOOLS, RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE Install permanent water meters that measure the total potable water use for the building and associated grounds. Meter data must be compiled into monthly and annual summaries; meter readings can be manual or automated. Commit to sharing with USGBC the resulting whole-project water usage data for a five-year period beginning on the date the project accepts LEED certification or typical occupancy, whichever comes first. This commitment must carry forward for five years or until the building changes ownership or lessee.	●	RA3.4 Monitor water systems	Yes	Enhanced		(A) The project includes monitoring capabilities. Equipment and/or software are incorporated in the design to allow detailed monitoring of performance (quantity or quality). The equipment is capable of monitoring all primary project functions, accounting for at least 75% of water use. (Superior: 95%)

LEED v4.1 Prerequisite Credits/ Envision Credit Correlation (cont.)

	LEED v4.1 Prerequisite Credits	LEED Criteria	Envision Correlation	Correlating Envision Credit(s)	Anticipate Pursuing for Re-Gen	Anticipated LOA or LOA Range (*indicates highest LOA)	Notes/ Explanation	Envision Credit Criteria or Requirements for the Anticipated LOA
ENERGY & ATMOSPHERE	Fundamental Commissioning and Verification	Intent: To support the design, construction, and eventual operation of a project that meets the owner's project requirements for energy, water, indoor environmental quality, and durability. Requirements: NC, CS, SCHOOLS, RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE Commissioning Process Scope Complete the following commissioning (Cx) process activities for mechanical, electrical, plumbing, and renewable energy systems and assemblies, in accordance with ASHRAE Guideline 0-2013 and ASHRAE Guideline 1.1-2007 for HVAC&R Systems, as they relate to energy, water, indoor environmental quality, and durability. Commissioning Authority Qualifications By the end of the design development phase, engage a commissioning authority with the following qualifications... Current Facilities Requirements and Operations and Maintenance Plan Prepare and maintain a current facilities requirements and operations and maintenance plan that contains the information necessary to operate the building efficiently.	●	RA2.4 Commission and monitor energy systems	Yes	Enhanced		(A) The project includes energy monitoring capability. Equipment and/or software are incorporated to allow detailed monitoring of performance during operation. The equipment is capable of independently monitoring all primary project functions, accounting for at least 75% of energy use/consumption. (B) The project conducts an initial commissioning of energy systems accounting for at least 75% of the total energy consumption/generation. Commissioning includes a detailed log of issues.
	Minimum Energy Performance	Intent: To reduce the environmental and economic harms of excessive energy use by achieving a minimum level of energy efficiency for the building and its systems. Requirements: NC, CS, SCHOOLS, RETAIL,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE Comply with ANSI/ASHRAE/IESNA Standard 90.1-2016, with errata or a USGBC-approved equivalent standard. For projects using Normative Appendix G Performance Rating Method: Greenhouse gas emissions: The total greenhouse gas emissions, in terms of carbon dioxide equivalents, shall be calculated for the baseline building performance rating and for the proposed building performance rating, and the percentage improvement shall be determined using carbon dioxide equivalent emissions.	●	RA2.1 Reduce Operational Energy Consumption	Yes	Improved		(A) The project team determines the estimated annual energy consumption of the project. If annual energy consumption varies, the project team submits the range of estimated performance over the project life. (B) Operational energy is reduced **at least 10%**. Enhanced: 30% - Superior: 50% - Conserving: 70%
				CR1.2 Reduce Greenhouse Gas Emissions	Yes	at least Improved		(A) The project team demonstrates at least a __% reduction in total CO2e over the operational life of the project compared to the baseline. Calculations should be in tons CO2e. **Improved: 10%** - Enhanced: 25% - Superior: 50% - Conserving: 100% - Restorative: carbon negative (B) The project team maps and calculates the total annual greenhouse gas emissions of the final project design for reporting purposes. This includes direct and indirect greenhouse gas emissions and sequestration associated with project operations.
	Building-Level Energy Metering	Intent: To support energy management and identify opportunities for additional energy savings by tracking building-level energy use. Requirements: NC, SCHOOLS, RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE Install new or use existing building-level energy meters, or submeters that can be aggregated to provide building-level data representing total building energy consumption (electricity, natural gas, chilled water, steam, fuel oil, propane, biomass, etc). Utility-owned meters capable of aggregating building-level resource use are acceptable. Commit to sharing with USGBC the resulting energy consumption data and electrical demand data (if metered) for a five-year period beginning on the date the project accepts LEED certification. At a minimum, energy consumption must be tracked at one-month intervals. This commitment must carry forward for five years or until the building changes ownership or lessee.	●	RA2.4 Commission and monitor energy systems	Yes	Enhanced		(A) The project includes energy monitoring capability. Equipment and/or software are incorporated to allow detailed monitoring of performance during operation. The equipment is capable of independently monitoring all primary project functions, accounting for at least 75% of energy use/consumption. (B) The project conducts an initial commissioning of energy systems accounting for at least 75% of the total energy consumption/generation. Commissioning includes a detailed log of issues.
	Fundamental Refrigerant Management	Intent: To reduce stratospheric ozone depletion. Requirements: NC, CS, SCHOOLS, RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE Do not use chlorofluorocarbon (CFC)-based refrigerants in new heating, ventilating, air-conditioning, and refrigeration (HVAC&R) systems. When reusing existing HVAC&R equipment, complete a comprehensive CFC phase-out conversion before project completion. Phase-out plans extending beyond the project completion date will be considered on their merits. Existing small HVAC&R units (defined as containing less than 0.5 pound [225 grams] of refrigerant) and other equipment, such as standard refrigerators, small water coolers, and any other equipment that contains less than 0.5 pound (225 grams) of refrigerant, are exempt.	●	CR2.2 Assess Climate Change Vulnerability	Yes	Improved-Superior		(A) The project team conducts, or relies on, an existing, comprehensive threat/hazard identification study, or assessment, due to climate change. The assessment should account for climate change's impact on the frequency, duration, and severity of threats/hazards. (B) The project team determines vulnerabilities and increased risk to the project, or performance, over its operational life due to climate change-related threats. This should include whether current design variables will continue to meet performance goals over the life of the project under changing operating conditions (i.e., climate, weather patterns, natural hazard frequency and intensity). (C) The project team determines vulnerabilities and increased risk to the connected/related infrastructure system or network due to climate change-related threats. This should include how project vulnerabilities may impact system performance and how system vulnerabilities may impact the project. This should include direct and indirect impacts such as resource and service availability. (D) The project team determines vulnerabilities and increased risk to the broader community due to climate change threats. This should include how project vulnerabilities may impact the broader community and how
				CR1.3 Reduce Air Pollutant Emissions	Yes	Improved		(A) The project meets all applicable air quality standards and regulations for air pollutants. (B) The project implements strategies to reduce air pollutant emissions during operations.

LEED v4.1 Prerequisite Credits/ Envision Credit Correlation (cont.)

	LEED v4.1 Prerequisite Credits	LEED Criteria	Envision Correlation	Correlating Envision Credit(s)	Anticipate Pursuing for Re-Gen	Anticipated LOA or LOA Range (*indicates highest LOA)	Notes/ Explanation	Envision Credit Criteria or Requirements for the Anticipated LOA
MATERIALS & RESOURCES	Storage and Collection of Recyclables	Intent: To reduce the waste that is generated by building occupants and hauled to and disposed of in landfills. Requirements: NC, CS, SCHOOLS, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY NC, HEALTHCARE Provide dedicated areas accessible to waste haulers and building occupants for the collection and storage of recyclable materials for the entire building. Collection and storage areas may be separate locations. Recyclable materials must include mixed paper, corrugated cardboard, glass, plastics, and metals. Take appropriate measures for the safe collection, storage, and disposal of two of the following: batteries, mercury-containing lamps, and electronic waste.	●	RA1.3 Reduce Operational Waste	Yes	Conserving*		(A) Develop an operational waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or commingled. (B) The project team identifies waste streams or byproducts that will occur as a result of the operation of the project. The project is planned or designed to divert at least __% of operational waste. Improved: 25% - Enhanced: 50% - Superior: 75% - **Conserving: 95%**
	Construction and Demolition Waste Management Planning	Intent: To reduce construction and demolition waste disposed of in landfills and incineration facilities by recovering, reusing, and recycling materials. Requirements: NC, CS, SCHOOLS, RETAIL NC, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY NC, HEALTHCARE Develop and implement a construction and demolition waste management plan: • Establish waste diversion goals for the project by identifying at least five materials (both structural and nonstructural) targeted for diversion. • Specify whether materials will be separated or comingled and describe the diversion strategies planned for the project. Describe where the material will be taken and how the recycling facility will process the material including expected diversion rates for each material stream. Provide a final report detailing all major waste streams generated, including disposal and diversion rates. Alternative daily cover (ADC) does not qualify as material diverted from disposal. Include materials destined for ADC in the calculations as waste. Land-clearing debris is not considered construction, demolition, or renovation waste that can contribute to waste diversion.	●	RA1.4 Reduce Construction Waste	Yes	Superior-Conserving*		(A) Implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or commingled. (B) The project team sets a target goal for construction waste diversion. During construction at least __% of waste materials are recycled, reused, and/or salvaged. Improved: 25% - Enhanced: 50% - **Superior: 75% - Conserving: 95%**
				LD1.4 Pursue Byproduct Synergies	Yes	Restorative*		(A) The project team conducts an assessment of the availability and viability of excess resources (i.e., waste) or capacity, including but not limited to waste materials, heating or cooling, financial capacity, land area/space, or management/personnel capacity. (B) Candidates for byproduct synergies or reuse are identified. This can include finding a beneficial reuse for the project's waste or excess resources, or the project's beneficial reuse of external waste or excess resources. Project teams should also consider ecosystem services where project waste or excess resources can support natural systems, or where natural systems can process and remove project waste. (E) The project is fully engaged in a circular economy system whereby the majority of its operational waste is beneficially reused OR the majority of its operational resources are sourced from external waste streams.
				RA1.1 Support sustainable procurement practices	No	-		(A) A written sustainable procurement policy/program is in place that includes a well-defined process for selecting suppliers and/or manufacturers of materials, supplies, and equipment, including selection criteria focused on environmental practices and social responsibility. (B) At least __% of all project materials, supplies, and equipment meet the sustainable procurement policy/program requirements. Improved: 5% - Enhanced: 15% - Superior: 25% - Conserving: 50%
				RA1.2 Use recycled materials	Yes	Improved		(A) At least __% (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials. **Improved: 5%** - Enhanced: 15% - Superior: 25% - Conserving: 50%
INDOOR ENVIRONMENTAL QUALITY	Minimum Indoor Air Quality Performance	Intent: To contribute to the comfort and well-being of building occupants by establishing minimum standards for indoor air quality (IAQ). Requirements: NC, CS, SCHOOLS, RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY Mechanically Ventilated Spaces For mechanically ventilated spaces (and for mixed-mode systems when the mechanical ventilation is activated), meet the requirements for both ventilation (option 1 or option 2) and monitoring. Naturally Ventilated Spaces For naturally ventilated spaces (and for mixed-mode systems when the mechanical ventilation is inactivated), confirm that natural ventilation is an effective strategy for the project by following the flow diagram in the Chartered Institution of Building Services Engineers (CIBSE) Applications Manual AM10, March 2005, Natural Ventilation in Nondomestic Buildings, Figure 2.8 and meet the requirements for both ventilation (option 1, option 2, or option 3) and monitoring. All Spaces The indoor air quality procedure defined in ASHRAE Standard 62.1-2016, Section 6.3 may not be used to comply with this prerequisite.	●	CR1.3 Reduce Air Pollutant Emissions	Yes	Improved	Because Envision is not intended for conditioned indoor spaces, the framework does not include credits focused on indoor air quality improvements	(A) The project meets all applicable air quality standards and regulations for air pollutants. (B) The project implements strategies to reduce air pollutant emissions during operations.
	Environmental Tobacco Smoke Control	Intent: To prevent or minimize exposure of building occupants, indoor surfaces, and ventilation air distribution systems to environmental tobacco smoke. Requirements: NC, CS, RETAIL, DATA CENTERS,WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE For this prerequisite smoking includes tobacco smoke, as well as smoke produced from the combustion of cannabis and controlled substances and the emissions produced by electronic smoking devices. Prohibit smoking inside the building. Prohibit smoking outside the building except in designated smoking areas located at least 25 feet (7.5 meters) (or the maximum extent allowable by local codes) from all entries, outdoor air intakes, and operable windows. This smoking requirement also applies to any spaces outside the property line that are used for business purposes. Communicate the no-smoking policy to occupants. Have in place provisions for enforcement or no-smoking signage.	●	No equivalent	-	-		

Appendix D. Envision Energy- and Emissions-Related Credits

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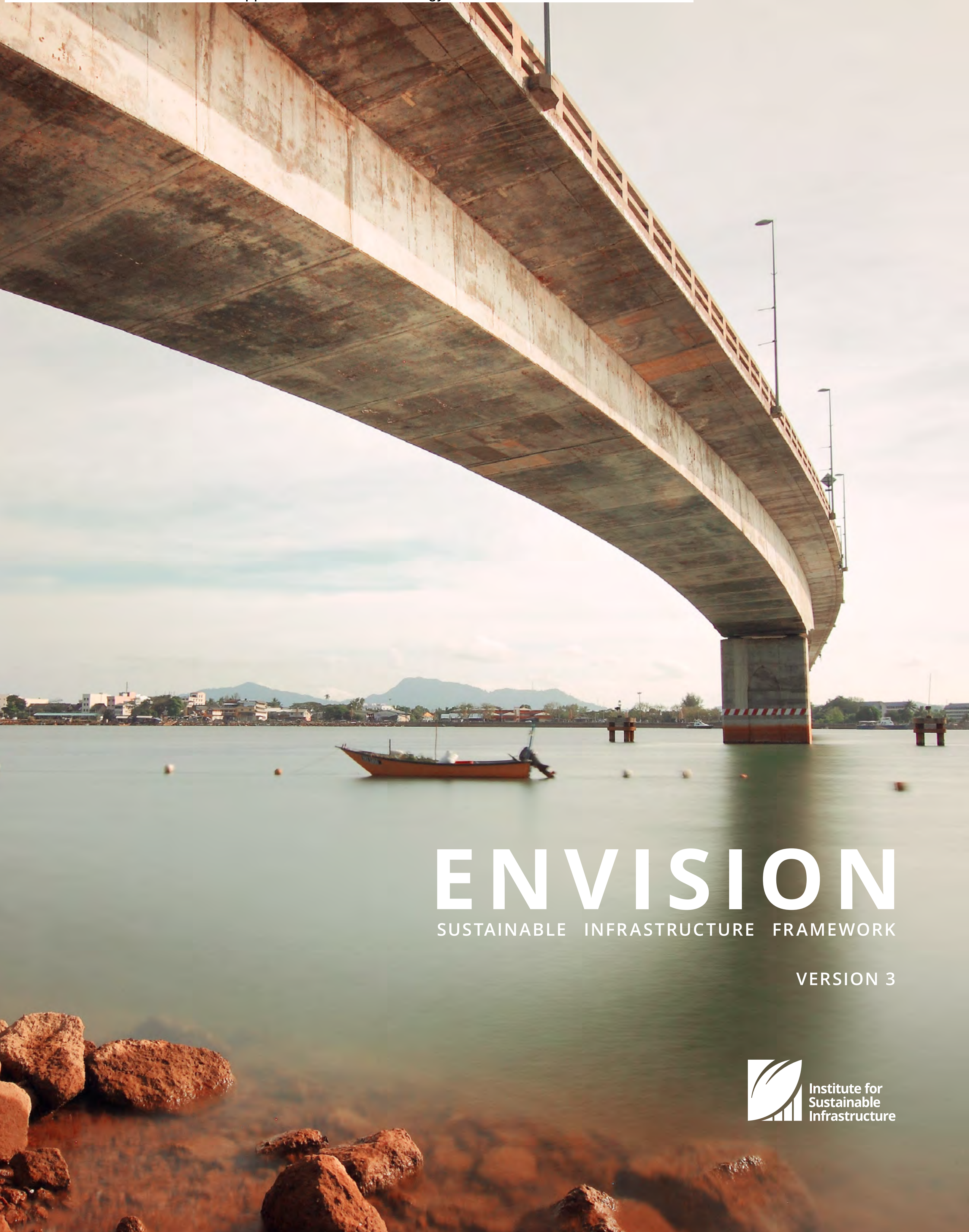
Table D1. Energy and Emissions Envision Credits

Credit	Anticipated LOA	Notes
RA2.1 Reduce Operational Energy Consumption *Accepted methodologies for establishing baseline performance data include existing conditions, a seriously considered alternative, standard practice, or a comparable existing project/facility.*	**Improved** Operational energy is reduced **at least 10%** over the established baseline. The baseline for this credit would likely be existing conditions or seriously considered alternative.	Conserving is the highest level of achievement for this credit. The criterion for Conserving is for operational energy to be reduced by **at least 70%.** Given the energy intensity of the processes involved in the operating project, significant energy reduction would be difficult. Energy optimization through the use and production of renewable energy will help to offset the energy use.
RA2.2 Reduce Construction Energy Consumption	**Enhanced** The project implements, or has written requirements to implement, at least **two energy reduction strategies** during construction.	Conserving is the highest level of achievement for this credit. The criterion for Conserving is for the project to implement at least **six energy reduction strategies** during construction. The project team discussed that challenging the contractor to implement two strategies advanced beyond current practices. Requesting more to get to higher LOAs would likely be cost prohibitive. LEED does not have a comparable credit.
RA2.3 Use Renewable Energy	**Restorative** The project generates a net positive amount of renewable energy.	
RA2.4 Commission & Monitor Energy Systems	**Enhanced** The project includes **energy monitoring capability**. Equipment and/or software are incorporated to allow detailed monitoring of performance during operation. The equipment is capable of independently monitoring all primary project functions, accounting for at least 75% of energy use/consumption. The project conducts an **initial commissioning** of energy systems accounting for at least 75% of the total energy consumption/ generation. Commissioning includes a detailed log of issues.	Conserving is the highest level of achievement for this credit. The criterion for Conserving includes energy monitoring accounting for at least 90% of energy use/consumption, engaging an **independent third-party commissioning agent**, and developing a comprehensive plan for **ongoing periodic re-commissioning**/review of energy systems throughout the expected life of the project.

Credit	Anticipated LOA	Notes
CR1.1 Reduce Net Embodied Carbon	Likely not pursued	This credit addresses the embodied carbon of materials used over the life of the project. This combines concepts of sourcing local materials, using materials more efficiently, and using lower-impact materials to reduce the combined environmental impacts of material use. Criteria include: • Identifying primary materials to be used on the project during construction and operation; and team determining which materials are the primary contributors to net embodied carbon (collectively >80%) • Calculating embodied carbon for the primary materials • Demonstrating a reduction (5%–15%–30%–50%) in total embodied carbon of materials over the life of the project compared to the baseline
CR1.2 Reduce Greenhouse Gas Emissions	Improved The project team demonstrates at least a 10% reduction in total CO_2e over the operational life of the project compared to the baseline. The baseline for this credit would likely be existing conditions.	The criterion for a Restorative LOA is for the completed project to be **carbon negative** (i.e., sequesters/removes more CO_2e than it produces over the operational life).
CR1.3 Reduce Air Pollutant Emissions	Improved The project implements strategies to **reduce air pollutant emissions** during operations.	The criterion for a Restorative LOA includes: • Eliminating air pollutant sources in the design, choosing a non-polluting alternative, or achieving at **least a 98% net reduction in air pollution emissions compared to the baseline** • Putting systems in place for the ongoing monitoring of any direct sources of air pollution, with processes in place to identify and address changes in emissions to maintain performance targets • Assessing whether volatile organic compounds harmful to human health are material to the project and, if so, implementing strategies to reduce their use during construction and/or within occupied spaces of the completed project • Including the direct removal of previously existing air pollutant sources, or capturing and safely storing/disposing of air pollutants for a net positive impact


ENVISION
SUSTAINABLE INFRASTRUCTURE FRAMEWORK
VERSION 3
Institute for Sustainable Infrastructure

ENVISION POINTS TABLE

			Improved	Enhanced	Superior	Conserving	Restorative	Maximum Points
Quality of Life	Purpose	QL1.1 Improve Community Quality of Life	2	5	10	20	26	200
		QL1.2 Enhance Public Health & Safety	2	7	12	16	20	
		QL1.3 Improve Construction Safety	2	5	10	14	—	
		QL1.4 Minimize Noise & Vibration	1	3	6	10	12	
		QL1.5 Minimize Light Pollution	1	3	6	10	12	
		QL1.6 Minimize Construction Impacts	1	2	4	8	—	
	Wellbeing	QL2.1 Improve Community Mobility	1	3	7	11	14	
		QL2.2 Encourage Sustainable Transportation	—	5	8	12	16	
		QL2.3 Improve Access & Wayfinding	1	5	9	14	—	
	Community	QL3.1 Advance Equity & Social Justice	3	6	10	14	18	
		QL3.2 Preserve Historic & Cultural Resources	—	2	7	12	18	
		QL3.3 Enhance Views & Local Character	1	3	7	11	14	
		QL3.4 Enhance Public Space & Amenities	1	3	7	11	14	
Leadership	Collaboration	LD1.1 Provide Effective Leadership & Commitment	2	5	12	18	—	182
		LD1.2 Foster Collaboration & Teamwork	2	5	12	18	—	
		LD1.3 Provide for Stakeholder Involvement	3	6	9	14	18	
		LD1.4 Pursue Byproduct Synergies	3	6	12	14	18	
	Planning	LD2.1 Establish a Sustainability Management Plan	4	7	12	18	—	
		LD2.2 Plan for Sustainable Communities	4	6	9	12	16	
		LD2.3 Plan for Long-Term Monitoring & Maintenance	2	5	8	12	—	
		LD2.4 Plan for End-of-Life	2	5	8	14	—	
	Economy	LD3.1 Stimulate Economic Prosperity & Development	3	6	12	20	—	
		LD3.2 Develop Local Skills & Capabilities	2	4	8	12	16	
		LD3.3 Conduct a Life-Cycle Economic Evaluation	5	7	10	12	14	
Resource Allocation	Materials	RA1.1 Support Sustainable Procurement Practices	3	6	9	12	—	196
		RA1.2 Use Recycled Materials	4	6	9	16	—	
		RA1.3 Reduce Operational Waste	4	7	10	14	—	
		RA1.4 Reduce Construction Waste	4	7	10	16	—	
		RA1.5 Balance Earthwork On Site	2	4	6	8	—	
	Energy	RA2.1 Reduce Operational Energy Consumption	6	12	18	26	—	
		RA2.2 Reduce Construction Energy Consumption	1	4	8	12	—	
		RA2.3 Use Renewable Energy	5	10	15	20	24	
		RA2.4 Commission & Monitor Energy Systems	3	6	12	14	—	
	Water	RA3.1 Preserve Water Resources	3	5	7	9	12	
		RA3.2 Reduce Operational Water Consumption	4	9	13	17	22	
		RA3.3 Reduce Construction Water Consumption	1	3	5	8	—	
		RA3.4 Monitor Water Systems	1	3	6	12	—	
Natural World	Siting	NW1.1 Preserve Sites of High Ecological Value	2	6	12	16	22	232
		NW1.2 Provide Wetland & Surface Water Buffers	2	5	10	16	20	
		NW1.3 Preserve Prime Farmland	—	2	8	12	16	
		NW1.4 Preserve Undeveloped Land	3	8	12	18	24	
	Conservation	NW2.1 Reclaim Brownfields	11	13	16	19	22	
		NW2.2 Manage Stormwater	2	4	9	17	24	
		NW2.3 Reduce Pesticide & Fertilizer Impacts	1	2	5	9	12	
		NW2.4 Protect Surface & Groundwater Quality	2	5	9	14	20	
	Ecology	NW3.1 Enhance Functional Habitats	2	5	9	15	18	
		NW3.2 Enhance Wetland & Surface Water Functions	3	7	12	18	20	
		NW3.3 Maintain Floodplain Functions	1	3	7	11	14	
		NW3.4 Control Invasive Species	1	2	6	9	12	
		NW3.5 Protect Soil Health	—	3	4	6	8	
Climate and Resilience	Emissions	CR1.1 Reduce Net Embodied Carbon	5	10	15	20	—	190
		CR1.2 Reduce Greenhouse Gas Emissions	8	13	18	22	26	
		CR1.3 Reduce Air Pollutant Emissions	2	4	9	14	18	
	Resilience	CR2.1 Avoid Unsuitable Development	3	6	8	12	16	
		CR2.2 Assess Climate Change Vulnerability	8	14	18	20	—	
		CR2.3 Evaluate Risk and Resilience	11	18	24	26	—	
		CR2.4 Establish Resilience Goals and Strategies	—	8	14	20	—	
		CR2.5 Maximize Resilience	11	15	20	26	—	
		CR2.6 Improve Infrastructure Integration	2	5	9	13	18	
							Maximum TOTAL Points	1,000

RESOURCE ALLOCATION: ENERGY

RA2.1 Reduce Operational Energy Consumption

26

POINTS

INTENT

Conserve energy by reducing overall operational energy consumption throughout the project life.

METRIC

Percentage of operational energy reductions achieved.

LEVELS OF ACHIEVEMENT

IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
A + B	A + B	A + B	A + B	Not Available
(6) 10% Energy Reduction	(12) 30% Energy Reduction	(18) 50% Energy Reduction	(26) 70% Energy Reduction	
(A) The project team determines the estimated annual energy consumption of the project. If annual energy consumption varies, the project team submits the range of estimated performance over the project life.				
(B) Operational energy is reduced at least 10%.	**(B)** Operational energy is reduced at least 30%.	**(B)** Operational energy is reduced at least 50%.	**(B)** Operational energy is reduced at least 70%.	

DESCRIPTION

This credit addresses the important need to reduce overall energy consumption. Energy generation is the primary source of greenhouse gas emissions and numerous other pollutants harmful to the environment and human health. While use of renewable energy reduces impacts, the primary goal of all projects should be to minimize the overall energy consumed as much as possible.

There are significant and compounding cost savings to reducing operational energy use. Project teams should take a whole-systems design approach when considering options in order to maximize achievement. While single actions like replacing fluorescent lights with light emitting diodes (LEDs) are a positive first step, large energy savings can be achieved when considering project alternatives and the design of major energy consuming systems.

PERFORMANCE IMPROVEMENT

Improving – Conserving: Levels in this credit are distinguished by the percentage of operational energy reductions. As industry standards on operational energy use do not exist for most infrastructure projects, project teams are required to provide calculations for an appropriate base case. Accepted methodologies for establishing baseline performance data are explained in detail in the front of this manual and include existing conditions, a seriously considered alternative, standard practice, or a comparable existing project/facility. It is the intent of Envision to support data collection in order to eventually provide this baseline data for project teams and the industry as a whole. This is why it is required to submit calculations in acceptable standard units.

Calculations should include the anticipated annual energy consumption during the operational life of the project. If industry standards such as ASHRAE (formerly American Society of Heating Refrigerating and Air-Conditioning Engineers) are available for the project type, they can be used in calculating the project's anticipated energy consumption as well as the industry base case. Calculations should include energy purchased from the grid, energy generated and used on site, and fuels used on site by the project.

Energy generation projects should use energy conversion efficiency as the measure of energy efficiency, with the goal of increasing the capture of electrical, mechanical, or thermal energy output of the system. Similarly, energy distribution projects should calculate reductions in energy loss, with the goal of achieving better efficiency in energy delivery.

Applicability: This credit is applicable to all projects that consume energy during their operation. Projects that do not include operational energy may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of operational energy use is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of operational energy use in the context of the project.

EVALUATION CRITERIA AND DOCUMENTATION GUIDANCE

A. Has the project team determined the estimated annual energy consumption of the project during operations?

1. *Estimates of the annual energy consumption of the project during operations. Energy data should be presented in standard units. If annual energy consumption varies, the project team submits the range of estimated performance over the project life. Energy consumption of the project includes:*

- *Energy purchased from the grid*
- *Energy generated on site*
- *Fuels used on site by the project*

Note that energy generation projects should use energy conversion efficiency as the measure of energy efficiency, with the goal of increasing the capture of electrical, mechanical, or thermal energy output of the system. Similarly, energy distribution projects should calculate reductions in energy loss, with the goal of achieving better efficiency in energy delivery.

B. To what extent has the project reduced operational energy consumption?

1. *Calculation of the baseline energy consumption. All energy sources should be converted into standard units.*
2. *Submit calculations for the project's estimated annual energy consumption over the life of the project. Document the percentage reduction over the baseline. All energy sources should be converted into standard units.*

RELATED ENVISION CREDITS

QL1.5 Minimize Light Pollution

QL2.2Encourage Sustainable Transportation

LD2.1 Establish a Sustainability Management Plan

RA2.4 Commission and Monitor Energy Systems

CR1.2Reduce Greenhouse Gas Emissions

CR1.3Reduce Air Pollutant Emissions

PROJECT EXAMPLE: SOUTH LOS ANGELES WETLAND PARK

The South Los Angeles Wetland Park (Envision Platinum, 2014) in California reduced operational energy use by 77% by disconnecting all lighting associated with the project from the electrical grid and using solar powered lighting instead. The project team also designed the pump systems to further reduce operational energy requirements; two smaller sump pumps requiring less energy operate throughout the majority of the year when stormwater discharge rates are low. Only during rain events will three large process pumps that consume more energy operate.

RA2.2 Reduce Construction Energy Consumption

12
POINTS

INTENT

Conserve resources and reduce greenhouse gases and air pollutant emissions by reducing energy consumption during construction.

METRIC

The number of strategies implemented on the project during construction that reduce energy consumption and emissions.

LEVELS OF ACHIEVEMENT

IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
A	A + B	A + B	A + B	Not Available
(1) Identify Reduction Opportunities	**(4) At Least Two Reduction Strategies**	**(8) At Least Four Reduction Strategies**	**(12) At Least Six Reduction Strategies**	
(A) The project team conducts one or more planning reviews to identify and analyze options for reducing energy consumption during construction.				
	(B) The project implements, or has written requirements to implement, at least two (2) energy reduction strategies.	**(B)** The project implements, or has written requirements to implement, at least four (4) energy reduction strategies.	**(B)** The project implements, or has written requirements to implement, at least six (6) energy reduction strategies.	

DESCRIPTION

This credit addresses the important need to reduce construction energy consumption. As construction energy use is closely linked to emissions, many actions in this credit address energy efficiency, energy reduction, renewable energy use, and reduced emissions. Therefore, in addition to other Resource Allocation credits, RA2.2 Reduce Construction Energy Consumption is also connected to CR1.1 Reduce Net Embodied Carbon, and CR1.2 Reduce Greenhouse Gas Emissions.

Significant cost savings can be achieved by reducing fuel consumption during construction. Project teams should consider the secondary and tertiary benefits of reduced truck trips, improved air quality, and support for renewable energy systems. While single actions like replacing fluorescent lights with light emitting diodes (LEDs) is a positive first step, large energy savings can be achieved when considering broader construction logistics and coordination.

PERFORMANCE IMPROVEMENT

Improved: Project teams begin with a thorough review of the means and methods of constructing the project, including a review of how energy is to be consumed during construction and opportunities for energy reduction. The list of energy reduction strategies should be used as a guide to identify and analyze options.

Enhanced – Conserving: Conducting detailed calculations of construction energy consumption can be burdensome if not impossible. Additionally, like other Resource Allocation credits, industry standards on construction energy use do not exist. Therefore, this credit assesses the number of energy-conserving and emission-reducing strategies deployed on the project as the metric for achievement. Strategies that meet the credit requirements are listed under criterion B. These activities may be more or less difficult to achieve depending on the project type and context, which is why a wide range of options are available.

Applicability: This credit is applicable to all projects that consume energy during construction. It would therefore be difficult to demonstrate that the credit is not relevant or applicable to a project seeking an Envision award. In rare cases, where the amount of energy used during construction is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of construction energy use in the context of the project.

EVALUATION CRITERIA AND DOCUMENTATION GUIDANCE

A. Has the project team conducted planning reviews to reduce energy consumption during construction?

1. *Documentation that one or more planning reviews were conducted to identify and analyze the potential for reducing energy consumption during construction.*

B. To what extent have energy conservation strategies been implemented during construction?

1. *Documentation that the project has implemented, or has policies to implement, energy conservation strategies during construction. Strategies that meet the credit requirements include:*

a. Tier IV construction equipment or Tier III with Best Available Technology (BAT) for at least 75% of non-road equipment fleet greater than 50 horsepower;

b. Alternative fuels in heavy equipment such as biodiesel for at least 5% of total fuel consumption;

c. Hybrid or fully electric project vehicles for at least 50% of fleet;

d. Electrified equipment for at least 20% of equipment (vs. gas or diesel engines);

e. Employee commuting programs with incentives (shuttles to transit, ride-share programs, biking facilities, etc.);

f. Reduce purchased energy for workstations (construction trailer/ office energy) by 30% for two of the following: (1) lighting; (2) HVAC; (3) plug loads;

g. Purchase green power (RECs) for 30% of workstation energy consumption;

h. Offset electrical consumption by generating 5% renewable energy on site (e.g., solar panels on trailer complex, solar-powered temporary light plant, solar-powered cameras and variable message sign boards); and

i. Reduce overall fuel consumption by 10% through improved planning and logistics. Specific strategies may include:

- *i. Reduce number of deliveries;*
- *ii. Reduce idle times;*
- *iii. On-site reuse of soils or other materials to decrease truck traffic to and from site (ties into Reduced Excavated Material taken off site);*
- *iv. Reduce on-site trucking – proper logistics planning such as staging material in close proximity to installation location;*
- *v. Schedule acceleration without additional resource consumption;*
- *vi. Waterborne/rail transportation of materials versus trucking (third-party distribution or logistics);*
- *vii. On-site plants (concrete plant/asphalt plant) in lieu of trucking material to the site; and*
- *viii. Prefabrication of design elements.*

RELATED ENVISION CREDITS

LD2.1 Establish a Sustainability Management Plan

RA1.5 Balance Earthwork On Site

CR1.2Reduce Greenhouse Gas Emissions

CR1.3Reduce Air Pollutant Emissions

PROJECT EXAMPLE: HIGHWAY I-4 ULTIMATE

On the Highway I-4 Ultimate project (Envision Platinum, 2017), a 21 mile stretch of highway between Orange County and downtown Orlando in Florida, the contractor deployed state-of-the-art equipment monitoring technologies and software to reduce environmental impacts during construction. Fuel management technologies to monitor fuel dispensing into each piece of equipment and to track consumption were deployed. Also, auxiliary air conditioning units on crawler cranes were implemented. These measures led to a 20% reduction of machine hours and associated fuel consumption.

RESOURCE ALLOCATION: ENERGY

RA2.3 Use Renewable Energy

24

POINTS

INTENT

Meet operational energy needs through renewable energy sources.

METRIC

Extent to which renewable energy sources are incorporated.

LEVELS OF ACHIEVEMENT

IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
A	A	A	A	A
(5) At Least 5%	**(10) At Least 15%**	**(15) At Least 30%**	**(20) At Least 50%**	**(24) Net Positive**
(A) The project meets: 5% of energy needs (electricity and fuel) from renewable sources.	**(A)** The project meets: 15% of energy needs (electricity and fuel) from renewable sources.	**(A)** The project meets: 30% of energy needs (electricity and fuel) from renewable sources.	**(A)** The project meets: 50% of energy needs (electricity and fuel) from renewable sources.	**(A)** The project generates a net positive amount of renewable energy.

DESCRIPTION

While reducing energy use is the primary goal, a net-zero energy society will require significant investment in renewable energy sources. When appropriate, renewable energy can be generated on site to help reduce the need for fossil fuel sources. However, it is important to note that large-scale off-site renewable energy sources, such as wind farms, large hydroelectric facilities, or solar arrays, are often more efficient. It can be challenging to demonstrate a direct connection to these sources and ensure that their energy generation is not double-counted by other projects. Project teams should evaluate the feasibility of renewable energy, including nontraditional energy sources, to effectively increase the portion of operational energy that comes from renewable sources.

PERFORMANCE IMPROVEMENT

Improved – Conserving: Levels in this credit are distinguished by the percentage of total energy use from renewable sources. Unlike energy consumption in buildings, which are almost always dominated by electricity, infrastructure operational energy use can include both electricity and fuel consumption. For this credit, project teams should consider both electricity and fuel consumption in their calculations.

Renewable energy can be sourced from on-site generation, purchased in fuels, or purchased from the grid through a direct purchase agreement (e.g., renewable energy power purchase agreement). For purchased renewable energy from the grid, the electricity service provider sources power from a renewable energy source and sells that power directly to the project. Renewable energy sources must be in the same power grid as the project in this type of transaction. Project teams cannot attribute latent renewable energy within the grid to the project without a purchase agreement.

Projects may only count Renewable Energy Credits (RECs) purchased or under contract at the time of assessment. Nonbinding commitments for future REC purchases cannot be counted toward achievement in this credit. Purchased RECs must be annualized over the life of the project. For example, if a project with a 20-year life purchases RECs for 100% of its energy consumption for one year, this would translate to 5% of its overall energy consumption.

On-site generation put back onto the grid is accounted for in determining percentage of electricity used. For example, in a case with 100 kWh of electricity used on site, 20 kWh of renewables purchased from the grid, 10 kWh of renewables generated and used on site, and 5 kWh of renewables returned to the grid, the result is a level of 35% renewables attained.

Applicability: This credit is applicable to all projects that consume energy (fuel or electricity) during their operation. Projects that do not include operational energy may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of operational energy use is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of operational energy use in the context of the project.

EVALUATION CRITERIA AND DOCUMENTATION GUIDANCE

A. To what extent does the project meet electricity or fuel needs from renewable sources?

1. *Documentation of the anticipated annual output of all renewable sources, direct renewable electricity purchases, or exports to the grid, and the resulting overall percentage of renewable energy*

to total energy consumption. The latent renewable energy mix within the grid does not contribute to achievement in this credit. Calculations should be in standard units of energy (Btu or kJ).

2. *Breakdown of renewable energy sources by type. Renewable energy may include:*

- *solar energy (thermal heating, both active and passive, and photovoltaic);*
- *wind (electricity generation);*
- *water (hydro or tidal for electricity generation);*
- *biomass (electricity generation or as fuels);*
- *geothermal (electricity generation or heating and cooling); and*
- *hydrogen/fuel cells (used as a fuel).*
- *renewable transportation fuel or electric vehicle use.*

RELATED ENVISION CREDITS

CR1.2 Reduce Greenhouse Gas Emissions

CR1.3 Reduce Air Pollutant Emissions

Common Fuel Conversions

Fuel	Imperial Unit	Btu	Metric Unit	kJ
Electricity	1 Kilowatt-hour	3,412	1 Kilowatt-hour	3,600
Gasoline	1 Gallon	120,476	1 Litre	33,579
Diesel	1 Gallon	137,452	1 Litre	38,310
Natural Gas	1 Cubic foot	1,037	1 Cubic Meter	38,638
Propane LPG	1 Gallon	91,333	1 Litre	25,456
Propane Gas	1 Cubic Foot	2,550	1 Cubic Meter	95,011
Ethanol	1 Gallon	76,330	1 Litre	21,275

Source: US Energy Information Administration

PROJECT EXAMPLE: WATER SOURCE GEOTHERMAL

A lake formed in an abandoned quarry near the Nashville International Airport in Tennessee, long considered a liability for the Airport Authority, was turned into a beneficial resource with the implementation of a Water Source Geothermal project (Envision Silver, 2017). By harnessing the chilled water of the quarry lake, the Airport Authority was able to save more than $430,000 in electricity costs per year, a 50% improvement over the baseline that was established for the project.

RESOURCE ALLOCATION: ENERGY

RA2.4 Commission and Monitor Energy Systems

14

POINTS

INTENT

Ensure efficient functioning and extend useful life by specifying commissioning and monitoring of energy systems.

METRIC

The inclusion of monitoring equipment and software, the extent of commissioning, and the commissioning agent's independence from the project.

LEVELS OF ACHIEVEMENT

<table>
<tr><th>IMPROVED</th><th>ENHANCED</th><th>SUPERIOR</th><th>CONSERVING</th><th>RESTORATIVE</th></tr>
<tr><td>A + B</td><td>A + B</td><td>A + B + C</td><td>A + B + C</td><td>Not Available</td></tr>
<tr><td>(3) Basic Initial Commissioning</td><td>(6) Extensive Initial Commissioning</td><td>(12) Long-Term Commissioning</td><td>(14) Advanced Initial And Long-Term Commissioning</td><td rowspan="4"></td></tr>
<tr><td>(A) The project includes energy monitoring capabilities.

Equipment and/or software are incorporated to allow detailed monitoring of performance during operation.

The equipment is capable of independently monitoring all primary project functions, accounting for at least 50% of energy use/consumption.</td><td>(A) The project includes energy monitoring capability.

Equipment and/or software are incorporated to allow detailed monitoring of performance during operation.

The equipment is capable of independently monitoring all primary project functions, accounting for at least 75% of energy use/consumption.</td><td colspan="2">(A) The project includes integrated energy management systems.

Energy management software is incorporated to allow for detailed and centralized monitoring and reporting of performance.

The equipment is capable of independently monitoring all primary project functions, accounting for at least 90% of energy use/consumption.</td></tr>
<tr><td>(B) The project conducts an initial commissioning of energy systems accounting for at least 50% of the total energy consumption/generation.

Commissioning includes a detailed log of issues.</td><td>(B) The project conducts an initial commissioning of energy systems accounting for at least 75% of the total energy consumption/generation.

Commissioning includes a detailed log of issues.</td><td>(B) The project conducts an initial commissioning of energy systems accounting for at least 90% of the total energy consumption/generation.

Commissioning includes a detailed log of issues.

The owner engages a third party or in-house commissioning agent not involved in the planning/design of the project.</td><td>(B) The project conducts an initial commissioning of energy systems accounting for at least 90% of the total energy consumption/generation.

Commissioning includes a detailed log of issues.

The owner engages an independent third-party commissioning agent.</td></tr>
<tr><td colspan="2"></td><td colspan="2">(C) A comprehensive plan is developed for ongoing periodic re-commissioning/review of energy systems throughout the expected life of the project.</td></tr>
</table>

DESCRIPTION

Planning, designing, and constructing projects to reduce energy use is the first step toward achieving energy efficiency goals. However, commissioning and ongoing monitoring are necessary to ensure the proper operation of the energy system in order to realize those goals. Systems designed to be energy efficient can fail because of installation errors or degradation over time during operations. Commissioning ensures systems are functioning as intended from the start of operations. Installing advanced monitoring equipment and software better allows operators to identify efficiency loss. In addition, monitoring equipment allows operators to identify high-energy processes and target them in their own sustainability efforts. Higher-resolution monitoring increases the likelihood that projects will achieve and maintain high levels of energy efficiency throughout their useful life.

PERFORMANCE IMPROVEMENT

Improved: The assessment is based on the scope of the energy monitoring capabilities and initial commissioning. The intent is to focus on important or primary sources of energy consumption.

Enhanced: The project team expands the scope of monitoring capabilities and commissioning.

Superior: The project team can demonstrate that the commissioning agent was independent from the project, though the commissioning may still be conducted within the same organization. Energy management systems include detailed performance monitoring and management capabilities. An operations plan is developed for ongoing performance reviews.

Conserving: The commissioning was conducted by an independent third-party agent.

Applicability: This credit is applicable to all projects that consume energy during their operation. Projects that do not include operational energy may apply to have this credit deemed not applicable with supporting documentation. In rare cases, where the amount of operational energy use is insignificant in comparison to the scale of the project, teams may apply to have this credit deemed not applicable with supporting documentation. However, the reviewer may exercise his/her discretion in determining what constitutes an insignificant quantity of operational energy use in the context of the project.

EVALUATION CRITERIA AND DOCUMENTATION GUIDANCE

A. Does the design incorporate advanced integrated monitoring systems in order to enable more efficient operations?

1. *Documentation that equipment and/or software are incorporated in the design to allow detailed monitoring of performance. Design documents and specifications showing the location, purpose, and type of monitoring equipment installed. Documentation that the equipment installed is capable of monitoring all primary project functions, accounting for the required percentage of energy consumption (e.g., 50%, 75%, 90%).*
2. *Rationale as to how the monitoring equipment may enable more efficient operations over the industry norm.*
3. *Documentation that energy management systems and associated software are incorporated into the project accounting for the required percentage of energy consumption (e.g., 50%, 75%, 90%).*

B. To what extent has a commissioning been conducted?

1. *Documentation that the project has undergone or will undergo a commissioning (e.g., specification, tender document, contract document).*
2. *Documentation that the commissioning was executed and covered systems responsible for using or generating the required percentage of energy (e.g., 50%, 75%, 90%).*
3. *Documentation of the relationship between the owner and the commissioning agent depending on the level of achievement being pursued.*

   Note that for Superior, the owner may engage an in-house commissioning agent so long as they are independent of the planning/design of the project. For Conserving, an independent third-party agent must be used.
4. *Documentation of the commissioning log of issues.*

C. Is there a plan for ongoing commissioning of the energy systems throughout the project's life?

1. *Documentation of a plan for ongoing recommissioning/review of these systems throughout the expected life of the project.*

RELATED ENVISION CREDITS

LD2.3 Plan for Long-Term Monitoring and Maintenance

RA2.1 Reduce Operational Energy Consumption

CLIMATE AND RESILIENCE: EMISSIONS

CR1.1 Reduce Net Embodied Carbon

20

POINTS

INTENT

Reduce the impacts of material extraction, refinement/manufacture, and transport over the project life.

METRIC

Percentage of reduction in net embodied carbon of materials.

LEVELS OF ACHIEVEMENT

IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
A + B + C	A + B + C	A + B + C	A + B + C	Not Available
(5) At Least 5% Reduction	**(10) At Least 15% Reduction**	**(15) At Least 30% Reduction**	**(20) At Least 50% Reduction**	
(A) The project team identifies primary materials to be used on the project during construction and operation. The team determines which materials are the primary contributors to net embodied carbon (collectively >80%).				
(B) Embodied carbon is calculated, or acquired by a validated source, for the primary materials identified in criterion A. Calculations include: • Embodied carbon of production, including raw material extraction, refinement, and manufacture. • Embodied carbon of transporting materials to the project site. • The replacement, repair, or refurbishment of materials over the life of the project.				
(C) The project team demonstrates at least a 5% reduction in total embodied carbon of materials over the life of the project compared to the baseline. Calculations should be in tons CO_2.	**(C)** The project team demonstrates at least a 15% reduction in total embodied carbon of materials over the life of the project compared to the baseline. Calculations should be in tons CO_2.	**(C)** The project team demonstrates at least a 30% reduction in total embodied carbon of materials over the life of the project compared to the baseline. Calculations should be in tons CO_2.	**(C)** The project team demonstrates at least a 50% reduction in total embodied carbon of materials over the life of the project compared to the baseline. Calculations should be in tons CO_2.	

DESCRIPTION

This credit addresses the embodied carbon of materials used over the life of the project. This combines concepts of sourcing local materials, using materials more efficiently, and using lower-impact materials in order to reduce the combined environmental impacts of material use. In the calculations, carbon is used as a proxy unit of measure to compare various impacts across the entire supply chain of material consumption. One stage of this supply chain involves raw material extraction/harvesting, refinement, and manufacturing into products. The second involves transportation of the materials from the manufacturer to their final destination on site. By designing projects to use less material, use material efficiently, or specifying materials with lower embodied carbon, as well as reducing transportation distances, project teams can reduce the overall impact of the project.

Material use is specifically addressed over the life of the project, including the necessary replacement or renewal of materials. Often, materials with slightly higher initial embodied carbon will have a lower net embodied carbon over the life of the project if they are more durable and less likely to require repair or replacement.

PERFORMANCE IMPROVEMENT

Improved – Conserving: Levels are distinguished by the percentage reduction in embodied carbon of materials over a baseline. As industry standards on carbon intensity of materials do not exist for most infrastructure projects, project teams are required to provide calculations for an appropriate base case. Accepted methodologies for establishing baseline performance data are explained in detail in the front of this manual and include (1) existing conditions, (2) a seriously considered alternative, (3) standard practice, or (4) a comparable existing project/facility. Envision intends to support data collection in order to eventually provide this baseline data for project teams and the industry as a whole. This is why it is required to submit calculations in acceptable standard units.

Availability of data on the carbon intensity of materials is often limited, and some projects may involve hundreds or thousands of products. Therefore, ISI accepts a streamlined method for conducting calculations on this credit. Project teams may identify a select list of primary materials/products that collectively make up greater than 80% of the total embodied carbon. If data on embodied carbon or material intensity is not available from the manufacturer, project teams may use averages or generalized data from studies or material databases. Project teams should track, document, and clearly explain their methodology for calculating material intensity in this credit.

Transportation of materials to project sites can be a significant contributor to the embodied carbon of materials. Local or regional materials—even materials sourced or processed on site—reduce the impact of long transport and support local economies. It is important to note that while it is generally desirable to use locally sourced materials for the aforementioned reasons, use of local materials could have negative impacts on performance if those materials result in reduced durability, safety, or service life. Carbon emissions associated with the transportation of materials to the project site are specifically broken out as they are often simpler to calculate based on distance; quantity; and standard truck, air, rail, or shipping fuel consumption. They are also calculated separately in order to show the possible conflicts that exist of sourcing a lower-intensity material from farther away. Project teams should consider choices that reduce the overall net embodied carbon of materials.

Applicability: This credit is applicable to all projects that include the use or consumption of physical materials in construction or operation.

EVALUATION CRITERIA AND DOCUMENTATION GUIDANCE

A. Has the project team determined materials that are the primary contributors to embodied carbon for the project during construction and operation?

1. *Documentation of the primary materials to be used in the construction and ongoing operation of the project over its life. Documentation should include:*
   a. *The materials used.*
   b. *General estimates of the quantities of materials used. Note that operations materials may need to be multiplied by the frequency of use over the project life. Material estimates should include anticipated repairs/upkeep (e.g., road resurfacing).*
   c. *Estimates of the embodied carbon of materials. Estimates may use readily available public information such as regional, national, or global averages.*
2. *Identification of the select materials that collectively will make up over 80% of the total estimated embodied carbon of the project.*

B. Has the project team calculated the primary contributors to overall embodied carbon?

1. *Index of the embodied carbon calculations of the primary contributors to carbon intensity over the life of the project (construction and operations) identified in criterion A. This should include:*
   a. *Carbon emissions to produce the material, including raw material extraction, refinement, and manufacture including secondary or tertiary processing.*
   b. *Carbon emissions from transporting the material from the manufacturer to the project site, including intermediary points.*

Embodied carbon data may come from the manufacturer, reputable databases, reputable embodied energy software, or from project team calculations. If the source or specific type of materials is not known at the time of assessment, calculations may present a range of values or rely on likely material choices. Calculations should be in tons CO_2.

C. To what extent does the project reduce the net embodied carbon of materials used in construction and operation?

1. *Documentation that the project has set targets for reducing net embodied carbon.*
2. *Documentation of strategies/plans to reduce net embodied carbon. These may include but are not limited to:*
   a. *Sizing the project to require less material;*
   b. *Designing the project to use less material;*
   c. *Choosing materials that have lower embodied carbon;*
   d. *Reducing material needed for repair and maintenance;*
   e. *Reducing material waste during construction;*
   f. *Reducing material waste during operation;*
   g. *Sourcing local materials to reduce transportation emissions;*
   h. *Utilizing lower-carbon transportation modes.*
3. *Calculations of reductions in embodied carbon achieved. Calculations should compare total carbon intensity of materials for the project against the total carbon intensity of the baseline. Calculations should be in tons CO_2.*

RELATED ENVISION CREDITS

LD2.3 Plan for Long-Term Monitoring and Maintenance

LD2.4 Plan for End-of-Life

CR1.2 Reduce Greenhouse Gas Emissions

CR1.3 Reduce Air Pollutant Emissions

CLIMATE AND RESILIENCE: EMISSIONS

CR1.2 Reduce Greenhouse Gas Emissions

26 POINTS	INTENT	METRIC
	Reduce greenhouse gas emissions during the operation of the project, reducing project contribution to climate change.	Percentage of reduction in operational greenhouse gas emissions.

LEVELS OF ACHIEVEMENT

IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
A + B	A + B	A + B	A + B	A + B
(8) At Least 10% Reduction	**(13) At Least 25% Reduction**	**(18) At least 50% Reduction**	**(22) 100% Reduction**	**(26) Carbon Negative**
(A) The project team demonstrates at least a 10% reduction in total CO_2e over the operational life of the project compared to the baseline. Calculations should be in tons CO_2e.	**(A)** The project team demonstrates at least a 25% reduction in total CO_2e over the operational life of the project compared to the baseline. Calculations should be in tons CO_2e.	**(A)** The project team demonstrates at least a 50% reduction in total CO_2e over the operational life of the project compared to the baseline. Calculations should be in tons CO_2e.	**(A)** The project team demonstrates a 100% reduction in total CO_2e over the operational life of the project compared to the baseline. Calculations should be in tons CO_2e.	**(A)** The completed project is carbon negative (i.e., sequesters/removes more CO_2e than it produces over the operational life).
(B) The project team maps and calculates the total annual greenhouse gas emissions of the final project design for reporting purposes. This includes direct and indirect greenhouse gas emissions and sequestration associated with project operations. Calculations must be in CO_2e.				

DESCRIPTION

This credit addresses greenhouse gas emissions during operations and the project's contribution in reducing the impacts of climate change. The embodied carbon of materials is specifically addressed in CR1.1 Reduce Net Embodied Carbon. Emission of greenhouse gases during construction is addressed in RA2.2 Reduce Construction Energy Consumption.

The increased release of carbon dioxide (CO_2) and other greenhouse gases (GHGs) has caused a significant increase in the concentration of CO_2 in the atmosphere, enhancing the greenhouse effect. The subsequent increase in the average temperature of the earth's surface causes various cascading effects, including melting glaciers, arctic sea ice loss, sea level rise, increased ocean temperatures, increased ocean acidity, changing vegetation patterns, increased range of disease vectors, decreased snowmelt, changing precipitation patterns, increased flooding, increased storm intensity, and increased storm frequency, to name a few. This can have many unintended consequences such as flooding when historic periods of snowfall change to rain, drought from increased evaporation and lack of snowmelt, loss of coral reefs and aquatic biodiversity from ocean acidification, and food scarcity as increased temperatures reduce crop production. Reducing the emission of GHGs now will help mitigate the effects of climate change in the future.

PERFORMANCE IMPROVEMENT

Improved – Restorative: Levels in this credit are distinguished by the percentage of reduction in greenhouse gas emissions over a base case. As industry standards on greenhouse gas emissions do not exist for many infrastructure projects, project teams are required to provide calculations for an appropriate base case. Accepted methodologies for establishing baseline performance data are explained in detail in the front of this manual and include existing conditions (or no-build alternative), a seriously considered alternative, standard practice, or a comparable existing project/facility. Envision intends to support data collection in order to eventually provide this baseline data for project teams and the industry as a whole. This is why it is required to submit calculations in acceptable standard units.

Greenhouse gases are factored according to their global warming potential (GWP), resulting in a CO_2 equivalency (CO_2e). All greenhouse gas emissions calculations should be quantified in tons of CO_2e. Unavoidable CO_2e emissions can be offset by carbon sequestration, in which CO_2 is removed from the atmosphere (e.g., planting trees that absorb and use CO_2 for their growth).

Project teams should take care not to double count greenhouse gas reductions as offsets. For example, if a project will produce 50 percent less greenhouse gas emissions than the baseline over its 25-year life, then it has achieved a 50 percent reduction. This project would not be able to claim that because produced emissions (50%) equal displaced emissions (50%), so it has achieved 'net-zero' carbon emissions (i.e., 100% reduction).

Applicability: This credit is applicable to all projects that consume energy, fuel, or otherwise produce greenhouse gas emissions during their operation. Projects that do not include greenhouse gas emissions during operations may apply to have this credit deemed not applicable with supporting documentation. However, projects that do not produce greenhouse gas emissions because of intentional planning decisions may apply for the Conserving level with supporting documentation.

EVALUATION CRITERIA AND DOCUMENTATION GUIDANCE

A. To what extent does the project reduce greenhouse gas emissions during its operational life?

1. *Calculations of the baseline greenhouse gas emissions over a period equivalent to the operational life of the project (e.g., 25 years).*
2. *Submit calculations for:*
   - *a. the project's estimated annual greenhouse gas emissions over the life of the project;*
   - *b. the operational life of the project over which the calculations are made (e.g., 2025-2050); and*
   - *c. Calculations of the percentage reduction compared to the baseline used over the same period.*

   Calculations should include any natural or mechanical methods of carbon sequestration. Purchased carbon offsets may be included in the calculations.

   In certain cases where a demand or volume increase is anticipated over the life of the project, project teams may choose to calculate emissions reductions on a per unit basis (passenger miles traveled, millions of gallons of water treated, etc.).

B. Has the project team calculated and reported the annual greenhouse gas emissions of the project?

1. *Calculation of annual greenhouse gas emissions over the life of the project. All greenhouse gas emissions should be in tons of CO_2e (tCO_2e). Calculations include all sources of emissions from facilities, processes, or vehicles owned or controlled within the project boundary, as well as indirect emissions from the off-site generation of energy used by the project. Emissions should be classified by the following categories if applicable:*
   - *a. Off-Site Energy Generation*
   - *b. Stationary Fuel Combustion Emissions (non-vehicular combustion occurring at the facility intended for energy production)*
   - *c. Operations Transportation Emissions*
   - *d. Waste Emissions*
   - *e. Wastewater Emissions*
   - *f. Biomass Emissions*
   - *g. Industrial Process Emissions*
   - *h. Fugitive Emissions*

RELATED ENVISION CREDITS

QL2.2 Encourage Sustainable Transportation

LD2.1 Establish a Sustainability Management Plan

CR1.1 Reduce Net Embodied Carbon

RA1.5 Balance Earthwork On Site

RA3.2 Reduce Operational Water Consumption

RA3.3 Reduce Construction Water Consumption

PROJECT EXAMPLE: HOLLAND ENERGY PARK

The Holland Board of Public Works in Michigan considered a number of ways to meet the community's need for more local power and in 2012, they conducted a comprehensive Sustainable Return on Investment (SROI) study to determine whether less expensive and less carbon-intensive alternatives could be pursued rather than the original plan to build a coal-fired power plant. In part through this SROI, the decision was made to build a natural gas combined cycle (NGCC) power plant, known as the Holland Energy Park (Envision Platinum, 2016). The project team undertook a life-cycle assessment (LCA) of greenhouse gas emissions to compare the emissions from the NGCC and the emissions from a coal-fired plant. The LCA revealed the NGCC would result in a more than 50% reduction of greenhouse gas emissions over the life of the project.

CLIMATE AND RESILIENCE: EMISSIONS

CR1.3 Reduce Air Pollutant Emissions

18

POINTS

INTENT

Reduce emissions of air pollutants: particulate matter (including dust), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, lead, and volatile organic compounds.

METRIC

Reduction of air pollutants compared to baseline.

LEVELS OF ACHIEVEMENT

<table>
<tr><th>IMPROVED</th><th>ENHANCED</th><th>SUPERIOR</th><th>CONSERVING</th><th>RESTORATIVE</th></tr>
<tr><td>A + B</td><td>A + B + C</td><td>A + B + C + D</td><td>A + B + C + D</td><td>A + B + C + D + E</td></tr>
<tr><td>(2) Exceeding Requirements</td><td>(4) Ongoing Monitoring</td><td>(9) VOC Minimization</td><td>(14) Air Pollutant Elimination</td><td>(18) Air Quality Improvement</td></tr>
<tr><td colspan="5">(A) The project meets all applicable air quality standards and regulations for air pollutants.</td></tr>
<tr><td>(B) The project implements strategies to reduce air pollutant emissions during operations.</td><td>(B) The project reduces emissions through the use of best available control systems or best management practices.</td><td>(B) Air pollution controls are within the 95th percentile, or represent the lowest levels possible compared to projects of similar type.</td><td colspan="2">(B) The project eliminates air pollutant sources in the design, chooses a non-polluting alternative, or achieves at least a 98% net reduction in air pollution emissions compared to the baseline.</td></tr>
<tr><td></td><td colspan="4">(C) Systems are in place for the ongoing monitoring of any direct sources of air pollution.

Processes are in place to identify and address changes in emissions in order to maintain performance targets.</td></tr>
<tr><td></td><td></td><td colspan="3">(D) The project team assesses whether volatile organic compounds harmful to human health are material to the project and, if so, implement strategies to reduce their use during construction and/or within occupied spaces of the completed project.</td></tr>
<tr><td></td><td></td><td></td><td></td><td>(E) The project includes the direct removal of previously existing air pollutant sources, or captures and safely stores/disposes of air pollutants for a net positive impact.</td></tr>
</table>

DESCRIPTION

The criteria pollutants include carbon monoxide, nitrogen oxides, sulfur dioxide, suspended particulate matter smaller than PM-10, ozone, lead, and volatile organic compounds. These pollutants damage human health, property, and the environment. Those most at risk are children, the elderly, and people with lung diseases such as asthma, chronic bronchitis, and emphysema. Dust and odors also can cause a nuisance for nearby residents, reduce property values, and aggravate the aforementioned lung conditions.

PERFORMANCE IMPROVEMENT

The credit assessment begins with demonstrating attainment of applicable air quality standards and/or regulations. Note that use of the terms, or variations of the terms “best available control technology” and “lowest achievable emissions rates” within this credit have no relationship to US EPA guidelines with similar names. These terms should be interpreted at face value.

Project teams are only required to provide supporting documentation for air pollutants relevant to the project. If a project does not emit certain air pollutants listed in the credit intent they can clarify this in their documentation.

Improved: Projects can demonstrate strategies were implemented to reduce air pollutants emissions during operations.

Enhanced: Modeling life-cycle air pollutant emissions can be challenging for some types of infrastructure. This level recognizes project teams that have utilized the best available control systems, technologies, or methods to reduce emissions with the assumption that, if properly monitored and maintained, these will significantly reduce air pollutants emissions over the project life. Project teams are required to provide documentation as to how controls represent industry best practices.

Superior: Completely eliminating air pollutant emissions may not be possible for certain projects. However, this level recognizes projects that have achieved 'best-in-class' status by reducing air pollutant emissions to the lowest possible levels or within the 95th percentile compared to similar projects. This may include, for example, replacing old or outdated systems with state-of-the-art systems. Project teams are required to determine and provide supporting documentation for what constitutes best-in-class status for their project type.

Conserving: The project completely eliminates air pollutant emissions. Often this is because a non-polluting alternative was chosen. Projects that can demonstrate at least a 98% reduction compared to the baseline are included in this level.

Volatile organic compounds have negative health impacts on building/facility occupants and, in certain conditions, construction workers.

Restorative: Reserved for rare cases where the project eliminates existing sources of air pollutants or captures and safely stores/ repurposes air pollutants. Note that replacing existing sources of air pollutants with less polluting sources would count toward a reduction and not an 'elimination' of air pollutants.

Applicability: This credit is applicable to all projects that directly produce any of the criteria pollutants. Projects that do not include air pollutant emissions may apply to have this credit deemed not applicable with supporting documentation. However, projects that do not produce air pollutant emissions because of intentional planning decisions to choose non-polluting alternatives may apply for the Conserving level with supporting documentation.

EVALUATION CRITERIA AND DOCUMENTATION GUIDANCE

Note that use of the terms, or variations of the terms, "best available control technology" and "lowest achievable emissions rates" within this credit have no relationship to US EPA guidelines with similar names. For Envision use of these terms should be interpreted at face value.

A. Does the project meet all relevant minimum air quality standards and regulations?

1. *Documentation indicating the local, regional, or national standards and regulations relevant to the project.*
2. *Documentation demonstrating that the project has met or will meet all relevant standards and regulations.*

B. To what extent does the project reduce air pollutant emissions during operations?

1. *Estimates of total annual air pollutant emissions over the life of the project.*
2. *Documentation of all strategies deployed to reduce air pollutant emissions.*

   a. *Documentation demonstrating that the project uses best available control systems or best management practices (Enhanced).*

   OR

   b. *Documentation demonstrating that air pollution controls are within the 95th percentile, or represent the lowest levels possible compared to projects of similar type (Superior)*

   OR

   c. *Documentation that the project eliminates all air pollutant sources, chooses a non-polluting alternative, or achieves at least a 98% net reduction in air pollution emissions compared to the baseline (Conserving and Restorative).*

C. Does the project include the ongoing monitoring and management of direct air pollutant emissions?

1. *Documentation that the project includes systems for monitoring any air pollutants directly emitted during operations.*
2. *Documentation of processes, procedures, or systems designed to identify and address changes in emissions in order to maintain performance.*

   Note that monitoring is not necessary if the project does not produce air pollutants. Documentation that the project does not produce air pollutants emissions is sufficient to satisfy criterion C for certain projects pursuing Conserving or Restorative. If the project produces air pollutants but achieves zero emissions through control systems, the project is still required to meet the monitoring requirements.

D. Has the project team assessed the materiality of volatile organic compounds to the health of construction workers and the project operators?

1. *Documentation that the use of products and materials containing volatile organic compounds (VOCs) and their potential impact on human health over the project life was assessed. If VOCs will be present during construction or operations documentation must include:*

   a. *Specifications limiting the use of, or controlling the exposure to, volatile organic compounds during construction.*

   b. *For projects/facilities with interior occupied spaces, documentation of steps taken to reduce VOCs in material choices.*

E. Does the project remove existing air pollutant sources?

1. *Documentation of how the project includes the direct removal of existing air pollutant sources or the capture and sequestration of air pollutants in order to achieve a net positive impact.*

RELATED ENVISION CREDITS

QL1.2 Enhance Public Health and Safety

QL2.2 Encourage Sustainable Transportation

LD2.1 Establish a Sustainability Management Plan

RA2.1 Reduce Operational Energy Consumption

RA2.3 Use Renewable Energy

Appendix E. Envision Assessment Scorecard

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Arlington Re-Gen

ISI ENVISION 3.0 CREDITS

Must provide a clear justification if a credit is identified as not applicable to a project for exclusion.

CATEGORY	SUB-CATEGORY	CREDIT NAME/NUMBER	Excluded	None	Improved	Enhanced	Superior	Conserving	Restorative
				LEVEL OF ACHIEVEMENT					
QUALITY OF LIFE	PURPOSE	QL1.1 Improve Community Quality of Life	0	0	2	5	10	20	26
		QL1.2 Enhance Public Health and Safety	0	0	2	7	12	16	20
		QL1.3 Improve Construction Safety	0	0	2	5	10	14	-
		QL1.4 Minimize Noise and Vibration	0	0	1	3	6	10	12
		QL1.5 Minimize Light Pollution	0	0	1	3	6	10	12
		QL1.6 Minimize Construction Impacts	0	0	1	2	4	8	-
	WELLBEING	QL2.1 Improve Community Mobility and Access	0	0	1	3	7	11	14
		QL2.2 Encourage Sustainable Transportation	0	0	-	5	8	12	16
		QL2.3 Improve Access and Wayfinding	0	0	1	5	9	14	-
	COMMUNITY	QL3.1 Advance Equity and Social Justice	0	0	3	6	10	14	18
		QL3.2 Preserve Historic and Cultural Resources	-18	0	-	2	7	12	18
		QL3.3 Enhance Views and Local Character	0	0	1	3	7	11	14
		QL3.4 Enhance Public Space and Amenities	0	0	1	3	7	11	14
		QL0.0 Innovation *(earn up to 8 points)*		2					
				Maximum QL Points	200				
				Excluded (n/a)	-18				
				High	98		*53.8%*		
				Low	88		*48.4%*		
LEADERSHIP	COLLABORATION	LD1.1 Provide Effective Leadership and Collaboration	0	0	2	5	12	18	-
		LD1.2 Foster Collaboration and Teamwork	0	0	2	5	12	18	-
		LD1.3 Provide for Stakeholder Involvement	0	0	3	6	9	14	18
		LD1.4 Pursue Byproduct Synergies	0	0	3	6	12	14	18
	PLANNING	LD2.1 Establish a Sustainability Management Plan	0	0	4	7	12	18	-
		LD2.2 Plan for Sustainable Communities	0	0	4	6	9	12	16
		LD2.3 Plan for Long-Term Monitoring and Maintenanc	0	0	2	5	8	12	-
		LD2.4 Plan for End-of-Life	0	0	2	5	8	14	-
	ECONOMY	LD3.1 Stimulate Economic Prosperity and Developme	0	0	3	6	12	20	-
		LD3.2 Develop Local Skills and Capabilities	0	0	2	4	8	12	16
		LD3.3 Conduct a Life-Cycle Economic Evaluation	0	0	5	7	10	12	14
		LD0.0 Innovation *(earn up to 6 points)*		2					
				Maximum LD Points	182				
				Excluded (n/a)	0				
				High	148		*81.3%*		
				Low	131		*72.0%*		
RESOURCE ALLOCATION	MATERIALS	RA1.1 Support Sustainable Procurement	0	0	3	6	9	12	-
		RA1.2 Use Recycled Materials	0	0	4	6	9	16	-
		RA1.3 Reduce Operational Waste	0	0	4	7	10	14	-
		RA1.4 Reduce Construction Waste	0	0	4	7	10	16	-
		RA1.5 Balance Earthwork On Site	0	0	2	4	6	8	-
	ENERGY	RA2.1 Reduce Operational Energy Consumption	0	0	6	12	18	26	-
		RA2.2 Reduce Construction Energy Consumption	0	0	1	4	8	12	-
		RA2.3 Use Renewable Energy	0	0	5	10	15	20	24
		RA2.4 Commission and Monitor Energy Systems	0	0	3	6	12	14	-
	WATER	RA3.1 Preserve Water Resources	0	0	3	5	7	9	12
		RA3.2 Reduce Operational Water Consumption	0	0	4	9	13	17	22
		RA3.3 Reduce Construction Water Consumption	0	0	1	3	5	8	-
		RA3.4 Monitor Water Systems	0	0	1	3	6	12	-
		RA0.0 Innovation *(earn up to 9 points)*		4					
				Maximum RA Points	196				
				Excluded (n/a)	0				
				High	79		*40.3%*		
				Low	70		*35.7%*		

Arlington Re-Gen

ISI ENVISION 3.0 CREDITS

Must provide a clear justification if a credit is identified as not applicable to a project for exclusion.

CATEGORY	SUB-CATEGORY	CREDIT NAME/NUMBER	Excluded	None	Improved	Enhanced	Superior	Conserving	Restorative
				LEVEL OF ACHIEVEMENT					
NATURAL WORLD	SITING	NW1.1 Preserve Sites of High Ecological Value	-22	0	2	6	12	16	22
		NW1.2 Provide Wetland and Surface Water Buffers	-20	0	2	5	10	16	20
		NW1.3 Preserve Prime Farmland	-16	0	-	2	8	12	16
		NW1.4 Preserve Undeveloped Land	0	0	3	8	12	18	24
	CONSERVATION	NW2.1 Reclaim Brownfields	-22	0	11	13	16	19	22
		NW2.2 Manage Stormwater	0	0	2	4	9	17	24
		NW2.3 Reduce Pesticide and Fertilizer Impacts	0	0	1	2	5	9	12
		NW2.4 Protect Surface and Groundwater Quality	0	0	2	5	9	14	20
	ECOLOGY	NW3.1 Enhance Functional Habitats	-18	0	2	5	9	15	18
		NW3.2 Enhance Wetland and Surface Water Function	-20	0	3	7	12	18	20
		NW3.3 Maintain Floodplain Functions	-14	0	1	3	7	11	14
		NW3.4 Control Invasive Species	0	0	1	2	6	9	12
		NW3.5 Protect Soil Health	0	0	-	3	4	6	8
		NW0.0 Innovation *(earn up to 8 points)*		0					
				Maximum NW Points	232				
				Excluded (n/a)	-132				
				High	35			*35.0%*	
				Low	31			*31.0%*	
CLIMATE & RESILIENCE	EMISSIONS	CR1.1 Reduce Net Embodied Carbon	0	0	5	10	15	20	-
		CR1.2 Reduce Greenhouse Gas Emissions	0	0	8	13	18	22	26
		CR1.3 Reduce Air Pollutant Emissions	0	0	2	4	9	14	18
	RESILIENCE	CR2.1 Avoid Unsuitable Development	-16	0	3	6	8	12	16
		CR2.2 Assess Climate Change Vulnerability	0	0	8	14	18	20	-
		CR2.3 Evaluate Risk and Resilience	0	0	11	18	24	26	-
		CR2.4 Establish Resilience Goals and Strategies	0	0	-	8	14	20	-
		CR2.5 Maximize Resilience	0	0	11	15	20	26	-
		CR2.6 Improve Infrastructure Integration	0	0	1	4	8	14	18
		CR0.0 Innovation *(earn up to 5 points)*		0					
				Maximum CR Points (w/o Innovation)	190				
				Excluded (n/a)	-16				
				High	99			*56.9%*	
				Low	74			*42.5%*	

**Maximum points adjusted for category if criteria are determined not applicable (for high estimate only).

*** Not every credit has a restorative level. Therefore totals include the maximum possible points for each credit whether conserving or restorative.

1,000 total points (w/o 50 possible innovation points)	1000		
Total Excluded (n/a)	-166		
High	459	*55.0%*	*Platinum*
Low	394	*39.4%*	*Silver*

DEFINITIONS

Innovation Credits: The Envision framework strongly encourages innovative methods that advance sustainable infrastructure practices or show exceptional performance beyond the expectations of the credit requirements. Each category includes an “Innovate or Exceed Credit Requirements” credit, indicated by a “0.0.” Projects may achieve all or part of the points in these credits. Maximum points allotted for innovation in any one category is 10 points and the submitter determines the number of points (zero to the maximum) for which the credit will be submitted. The 0.0 credits are not required, and these points act as bonus points that are added to the category or total score.

Not Applicable Credits: ISI has provided guidance indicating that a project should not be awarded Envision points for avoiding certain situations or locations if there is no reasonable chance that those locations or situations were being considered during the project decision-making process. Providing documentation to support the exclusion of these credits would ultimately help the project increase the percentage of points earned by reducing the total points available.

Technical Memorandum No. 16

Date:	November 30, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Biogas Conditioning Evaluation

Contents

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Figures

1.0 Introduction

This introductory section presents the background and purpose of this project and the biogas conditioning evaluation, followed by a description of the evaluation approach.

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary sludge (PS) and waste activated sludge (WAS) thickening, dewatering, and Class B lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a Class A THP and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The purpose of this biogas conditioning evaluation is to further assess requirements and technologies for biogas conditioning. The results of this evaluation will inform a final decision on which technology will be chosen for biogas conditioning.

1.2 Evaluation Approach

A suite of alternatives using various biogas conditioning technologies was developed. Conceptual process conditions, configurations, cooling technology sizing, and conceptual operation costs were prepared and then presented and reviewed at the July 22, 2021 and August 30, 2021 project workshops with the County. In this evaluation, the technologies are evaluated and compared based on budgetary capital equipment costs, conceptual operating cost estimates, and non-cost considerations including space requirements and noise. A 20-year life-cycle cost analysis was also completed.

2.0 Biogas Conditioning

The level of biogas conditioning required is directly related to the end use of the biogas. With the recommended alternative of upgrading the biogas to renewable natural gas, the required biogas conditioning will include H_2S, moisture, siloxane, carbon dioxide, and volatile organic compound (VOC) removal with compression and tail gas disposal. Emergency biogas disposal will be through a waste gas flare.

2.1 Hydrogen Sulfide Removal

Hydrogen sulfide removal would be required for any of the gas utilization alternatives considered. When hydrogen sulfide (H_2S) is combusted (either onsite in boilers or engines or offsite as RNG), sulfur dioxide forms. This can condense into sulfuric acid with the presence of water vapor and cause significant corrosion issues. Removing H_2S prior to combustion reduces the likelihood of corrosion. Hydrogen sulfide is typically removed by precipitating the dissolved sulfide in the anaerobic digesters (thus preventing its formation in the biogas) or by directly removing the hydrogen sulfide from the biogas in a biogas scrubber. Removal with biogas scrubbers requires the gas to be fully saturated with moisture to reduce safety concerns (fires) associated with the exothermic nature of the treatment process. Therefore, hydrogen sulfide is normally the first constituent removed from raw biogas in traditional biogas uses as the raw biogas is fully saturated,

The Arlington WPCP currently uses iron salt addition, in the form of ferric chloride ($FeCl_3$), to provide chemical phosphorus removal in the liquid stream process. $FeCl_3$ is added at multiple locations in the process including the primary clarifiers and secondary clarifiers to precipitate dissolved orthophosphate, which ends up in the solids treatment train. At the current high dosage levels, it is anticipated that a significant amount of dissolved hydrogen sulfide in the digesters will also be precipitated along with the phosphate, which will significantly lower the H_2S concentrations in the biogas. If this practice continues, the H_2S concentrations in the biogas may be below 200 ppm, in which case no further removal would be required for any of the alternatives. However, if the facility were to move away from chemical phosphorus removal to an enhanced biological phosphorus removal (EBPR) approach, hydrogen sulfide concentrations would increase and additional treatment would be required. For the purposes of this alternative, H_2S removal is retained in all alternatives. Pilot testing currently being conducted by Virginia Tech will provide data on potential H_2S concentrations in the biogas and ultimately inform the final design.

2.1.1 Precipitation with Iron Salt Addition

Iron salts combine chemically with dissolved sulfide to form relatively insoluble metal sulfides that precipitate from the wastewater, thus preventing the release of H_2S gas. Iron sulfide precipitates exist as soft, black, or reddish-brown flocs that usually do not settle well in the collection system but are easily removed at treatment plants. Sulfur precipitation with iron salts has the following advantages and disadvantages:

- Advantages:
  - Long residuals can be maintained to precipitate sulfides as they are generated.
  - Iron salts Iron salts can be used to treat sludge or full wastewater flows.
  - Reaction by-products are harmless.
  - The precipitates are beneficial to downstream treatment processes because they help increase settling and remove phosphorus.
- Disadvantages:
  - Precipitates can dissociate at lower pH levels (less than 6.5), allowing sulfides to release back into the wastewater.
  - Dissolved sulfide cannot be decreased to much lower than 0.2 to 0.5 milligram per liter (mg/L) using iron salts.
  - Iron salts can form a film on pipe walls, instrument sensors, and ultraviolet treatment equipment.
  - Precipitates increase sludge production.

As stated previously, the Arlington WPCP currently uses iron salt addition, in the form of FeCl3, to provide chemical phosphorus removal in the liquid stream process. A stoichiometric dose of 3.3 to 4.9 pounds of FeCl3 is required per pound of sulfide. However, field and laboratory experiments indicate that the typical required dose to remove sulfide in domestic wastewater is between 3 and 7 pounds of FeCl3 per pound of sulfide removed. In the near term, it is anticipated that the WPCP will continue to utilize FeCl3 optimized for phosphorus (not sulfide removal). Impacts of this $FeCl_3$ dosing strategy on biogas H_2S removal will be evaluated in on-going pilot tests with Virginia Tech.

2.1.2 Adsorptive Media

Adsorptive media is commonly used to remove hydrogen sulfide from biogas ahead of downstream unit processes. Hydrogen sulfide is removed by chemical adsorption in the fixed-media vessel using metal oxides. Common media types include iron sponge, Sulfatreat™, and other proprietary products.

Iron sponge media is typically wood chips impregnated with iron oxide. The iron oxide reacts with the hydrogen sulfide and binds to the media as iron sulfide and water. The metal sulfides are contained within the media. Once the media is spent, it must be replaced. Engineered iron oxide media, such as Sulfatreat™, is also available for H_2S removal. This media is typically more expensive than iron sponge but is easier to remove once the media is exhausted. The primary advantages of the solid media technology are the passive operation, simple use, and reliability. If the $FeCl_3$ addition continues, the County's low H_2S concentrations will likely require infrequent media replacement.

Several companies manufacture the adsorptive media treatment systems for installation in the United States. Common iron sponge providers for installation at wastewater treatment plants include Unison Solutions, Marcab, Varec Biogas, and DMT Clear Gas Solutions. Figure 1 shows a photo of an adsorptive media system installation.

Figure 1. Adsorptive Media Installation Example

Table 1 below presents the advantages and disadvantages of the H_2S removal technologies.

Table 1. Advantages and Disadvantages of H_2S Removal Technologies

Alternative	Advantages	Disadvantages
Iron salt addition	• Already used at WPCP • Improves phosphorus removals and odor control • Can achieve good H_2S removal with high doses	• Safety considerations with storage and feed facilities • May not be used in the future if WPCP switches to biological phosphorus removal • High costs of chemicals
Adsorptive media (iron sponge)	• Proven technology with many installations • Simple configuration with no moving parts • Removes sulfur from the system • Lower media replacement costs at concentrations anticipated with iron salt addition	• Higher media replacement costs at anticipated H_2S levels without iron salt addition • Media can combust

2.2 Moisture Removal

Biogas is saturated with moisture as it leaves the digester and nearly all end uses require at least some level of moisture removal. For RNG, moisture must be nearly completely removed to meet injection specifications. It is recommended that a two-step process be used for moisture removal, where the first step is mechanical refrigeration for the bulk of the moisture, followed by an adsorption technology for final biogas drying. Figure 2 presents an example of a moisture removal installation.

Figure 2. Moisture Removal Installation Example

2.3 Siloxane and VOC Removal

Siloxanes and VOCs are typically removed following moisture removal and initial compression, as the vessels have higher head loss and require a dry gas environment to work properly. Siloxanes and VOCs at normal levels within biogas (between 1 and 5 parts per million by volume [ppmv]) are removed using similar solid sorptive media as with hydrogen sulfide, described above. The most common media choice is activated carbon. In addition to siloxane removal, the media also serves as polishing to remove residual hydrogen sulfide and VOCs that may be in the biogas. Because of this polishing, the media is exhausted as much by residual hydrogen sulfide and VOCs as it is by siloxanes. Figure 3 presents an example of siloxane removal equipment and media.

Figure 3. Siloxane Removal Equipment and Media

Caution should be used with media selection because gas flow is very important for effective removal. If the media size is too large, at lower gas flow rates the flow will channelize, resulting in breakthrough occurring because media is exhausted in a concentrated area, while the overall bed is in good condition. Small media size will distribute flow better. However, if flows are higher, small media size will result in high pressure drops and potentially fluidizing the bed, leading to carry-over of media out of the treatment vessel. Careful coordination between the engineers and vendors on the range of gas flows is important for selection of media size.

2.4 Carbon Dioxide Removal

Biogas treatment to natural gas quality requires the removal of carbon dioxide from the biogas stream. Several technologies are available to condition the biogas to RNG quality, including water wash, pressure swing adsorption (PSA), and membranes. These technologies are described in more detail later in this Chapter, but Table 2 provides a summary of the advantages and disadvantages of each.

Table 2. Biogas Storage Scenarios

Alternative	Advantages	Disadvantages
Water wash	• Proven technology with many installations • No media to be replaced • High CH_4 recovery (98%) at design efficiency point	• More appropriate for larger installations (>750 scfm) • Requires high-pressure water (~150 psig) and water cooling • Requires post-scrubbing drying • Reduction in CH_4 recovery efficiency at turndown • Moderate energy use
PSA	• Proven technology with many installations • Regenerative adsorbent has long media life	• Lowest CH_4 recovery (95%) • Continuous actuation of vessel valves during operation is loud and causes mechanical wear of equipment • Moderate energy use
Membrane	• Proven technology with many installations • Highest CH_4 recovery (99%) with three-pass system • Fewer moving parts • Modular design • Good for smaller installations (<600 scfm)	• Requires separate upstream treatment of H_2S, VOCs, and siloxanes • Requires multiple passes to get higher CH_4 recovery • Higher energy use

2.5 Waste Gas Management

In addition to biogas treatment options, there are alternatives for how to properly dispose of waste gas generated at the WPCP. Below are the viable options for waste gas management at Arlington County WPCP.

2.5.1 Enclosed Waste Gas Flares

The most common method of waste gas disposal is with a waste gas flare. Waste gas flares are mostly used to combust raw biogas or off-spec RNG that is higher in heating value, or Btu content, and can provide self-sustaining direct combustion. Waste gas flares are always provided at anaerobic digestion facilities as a safety provision to be able to dispose of the flammable biogas during system downtime regardless of the biogas utilization method. Because of the visibility of the WPCP and footprint constraints an enclosed waste gas flare is recommended for the Arlington WPCP. An example of an enclosed flare is shown in Figure 4.

Figure 4. Enclosed Waste Gas Flare

2.5.2 Regenerative Thermal Oxidizers

For lower-Btu waste gases, or tail gas, produced as a by-product from the processing of RNG, RTOs are often used. RTOs provide higher efficiencies than regular thermal oxidizers when the waste gas does not have the Btu content to provide self-sustaining combustion. They provide this efficiency with a common combustion chamber and two sets of ceramic media with switching valves to capture and reuse the heat provided by the combustion to preheat the incoming waste gas. Once the heat is recovered from one combustion cycle the waste gas flow is reversed with the valves to recover heat from the recently combusted gas. An RTO is shown in Figure 5 and Figure 6.

Like any other form of thermal oxidation, a startup burner (fueled by natural gas) is employed to raise the temperature of the unit to proper destruction conditions. Once at the proper temperature, the process gas can be introduced and blended with the correct amount of dilution/combustion air, and the RTO cycles through the combustion sequence. The burner provides supplemental fuel to maintain the combustion chamber temperature should the heat content fall below that required for self-sustaining operation. Using a hot-gas bypass can expand the range of possible operating conditions by diverting some of the combusted air directly to atmosphere, rather than sending it through the heat-recovery media.

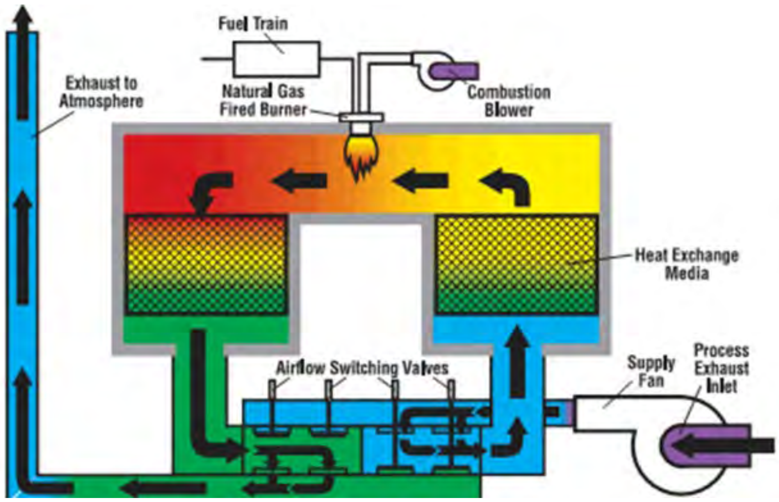

Figure 5. Regenerative Thermal Oxidizer

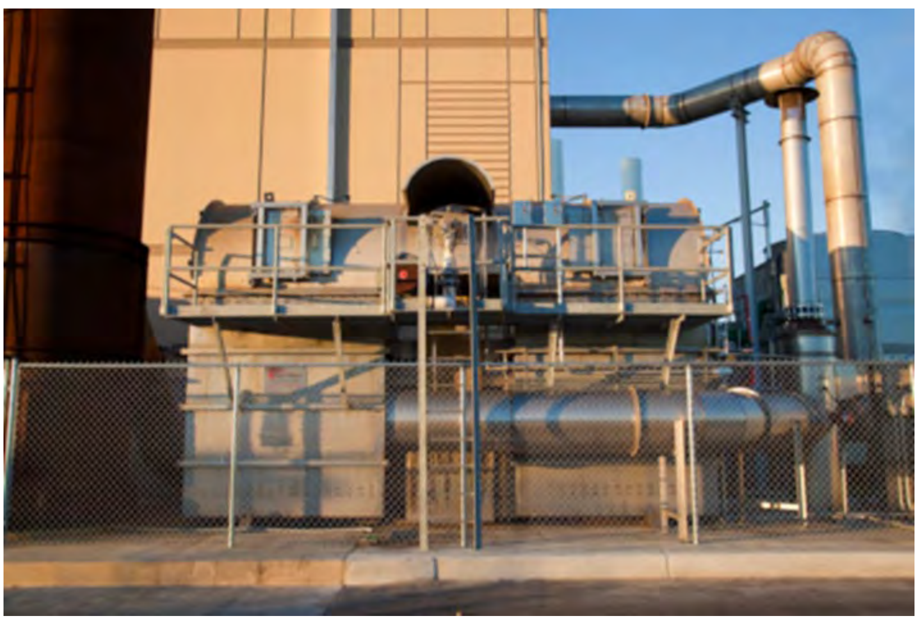

Figure 6. Regenerative Thermal Oxidizer

2.6 Pressure Boosting

Digester pressure is typically around 6 to as much as 20 inches of water column (in WC) or 0.2 to 0.7 psig. There are a wide range of pressure requirements for end use and for the associated treatment requirements described above that must be considered as part of a project. Depending on the technology used for biogas upgrading, a large range of pressure requirements are necessary to account for pressure losses through pipelines and the treatment system and achieve the required delivery pressure of the biogas equipment. Different RNG upgrading equipment technologies require a range between 100 and 250 psig for CO_2 removal. Typically, the upgrading equipment includes a compressor that can increase pressure necessary to the full requirement of that system. If there is pipeline injection, then it is also possible that an additional compressor would be needed to meet the requirement of the natural gas pipeline pressure for injection. Figure 7 shows an example of a biogas compression skid.

Figure 7. Biogas Compression Equipment Example

3.0 Biogas Upgrading Alternatives

With the recommended alternative of conditioning the biogas to be used as RNG off site, an additional analysis is needed to select the most appropriate carbon dioxide removal conditioning technology. There are three main types of biogas conditioning to produce RNG: membrane separation, pressure swing adsorption, and water wash scrubbing. The following sections provide additional descriptions of each technology followed by a life-cycle cost analysis to compare the three types and make a recommended selection for the Arlington WPCP.

3.1 Membrane Treatment

Membrane treatment systems consist of bundles of hollow membrane fibers fashioned together in canisters to remove carbon dioxide and other contaminants from the methane. The pores in the membrane fibers are sized to allow CO_2 molecules to pass through, while retaining the CH_4 molecules, as shown in Figure 8. Biogas is pressurized to 150 to 200 psig and conveyed through a series of canisters in a multi-pass configuration to improve CH_4 recovery and maintain a high CH_4 content in the product gas.

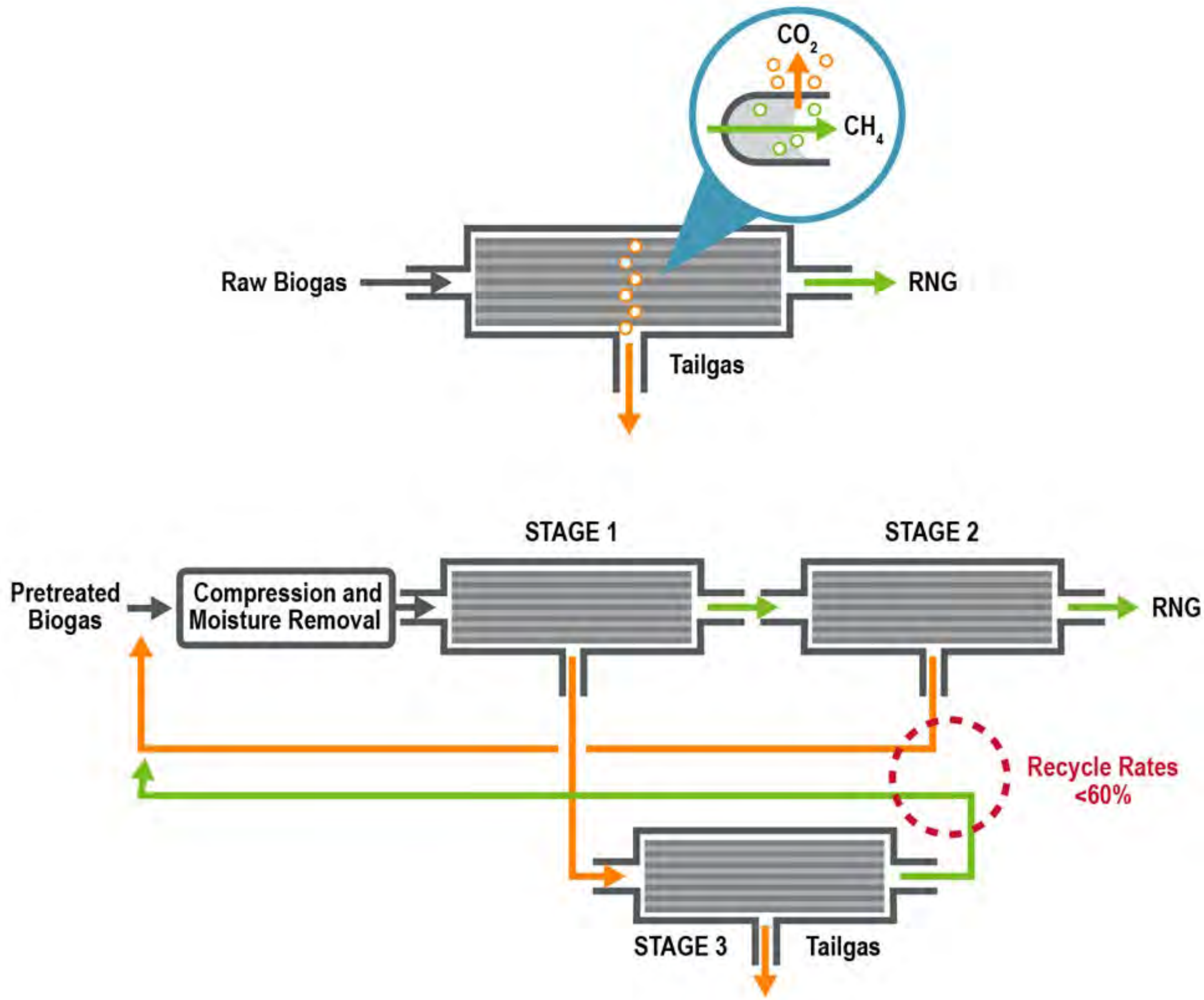

Figure 8. Membrane Treatment Schematic

Membrane systems must be used in combination with other technologies to remove hydrogen sulfide, siloxanes, moisture, and VOCs ahead of the membranes to protect the integrity of the fibers. The number of membrane filtration steps, or passes, determines the quality of the RNG and the methane recovery of the system. With additional membrane steps, higher finished gas quality is produced and/or more methane is captured from the waste tail gas stream. Gas typically passes through the membranes two to three times.

Currently, several companies manufacture membrane systems for installation in the United States: Unison Solutions, DMT Clear Gas Solutions, Greenlane Biogas, Air Liquide, and Pentair. A simplified schematic of a typical membrane system with mass balance is shown Figure 9. Figure 10 shows a photo of a typical membrane system installation.

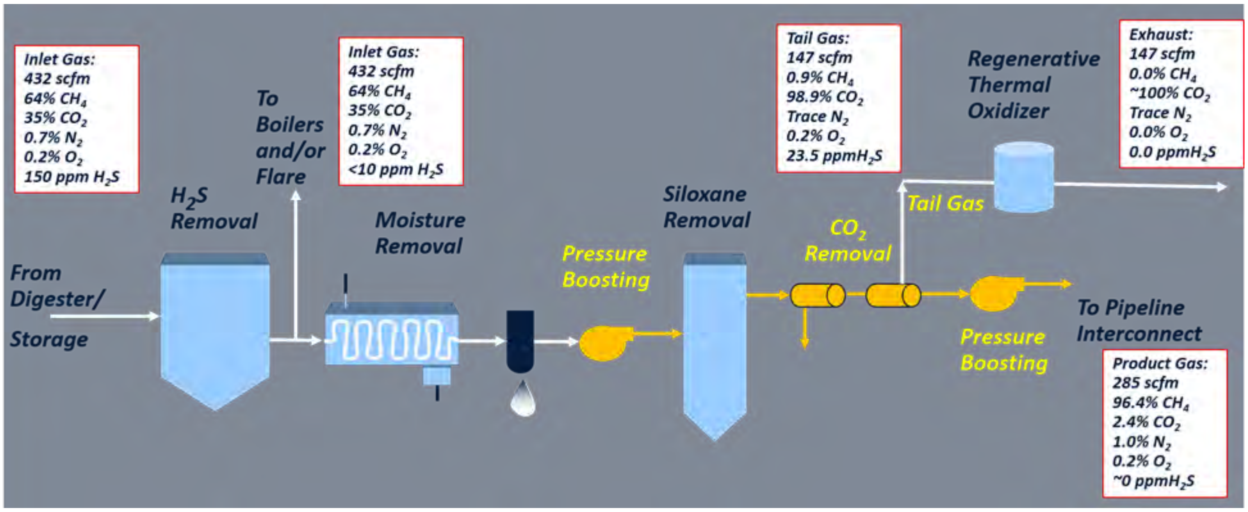

Figure 9. Membrane Treatment Process Flow Diagram

Figure 10. Typical Membrane Treatment Installation

3.2 Pressure Swing Adsorption

PSA systems remove hydrogen sulfide, carbon dioxide, and siloxanes in a single vessel by the adsorption of contaminants onto media under pressure (approximately 100 psig) and then regenerating the media under a vacuum. The systems operate with multiple pressure vessels so that the batch process of pressurizing the vessel, treating, and vacuum regeneration can be done while allowing for continuous operation. Figure 11 shows a schematic of the PSA treatment process. The systems are cost-effective; however, they typically have lower methane recovery rates (95 percent) compared to other gas upgrading systems being considered.

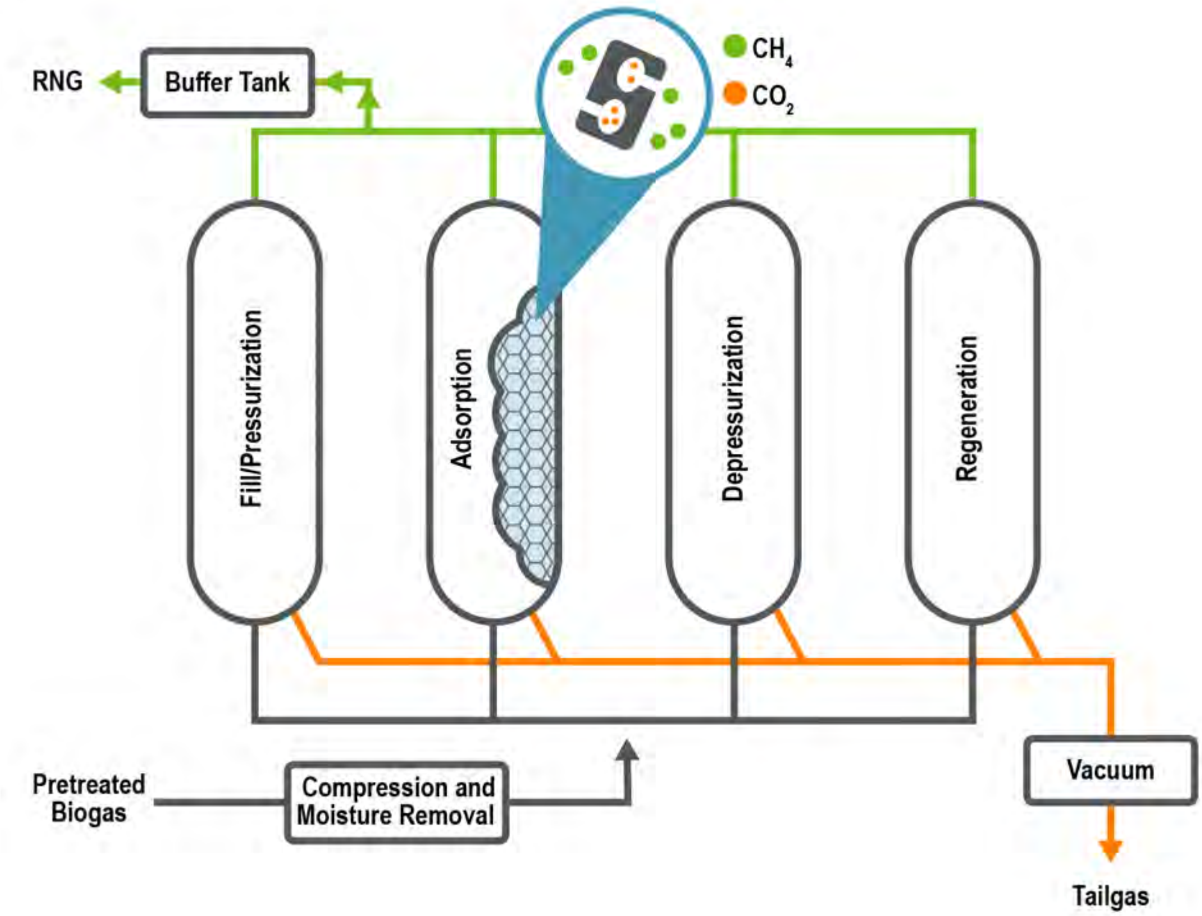

Figure 11. PSA Treatment Schematic

H_2S removal could occur upstream of the PSA or on the waste tail gas stream. The level of treatment provided will determine if an RTO or flare on the tail gas stream is needed to convert remaining hydrogen sulfide to sulfur oxides or if the stream can be vented to the atmosphere.

Currently, four companies manufacture PSAs for installation in the United States: Greenlane Biogas, Guild Associates, Xebec, and BioFERM. A simplified process flow diagram of a typical PSA system with mass balance is shown in Figure 12. Figure 13 shows a photo of a PSA system installation.

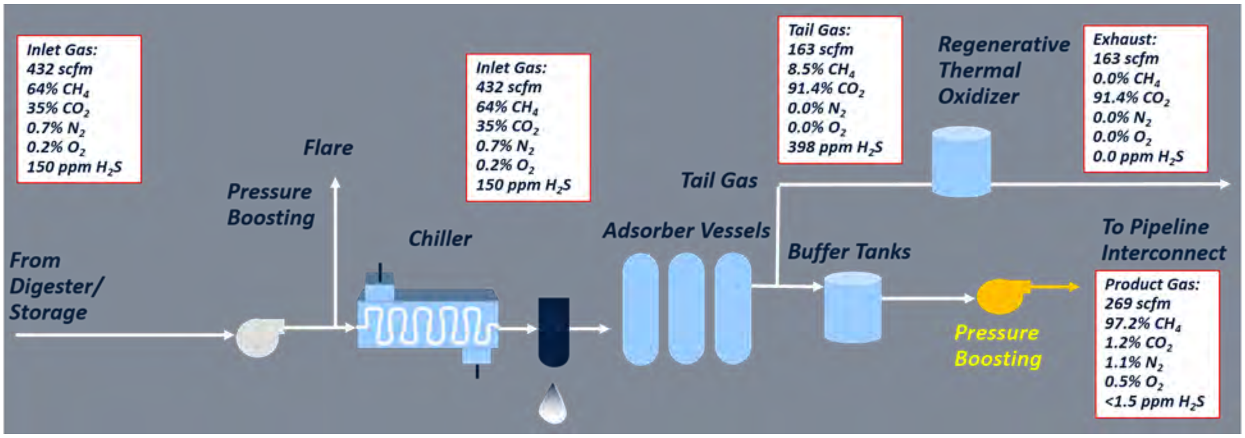

Figure 12. PSA Treatment Schematic

Figure 13. Typical PSA Installation

3.3 Water Wash Scrubber

The water wash, or water scrubber, treatment system dissolves carbon dioxide and other impurities in water to separate the CH_4 gas stream. Biogas compressed to approximately 150 psig enters the bottom of the scrubber vessel and flows upward through packing media as chilled water sprays downward. The carbon dioxide and other gas impurities (hydrogen sulfide, siloxanes, and VOCs) are dissolved in the water, the methane exits through the top of the scrubbing tower, and moisture is removed with a drier. The water, now saturated with carbon dioxide, is then depressurized in the flash tank, which operates as an intermediate step to release and recycle any methane that may have been absorbed in the water. The flash tank water is sent to the stripper vessel where pressure is lowest within the system. Lowering the pressure releases the carbon dioxide and contaminants into the tail gas waste stream. A schematic of the water wash treatment process is shown in Figure 14. A defoaming, antimicrobial, and pH adjustment solution may be fed to the water wash system to improve performance.

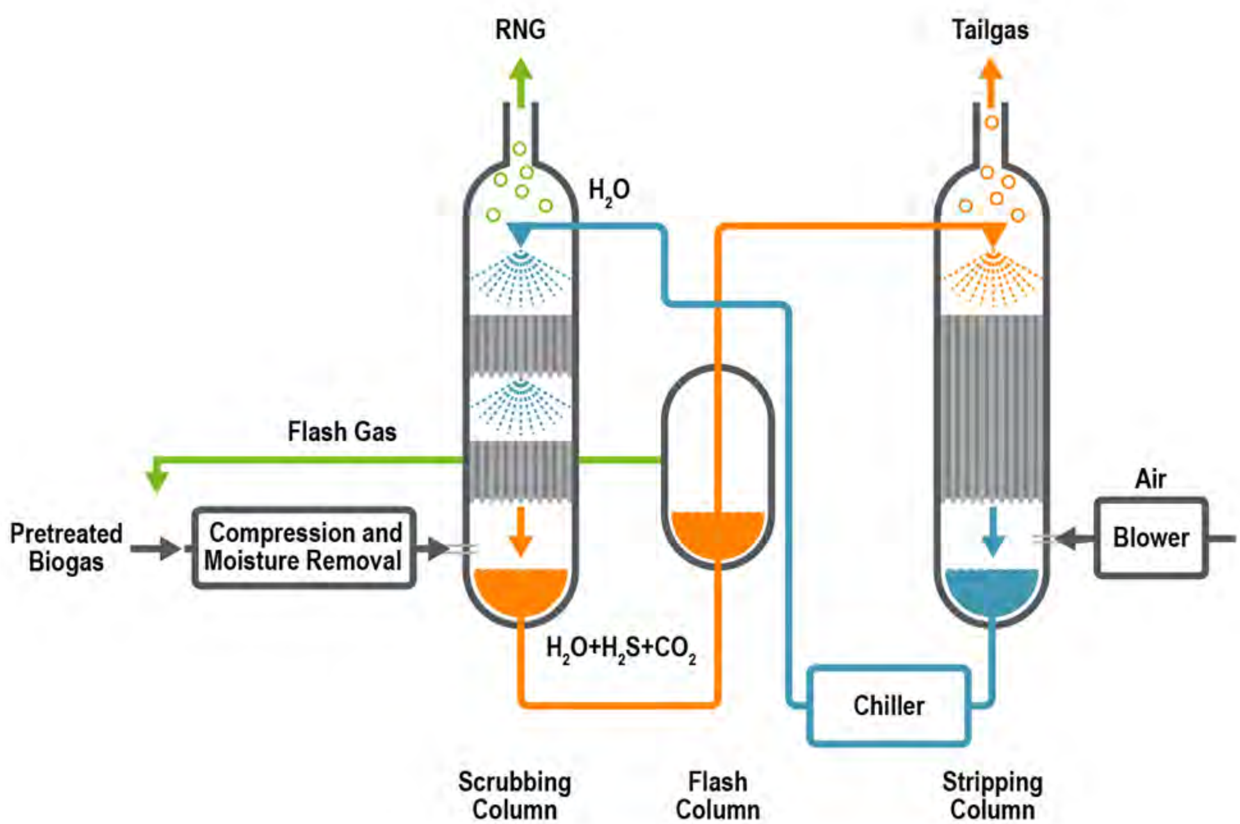

Figure 14. Water Wash Treatment

It should be noted that while the water wash systems remove hydrogen sulfide from the methane stream, the process does not actually treat it to a final product. The H_2S removal could occur upstream of the water wash process or on the waste tail gas stream. The level of treatment provided will determine if an RTO on the tail gas stream is needed to convert remaining hydrogen sulfide to sulfur oxides or if the stream can be vented to the atmosphere.

Water wash systems can achieve CH_4 recovery rates of up to 98 percent. However, this recovery rate drops when the system is operating below the designed best efficiency point.

Currently, two companies manufacture water wash systems for installation in the United States: Greenlane Biogas and Dürr Megtec. A simplified schematic of a typical water wash system with mass balance is shown in Figure 15. Figure 16 shows a photo of a water wash system installation.

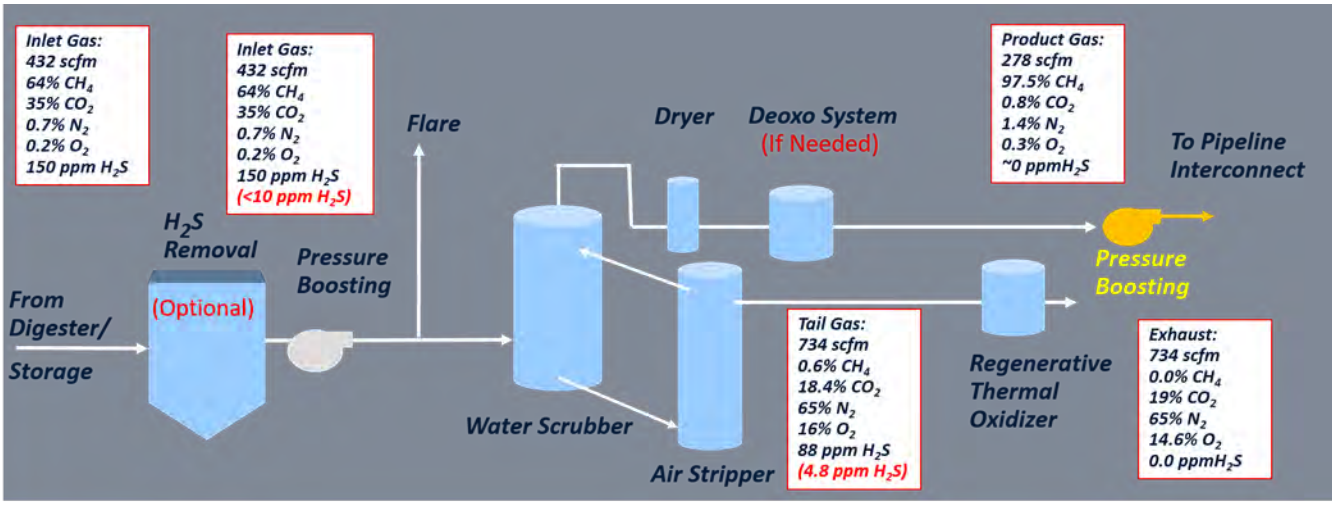

Figure 15. Water Wash System Process Flow Diagram

Figure 16. Typical Water Wash systems Installation
Source: HDR, Portland, Oregon.

4.0 Life-Cycle Cost Comparison

Similar to the gas utilization alternatives analysis, a life-cycle cost comparison was developed to evaluate and compare the three technologies from a capital and O&M cost basis.

4.1.1 Conceptual Capital Costs

Conceptual capital costs have been developed for each biogas conditioning alternative. Manufacturers for each equipment type were contacted for budgetary equipment pricing. The following multiplier percentages were used in the capital cost development:

- Electrical and instrumentation/controls: 28 percent
- Sitework/general civil: 15 percent
- Specialty piping: 5 percent
- Contractor general requirements (O&P, mobilization, etc.): 23 percent
- Contingency: 20 percent

No salvage or deep foundation costs or engineering, legal, and administrative costs are included in the cost estimates.

Capital costs are associated with the interconnection to the natural gas utility pipeline injection. These costs typically include the custody transfer station and the pipeline to the tie-in location. An estimated cost of $5 million is applied to all RNG injection alternatives and is based on preliminary feedback from the gas utility. This cost will be confirmed as additional discussions with the natural gas utility are conducted.

It is assumed that the natural gas pipeline will require post-treatment compression to 600 psig to inject RNG into the pipeline. Each pipeline injection alternative includes capital cost for this pressure increase. Each CO_2 removal technology discharges RNG at a different pressure, between 80 and 190 psig, so the compression needs vary for each alternative.

Capital costs for the conditioning alternatives are summarized in Table 3. The vendor quotes for each alternative are included in Appendix D.

Table 3. Biogas Conditioning Conceptual Capital Costs

Item		Membrane	PSA	Water Wash
Boilers		\$0.60M	\$0.60M	\$0.60M
Building requirements		\$2.45M	\$2.45M	\$2.45M
Pretreatment H_2S and siloxane removal		\$0.50M	\$0.00M	\$0.00M
Inlet conditioning		\$0.27M	\$0.27M	\$0.27M
CO_2 removal		\$3.53M	\$3.39M	\$3.86M
Tail gas handling		\$0.15M	\$0.15M	\$0.25M
Compression to delivery		\$0.49M	\$0.49M	\$0.49M
Custody transfer station and pipeline		\$5.00M	\$5.00M	\$5.00M
Total direct costs		\$7.98M	\$7.34M	\$7.92M
Markups				
Electrical, instrumentation/controls	28%	\$2.24M	\$2.06M	\$2.22M
Sitework	15%	\$1.20M	\$1.10M	\$1.19M
Specialty piping	5%	\$0.40M	\$0.37M	\$0.40M
Contingency	20%	\$2.36M	\$2.17M	\$2.34M
Contractor general requirements	23%	\$3.26M	\$3.00M	\$3.23M
Conceptual Capital costs		**\$22.44M**	**\$21.04M**	**\$22.30M**
Compared to minimum		107%	100%	106%

4.2 O&M Costs

Similar to the capital costs, O&M costs have been estimated from vendor proposals, reference project experience, and the County's historical cost information. Anticipated O&M costs were developed and are presented in Table 4. Assumptions include costs related to operations labor, maintenance labor, labor parts, power requirements, water use, media replacement, and chemical costs. The common values used across all alternatives include the following:

- Power cost: \$0.06/kWh
- Natural gas cost: \$0.85/therm
- Operations labor: \$80/hr
- Maintenance labor: \$60/hr

Annual O&M cost summaries for the conditioning alternatives are provided in Table 4.

Table 4. Annual Biogas Conditioning O&M Costs at Start-up

Item	Membrane	PSA	Water Wash
Pretreatment H_2S and siloxane removal	$29,700	$0	$0
Inlet conditioning	$25,900	$25,900	$25,900
CO_2 removal	$237,500	$197,000	$252,600
Tail gas H_2S treatment	$0	$0	$0
Tail gas handling	$12,000	$12,000	$12,900
Compression to delivery	$17,900	$17,900	$17,900
Total O&M	**$323,000**	**$252,800**	**$309,300**
Total O&M $/MMBtu	**$2.45**	**$1.91**	**$2.34**

The membrane system has the highest annual O&M cost of the three options because of the higher power requirements and also media costs associated with H_2S and siloxane removal systems.

4.3 Present Values

The net present financial values for each technology option were calculated using the same heating requirements, biogas production quantities, annual costs, and financial assumptions as Alternatives 3A and 3B presented in Chapters 04 and 05 of the Arlington Re-Gen Biogas Utilization Report. These included the same WPCP energy costs for electricity and natural gas, O&M inflation, discount rate, and planning period.

Table 5 presents the present financial values for Alternatives 1, 3A, and 3B for each of the biogas conditioning technologies. The present financial values are presented for a range of RIN market values from $5/RIN to $35/RIN. The main differences between the options are the specific capital and O&M costs presented above as well as the methane capture for each of the technologies.

This analysis shows that the PSA technology has the lowest net present financial value as compared to the membrane and water wash system. This is mostly due to the difference in capital costs and slightly lower O&M costs for the PSA system. Even with the higher percentage methane capture for membranes and water wash, the difference in capital and O&M cannot be overcome through RNG revenue.

Table 5. Net Financial Values, $M

Item	Membrane	PSA	Water Wash
Conceptual Capital Cost	$22.4M	$21.0M	$22,3M
Annual Operating and Maintenance Costs	($0.32M)	($0.25M)	($0.31M)
Annual RIN Revenue at $15/MMBtu	$1.85M	$1.78M	$1.84M
Total Net Present Value	$3.46M	$1.92M	$3.32M

4.4 Summary

Overall, the three biogas conditioning technologies are very comparable in present value and performance; however, some differences should be discussed before the final decision is made.

Table 6 presents these differences graphically. The membrane system has the highest capital and O&M costs, but also the highest methane capture while the PSA has the lowest capital and O&M costs and the lowest methane capture. From an uptime perspective, all the technologies are similar. The PSA equipment will likely by louder and will not have the flexibility to simply add CHP in the future (additional pre-treatment would be required). The noise production of the PSA will be evaluated as part of the future site visits. Water wash has similar challenges and also will be less aesthetically pleasing because of its height, and tail gas management would be more costly because of higher gas flows. Membranes will be similar to or better than PSA and water wash in all of these categories.

Table 6. Technology Comparison

Criterion	Membranes	PSA	Water Wash
Capital cost	↑	↓	↑
O&M cost	↑	↓	↓
Methane capture	↑	↓	↑
Uptime	↔	↔	↔
Noise	↓	↑	↓
Aesthetics	↑	↑	↓
Flexibility for future CHP	↑	↓	↓
Tail gas management	↑	↑	↓

5.0 Recommended Alternative

Based on the analysis presented, it was recommended that the Program continue to pursue all three biogas treatment technologies until more understanding of the day-to-day operations and maintenance can be obtained. This was accomplished with additional discussions with the equipment vendors and site visits to existing installations to see the equipment in person and talk to O&M staff who have experience with the equipment options. Recommended next steps for the biogas utilization equipment selection included:

- Schedule technical brown bag sessions with equipment suppliers for the membrane, water wash, and PSA conditioning systems. This next step is currently in progress and potential dates and times are being discussed. *These technical brown bag sessions were conducted over three lunch and learn sessions in October 2021.*
- Identify potential facilities to perform in-person site visits. The equipment suppliers have provided lists of relevant installations, but additional facilities are currently being identified. A preliminary list of facilities that are being considered is shown in Table 7. The site visits should have relevance to the Arlington WPCP

where biogas from domestic wastewater digestion is conditioned to natural gas quality. Facilities of similar size and biogas conditioning capacity will be preferred.

- Schedule and perform site visits. It is anticipated that this will occur sometime in late 2021 or early 2022 depending on COVID-19 protocols. *Site visits to representative installations were conducted in October 2022.*
- Select a technology for implementation based on the results of the vendor discussions, site visits, and further refinement of the WPCP requirements as part of the Program.

Based on the results of this analysis, lessons learned from vendor presentations and discussions with operations and maintenance staff during site visits at representative installations, the preferred biogas treatment technology for implementation at the WPCP is membrane separation. The final technology and manufacturer selection will be determined during the detailed design phase of the Program.

Table 7. Technology Installation Lists

Water Wash (Greenlane)	PSA (Guild)	Membrane (Unison/Air Liquide)
Fair Oaks, Indiana (manure)	San Antonio, Texas (muni)	Atlanta, Georgia (LFG)
Perris, California	Dayton, Ohio (muni)	Pittsburgh, Pennsylvania (LFG)
Canton, Michigan	Newark, Ohio (muni)	Waste Management (LFG: multiple locations)
Weld County, Colorado (manure, food waste)	Des Moines, Iowa (muni)	Avondale, Louisiana (LFG)
Portland, Oregon (muni) startup end of 2021		Lincoln, Nebraska (muni)

Technical Memorandum No. 17

Date:	February 14, 2023
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Arlington Re-Gen Envision Assessment Summary

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1.0 Program Overview and Workshop Purpose

Arlington County (County) has initiated the implementation of the Arlington County Water Pollution Control Plant (WPCP) Re-Gen Program (Program) for the next generation of biosolids management facilities at the Arlington WPCP. A comprehensive Program will be developed and managed by the Program Team for the engineering, design, construction, maintenance, startup, and operation necessary to add sustainable equipment and systems to effectively recover the County's renewable resources, produce a Class A biosolids product, and most efficiently utilize the biogas. The new solids handling processes (Facilities) will entail upgrades or replacement of nearly all Facilities. A thermal hydrolysis process (THP) followed by anaerobic digestion (AD) form the backbone of the new treatment train. A marketable Class A biosolids product and biogas utilization system to clean and make use of methane gas either on or off site are also envisioned. The completed Program will enhance operating conditions and reliability of the Facilities while continuing to meet all permit requirements and ensure an unrelenting commitment to environmental stewardship.

Mission Statement: *Upgrade resource recovery facilities to produce Class A biosolids and renewable energy, maximizing sustainability and community acceptance. Collaborate with team members to select and implement processes that are safe, reliable, and financially responsible throughout planning, design, construction, operations, and maintenance.*

The Envision sustainability rating system will be used to track and verify the Program's sustainable elements. For a description and background of the Envision framework and a discussion on how its use will support the Program's alignment with the Arlington County Facility Sustainability Policy for New Construction and Major Renovation (Green Building Policy, April 30, 2019), refer to *Technical Memorandum No. 15: Envision Recommendations*. An Envision workshop was held with the Program's Sustainability Workgroup on September 30, 2021. This memorandum and appendices record the results of the initial Envision credit assessment discussed during this workshop and provides a snapshot in time for the credits the Program could achieve. As the Program progresses, the level of achievement for each Envision credit will be reassessed and revised as design decisions are made.

Prior to the workshop, HDR Engineering, Inc. (HDR) conducted an internal credit review to:

- Evaluate each credit for relevance
- Conduct initial analysis into the potential Level of Achievement (LOA)
- Discuss potential documentation sources
- Identify potential opportunities for incremental improvements in sustainable performance
- Note areas for improvement or efforts that may push the Program to achieve higher LOAs

The outcome of the internal credit review provided a status for the 59 credits in the Envision framework:

- **21 credits:** confident with LOA/range
- **10 credits:** need additional discussion once an alternative is selected
- **9 credits:** not applicable (N/A)
- **6 credits:** not likely to pursue
- **13 credits:** for discussion

The purpose of the Envision workshop was to:

- Continue to build understanding of Envision and what is needed to document the Program for verification
- Discuss the 13 credits identified as needing additional input from the Sustainability Workgroup to try to determine if they will be pursued and, if so, at which LOA

Participants included the following entities and individuals:

- Arlington County:
    - Mary Strawn, Chief Engineer
    - Lisa Racey, Principal Engineer
    - Wilbur Brown, Management Specialist
    - Christian Zepeda, Operator
    - Beau Dodge, Pretreatment Program Coordinator
    - Charles Njoku, Environmental Management Specialist, Office of Sustainability and Environmental Management
- HDR:
    - Brian Balchunas, Program Manager
    - Laurissa Hoyle, Service Area (SA) 1, Program Management
    - Stephanie Spalding, SA2, Scope Development
    - Jen Ninete, Senior Sustainability Consultant
    - Michaella Wittman, Sustainability and Resilience Director

The internal assessment in conjunction with the Envision workshop represents a preliminary review of Envision for Arlington Re-Gen, including a review of the Program's sustainable attributes, as well as the potential effort required to earn recognition through the Envision verification process. The Program team will continue discussions to refine credit LOAs and determine documentation needs and responsibilities required to submit the Program for verification.

The Program is currently in the facilities planning phase. Envision is often launched during planning or at the design kickoff, allowing Envision conversations throughout the planning and design processes and offering the most opportunities to integrate scope considerations during the entire Program process.

2.0 Envision Overview

Envision is a sustainable infrastructure framework developed through a joint collaboration between the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure (ISI). ISI is a not-for-profit education and research organization, dedicated to developing and maintaining a civil infrastructure rating system, and was formed by the American Council of Engineering Companies (ACEC), American Public Works Association (APWA), and American Society of Civil Engineers (ASCE).

Envision provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects, giving recognition to those projects that use transformational, collaborative approaches to assess the sustainability indicators over the course of the project's life cycle. The system has 64 sustainability credits divided into five sections: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Resilience. Envision is similar in structure to the Leadership in Energy and Environmental Design (LEED) rating system. While LEED evaluates buildings, Envision provides industry-wide sustainability metrics for **infrastructure projects of all types**.

An overview of the Envision framework and a one-page summary of the credits is included as Appendix A.

Any infrastructure project may use Envision as a framework for evaluating sustainability performance. Recognition is sometimes a driver when using the system, but most agencies use Envision because of benefits like:

- Raising the bar for sustainability decisions by starting project team dialogue about issues that might not otherwise have been raised
- Illustrating that the project addresses community concerns
- Ensuring that public funds are being spent in the public's best interest
- Looking at long-term costs and risks
- Drawing public attention to good work being done throughout the community
- Providing a quality control system for project decisions
- Tracking performance and establishing design, construction, and operations metrics
- Demonstrating agency commitment to implementing more sustainable infrastructure

To earn formal recognition from ISI, a project must be officially registered and submitted for verification. To do so, supporting documentation must be submitted electronically to ISI through its online system. ISI then provides the documentation to a trained third-party verifier who evaluates the information and returns an assessment to ISI for review and authentication.

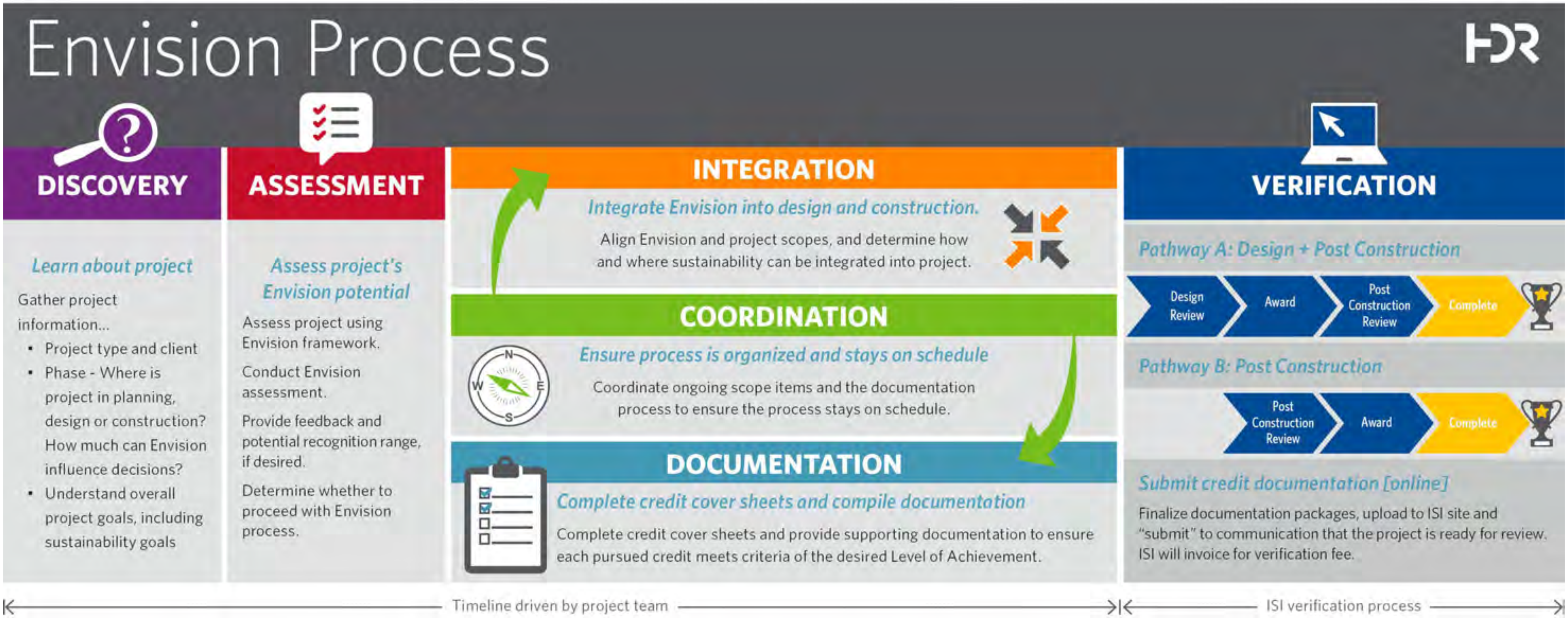


Figure 1. Envision Process

2.1 Pathways

Infrastructure projects may seek third-party verification at or after 95 percent design completion. This means that all major design decisions must be made prior to seeking third-party verification and award. There are two verification pathways—Pathway A: Design + Post-Construction and Pathway B: Post-Construction—the steps of which are outlined in Figure 2. The Arlington Re-Gen Program will use Pathway A.

Figure 2. Verification Pathways

2.2 Recognition Levels

Envision recognition levels are awarded based on the percentage of total applicable points achieved. This recognition provides third-party confirmation of the team's commitment to the environment and its community. Higher levels of recognition illustrate greater levels of contribution to environmental, economic, and social aspects of sustainability (see Figure 3):

- **Verified:** 20 percent or more, but less than 30 percent
- **Silver:** 30 percent or more, but less than 40 percent
- **Gold:** 40 percent or more, but less than 50 percent
- **Platinum:** 50 percent or more

Envision establishes standard practices as the benchmark; therefore, project teams should consider their percentage score as the degree to which sustainability was incorporated above and beyond standard practice rather than as a fraction of 100.

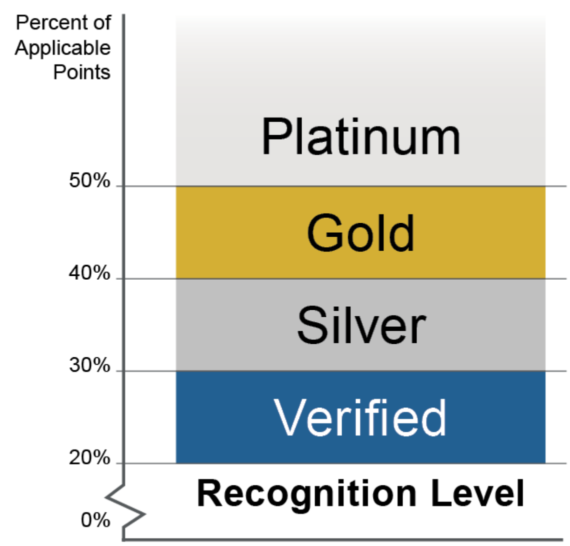


Figure 3. Envision Recognition Levels

3.0 Envision Credit Review

To complete the preliminary Envision assessment for the Re-Gen Program, the workshop participants reviewed the Program against the 64 Envision credits, which are discussed further in subsequent sections and grouped by category. It is important to note that the evaluation considered not only project design, but the full scope of the project from planning through operations, and how it fits within the community. This process takes into consideration the project's life cycle, is consistent with how Envision is applied from the start of a project and takes into account all of the decision points from ideation through completion of construction. These subsequent sections detail the results of the initial Envision credit assessment discussed during this workshop and provides a snapshot in time for the credits the Program could achieve. As the Program progresses, the level of achievement for each Envision credit will be reassessed and revised as design decisions are made.

3.1 Envision Rating Exercise

A detailed review of each credit, including the estimated range of points attainable for each, is included as Appendix B. Based on the level of current development for the Program, the Envision review exercise concluded that the Program could reasonably pursue credits that could result in a Silver or Gold recognition level, provided that supporting documentation is available. Figure 4 illustrates the Program's score range after the preliminary Envision assessment, showing the recognition level(s) that the Program may be able to attain.

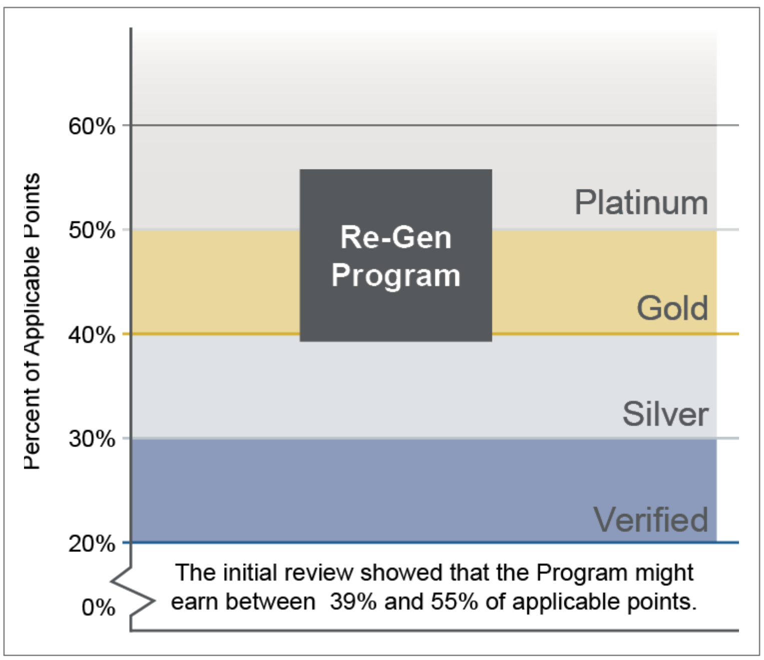


Figure 4. Projected Envision Recognition Level

Though the review shows that a Gold recognition level is possible, it may require the Program team to apply additional effort or add to the Program's scope. Additional costs that could be incurred may be related to supplemental research and reports for credits like LD3.3 Conduct a Life-cycle Economic Evaluation, or for specifying additional contractor responsibilities for activities like reducing construction water consumption. There are no requirements for these additional efforts. For each instance where the

Program may consider striving to attain a higher LOA by expending additional effort, the Program team would conduct a simple and informal cost/benefit analysis to determine if the value to the Program corresponds with the required level of effort and/or cost. The ultimately desired LOA, including the decision to expend additional effort or add to Program scope, will be determined by the County during the detailed design phase. The final decision on recognition level achieved will be determined by the third-party verifier and ISI authenticator—who will confirm if each credit achieves the pursued LOA. Based on experience with other Envision projects, it is unlikely that all submitted credits will achieve the pursued LOA as determined by the verifier.

Each Envision credit applicable to a project is scored at one of the following LOAs, with an associated number of points achieved for each credit level achieved (or zero points if not even the improved level is achieved):

- ***Improved:*** performance that is above conventional
- ***Enhanced:*** sustainable performance that is on the right track; indications that superior performance is in reach
- ***Superior:*** sustainable performance that is noteworthy
- ***Conserving:*** performance that has achieved essentially zero impact
- ***Restorative:*** performance that restores natural or social systems

Envision is designed to help the Program strive for incremental sustainability improvement by setting challenging goals of net-zero impacts or restorative actions. However, ISI states that achieving a conserving or restorative level of achievement for every credit, and therefore achieving a 100 percent score, is not possible. Envision points are designed to encourage the team to focus efforts where the Program can achieve the greatest impact. The benefit of using the rating system is the ability to document deliberate decisions using a standardized system.

Figure 5 shows the total points per category and the projected achievement by the Program. Each bar illustrates the estimated achievable points and potential additional points, as well as points that are not applicable to the project and points that are not achievable by the Program in each category.

The range of estimated achievable points for the Program reflects the potential LOA by category using the current level of Program development, showing what level is potentially possible with additional effort or information. The low end of the range is a projection based on what has been done to date and where documentation is already reasonably available or is anticipated to be available. The high end of the range is an estimate based on what could still be implemented or determined based on additional Program development and documentation efforts.

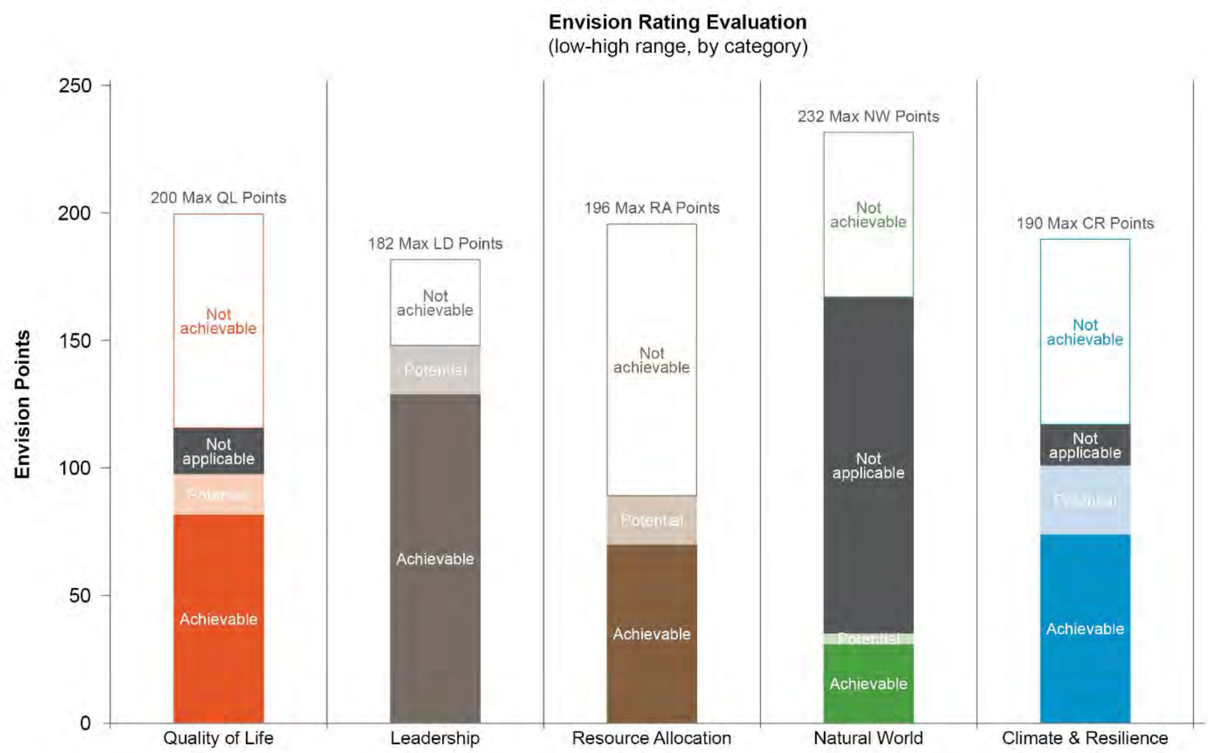


Figure 5. Envision Rating Evaluation (low–high range, by category)

Points are considered not achievable for two primary reasons:

- Some credits will not be pursued but are still applicable to the Program, meaning that all the points for that credit are not achievable. For example, QL3.4 Enhance Public Space and Amenities, a credit worth 14 points, will not be pursued. The intent of the credit is to improve amenities and publicly accessible spaces to enhance community livability. Because of the nature and scope of the Program, there are not practical ways to meet the intent of the credit within the current scope. It was determined during the assessment that it would be unlikely for the Program to add scope to enhance public space, so the Sustainability Working Group decided that the credit would not be pursued.
- Many credits will not be pursued at the highest LOA, thus not achieving all possible points on those credits. For example, the highest LOA for RA3.3 Reduce Construction Water Consumption (Conserving) is 8 points. The Program could likely achieve an Improved LOA for 1 point. To increase the LOA, additional potable-water conservation strategies would need to be implemented during construction. The Sustainability Working Group determined that implementing three strategies would be unlikely or would cause undue burden for the contractor, which may result in additional cost.

3.2 Credit Designation

This section describes the credit designation process, including innovation credits and not applicable credits.

3.2.1 Pursued Credits

Pursued credits have a target level LOA and will be tracked as the Program progresses. Pursued credits include both those related to planning-level decisions that have already been made and credits related to design and/or construction. For design/construction-related credits, the team will need to integrate sustainable considerations into the Program to fulfill Envision criteria requirements. Because the Program intends to submit the project to ISI for verification, the team will prepare ISI-provided credit cover sheets and supporting documentation for each of these credits.

3.2.2 Not Applicable Credits

ISI has provided guidance indicating that a project should not be awarded Envision points for avoiding certain situations or locations if there is no reasonable chance that those locations or situations were being considered during the project decision-making process. For the credits to be deemed not applicable during the verification process, the project team must provide documentation to support the exclusion of these credits. This is beneficial to the project because it reduces the number of applicable points used in the project award level calculation.

For example, the intent of credit NW1.3 Preserve Prime Farmland is to "identify and protect soils designated as prime farmland, unique farmland, or farmland of importance." The entirety of the Program is located on the existing WPCP site, which has already been completely developed and does not include any prime farmland. The Program team would submit this credit as not applicable based on the applicability criteria in the Envision Guidance manual, "projects that do not contain prime farmland, and for which no siting options containing prime farmland were possible or seriously considered, may apply to have this credit deemed not applicable with supporting documentation."

3.2.3 Innovation Credits

The Envision framework strongly encourages innovative methods that advance sustainable infrastructure practices or show exceptional performance beyond the expectations of the credit requirements. Each category includes an "Innovate or Exceed Credit Requirements" credit, indicated by a "0.0." Projects may achieve all or part of the points in these credits. Maximum points allotted for innovation in any one category is 10 points and the submitter determines the number of points (zero to the maximum) for which the credit will be submitted. The 0.0 credits are not required, and these points act as bonus points that are added to the category or total score.

3.3 Envision Credit Assessment Scorecard Snapshot

The Envision credit assessment scorecard snapshot illustrated by Table 1 is a record of the Envision assessment discussion and shows the outcomes at the time of the assessment with the Sustainability Workgroup. The highlighted or shaded points for each credit reflect the anticipated LOA based on the preliminary assessment. This scorecard is part of an Envision Workbook, which is a living document that continues to evolve over the life of the Program. Refer to Appendix B.

Note that credit and Program LOAs are anticipated based on assessment discussions, but actual LOAs may vary depending on available documentation, as well as the verifiers' review process.

Table 1. Envision Credit Assessment Scorecard Snapshot (September 30, 2021)

Category	Credit	N/A	None	Improved	Enhanced	Superior	Conserving	Restorative
Quality of Life	QL1.1 Improve Community Quality of Life	0	0	2	5	10	20	26
	QL1.2 Enhance Public Health and Safety	0	0	2	7	12	16	20
	QL1.3 Improve Construction Safety	0	0	2	5	10	14	-
	QL1.4 Minimize Noise and Vibration	0	0	1	3	6	10	12
	QL1.5 Minimize Light Pollution	0	0	1	3	6	10	12
	QL1.6 Minimize Construction Impacts	0	0	1	2	4	8	-
	QL2.1 Improve Community Mobility and Access	0	0	1	3	7	11	14
	QL2.2 Encourage Sustainable Transportation	0	0	-	5	8	12	16
	QL2.3 Improve Access and Wayfinding	0	0	1	5	9	14	-
	QL3.1 Advance Equity and Social Justice	0	0	3	6	10	14	18
	QL3.2 Preserve Historic and Cultural Resources	-18	0	-	2	7	12	18
	QL3.3 Enhance Views and Local Character	0	0	1	3	7	11	14
	QL3.4 Enhance Public Space and Amenities	0	0	1	3	7	11	14
	QL0.0 Innovation				2			
	Maximum QL points	200		Low	88		48.4%	
	Applicable QL points	182		High	98		53.8%	
Leadership	LD1.1 Provide Effective Leadership and Collaboration	0	0	2	5	12	18	-
	LD1.2 Foster Collaboration and Teamwork	0	0	2	5	12	18	-
	LD1.3 Provide for Stakeholder Involvement	0	0	3	6	9	14	18
	LD1.4 Pursue Byproduct Synergies	0	0	3	6	12	14	18
	LD2.1 Establish a Sustainability Management Plan	0	0	4	7	12	18	-
	LD2.2 Plan for Sustainable Communities	0	0	4	6	9	12	16
	LD2.3 Plan for Long-Term Monitoring and Maintenance	0	0	2	5	8	12	-
	LD2.4 Plan for End-of-Life	0	0	2	5	8	14	-
	LD3.1 Stimulate Economic Prosperity and Development	0	0	3	6	12	20	-
	LD3.2 Develop Local Skills and Capabilities	0	0	2	4	8	12	16
	LD3.3 Conduct a Life-Cycle Economic Evaluation	0	0	5	7	10	12	14
	LD0.0 Innovation				2			
	Maximum LD points	182		Low	129		70.9%	
	Applicable LD points	182		High	148		81.30%	
Resource Allocation	RA1.1 Support Sustainable Procurement	0	0	3	6	9	12	-
	RA1.2 Use Recycled Materials	0	0	4	6	9	16	-
	RA1.3 Reduce Operational Waste	0	0	4	7	10	14	-
	RA1.4 Reduce Construction Waste	0	0	4	7	10	16	-
	RA1.5 Balance Earthwork On Site	0	0	2	4	6	8	-
	RA2.1 Reduce Operational Energy Consumption	0	0	6	12	18	26	-
	RA2.2 Reduce Construction Energy Consumption	0	0	1	4	8	12	-
	RA2.3 Use Renewable Energy	0	0	5	10	15	20	24
	RA2.4 Commission and Monitor Energy Systems	0	0	3	6	12	14	-
	RA3.1 Preserve Water Resources	0	0	3	5	7	9	12
	RA3.2 Reduce Operational Water Consumption	0	0	4	9	13	17	22
	RA3.3 Reduce Construction Water Consumption	0	0	1	3	5	8	-
	RA3.4 Monitor Water Systems	0	0	1	3	6	12	-
	RA0.0 Innovation				4			
	Maximum RA points	196		Low	70		35.7%	
	Applicable RA points	196		High	83		42.30%	

Category	Credit	N/A	None	Improved	Enhanced	Superior	Conserving	Restorative
Natural World	NW1.1 Preserve Sites of High Ecological Value	-22	0	2	6	12	16	22
	NW1.2 Provide Wetland and Surface Water Buffers	-20	0	2	5	10	16	20
	NW1.3 Preserve Prime Farmland	-16	0	-	2	8	12	16
	NW1.4 Preserve Undeveloped Land	0	0	3	8	12	18	24
	NW2.1 Reclaim Brownfields	-22	0	11	13	16	19	22
	NW2.2 Manage Stormwater	0	0	2	4	9	17	24
	NW2.3 Reduce Pesticide and Fertilizer Impacts	0	0	1	2	5	9	12
	NW2.4 Protect Surface and Groundwater Quality	0	0	2	5	9	14	20
	NW3.1 Enhance Functional Habitats	-18	0	2	5	9	15	18
	NW3.2 Enhance Wetland and Surface Water Functions	-20	0	3	7	12	18	20
	NW3.3 Maintain Floodplain Functions	-14	0	1	3	7	11	14
	NW3.4 Control Invasive Species	0	0	1	2	6	9	12
	NW3.5 Protect Soil Health	0	0	-	3	4	6	8
	NW0.0 Innovation					0		
	Maximum NW points	232		Low	31		31.00%	
	Applicable NW points	100		High	35		35.0%	
Climate Resilience	CR1.1 Reduce Net Embodied Carbon	0	0	5	10	15	20	-
	CR1.2 Reduce Greenhouse Gas Emissions	0	0	8	13	18	22	26
	CR1.3 Reduce Air Pollutant Emissions	0	0	2	4	9	14	18
	CR2.1 Avoid Unsuitable Development	-16	0	3	6	8	12	16
	CR2.2 Assess Climate Change Vulnerability	0	0	8	14	18	20	-
	CR2.3 Evaluate Risk and Resilience	0	0	11	18	24	26	-
	CR2.4 Establish Resilience Goals and Strategies	0	0	-	8	14	20	-
	CR2.5 Maximize Resilience	0	0	11	15	20	26	-
	CR2.6 Improve Infrastructure Integration	0	0	1	4	9	14	18
	CR0.0 Innovation (earn up to 5 points)					2		
	Maximum CR points	190		Low	74		42.50%	
	Applicable CR points	174		High	101		58.0%	

Maximum of 1,000 total points (without 50 possible innovation points)	1,000	Low	392	39.2%
Applicable points	834	High	465	55.8%

High percentage calculated with applicable points; low percentage calculated with maximum points to consider the potential for N/A credits not being approved as submitted.

3.4 Credit Review by Envision Category

The sections below provide the preliminary LOA by the Re-Gen Program for each Envision credit, by Envision category, based on the workshop assessment.

3.4.1 Quality of Life

The Quality of Life category addresses a project's impact on affected communities, from the health and wellbeing of individuals to the wellbeing of the larger social fabric as a whole. These impacts may be physical, economic, or social. Quality of Life focuses on assessing whether infrastructure projects align with community goals, are incorporated into existing community networks, and will benefit the community in the long term. The section also assesses to what degree community members affected by the project were considered important stakeholders in the decision-making process.

The Quality of Life section includes 13 credits and 200 points, representing 20 percent of the total points available. Based on the review, the Program could potentially earn between 88 and 96 points by pursuing 10 credits. Those credits are outlined in Table 2 below, which also provides topics, notes, and/or documentation that would likely be included in the credit package and action items, next steps, or future considerations to work toward submitting the credit for verification.

Table 2. Quality of Life Credits

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
QL1.1: Improve Community Quality of Life	Conserving	• Reference to goals in County plans, Comprehensive Plan, Solids Master Plan • Replacing failing and end-of-life equipment • Mitigating the risk of potential future regulatory changes to the current practice of recycling Class B biosolids through application to agricultural land • Providing a solution that reduces the energy and GHG footprint of the WPCP • Achieving additional County-wide sustainability goals • Developing a solids management strategy that offers long-term reliability • Establishing an implementation plan compatible with County Capital Improvement Program (CIP) funding • Plan supports the Chesapeake Bay Preservation Ordinance, a statewide program to help restore the Bay to health	• Incorporate poll/survey to ask about stakeholder engagement/satisfaction • Consider potential for website where community can submit comments
QL1.2: Enhance Public Health and Safety	Superior–Conserving	• Reference Safety, Health, and Environmental (SH&E) Plan • Moving from a Class B product to a pathogen-free, Class A Exceptional Quality product • Reducing truck traffic from solids and lime hauling • Demographics of customers/area: statics/map	• Develop statistics/map showing demographics of customers/area • Research/explain where land application of biosolids has been going and will go to after project is complete; different counties and farms

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
		• CIP: implement more effective technology that will reduce the need for maintenance and reduce safety risks to staff	
QL1.3: Improve Construction Safety	Conserving	• Specifications: contractor hired to do the work will be required to develop its own safety plan • County's internal programs for health screenings, and new policy has been put into place requiring contractors to have either COVID-19 vaccines or regular COVID-19 testing	• Develop specifications outlining contractor requirements for developing a safety plan to fulfill Envision criteria, including feedback mechanism • Collect/provide information about County programs and new contractor policy
QL1.4: Minimize Noise and Vibration	Superior–Conserving	• Baseline: existing facility • Note change in noise during operation of updated facility over existing facility • Less truck traffic, but potentially more noise from equipment • Standby generators located on site, used as needed, tested biweekly; located in a building with sound attenuation • Noise and vibration outlined as an issue at stakeholder meeting	• Document how the stakeholder engagement process demonstrates community awareness of noise and vibration targets
QL1.5: Minimize Light Pollution	Improved (or better)	• Exterior lighting needs and solutions • If applicable, specifications: lighting requirements, i.e., backlight, uplight, and glare (BUG) requirements, cutoff fixtures • Explanation for additional lighting: more equipment outside, safety/security issues • Updates to Green Building Incentive Policy: "minimum light pollution reduction criteria for exterior light fixtures must be met to safely reduce light pollution"	• Assess exterior lighting needs • Review mitigation hierarchy form • Review lighting plan • Consider light fixture selection to meet BUG rating uplight requirements • Consider higher LOA
QL1.6: Minimize Construction Impacts	Conserving	• Specifications: construction management plan requirement, including all items listed in manual—noise, safety/wayfinding, access/mobility, lighting • Construction Management Plan • Documentation of signage on the construction fencing to share information with the public	• Develop specifications outlining contractor requirements for developing a Construction Management Plan to fulfill Envision criteria • Add contractor "Envision Action Plan" to the Sustainability Management Plan (SMP)/Envision management plan
QL2.1: Improve Community Mobility and Access	Enhanced	• Changes in truck logistics • Trucks currently cross Eads Street and back into WPCP; new solids loading facilities will be drive-	• Include mobility issues, like truck traffic in stakeholder discussions

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
		through instead of back-in, which will eliminate the need to back in across Eads Street into the WPCP • Solids reduced by 50%, resulting in less truck traffic and hauling costs	• Share any input from the community regarding changes in mobility/access during operation of finished project
QL2.2: Encourage Sustainable Transportation	Restorative	• Bike paths and bike-friendly roads adjacent that connect to trail along river • Electric transportation stations worth including, if already planned for the project • Think about this project from the perspective of project processes vs. land use—because of renewable natural gas (RNG) being supplied for potential use by adjacent facilities to support mass transit	• Follow up to see if WPCP is getting an electric vehicle (EV) on site; provide update. If so, consider how EV contributes to power requirements for the project
QL2.3: Improve Access and Wayfinding	Enhanced	• May be modifying access from WPCP for trucks • Addition of street-facing signage • Changing gates onto WPCP site; will need to have good wayfinding because of changes	• Consider impact of wayfinding signage
QL3.3: Enhance Views and Local Character	Enhanced	• Very visible from surrounding neighborhoods • Viewshed discussion part of site planning • Screening; much of the piping hidden; do not want project to look like equipment • Many discussions with stakeholders • A lot of current aesthetic was driven by stakeholders' input; have taken this into account in the past. Will assess aesthetic standard for this project. Use this as basis for "Guidelines are adopted or developed to preserve or enhance views and local character." • The Public Art Master Plan, adopted in November 2021, notes County-owned utility infrastructure, such as the WPCP and associated pump stations, as possible locations for public art.	• Continue discussion as part of site planning • Determine if anything needs to, and/or will, be done regarding public artwork • Collect documentation supporting previous stakeholder discussions • Collect documentation supporting previous decisions about WPCP aesthetic based on stakeholder input

One credit would likely be submitted as "not applicable" and excluded from scoring:

- QL2.2: Preserve Historic and Cultural Resources

The project would likely not earn any points in the following credits:

- QL3.1: Advance Equity and Social Justice
    - Likely not to pursue because of specific criteria requirements
- QL3.4: Enhance Public Space and Amenities
    - This credit would be deemed applicable but would be difficult or costly to pursue. Per the Envision guidance manual, “Not addressing the potential for public space or amenities is not sufficient alone to designate this credit not applicable. Infrastructure projects, especially those traditionally viewed as inaccessible, are encouraged to consider how they can benefit their surrounding community through the enhancement or provision of public space and amenities.”

Innovation credit: The assessment brought up one topic that may be considered for submission in an Innovation credit for Quality of Life: QL0.0. Content for this credit could include:

- Project branding: mission, vision, etc. for 2 points

3.4.2 Leadership

The Leadership category encourages and rewards projects that embrace a new way of thinking about project development and delivery. Specifically, projects achieve a higher LOA when teams communicate and collaborate early, involve a wide variety of people, and understand the long-term, holistic view of the project and its life cycle. The Leadership section rewards these actions under the view that, together with traditional sustainability actions such as reducing energy and water use, effective and collaborative leadership produces a truly sustainable project that contributes positively to the world around it.

The Leadership section includes 11 credits and 182 points, representing 18 percent of the total points available. Based on the review, the Program could potentially earn between 129 and 148 points by pursuing 10 credits. Those credits are outlined in Table 3 below, which also provides topics, notes, and/or documentation that would likely be included in the credit package and action items, next steps, or future considerations to work toward submitting the credit for verification.

Table 3. Leadership Credits

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations

LD1.1: Provide Effective Leadership and Commitment	Conserving	• Arlington County
		  ◦ Facility Sustainability Policy
		  ◦ Community Energy Plan (CEP); goal for Arlington to be a carbon-neutral community by 2050
		  ◦ Green Building Incentive Policy for Site Plan Projects
			• All key members of the project team provide evidence showing they have made organizational commitments to sustainability: in their businesses, not project-specific

LD1.2: Foster Collaboration and Teamwork	Conserving	• Sustainability Workgroup; meetings, etc. • Inclusion of diverse group, operations and maintenance (O&M) staff	• Keep criteria in mind going forward

LD1.3: Provide for Stakeholder Involvement	Restorative	• Public involvement (PI) leadership
		• The County has a well-documented engagement process
		• Criterion E: Feedback is sought from stakeholders as to their satisfaction with the engagement process, and the resulting decisions were made "based on their input."
		  ◦ Reduction of noise for lime delivery
		  ◦ Stakeholder involvement has informed four feedback categories: noise, odor, emissions, visual
			• Continue to gather feedback and consider/document how public input influences or validates solutions
			• Determine how to show that our decisions were based upon stakeholder issues; stakeholder satisfaction

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
		• Criterion F: Partner—Arlington Transit, potential beneficial use of biogas	
LD1.4: Pursue Byproduct Synergies	Restorative	• Class A fertilizer product that can be marketed to the community • High-quality soil amendment available to agriculture and community • RNG generated by the process can be reused on site for power generation or off site for vehicle fuel • Potential for future phosphorus harvesting can be considered • Potential for future receiving of fats, oils, and greases (FOG) to generate additional RNG	• Review once final decisions are made for byproduct use
LD2.1: Establish a Sustainability Management Plan	Superior–Conserving	• Program sustainability goals • Project-specific SMP • Include Envision work plan	• Draft Sustainability Management Plan, including Envision work plan and contractor action plan
LD2.2: Plan for Sustainable Communities	Conserving–Restorative	• Reference to goals in County plans and Solids Master Plan	• No action items
LD2.3: Plan for Long-Term Monitoring and Maintenance	Conserving	• Comparison of new facilities vs. using existing facilities; evaluation criteria • CIP: implement more effective technology that will reduce the need for maintenance • Show how Monitoring Plan drives decisions regarding operations	• Consider/document how monitoring and maintenance plan supports sustainability performance targets • Discuss O&M staffing plan for upgrades
LD2.4: Plan for End-of-Life	Improved (or better)	• TBD	• Consider pursuing • Discuss what an "end-of-life" plan might include, such as a table with anticipated end-of-life for components/equipment • Document discussions around adaptability and plans for expansion in the future
LD3.1: Stimulate Economic Prosperity and Development	Superior	• Biosolids: fertilizer product • Increased capacity; meeting regulations • Criterion C: reducing carbon footprint—less negative impact; reducing truck traffic; biogas—expanding offerings • Criterion D: helping Arlington meet its sustainability goals	• No action items

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
LD3.3: Conduct a Life-Cycle Economic Evaluation	Enhanced–Restorative	• Solids master plan • Gas utilization life-cycle cost analysis (LCCA) (component) sustainable return on investment (SROI)	• Review credit criteria and connect to Solids Master Plan, gas utilization LCCA (component) SROI, and other previous assessments/evaluations

No Leadership credits would be submitted as "not applicable" and excluded from scoring.

The project would likely not earn any points for the following credit:

- LD3.2: Develop Local Skills and Capabilities
    - Likely not to pursue because of specific criteria requirements
    - This credit focuses on training programs, particularly those that target local skill gaps

Innovation credit: The assessment concluded that an Innovation credit could be submitted for Leadership: LD0.0. Content for this credit could include:

- Additional information related to byproduct synergies, noting that only a handful of organizations are doing biogas utilization for 2 points

3.4.3 Resource Allocation

The Resource Allocation category recognizes natural resources as assets that are needed to build and operate infrastructure. This category is broadly concerned with the quantity, source, and characteristics of these resources and their impacts on the overall sustainability of the project. Resources addressed include physical materials (both those that are consumed and those that leave the project), energy, and water use. Projects earn points for treating these finite resources as assets and showing that they are used respectfully.

The Resource Allocation section includes 13 credits and 196 points, representing 20 percent of the total points available. Based on the review, the Program could potentially earn at least 70 points by pursuing 11 credits. Those credits are outlined in Table 4 below, which also provides topics, notes, and/or documentation that would likely be included in the credit package and action items, next steps, or future considerations to work toward submitting the credit for verification.

Table 4. Resource Allocation Credits

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
RA1.2: Use Recycled Materials	Improved (or better)	• Include building reuse if applicable • Include reuse of gravity thickeners • Reference Department of Solid Waste zero waste policy; how does it apply to this project?	• After alternative is selected, assess what structures will be reused and which types of materials will be used in the project that could contain recycled content • Record if any materials were selected because of including recycled content • Calculate (estimated) percentage of recycled/reused materials vs. overall materials • Investigate/evaluate the Department of Solid Waste's zero waste policy and determine if anything has to be done for this project • Consider higher LOA
RA1.3: Reduce Operational Waste	Conserving	• Operational waste: biosolids product (higher-quality biosolids than produced by existing processes), energy, wastewater (back to creek or used for process) • Only landfilled waste would be screenings; estimate vs. total waste produce • Reference County operational waste policy, update to Solid Waste Management Plan • County Zero Waste Resolution (11/19/2015)	• Calculate percentage of screenings that will go to landfill, to use in calculation of the percentage of waste that is diverted from landfill

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
RA1.4: Reduce Construction Waste	Enhanced: superior	• Specifications: construction waste diversion goal and require a Construction Waste Management Plan • Construction Waste Management Plan document	• Determine what previous projects have done regarding construction waste • Assess what types of waste will be generated during construction • Determine potential for Department of Solid Waste processing of asphalt and concrete recycling on site • If available, determine quantities • Confirm construction waste diversion goal (75%?) • Develop specifications outlining construction waste diversion goal and contractor requirements for developing a Construction Waste Management Plan to fulfill Envision criteria
RA1.5: Balance Earthwork On Site	Improved (or better)	• Earthwork required because of hill • Goal would be to reuse soil on site, but likely have to haul off soil	• After alternative is selected, determine amount of earthwork needed • Determine if any related requirements will be outlined for the delivery team; determine if these would create any cost implications • Determine if the County has any nearby location that could use any extra soil • Consider higher LOA

RA2.1: Reduce Operational Energy Consumption	Improved (or better)	• Determine baseline: existing facility or equipment alternatives
		• There is an ISI calculator for this calculation
		• Calculation may be based on equipment selection, showing that the selected alternative uses less energy than other seriously considered alternatives
		• Reference CIP: "Implement more effective technology that will be more energy efficient; recover energy from the wastewater process—energy recovered in the form of methane may be utilized to power the ART fleet, reduce the Plant's energy footprint, and/or sold back into the power grid or to Washington Gas as renewable natural gas."
			• Determine operational energy uses:
			  • Equipment
			  • Lighting
			    • What type of lighting is used in existing facility, i.e., fluorescent vs. light-emitting diode (LED)?
			    • How will lighting type change because of project? (Previously said more lighting will be added)
			  • Cooling options
			  • Heating, ventilation, and air conditioning (HVAC)
			• Look at RA2.1 calculator to determine inputs and do a preliminary calculation
			• Consider higher LOA

RA2.2: Reduce Construction Energy Consumption	Enhanced	• There is an ISI calculator for this calculation • County truck idling policy • Specifications: re: contractor to implementation of energy reduction strategies	• Conduct a review to identify/analyze potential options for reducing energy consumption during construction

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
		• Information about contractor energy reduction strategies	• Develop specifications outlining contractor requirements to implement at least 2 energy reduction strategies to fulfill Envision criteria
RA2.3: Use Renewable Energy	Restorative	• There is an ISI calculator for this calculation • Note that this credit is referenced in the manual for offsetting the project's energy needs through renewal energy • Making energy on site via biogas; used to offset fossil fuels in transportation vehicles	• Contact ISI to discuss; ask ISI about this credit re: Study/LCC done to determine the biggest value and best GHG reduction. • Look at RA2.3 calculator to determine inputs and do a preliminary calculation
RA2.4: Commission and Monitor Energy Systems	Enhanced	• There is an ISI calculator for this calculation • Systems in place for energy monitoring at current WPCP for 100% of energy usage; Business Intelligence (BI) dashboard with all energy/electricity usage • Commissioning is required	• Look at RA2.4 calculator to determine inputs and do a preliminary calculation
RA3.1: Preserve Water Resources	Enhanced	• Reference site planning • Use of plant effluent water (PEW) vs. potable water when possible • Reduced amount of lime trucked on site • County Comprehensive Plan: Stormwater Management Plan, Chesapeake Bay preservation plan, Water Distribution Management Plan • May reference Watershed Retrofit Study • MS4 permit compliance on site	• Estimate water use and wastewater generation over the life of the project)
RA3.3: Reduce Construction Water Consumption	Improved	• Project team planning review • Specifications: re: construction water monitoring or other water reduction strategy(s)	• Conduct a review to identify/analyze potential options for reducing water consumption during construction • Develop specifications outlining contractor requirements for implementing one potable water conservation strategy, likely water monitoring
RA3.4: Monitor Water Systems	Enhanced	• Systems in place to monitor water at current plan	• No action items

No credits would be submitted as “not applicable” and excluded from scoring.

The project would likely not earn any points for the following credits:

- RA1.1: Support Sustainable Procurement Practices

    - Likely not to pursue because of specific criteria requirements and additional level of effort needed

- RA3.2: Reduce Operational Water Consumption
    - Likely not to pursue because project upgrades will use more water during operation than the existing facility

Innovation credit: The assessment concluded that an Innovation credit could be submitted for Resource Allocation: EA0.0. Content for this credit could include:

- Biofuel analysis/study for 2 points
- Energy analysis for process cooling needs for 2 points

3.4.4 Natural World

The Natural World section addresses the impacts that infrastructure projects have on the natural world around them, including habitats, species, and non-living natural systems. The way a project is located within these systems and the new elements they may introduce to a system can create unwanted impacts. This Natural World section rewards projects that understand and minimize negative impacts while incorporating ways in which the project interacts with natural systems in a synergistic, positive way.

The Natural World section includes 13 credits and 232 points, representing 23 percent of the total points available. Based on the review, the project could potentially earn at least 30 points by pursuing four to five credits. Those credits are outlined in Table 5 below, which also provides topics, notes, and/or documentation that would likely be included in the credit package and action items, next steps, or future considerations to work toward submitting the credit for verification.

Table 5. Natural World Credits

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
NW1.4: Preserve Undeveloped Land	Conserving	• Proposed facilities fit within existing WPCP site	• No action items
NW2.2: Manage Stormwater	TBD	• Project may pursue credit after additional review • Reference County stormwater goals; Comprehensive Plan • Compare criteria to what is required for permitting	• Compare criteria to what is required for permitting to determine which, if any LOA could be pursued
NW2.3: Reduce Pesticide and Fertilizer Impacts	Conserving	• Specify plants shall not require pesticides or fertilizers • Reference County Comprehensive Plan and specification; website resources for verification of native plants • Reference landscaping contracts, if applicable	• Look at Arlington's landscaping contracts to determine if there is any language related to reduced fertilizer and/or native plants • Develop specifications outlining planting of native plants that do not require pesticides or fertilizers to fulfill Envision criteria
NW2.4: Protect Surface and Groundwater Quality	Improved	• Reference Solids Master Plan • Spill and leak diversion systems, spill prevention plans, and cleanup protocols	• No action items
NW3.4: Control Invasive Species	Enhanced–Superior	• Reference best practices should be used to prevent unintentional introduction of invasive species • Invasive-species site investigation map/report • Reference urban forest master plan	• HDR environmental specialist to identify, map, and/or document invasive-species infestations on site • Determine if the County has any policies or practices that would apply to this credit/site • Consider conserving LOA if documentation already exists

Seven credits would likely be submitted as “not applicable” and excluded from scoring:

- NW1.1: Preserve Sites of High Ecological Value
- NW1.2: Provide Wetland and Surface Water Buffers
- NW1.3: Preserve Prime Farmland
- NW2.1: Reclaim Brownfields
- NW3.1: Enhance Functional Habitats
- NW3.2: Enhance Wetland and Surface Water Functions
- NW3.3: Maintain Floodplain Functions

The project would likely not earn any points for the following credit:

- NW3.5: Protect Soil Health
  - Likely not to pursue because of specific criteria requirements and additional level of effort needed

Innovation credit: The assessment did not bring up any opportunities for the Innovation credit during the workshop. There may be opportunities for innovation points for Natural World: NW0.0. This topic will be revisited as the project progresses.

3.4.5 Climate and Resilience

The Climate and Resilience category focuses on minimizing emissions that may contribute to increased short- and long-term risks and ensuring resilience to short-term hazards or adaptability to long-term future conditions.

The Climate and Resilience section includes nine credits and 190 points, representing 19 percent of the total points available. Based on the review, the project could potentially earn between 74 and 99 points by pursuing seven credits. Those credits are outlined in Table 6 below, which also provides topics, notes, and/or documentation that would likely be included in the credit package and action items, next steps, or future considerations to work toward submitting the credit for verification.

Table 6. Climate and Resilience Credits

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
CR1.2: Reduce Greenhouse Gas Emissions	Improved (or better)	• Baseline: existing condition (over a period equivalent to the operational life of the project) • Solids reduced by 50% resulting in less truck traffic and hauling costs • Reference project-related GHG analysis • Reference CEP • Reference CEP Analysis for the Solids Master Plan	• Ongoing work re: GHG emissions
CR1.3: Reduce Air Pollutant Emissions	Improved (or better)	• Baseline: TBD • Reduced product odors • Solids Master Plan: Appendix K Air Emissions Modeling Report • Reference project-related air pollutant emissions analysis	• Ongoing work re: air pollutant emissions
CR2.2: Assess Climate Change Vulnerability	Improved–Superior	• Reference Comprehensive Plan: CEP; Climate Action Resolution; Climate Change, Energy, and Environment Commission (C2E2); Arlington Emergency Operations Plan; Northern Virginia Hazard Mitigation Plan Update; and Virginia Coastal Resilience Master Planning Framework	• Compile related information from available reports • Use HDR resilience review format to include information needed for related Envision criteria
CR2.3: Evaluate Risk and Resilience	Improved–Enhanced	• Additional discussions needed after project alternative selected • There are two ongoing projects on evaluating flood risk and mitigating strategies: one by the Arlington County Department of Environmental Services and one by the U.S. Army Corps of Engineers	• TBD

Credit	Targeted LOA	Credit Topics, Notes, and Documentation	Action Items, Next Steps, and Future Considerations
CR2.4: Establish Resilience Goals and Strategies	Conserving	• Additional discussions needed after project alternative selected	• TBD
CR2.5: Maximize Resilience	Improved–Enhanced	• Additional discussions needed after project alternative selected	• TBD
CR2.6: Improve Infrastructure Integration	Conserving–Restorative	• Additional discussions needed after project alternative selected	• TBD

One credit would likely be submitted as "not applicable" and excluded from scoring:

- CR2.1: Avoid Unsuitable Development

The project would likely not earn any points for the following credit:

- CR1.1: Reduce Net Embodied Carbon
  - Likely not to pursue because of specific criteria requirements and additional level of effort needed

Innovation credit: The assessment did not bring up any opportunities for the Innovation credit during the workshop. There may be opportunities for innovation points for Climate and Resilience: CR0.0. This topic will be revisited as the project progresses.

4.0 Envision Application

Because this Program is still in the facilities planning phase, the Envision process can be used to inform design decisions and construction guidelines. The following provides an overview of how Envision could be approached for the Program at the current stage.

The Envision process is managed by the Envision Lead (or Lead Envision Sustainability Professional [ENV SP]). This person is a Program team member and a professional credentialed through ISI and familiar with the Envision framework. The Envision Lead ensures that Envision discussions continue throughout the Program and related design decisions are documented, develops a plan for obtaining and organizing needed documentation, coordinates development of submittal materials, submits information for verification, and interfaces with ISI and the verifier as needed.

4.1 Potential Improvement Areas

"Potential improvement areas" are considered changes to processes, scope, design, and specifications that will improve Program sustainability and offer opportunities for the Program to rate more favorably when verified with Envision. These are items that likely would not have been included if the Program had not completed an Envision assessment. The items mentioned are not required by Envision, but are meant to start a conversation into the larger perspective of Program and community sustainability. During the assessment, specific discussions occurred for each credit regarding additional level of effort and potential for scope and/or Program changes. For example, at the Envision workshop, there was discussion about setting a construction waste diversion goal, challenging the contractor to implement two energy reduction strategies, and specifying plants that do not require pesticides or fertilizers. See credit-specific action items, next steps, and future considerations for each category in Section 3.4.

4.2 Documentation Requirements

Achieving Envision recognition is dependent upon providing a third-party verifier with a clear narrative description of how the Program meets the evaluation criteria of each credit, and providing documentation to support these assertions. For some credits, existing documents are available that can be used as supporting evidence to fulfill the credit requirements. For example, excerpts from the Solids Master Plan can be used as part of the documentation for multiple credits. Stakeholder engagement documentation also supports multiple credits. See ▯.

For other credits, required documentation will be available as the Program progresses, as a result of either design or construction. An example of this might be RA1.2: Use Recycled Materials. Stating that structures will be reused or that materials contain recycled content is not adequate to earn points for this credit. Documentation requirements include inventories for both materials containing recycled and existing materials or structures being reused. This includes weight, volume, or cost so that the percentage of reused and/or recycled materials relative to total materials used on the Program can be calculated. In this case, because the Program plans to submit the design for verification review prior to construction, credit documentation would need to show Program specifications requiring reuse or procurement of materials and estimates of identified structures/materials.

Finally, there are some credits for which the Program may meet the credit intent but gathering the supporting documentation would not be feasible or would require too great an effort for the benefit of the additional points. For example, for RA 1.1: Support Sustainable Procurement Practices, the County mentioned that it has been talking about which vendors have green practices, but there is not a formal program in place. While the Program may be able to show that a modest amount of materials are purchased from manufacturers or suppliers that demonstrate sustainable practices, the criteria call for evidence of written procurement policies, an inventory of materials, and documentation from manufacturers and suppliers. As such, this credit was deemed “likely not to pursue” during the assessment because the costs and level of effort outweigh the benefit. Based on policy acceptance and the County’s recent membership to Sustainable Purchasing Leadership Council, the project team could revisit if the credit requirements could be met. This would include assessing manufacturer and supplier practices, inventorying materials and calculating the percent of materials that meet the sustainable policy requirements.

4.3 Steps for Envision Documentation and Verification

This section outlines steps for Envision documentation and verification.

4.3.1 Project Registration

The following are tasks for project registration:

- Projects may be registered at any time in the process, although documentation typically cannot be submitted for the design review in Pathway A until design is at least at 95 percent completion. A new project needs to be created in the ISI system. The ISI project record includes a score sheet that will be updated to include the targeted LOA for each credit. The LOA can be changed at any time.
- Using the online project record, the project is registered and the registration fee ($2,000 for all projects) is invoiced. The Envision Lead will input project details into the record, including project cost, project team, and description, as well as estimated design and construction completion timing, so that ISI can understand when a verifier might need to be assigned.

4.3.2 Design Submittal Credit Writing and Compiling Documentation

The following are tasks for design submittal credit writing and compiling documentation:

- To support each credit at the targeted LOA, a narrative will be developed to describe how the project meets the evaluation criteria. This is done using ISI-provided credit cover sheets.
- In addition to the narrative, supporting documentation for each evaluation criterion must be included to enable the verifier (selected by ISI) to validate the LOA.
- For Pathway A (pre-construction verification), this process takes place at the end of the design phase and is submitted after 95 percent design completion. Credits that will need to be confirmed after construction will be marked as “pending” in the scorecard. For credits marked “pending,” narratives and additional supporting documentation will need to be submitted after 95 percent construction completion.

4.3.3 Submittal of Documentation for Verification

The following are tasks for submittal of documentation for verification:

- The online score sheet is completed and all credit documentation is uploaded.
- The project team submits the Verification Quality Assurance Checklist to ISI, along with a project description and project boundary map.
- Once the project is submitted, a verification invoice will be generated.

- The verification fee is based on project size. For projects ranging from $25 million to $100 million, the verification fee is $26,000 (Pathway A, member pricing). For projects ranging from $100 million to $250 million, the verification fee is $33,000 (Pathway A, member pricing).

4.3.4 Verification

The following are tasks for verification:

- The verifier reviews the credit documentation and communicates with ISI for any clarification or additional information that may be needed.
- The verifier and ISI develop a round 1 review score and recognition level, along with providing comments for any credits that may not have achieved the desired LOA.
- The project team has the opportunity to submit additional documentation for credits needing additional explanation or documentation for a second review.

4.3.5 Authentication

The following are tasks for authentication:

- ISI reviews and authenticates the verifier's score.
- The project team completes the verification closeout. If using Pathway A, the project would begin to prepare for the post-construction submittal.

4.3.6 Recognition

The project team works with ISI to prepare a press release and determines plans for an award ceremony or celebration to be recognized for its Envision verification.

4.3.7 Preparation for Post-construction Submittal/Monitoring Documentation through Construction

The following are tasks for preparation for post-construction submittal/monitoring documentation through construction:

- The project team compiles a document to guide documentation collection and credit content for pending credits, to be submitted at substantial construction completion
- The project team continues documentation collection throughout construction.

4.3.8 Post-construction Submittal Credit Writing and Compiling Documentation

The following are tasks for post-construction submittal credit writing and compiling documentation:

- To support each pending credit at the targeted LOA, the project team develops a narrative to describe how the project has met the construction-related evaluation criteria. This is done using ISI-provided credit cover sheets.
- The project team must include supporting documentation outlined in the design-review credits/post-construction guidance document for each pending credit to confirm achievement of LOA.

4.3.9 Complete Project Verification Process

The project concludes once the final score is returned to the project team.

5.0 Discussion and Next Steps

This section presents a discussion of additional information and next steps.

5.1 Leverage the Envision Framework

The project team should use the Envision framework to ensure that the project is meeting sustainability goals and striving not only to reduce impacts, but also to provide environmental, social, and economic benefits to the community. Design discussions should continue to reference Envision credits that can influence and improve design decisions and project solutions, including and beyond those listed under credit-specific action items, next steps, and future considerations described for each category in Section 3.4.

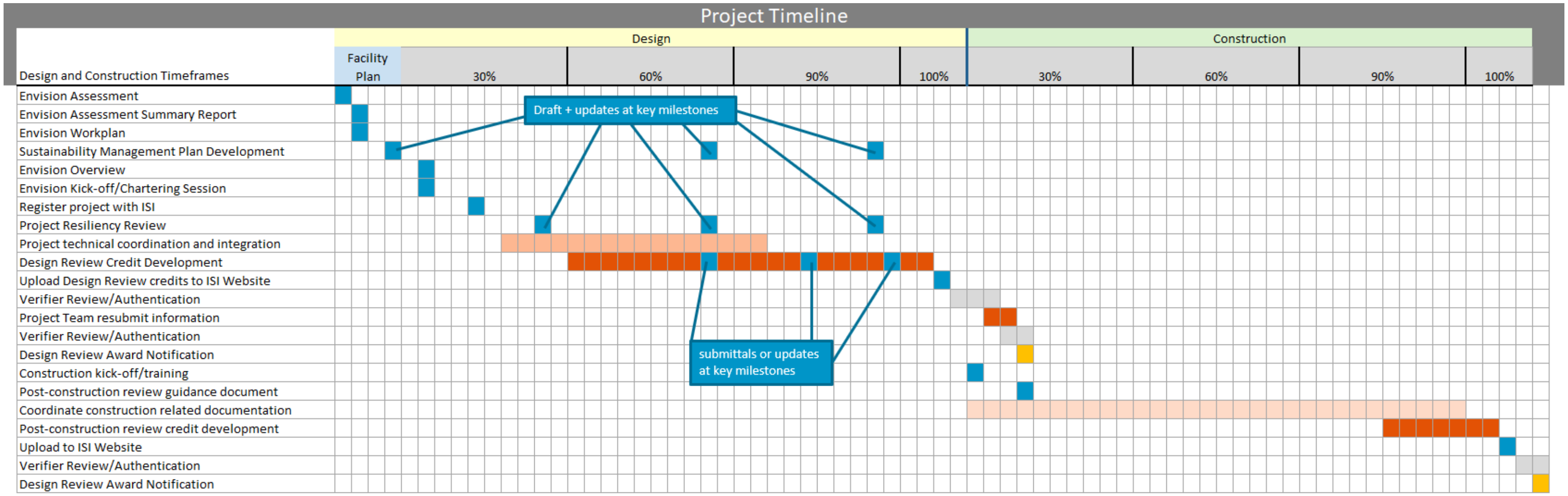
The project team should consider how to best leverage submitting for Innovation credits in the five Envision categories. Innovation credits award additional points for projects that exceed credit requirements or pilot innovative methods, applications, or technologies.

5.2 Project Documentation and Verification

Based on assessment and Envision workshop discussion, alternative selection, and costs associated with potential additional effort, the Envision team will continue to narrow the LOA range for each credit. The project team should periodically reassess the assessment to consider if any credits currently identified as pursuable become unachievable or result in too great an additional level of effort.

5.2.1 Credit Development Schedule

The Envision Lead will create a preliminary Envision Work Plan and Schedule (Figure 7) for inclusion in the project's Sustainability Management Plan that outlines the recommended sequence of credit development based on types of documentation available throughout the project process. This will allow credit development to be spread out over a period of time, depending on when the information is available to complete the documentation.



* Estimated - Driven by third-party verifier and ISI

Figure 6. Preliminary Credit Development Schedule

5.2.2 Collecting Documentation

During the Envision workshop, the Sustainability Workgroup discussed a process for gathering and storing documentation that may be needed to support credit narratives. It was determined that a folder structure will be developed on the project Teams site to serve as a document repository. This folder structure will include a general documentation folder for documents that may apply to credits in multiple categories and folders for each category. A documentation log will be developed to list the documents and note to which credits each will likely apply.

Types of documentation include the following:

- Solids Master Plan
- Project-related studies and reports
- Public involvement information
- Design documents/specifications
- Meeting minutes
- Presentations
- County policies/procedures

Once credit writing begins, the project team will designate someone as the Envision team's designated point of contact (POC) for project documentation. This will allow the Envision Lead to direct documentation requests to one person knowledgeable about the project who can locate and/or provide documentation needed to successfully complete the Envision credit packages.

5.2.3 Envision Administration

The Envision Lead should organize credit documentation, facilitate quality reviews, and communicate with the project team to ensure that the process stays on schedule. It is helpful to schedule regular status update calls or progress reports to convey credit package progress and stay informed on project progress and changes that may affect the Envision documentation.

It is beneficial to maintain a status document for all credits being pursued so that information is easily accessible or transmittable to the project team as needed.

5.2.4 Envision Support

HDR's staff has successfully worked with clients on numerous Envision projects—through both the assessment and documentation phases. This has prompted development of numerous tools and resources that are used to streamline facilitation of the Envision process. These tools will be leveraged throughout the documentation and verification process.

Appendix A. Overview of Envision Framework

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ENVISION™

Envision® v3 Sustainable Infrastructure Framework

The framework provides a **flexible system of criteria and performance objectives** to aid decision makers and help project teams identify sustainable approaches during planning, design, and construction that will carry forward throughout the project's operations and maintenance and end-of-life phases.

Envision Benefits

Economic

- Consideration of future expansion
- Extend useful life of project
- Lower heating bills
- Lower O&M costs
- Reduce energy and water costs
- Reduce wastewater fees
- Return on investment

Societal

- Create more livable communities
- Demonstrating good governance to voters, taxpayers, or ratepayers
- Develop durable infrastructure, with less maintenance
- Improve/increase local job market
- Improve business environment
- Improve community safety, mobility, recreational opportunities
- Increase community/stakeholder involvement in process
- Integrate into the local environment
- Preserve community culture/ history
- Reduce construction impacts
- Reduce environmental impacts
- Reduce noise

Environmental

- Conserve energy and water
- Optimize resource efficiency
- Preserve greenfields/redevelop brownfields
- Reduced air pollution
- Reduce greenhouse gas emissions
- Reduce light pollution
- Reduce stormwater runoff
- Reduce waste sent to landfills
- Source local materials
- Use materials more efficiently
- Use recycled materials

Other

- Calibrate internal assessment against a common set of sustainability criteria
- Demonstrate commitment to environmental stewardship and social responsibility
- Improve public perception
- Strengthen inter-agency and project team collaboration

PURPOSE OF ENVISION

The purpose of Envision is to foster the dramatic and necessary improvement in the sustainable performance and resiliency of physical infrastructure by helping owners, planners, engineers, communities, contractors, and other infrastructure stakeholders to implement more cost-effective, resource-efficient and adaptable long-term infrastructure investments.

ENVISION BACKGROUND

Institute for Sustainable Infrastructure

Envision was created by a strategic alliance of the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure (ISI). ISI is a not-for-profit education and research organization, dedicated to developing and maintaining a civil infrastructure rating system, and was formed by the American Council of Engineering Companies, the American Public Works Association and the American Society of Civil Engineers.

WHERE DOES ENVISION APPLY?

- Designed as a holistic framework for all types and sizes of both public and private infrastructure
- Covers project in energy, water, waste, transportation, landscape, information and other civil infrastructure
- Not intended to evaluate interior, conditioned, buildings with the primary purpose of human occupation
- Has been applied extensively throughout the U.S. and Canada but is applicable, and has been used, all over the world
- Used by infrastructure owners, design teams, community groups, environmental organizations, constructors, regulators and policy makers

STRUCTURE

Credit Categories & Subcategories

1 | Quality of Life – Wellbeing, Mobility, Community

2 | Leadership – Collaboration, Planning, Economy

3 | Resource Allocation – Materials, Energy, Water

4 | Natural World – Siting, Conservation, Ecology

5 | Climate and Resilience – Emissions, Resilience

Levels of Achievement

1 | Improved – Performance that is above conventional.

2 | Enhanced – Sustainable performance that is on the right track.

3 | Superior – Sustainable performance at a very high level.

4 | Conserving – Performance that has achieved essentially zero negative impact.

5 | Restorative – Performance that restores natural or social systems.

Innovation Points

Potential points awarded in each category for methods that advance sustainable infrastructure practices or show exceptional performance beyond expectations.

VERIFICATION

Registration and Verification Fees

Registration: $2,000

Verification: Fees based on project size, membership and verification pathway. HDR is a member of ISI and can register client project's to receive member pricing.

Verification Pathways

Projects may pursue verification either after:

- The design phase (at or after 95% design completion)
- The construction phase (at or after 95% construction completion).

Projects pursuing verification after the design phase will be required to complete an additional post-construction review follow-up.

The post-construction review is required to maintain the Envision award earned after the design phase. The purpose of the post-construction review is to validate that commitments made in the planning and design stages of the project were carried through during construction

Project Award Levels

To receive recognition, projects must achieve a minimum percentage of the total applicable Envision points. Projects can be recognized at four levels.

- Verified: 20%
- Silver: 30%
- Gold: 40%
- Platinum: 50%

ENVISION v3 POINTS TABLE

			Improved	Enhanced	Superior	Conserving	Restorative
QUALITY OF LIFE	PURPOSE	QL1.1 Improve Community Quality of Life	2	5	10	20	26
		QL1.2 Enhance Public Health and Safety	2	7	12	16	20
		QL1.3 Improve Construction Safety	2	5	10	14	-
		QL1.4 Minimize Noise and Vibration	1	3	6	10	12
		QL1.5 Minimize Light Pollution	1	3	6	10	12
		QL1.6 Minimize Construction Impacts	1	2	4	8	-
	WELLBEING	QL2.1 Improve Community Mobility and Access	1	3	7	11	14
		QL2.2 Encourage Sustainable Transportation	-	5	8	12	16
		QL2.3 Improve Access and Wayfinding	1	5	9	14	-
	COMMUNITY	QL3.1 Advance Equity and Social Justice	3	6	10	14	18
		QL3.2 Preserve Historic and Cultural Resources	-	2	7	12	18
		QL3.3 Enhance Views and Local Character	1	3	7	11	14
		QL3.4 Enhance Public Space and Amenities	1	3	7	11	14
					Maximum QL Points	200*	
LEADERSHIP	COLLABORATION	LD1.1 Provide Effective Leadership and Collaboration	2	5	12	18	-
		LD1.2 Foster Collaboration and Teamwork	2	5	12	18	-
		LD1.3 Provide for Stakeholder Involvement	3	6	9	14	18
		LD1.4 Pursue Byproduct Synergies	3	6	12	14	18
	PLANNING	LD2.1 Establish a Sustainability Management Plan	4	7	12	18	-
		LD2.2 Plan for Sustainable Communities	4	6	9	12	16
		LD2.3 Plan for Long-Term Monitoring and Maintenance	2	5	8	12	-
		LD2.4 Plan for End-of-Life	2	5	8	14	-
	ECONOMY	LD3.1 Stimulate Economic Prosperity and Development	3	6	12	20	-
		LD3.2 Develop Local Skills and Capabilities	2	4	8	12	16
		LD3.3 Conduct a Life-Cycle Economic Evaluation	5	7	10	12	14
					Maximum LD Points	182*	
RESOURCE ALLOCATION	MATERIALS	RA1.1 Support Sustainable Procurement	3	6	9	12	-
		RA1.2 Use Recycled Materials	4	6	9	16	-
		RA1.3 Reduce Operational Waste	4	7	10	14	-
		RA1.4 Reduce Construction Waste	4	7	10	16	-
		RA1.5 Balance Earthwork On Site	2	4	6	8	-
	ENERGY	RA2.1 Reduce Operational Energy Consumption	6	12	18	26	-
		RA2.2 Reduce Construction Energy Consumption	1	4	8	12	-
		RA2.3 Use Renewable Energy	5	10	15	20	24
		RA2.4 Commission and Monitor Energy Systems	3	6	12	14	-
	WATER	RA3.1 Preserve Water Resources	3	5	7	9	12
		RA3.2 Reduce Operational Water Consumption	4	9	13	17	22
		RA3.3 Reduce Construction Water Consumption	1	3	5	8	-
		RA3.4 Monitor Water Systems	1	3	6	12	-
					Maximum RA Points	196*	
NATURAL WORLD	SITING	NW1.1 Preserve Sites of High Ecological Value	2	6	12	16	22
		NW1.2 Provide Wetland and Surface Water Buffers	2	5	10	16	20
		NW1.3 Preserve Prime Farmland	-	2	8	12	16
		NW1.4 Preserve Undeveloped Land	3	8	12	18	24
	CONSERVATION	NW2.1 Reclaim Brownfields	11	13	16	19	22
		NW2.2 Manage Stormwater	2	4	9	17	24
		NW2.3 Reduce Pesticide and Fertilizer Impacts	1	2	5	9	12
		NW2.4 Protect Surface and Groundwater Quality	2	5	9	14	20
	ECOLOGY	NW3.1 Enhance Functional Habitats	2	5	9	15	18
		NW3.2 Enhance Wetland and Surface Water Functions	3	7	12	18	20
		NW3.3 Maintain Floodplain Functions	1	3	7	11	14
		NW3.4 Control Invasive Species	1	2	6	9	12
		NW3.5 Protect Soil Health	-	3	4	6	8
					Maximum NW Points	232*	
CLIMATE & RESILIENCE	EMISSIONS	CR1.1 Reduce Net Embodied Carbon	5	10	15	20	-
		CR1.2 Reduce Greenhouse Gas Emissions	8	13	18	22	26
		CR1.3 Reduce Air Pollutant Emissions	2	4	9	14	18
	RESILIENCE	CR2.1 Avoid Unsuitable Development	3	6	8	12	16
		CR2.2 Assess Climate Change Vulnerability	8	14	18	20	-
		CR2.3 Evaluate Risk and Resilience	11	18	24	26	-
		CR2.4 Establish Resilience Goals and Strategies	-	8	14	20	-
		CR2.5 Maximize Resilience	11	15	20	26	-
		CR2.6 Improve Infrastructure Integration	2	5	9	13	18
					Maximum CR Points	190*	
		Maximum TOTAL Points	1,000*				

*Not every credit has a restorative level. Therefore totals include the maximum possible points for each credit whether conserving or restorative.

May 2018

Appendix B. Envision Credit Review Workbook

Note that credit and project LOAs are anticipated based on the initial assessment and Envision workshop discussions on September 30, 2021, but actual LOAs may vary depending on future decisions and available documentation, as well as the verifier review process.

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ISI ENVISION 3.0 CREDITS

**If the "Not Applicable" selection has an asterisk, it would be difficult to demonstrate that the credit is not applicable to a project - per the Envision v3 Guidance Manual.*

Stakeholder | Need additional review

ALL CREDITS *- The team will decide whether or not to exclude a credit and must provide a clear justification if a credit is deemed not applicable to a project.*

CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
QUALITY OF LIFE	PURPOSE		LEVEL OF ACHIEVEMENT				

QL1.1 Improve Community Quality of Life

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
Criteria	A + B	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F	A + B + C + D + E + F + G
Level	(2) Community Considerations	(5) Community Linkages	(10) Broad Community Alignment	(20) Holistic Assessment and Collaboration	(26) Protecting The Future

Projected Level of Achievement (Low)
(20) Holistic assessment and collaboration

Projected Level of Achievement (High)
(20) Holistic assessment and collaboration

Notes:
Goals from the Solids Master Plan
- Replacing failing and end of life equipment
- Mitigating the risk of potential future regulatory changes to the current practice of recycling Class B biosolids through application to agricultural land
- Providing a solution that reduces the energy and greenhouse gas footprint of the WPCP
- **Achieving additional County-wide sustainability goals**
- Developing a solids management strategy that offers long-term reliability
- Establishing an implementation plan compatible with County CIP funding

Plan supports the Chesapeake Bay Preservation Ordinance, a statewide program to help restore the bay to health

Incorporate poll/survey to ask about stakeholder engagement/satisfaction. Potential for website where community can submit comments.

(A) The project team identifies and takes into account community needs, goals, and issues. For example, the project team has located and reviewed the most recent community planning information and assessed relevant community needs, goals, and/or issues.
(B) The project meets or supports community needs and/or goals.
(C) The project assesses the social impacts it will have on the host and affected communities' quality of life.
(D) The affected communities are meaningfully engaged in identifying how the project supports community needs and/or goals.
(E) Based on the social assessment, potential negative impacts on the host or nearby affected communities are mitigated following a hierarchy that prioritizes avoidance, minimization, restoration, and offsetting.
(F) Community satisfaction is demonstrated by feedback from the stakeholder engagement process verifying actions taken in criteria A, B, C, and D.
(G) The project proactively addresses trends in changing social, economic, and/or environmental conditions within the community in order to ensure a high quality of life over the long term.

QL1.2 Enhance Public Health and Safety

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
Criteria	A + B	A + B + C	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F
Level	(2) Understanding Impacts	(7) Prioritizing Risk Reduction	(12) Improving Health & Safety	(16) Shared Benefits	(20) Protecting Communities

Projected Level of Achievement (Low)
(12) Improving Health & Safety

Projected Level of Achievement (High)
(16) Shared Benefits

Notes:
Move from a Class B product to a Pathogen free, Class A product
Reducing truck traffic
SH&E Plan
Demographics of customers/area - statistics/map
Land application of biosolids - different counties and farms; know where it has been going
CIP - Implement more effective technology that will reduce the need for maintenance and reduce safety risks to staff

(A) The project meets all health and/or safety regulations and laws for operation.
(B) The project includes health and/or safety improvements beyond minimum requirements established by regulations and laws.
(C) The project improves health and/or safety for its immediate surroundings.
(D) The project demonstrates a net positive impact on health and/ or safety for the host or affected communities.
(E) The health and safety benefits and/or negative impacts are equitably distributed within affected communities, and the project team can demonstrate that the project does not disproportionately burden one community over another (i.e., social/environmental justice).
(F) The project provides critical infrastructure services to communities experiencing, or at risk of experiencing, imminent, negative health and/or personal safety impacts

QL1.3 Improve Construction Safety

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
Criteria	A + B	A + B + C	A + B + C + D	A + B + C + D + E	Not Available
Level	(2) Commitment to Safety	(5) Risk Analysis, Training and Security	(10) Safe Work Practices and a Secure Site	(14) Health Beyond the Site	

Projected Level of Achievement (Low)
(14) Health Beyond the Site
Projected Level of Achievement (High)
(14) Health Beyond the Site

Notes:
SITE-SPECIFIC SH&E PLAN - confirm this would be communicated to contractor via specs

specs to contractor hired to do the work will be required to develop their own safety plan

[Discuss inclination of County toward including Envision requirements in contractor specs]

Envision workshop: Mary – County has a lot of internal programs for health screenings, and a new policy has been put into place requiring contractors to either have COVID vaccines or regular COVID testing.

(A) The owner and general contractor/construction manager have made strong commitments to monitor and improve health and safety for onsite construction operations.
(B) The project execution plan requires internal documentation that tracks health and safety performance and corrects deficiencies or promotes best practices during construction.
(C) Contractor implements safety and/or security competency training for all field personnel. Contractor or owner provides minimum training requirements for health and safety programs.
(D) The owner and contractor have a specific site and project security plan. The plan includes physical security as well as information security when appropriate. The contractor provides minimum training requirements.
(E) The owner or contractor provides programs that promote health and wellbeing, such as free health screenings or workshops.

ISI ENVISION 3.0 CREDITS

If the "Not Applicable" selection has an asterisk, it would be difficult to demonstrate that the credit is not applicable to a project - per the Envision v3 Guidance Manual.

Stakeholder	Need additional review

ALL CREDITS *- The team will decide whether or not to exclude a credit and must provide a clear justification if a credit is deemed not applicable to a project.*

CATEGORY: QUALITY OF LIFE
SUB-CATEGORY: WELLBEING

QL1.4 Minimize Noise and Vibration

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
LEVEL OF ACHIEVEMENT	A + B	A + B + C	A + B + C + D	A + B + C + D + E	A + B + C + D + E
	(1) Noise Assessment	(3) Target Noise Levels	(6) Stakeholder Support	(10) No Noise Increase	(12) Noise Reductions

(A) The project team assesses the potential for operational noise impacts on the surrounding community and/or environment. This assessment occurs when applicable vibrations are considered as a potential source of noise and/or disruption.
(B) Strategies are implemented to mitigate noise and/or vibrations during operations. Noise reduction follows a mitigation hierarchy of avoidance/source elimination, minimization, abatement/receiver reduction, and offsetting/compensation.
(C) The project adopts existing, or works with the community to set, target project noise levels for the impacted community
(D) The stakeholder engagement process demonstrates community awareness of targets (i.e. criterion C), mitigation strategies (i.e. criterion B), and noise impacts (i.e. criterion A).
(E - Conserving) Noise reduction strategies and controls are sufficient to not increase noise within the surrounding community beyond existing conditions.
(E - Restorative) Noise reduction strategies and controls are sufficient to reduce noise within the surrounding community beyond existing conditions.

Projected Level of Achievement (Low)
(6) Stakeholder Support
Projected Level of Achievement (High)
(10) No Noise Increase
Baseline: Existing facility
Notes:
Any change in noise during operation over existing facility?
Less truck traffic, but potentially more noise from equipment; were going to put generators on site, but not using now
Noise outlined as an issue at stakeholder meeting

QL1.5 Minimize Light Pollution

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
LEVEL OF ACHIEVEMENT	A + B	A + B + C	A + B + C + D	A + E	A + E + F
	(1) Light Pollution Reduction	(3) Master Lighting Plan	(6) Eliminating Uplight	(10) Backlight, Uplight, and Glare Reduction	(12) Night Sky Restoration

(A) The project identifies lighting needs and sensitive community and environmental areas potentially impacted by light pollution during operations.
(B) The project reduces light pollution following a mitigation hierarchy of avoidance, minimization, protection, and offsetting.
(C) The project implements a master lighting plan establishing lighting zones. For each zone, the plan outlines lighting goals, safety and security needs, specifies environmental conservation, and reduces lighting when no longer needed.
(D) Light emission beyond 90 degrees is prevented. All project lighting meets BUG rating uplight requirements with no light emitted above 90 degrees.
(E) All project lighting meets backlight, uplight, and glare requirements according to IES BUG rating standards.
(F) The project involves the removal or retrofitting of existing lighting so as to significantly reduce (>10%) overall existing lighting.

Projected Level of Achievement (Low)
(1) Light Pollution Reduction
Projected Level of Achievement (High)
(1) Light Pollution Reduction
Notes:
Exterior lighting needs? Inclination to spec lighting requirements, i.e. BUG requirements?

More equipment outside, with lighting. Potential for higher LOA; review.

Updates to Green Building Incentive Policy:
In order to address how buildings interact with nature, the Policy includes three new provisions focused on the relationship between urban development and nature.
Finally, minimum light pollution reduction criteria for exterior light fixtures must be met to safely reduce light pollution.

QL1.6 Minimize Construction Impacts

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
LEVEL OF ACHIEVEMENT	A + (B, C, D or E)	A + (B, C, D or E)	A + (B, C, D or E) + F	A + B + C + D + E + F	Not Available
	(1) Initial Management Plan	(2) Expanded Plan	(4) Stakeholder Feedback	(8) Complete Plan	

(A) The project team implements a **construction management plan** or policies to address the temporary inconveniences associated with construction. The plan or policies are informed by stakeholder engagement.
(B, C, D, or E) The management plan addresses one (1, 2, 3, or 4) type(s) of construction impact: noise, safety/wayfinding, access/mobility, or lighting.
(F) The construction management plan or policies include robust feedback mechanisms and performance monitoring and reporting for construction impacts.

Projected Level of Achievement (Low)
(8) Complete Plan
Projected Level of Achievement (High)
(8) Complete Plan
Notes:
Discuss inclination of County toward including Envision requirements in contractor specs
**Construction management plan
Include contractor "Envision Action Plan" SMP/Envision management plan

Envision workshop:
- Brian – A construction management plan will be required for this project.
- Mary – County requires all of these items.
- Agree with pursuing conserving level.
- We have used signage on the construction fencing to share information with the public.

QL2.1 Improve Community Mobility and Access

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
LEVEL OF ACHIEVEMENT	A + B	A + B + C	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F
	(1) Satisfactory Coordination	(3) Controlled Access	(7) Increased Access and Flow	(11) Connected Networks	(14) Restoring Community Connections

(A) The project team demonstrates consistency with local and regional transportation plans.
(B) The project team obtains input from the community and key stakeholders (e.g., public officials and operators of adjacent facilities, amenities, or transportation hubs) regarding improved access.
(C) The project includes strategies to increase capacity, manage congestion, reduce vehicle distance traveled, or lower accident rates
(D) The project team works with the community to expand mobility and access options and/or incorporate complete streets policies.
(E) The project addresses long-term mobility and access needs of the community.
(F) The project creates new or restores previous connections between communities.

Projected Level of Achievement (Low)
(3) Controlled Access
Projected Level of Achievement (High)
(3) Controlled Access
Notes:

Trucks currently cross eads street and back into plant; new solids loading facilities will be drive through instead of back-in, which will eliminate the needs to back in across Eads street into the plant.
Solids reduced by 50% resulting in less truck traffic and hauling costs

ISI ENVISION 3.0 CREDITS

If the "Not Applicable" selection has an asterisk, it would be difficult to demonstrate that the credit is not applicable to a project - per the Envision v3 Guidance Manual.

Stakeholder | Need additional review

ALL CREDITS *- The team will decide whether or not to exclude a credit and must provide a clear justification if a credit is deemed not applicable to a project.*

CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
QUALITY OF LIFE	WELLBEING	**QL2.2 Encourage Sustainable Transportation**	Not Available	A	A + B	A + B + C	A + B + C + D
		Projected Level of Achievement (Low) **(16) New Connections** *Projected Level of Achievement (High)* **(16) New Connections**		(5) Access to Transit or Active Transportation	(8) Encourages Transit or Active Transportation	(12) Transit or Active Transportation Programs	(16) New Connections
		Notes: Bike paths and bike-friendly roads adjacent that connect to trail along river. Consider higher LOA when thinking about "configured" as project processes vs. land use EV charging - plans for EV charging on south side of plant; potential for adding EV charging on north side New prerequisites include renewable energy, **electric vehicle charging,** social equity, and other energy and community sustainability criteria. Trail adjacent to WWTP along river Renewable fuel produced by project		**(A) The project creates or offers convenient access to shared/mass transportation OR active transportation (e.g., extended contiguous trails and/or bicycle networks).** (B) Beyond proximity, the project is configured and designed to encourage the use of active, shared, or mass transportation. (C) The project provides programs and/or facilities that support the use of active, shared, or mass transportation. (D) The active and/or shared transportation improvements contribute to a larger integrated transportation strategy for the community or region. The project creates new connections or rehabilitates/repurposes unused, underused, or previously disconnected pathways, bikeways, rail, and/or other modes of transportation to enhance the efficiency, quality, or level of service of the overall network.			
		QL2.3 Improve Access and Wayfinding	A	A + B	A + B + C	A + B + C + D	Not Available
		Projected Level of Achievement (Low) **(5) Protecting Surroundings** *Projected Level of Achievement (High)* **(5) Protecting Surroundings**	(1) Emergency Management	(5) Protecting Surroundings	(9) Safety Audits	(14) Public Access	
		Notes: May be modifying access from plant for trucks; addition of street-facing signage. Changing gates onto plant site; will need to have good wayfinding due to changes.	**(A) The project clearly accommodates incident management for users and emergency personnel.** **(B) The project identifies and utilizes access routes, safety features, and clear signage to reduce negative impact on its surroundings caused by vehicle or pedestrian traffic. The project integrates well with its surroundings through clear signage and wayfinding.** (C) The project provides points for safe public access. Universal design standards are used to ensure broad accessibility and safety. (D) The project has a positive and transformative impact on community or neighborhood access and/or wayfinding.				
	COMMUNITY	**QL3.1 Advance Equity and Social Justice**	A + B + C	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F	A + B + C + D + E + F + G
		Projected Level of Achievement (Low) **None** *Projected Level of Achievement (High)* **None**	(3) Understanding Equity	(6) Mitigation	(10) Empowerment	(14) Equitable Access to Benefits	(18) Equitable Futures
		Notes: Desktop analysis of populations, but hasn't looked specifically Updates to Green Building Incentive Policy: Equity: In keeping with the County Board's Equity Resolution (September 21, 2019), staff included a provision to support racial equity, diversity, and inclusion policies and programs within the firms on the development team. This was provision was modeled	(A) Stakeholder engagement is conducted early and informed by the historic context of equity, social justice, and environmental justice. When projects impact, or potentially impact, indigenous communities, specific attention is given to developing a relationship of respect and mutual understanding that supports the autonomy, authority, and rights of these communities. (B) The project team assesses the social impacts the project will have on the host and affected communities. This includes mapping impacts and benefits across local communities. (C) Key members of the project team make institutional commitments to equity and social justice, including non-discrimination; diversity and inclusion; and pay equity. Large-scale projects make targeted and project-specific commitments. (D) Based on the assessment of social impacts, the project addresses or mitigates social impacts. Mitigation strategies are informed by stakeholder consultation and participation. (E) The social, economic, and environmental benefits and impacts of the project are shown to not disproportionately favor or disfavor any community. (F) The project empowers communities to engage in the development process. Qualified professionals identify unconscious biases and barriers to inclusion. Programs target higher rates of engagement, and include transparent grievance mechanisms to facilitate resolutions. (G) The project positively addresses or corrects an existing or historic injustice or imbalance.				
		QL3.2 Preserve Historic and Cultural Resources	Not Available	A + B	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F
		Projected Level of Achievement (Low) **Not applicable** *Projected Level of Achievement (High)* **Not applicable**		(2) Stakeholder Consultation	(7) Expanded Search	(12) Conservation	(18) Restoration
		Notes: Documentation to support N/A.		(A) The project team works with the community and required regulatory and resource agencies to identify historic and cultural resources in and around the project site. (B) The project implements strategies to document, protect, or enhance historic and cultural resources. (C) The assessment of cultural resources intentionally extends beyond national or subnational registries to identify important parts of the community culture such as places, events, natural features, oral traditions, or local skills. (D) Stakeholders of the historic/cultural resources are consulted early in the project's development and contribute to developing a sensitive design approach. (E) For historic and/or cultural resources identified in criteria A and C the project is designed to fully preserve/protect the character-defining features of those resources. (F) The project enhances or restores a threatened or degraded historic/cultural resource or results in a historical resource being added to a protected registry.			

ISI ENVISION 3.0 CREDITS

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Stakeholder | Need additional review

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CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
QUALITY OF LIFE	COMMUNITY	**QL3.3 Enhance Views and Local Character**	A + B	A + B + C	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F
			(1) Value Identification	(3) Alignment With Community Values	(7) Preservation and Enhancement	(11) Connections and Collaboration	(14) Restoring Community Character
QUALITY OF LIFE	COMMUNITY	**QL3.4 Enhance Public Space and Amenities**	A + B	A + B + C	A + B + C + D	A + B + C + D	A + B + C + D
			(1) No Net Loss	(3) Community Involvement	(7) Improvement and Enhancement	(11) Overall Net Benefit	(14) Substantial Restoration

QL3.3 Enhance Views and Local Character

Projected Level of Achievement (Low)

(3) Alignment With Community Values

Projected Level of Achievement (High)

(3) Alignment With Community Values

Notes:

Very visible from surrounding neighborhoods. Viewshed discussion part of site planning.

All piping hidden; don't want it to look like equipment
Screening?

Envision workshop:
- Mary – So many discussions with stakeholder engagement – we should definitely get to A and B.
- Mary – on C – a lot of current aesthetic was driven by input from stakeholders. Have taken this into account in the past. Will assess aesthetic standard for this project.
- Decision: Confident on A and B – C and D may happen, based on county policies for public art or engagement with stakeholders.
- The County would have to get public input for any public art. There is an existing Public Art Commission.

(A) The project team identifies community values and concerns regarding protection and enhancement of views and local character.
(B) Specific design features preserve or enhance views and local character, and are informed by the stakeholder consultation process.
(C) Guidelines are adopted or developed to preserve or enhance views and local character. The aesthetic quality of the project is important.
(D) A construction management plan protects character features, high-value landscapes, or landscape features during construction.
(E) Community feedback from the stakeholder engagement process verifies actions taken in criteria A, B, and C.
(F) The project restores previously lost or degraded views or community features OR enhances the community by creating new features of local character. Actions are supported through the stakeholder engagement process.

QL3.4 Enhance Public Space and Amenities

Projected Level of Achievement (Low)

None

Projected Level of Achievement (High)

None

Notes:

Likely not pursued.

(A) The project assesses impacts to existing public amenities and implements mitigation strategies. The project will not result in the net loss of public amenities.
(B) The stakeholder engagement process specifically includes issues of public space and amenities.
(C) The project team can demonstrate stakeholder support for aspects of the project related to public space/amenities.
(D - Superior) The project involves significant enhancements to existing public space or amenities (e.g., not minor resurfacing or component replacements).
(D - Conserving) The project creates a new public resource or amenity to the community that did not previously exist. The scope of the new public space/amenity is commensurate with the scope and scale of the project.
(D - Restorative) The project restores lost, degraded/unusable, or at-risk public space or amenities. The public space/amenity is an asset of significance to the local community commensurate with the scope and scale of the project.

Innovation

Projected Level of Achievement (Low)

None

Projected Level of Achievement (High)

+2 points

Notes:
- Project branding; mission, vision

Potential "stretch" considerations from Green Building Incentive Policy:
Human Interaction with Nature (Biophilia), Bird Friendly and Light pollution reduction:
In order to address how buildings interact with nature, the Policy includes three new provisions focused on the relationship between urban development and nature. First, applicants must submit a narrative describing how the project optimizes energy efficiency and environmental conservation in the community. Second, the project must minimize bird strikes by meeting specific criteria outlined by the American Bird Conservancy.
Finally, minimum light pollution reduction criteria for exterior light fixtures must be met to safely reduce light pollution.

(+10) Innovate or exceed credit requirements.
(A) Implement innovative methods, technologies, or processes that are novel either in their use, application, or within the local regulatory or cultural context.
OR
(B) Implement measures that exceed the highest existing requirements within one or more Quality of Life credits.
OR
(C) Address additional aspects of sustainability not currently recognized in Envision

Maximum QL Points (w/o Innovation) 200

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Stakeholder	Need additional review

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CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
LEADERSHIP	COLLABORATION	**LD1.1 Provide Effective Leadership & Commitment/Collaboration**	A	A + B	A + B + C	A + B + C + D	Not Available
		Projected Level of Achievement (Low) **(18) Sustainability as a Core Value** *Projected Level of Achievement (High)* **(18) Sustainability as a Core Value**	(2) Limited commitment.	(5) Strong Commitment	(12) Strong Commitment	(18) Sustainability as a Core Value	
		Notes: Arlington County - Facility Sustainability Policy - Community Energy Plan; goal for Arlington to be a Carbon Neutral Community by 2050 - Green Building Incentive Policy for Site Plan Projects	**(A) A written commitment by the owner and project team to address the social, environmental, and economic aspects of the project. Commitments to sustainability are clearly articulated at the project level in a project chartering session and/or contract documents.** **(B) Commitments are supported by a sustainability management policy that is commensurate with the scope, scale, and complexity of the project.** **(C) Sustainability commitments, and progress toward their achievement, are revisited periodically through meetings or written reports.** **(D) Key members of the project team have made clear commitments to sustainability, as evidenced by:** • Organizational sustainability policies and/or reports. • Examples of projects, or initiatives, to improve sustainable performance. • Sustainability strategies embedded into their business strategy. • Third-party organizational recognition or commitments.				
		LD1.2 Foster Collaboration & Teamwork	A	A + B	A + B + C	A + B + C + D	Not Available
		Projected Level of Achievement (Low) **(18) Life-Cycle Collaboration** *Projected Level of Achievement (High)* **(18) Life-Cycle Collaboration**	(2) Early Collaboration	(5) Achieving Goals	(12) Ongoing Collaboration	(18) Life-Cycle Collaboration	
		Notes:	**(A) Sustainability goals are defined early during interdisciplinary collaborative project kickoff meetings among project staff at all levels.** **(B) The project team can demonstrate sustainability performance enhancements that resulted from the interdisciplinary collaborative process. Performance enhancements should result from a whole-systems design approach, rather than sustainability add-ons.** **(C) Ongoing collaboration meetings are conducted throughout design with the owner and the interdisciplinary project team to clarify expectations, discuss potential opportunities, and identify potential barriers to integrated design. Meetings involve a broad set of project participants.** **(D) The interdisciplinary collaboration or integrated design process specifically includes stakeholders from later construction, operations, and/or maintenance phases. Important considerations over the project life are understood and incorporated into the project.**				
		LD1.3 Provide for Stakeholder Involvement	A + B	A + B + C	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F
		Projected Level of Achievement (Low) **(18) Stakeholder Partnerships** *Projected Level of Achievement (High)* **(18) Stakeholder Partnerships**	(3) Active Engagement	(6) Direct Engagement	(9) Community Involvement	(14) Community Satisfaction	(18) Stakeholder Partnerships
		Notes: The update to the Green Building Incentive Policy followed the “Involve” level of public engagement. - Outreach Method, Community Feedback Project specific Criteria F: Arlington Regional Transit - beneficial use of biogas Envision workshop: - Charles – we have a well-documented engagement process for this - Beau – Can you please explain item E on this slide: “Feedback is sought from stakeholders as to their satisfaction with the engagement process, and the resulting decisions were made based on their input.” How can we show that our decisions were based upon stakeholder issues? - Mary – I wasn’t aware of the lime noise delivery issue - Mary – four feedback categories: noise, odor, emissions, visual are those where stakeholder involvement have informed this project.	**(A) Primary and secondary stakeholders are identified through a stakeholder mapping process. Stakeholder concerns and specific objectives for stakeholder engagement are defined.** **(B) A proactive stakeholder engagement process is established with clear objectives. This occurs at the earliest stages of planning and is sustained through project construction. Engagement moves beyond education into active dialogue. Stakeholder views are monitored, and a two-way line of communication is established to reply to inquiries. Sufficient opportunities are provided for stakeholders to be involved in decision making. The participation process is transparent with opportunities to provide meaningful input.** **(C) A lead person from the project team, in addition to any public involvement lead or manager, works with stakeholder groups to understand communication needs and the desire for and scope of involvement.** **(D) There are specific cases in which public input influenced or validated project outcomes. Potentially conflicting stakeholder views were evaluated and addressed equitably during decision making.** **(E) Feedback is sought from stakeholders as to their satisfaction with the engagement process, and the resulting decisions were made based on their input.** (F) One or more stakeholders, having mutual interests or interdependencies, are identified and engaged as partners.				
		LD1.4 Pursue Byproduct Synergies	A + B	A + B + C	A + B + D	A + B + D	A + B + E
		Projected Level of Achievement (Low) **(18) Circular Economy** *Projected Level of Achievement (High)* **(18) Circular Economy**	(3) Initial Investigation	(6) Synergy Pursued	(12) Short-Term Byproduct Reuse	(14) Long-Term Byproduct Reuse	(18) Circular Economy
		Notes: Class A fertilizer product that can be marketed to the community. High-quality soil amendment available to agriculture and community Natural gas generated by the process can be reused onsite for power generation or offsite for vehicle fuel Potential for future phosphorus harvesting can be considered 2 byproducts -	**(A) The project team conducts an assessment of the availability and viability of excess resources (i.e., waste) or capacity, including but not limited to waste materials, heating or cooling, financial capacity, land area/space, or management/personnel capacity.** **(B) Candidates for byproduct synergies or reuse are identified. This can include finding a beneficial reuse for the project’s waste or excess resources, or the project’s beneficial reuse of external waste or excess resources. Project teams should also consider ecosystem services where project waste or excess resources can support natural systems, or where natural systems can process and remove project waste.** **(C) The project team demonstrates an active attempt to incorporate at least one byproduct synergy or reuse into the project.** (D - Superior) The project successfully includes a byproduct synergy or reuse. Execution is a short-term or one-time byproduct synergy/reuse (e.g., during construction). **(D - Conserving) The project successfully includes a byproduct synergy or reuse. Execution is a long-term regularly recurring byproduct synergy/reuse throughout project operations.** (E) The project is fully engaged in a “circular economy” system whereby the majority of its operational waste is beneficially reused OR the majority of its operational resources are sourced from external waste streams.				

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Stakeholder | Need additional review

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CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
LEADERSHIP	PLANNING	LD2.1 Establish a Sustainability Management Plan	A + B	A + B + C	A + B + C + D	A + B + C + D + E	Not Available
			(4) Plan	(7) "Plan-Do-Check-Act"	(12) Full Implementation	(18) Managing Change	Not Available
		LD2.2 Plan for Sustainable Communities	A	A + B	A + B + C	A + B + C + D	A + B + C + D + E
			(4) Sustainability Indicators	(6) Alternative Analysis	(9) Sustainability Assessment	(12) Sustainable Planning	(16) More Sustainable Communities
		LD2.3 Plan for Long-Term Monitoring & Maintenance	A	A + B + C	A + B + C + D	A + B + C + D + E	Not Available
			(2) Reduced Maintenance	(5) Maintenance Plan	(8) Securing Resources	(12) Ongoing Improvement	
		LD2.4 Plan for End-of-Life	A + B	A + B + C	A + B + C + D	A + B + C + D + E	Not Available
			(2) End-of-Life Plan	(5) Enhancements	(8) Pushing Boundaries	(14) Extending Boundaries	
	ECONOMY	LD3.1 Stimulate Economic Prosperity & Development	A + B	A + B + C	A + B + C + D	A + B + C + D + E	Not Available
			(3) New Capacity	(6) Improved Choices	(12) Business Attraction	(20) Development Rebirth	

LD2.1 Establish a Sustainability Management Plan

Projected Level of Achievement (Low)
(12) Full Implementation
Projected Level of Achievement (High)
(18) Managing Change

Notes:
Develop program sustainability goals ✓

(A) Roles and responsibilities for addressing sustainability are assigned to key members of the project team. Their authority on the project to affect change is sufficient and clear.
(B) The project team develops a sustainability management plan, or adopts existing sustainability management plans or policies sufficient in scope and scale to address the sustainable performance of the project. The plan includes an index of all project features related to sustainability, and an assessment of the environmental, social, and economic aspects of the project. Sustainability goals and performance objectives are established and prioritized to reduce the project's impact. They are aligned with community needs and issues.
(C) The project management plan contains sufficient processes, action plans, and management controls to achieve its sustainability goals and performance targets.
(D) Implementation of the sustainability management plan, and progress toward established goals, is revisited periodically through meetings or written reports.
(E) The plan is adaptable, flexible, and resilient enough to manage changes in environmental, social, or economic conditions of the project over time.

LD2.2 Plan for Sustainable Communities

Projected Level of Achievement (Low)
(12) Sustainable Planning
Projected Level of Achievement (High)
(16) More Sustainable Communities

Notes:

(A) Sustainability indicators or outcomes are considered in project selection/identification and planning.
(B) Sustainable performance is included in alternative analyses during project identification. Alternatives include the sustainability of a "no-build" option.
(C) During project identification, the project's potential impact to broader external systems is assessed, such as growth patterns, congestion, energy and water demand/production, and how these impact the overall long-term sustainability of the community or region.
(D) The project is part of a comprehensive sustainable development plan at the level of the infrastructure system, municipality/community, or region. The project demonstrates a direct connection and contribution to achieving specific sustainable development goals identified in the plan.
(E) The project addresses an inherently unsustainable condition within the community.

LD2.3 Plan for Long-Term Monitoring & Maintenance

Projected Level of Achievement (Low)
(12) Ongoing Improvement
Projected Level of Achievement (High)
(12) Ongoing Improvement

Notes:
New facilities vs. using existing facilities. Evaluation criteria.
CIP - implement more effective technology that will reduce the need for maintenance

Envision workshop:
- Team discussion whether the Monitoring Plan drives decisions regarding operations and the conclusion was yes, which is directly related to this credit.

(A) The project includes strategies to reduce maintenance impacts. This may include better design, durable longer-lasting materials, or ease of access for maintenance and repair with minimal disruption to users and affected communities.
(B) A monitoring and maintenance plan is developed with specific sustainability performance targets and an implementation schedule with clear goals and milestones. It addresses any unique challenges of monitoring or maintaining the project's sustainability features.
(C) The project team meets with operations, monitoring, and maintenance staff to explain and discuss the operations plan.
(D) Owner identifies the key personnel to carry out the plan, funding sources, and other resources to cover associated costs. This includes training for the operation, monitoring, and maintenance staff, and provisions for necessary future training.
(E) A schedule is developed for future re-evaluation and modification of the maintenance plan based on monitored data.

LD2.4 Plan for End-of-Life

Projected Level of Achievement (Low)
(2) End-of-Life Plan
Projected Level of Achievement (High)
(2) End-of-Life Plan

Notes:
Inclination to create an 'end-of-life' plan?

Envision workshop:
- Mary – may be tough to do an end of life at this point.
- Brian – additional evaluations are being done?
- Lisa – concerns with getting there. But could we put together a table with anticipated end of life.
- Let's say "improved" for now.
- Mary – concur. Could be very beneficial to document new assets for asset management system – for end of life.
- Brian - we are looking at adaptability and plans for expansion in the future.

(A) The project team develops an end-of-life plan, including the necessary replacement/refurbishment of major components over the project life and its ultimate decommissioning, deconstruction, or replacement. Consideration is given to recyclability of materials and components and/or the ease of deconstruction or replacement (e.g., components or materials that can be easily separated for recycling or reuse). The plan is included in operations and maintenance documents.
(B) Relevant future demands, loads, or other requirements on the infrastructure system are estimated over the anticipated project life. The project extends useful life by providing opportunities for reconfiguration, future expansion, flexibility, or to beneficially repurpose the project after end-of-life.
(C) End-of-life impacts are assessed, including the environmental, social, and economic conditions of the site and surrounding community.
(D) The project includes an analysis of end-of-life costs and salvage value associated with deconstruction, decommissioning, or replacement.
(E) The project team demonstrates proactive stakeholder engagement in end-of-life planning and can demonstrate that the community understands the full life-cycle costs and benefits of the project.

LD3.1 Stimulate Economic Prosperity & Development

Projected Level of Achievement (Low)
(12) Business Attraction
Projected Level of Achievement (High)
(12) Business Attraction

Notes:
Biosolids - fertilizer
Capacity; regulations
C-reducing carbon footprint - less negative impact; reducing truck traffic; biogas - expanding offerings
D- helping Arlington meet their sustainability goals

(A) Jobs are created during design, construction, and/or operation. The project team determines the number, type, and duration of jobs created as a result of the project.
(B) The project adds new operating capacity. Capacity additions can apply to business, industry, or the public.
(C) The project provides additional access, increases the number of choices, and/or increases the quality of services. The project team can demonstrate that the addition of choices will drive competitiveness, efficiency, or improved productivity for business, industry, or cultural and recreational facilities.
(D) The project contributes to the host community's attractiveness for businesses, industries, or their workforce by improving the overall business or community environment (i.e., people want to live and/or work in the community).
(E) The project will stimulate local, regional, or national economic development. The economic projections take into account changing social, economic, and/or environmental conditions.

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Stakeholder | Need additional review

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CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
LEADERSHIP	ECONOMY	**LD3.2 Develop Local Skills & Capabilities**	A	A + B	A + B	A + B + C	A + B + C + D
		Projected Level of Achievement (Low)	(2) Gaining Skills	(4) Growing Capacity	(8) Building Communities	(12) Long-Term Opportunities	(16) Community Revitalization
		None *Projected Level of Achievement (High)* **None** **Notes:**	(A) The project includes training programs for local skill development. This may include designers, contractors, subcontractors, or operators. (B - Enhanced) Beyond general skill development, the project team identifies specific skill or capability gaps in the local workforce. Training programs target these gaps to improve local capacity. Skills are transferable beyond the end of the project. (B - Superior, Conserving, Restorative) The project team works with, or is informed by, community and local/state workforce development agencies to assess local employment and educational needs. Training programs target these gaps to improve local capacity. Skills are transferable beyond the end of the project. Skills developed are likely to provide the local workforce, agencies, and/or companies with a competitive advantage in the future. (C) Education, skill development programs and/or opportunities will continue after project delivery. This may include community education and awareness training. Programs may be at the organizational level but must be relevant to the project. (D) Training and skill development programs specifically target economically depressed, underemployed, or disadvantaged communities.				
		LD3.3 Conduct a Life-Cycle Economic Evaluation	A	A + B	A + B + C	A + B + C + D	A + B + C + D + E
		Projected Level of Achievement (Low)	(5) Life-Cycle Cost Analysis	(7) Life-Cycle Cost Alternatives Analysis	(10) Benefit Mapping	(12) Sustainability Cost Benefit Analysis	(14) Sustainability CBA Alternatives Analysis
		(7) Life-Cycle Cost Alternatives Analysis *Projected Level of Achievement (High)* **(14) Sustainability CBA Alternatives Analysis** **Notes:** Solids master plan; gas utilization lcca (component) SROI	**(A) A life-cycle cost analysis (LCCA) is conducted on the whole project to identify the total economic impacts of the project and provide additional insight into decision making.** **(B) LCCA is used to compare and assess alternatives for at least one major design component.** **(C) The project team maps the social, environmental, and financial costs and benefits of the project. Costs and benefits must be quantified but not necessarily monetized.** (D) The LCCA in criterion A is expanded into a comprehensive sustainability cost benefit analysis based on monetizing the social, environmental, and financial costs and benefits identified in criterion C. (E) The sustainability cost benefit analysis is used to compare and assess alternatives for at least one major design component. The selected alternative produces a net positive present value including social and environmental benefits.				
		Innovation *Projected Level of Achievement (Low)* **+2 points** *Projected Level of Achievement (High)* **+2 points** **Notes:** Possibly something here related to Byproduct Synergies - only a handful of places that are doing the biogas utilization	**(+10) Innovate or exceed credit requirements.** (A) Implement innovative methods, technologies, or processes that are novel either in their use, application, or within the local regulatory or cultural context. OR (B) Implement measures that exceed the highest existing requirements within one or more Leadership credits. OR (C) Address additional aspects of sustainability not currently recognized in Envision				

Maximum LD Points (w/o Innovation) | **182**

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CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
RESOURCE ALLOCATION	MATERIALS	**RA1.1 Support Sustainable Procurement Practices**	A + B	A + B	A + B	A + B	Not Available
		Projected Level of Achievement (Low) **None**	(3) 5% Sustainable Procurement	(6) 15% Sustainable Procurement	(9) 25% Sustainable Procurement	(12) 50% Sustainable Procurement	
		Projected Level of Achievement (High) **None**	(A) A written sustainable procurement policy/program is in place. The program includes a well-defined process for selecting suppliers and/or manufacturers of materials, supplies, and equipment, including selection criteria focused on environmental practices and social responsibility.				
		Notes: Any written sustainable procurement policy/program is in place? Envision workshop: Will likely not pursue this one.	(B) **At least 5%** of all project materials, supplies, and equipment meet the sustainable procurement policy/program requirements.	(B) **At least 15%** of all project materials, supplies, and equipment meet the sustainable procurement policy/program requirements.	(B) **At least 25%** of all project materials, supplies, and equipment meet the sustainable procurement policy/program requirements.	(B) **At least 50%** of all project materials, supplies, and equipment meet the sustainable procurement policy/program requirements.	
		RA1.2 Use Recycled Materials	A	A	A	A	Not Available
		Projected Level of Achievement (Low) **None**	(4) At Least 5% from Recycled	(6) At Least 15% from Recycled	(9) At Least 25% from Recycled	(16) At Least 50% from Recycled	
		Projected Level of Achievement (High) **(4) At Least 5% from Recycled** **Notes: Review after alternative is selected** Reuse of building? Ensuring quality and cost implications of specifying recycled materials. Reuse of existing structures? What materials would be used in the project? Envision workshop: - Mary – Make sure we're including the gravity thickeners in the "building reuse" calculation. - Charlies – Dept of solid waste has policies for zero waste - Mary – need to investigate/evaluate what the zero waste policy is with the solid waste division and determine what (if anything) has to be done for this project.	(A) **At least 5%** (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials. ***Mechanical, electrical, water equipment, and their components may be excluded from the calculations. In these instances, the most efficient equipment should be specified.*	(A) **At least 15%** (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials.	(A) **At least 25%** (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials.	(A) **At least 50%** (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials.	
		RA1.3 Reduce Operational Waste	A + B	A + B	A + B	A + B	Not Available
		Projected Level of Achievement (Low) **(14) Recycle/Reuse 95%**	(4) Recycle/Reuse At Least 25%	(7) Recycle/Reuse At Least 50%	(10) Recycle/Reuse At Least 75%	(14) Recycle/Reuse 95%	
		Projected Level of Achievement (High) **(14) Recycle/Reuse 95%**	(A) Develop an operational waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or commingled.				
		Baseline: Existing facility? **Notes:** List operational waste: biosolids product (better land application), energy, wastewater (back to creek or used for process) What % of total waste would go to landfill? County operational waste policy? Update to Solid Waste Management Plan? Zero Waste Resolution 11/19/15	(B) The project team identifies waste streams or byproducts that will occur as a result of the operation of the project. The project is planned or designed to **divert at least 25%** of operational waste. Diversion may be a combination of waste reduction measures and/or sourcing waste to other facilities for recycling or reuse.	(B) The project team identifies waste streams or byproducts that will occur as a result of the operation of the project. The project is planned or designed to **divert at least 50%** of operational waste. Diversion may be a combination of waste reduction measures and/or sourcing waste to other facilities for recycling or reuse.	(B) The project team identifies waste streams or byproducts that will occur as a result of the operation of the project. The project is planned or designed to **divert at least 75%** of operational waste. Diversion may be a combination of waste reduction measures and/or sourcing waste to other facilities for recycling or reuse.	(B) The project team identifies waste streams or byproducts that will occur as a result of the operation of the project. The project is planned or designed to **divert at least 95%** of operational waste. Diversion may be a combination of waste reduction measures and/or sourcing waste to other facilities for recycling or reuse.	
		RA1.4 Reduce Construction Waste	A + B	A + B	A + B	A + B	Not Available
		Projected Level of Achievement (Low) **(7) Recycle/Reuse 50%**	(4) Recycle/Reuse 25%	(7) Recycle/Reuse 50%	(10) Recycle/Reuse 75%	(16) Recycle/Reuse 95%	
		Projected Level of Achievement (High) **(10) Recycle/Reuse 75%**	(A) Implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or commingled.				
		Notes: Discuss inclination of County toward specifying a construction waste diversion goal and requiring a construction waste management plan. Envision workshop: - Brian – we will look and see what previous project have done, and provide guidance. Would like to include guidance from the contractors regarding - Mary – Suggest reaching out to solids waste – they do asphalt and concrete recycling on site. Need to determine what they could handle. - Lisa – In a previous project, contractor greatly exceeded goal (50-75%), as self-reported recycling/reuse as waste, just as a matter of course. - Reasonable to target 75%?	(B) The project team sets a target goal for construction waste diversion. During construction **at least 25%** of waste materials are recycled, reused, and/or salvaged. Diversion may be a combination of waste-reduction measures and sourcing waste to other facilities for recycling or reuse.	(B) The project team sets a target goal for construction waste diversion. During construction **at least 50%** of waste materials are recycled, reused, and/or salvaged. Diversion may be a combination of waste-reduction measures and sourcing waste to other facilities for recycling or reuse.	(B) The project team sets a target goal for construction waste diversion. During construction **at least 75%** of waste materials are recycled, reused, and/or salvaged. Diversion may be a combination of waste-reduction measures and sourcing waste to other facilities for recycling or reuse.	(B) The project team sets a target goal for construction waste diversion. During construction **at least 95%** of waste materials are recycled, reused, and/or salvaged. Diversion may be a combination of waste-reduction measures and sourcing waste to other facilities for recycling or reuse.	

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Stakeholder | Need additional review

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CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
RESOURCE ALLOCATION	MATERIALS	**RA1.5 Balance Earthwork On Site**	A	A	A	A	Not Available
		Projected Level of Achievement (Low) **None** *Projected Level of Achievement (High)* **(2) Reuse At Least 30% On Site**	(2) Reuse At Least 30% On Site	(4) Reuse At Least 50% On Site	(6) Reuse At Least 80% On Site	(8) Fully Balanced Site	
		Notes: Amount of earthwork needed? Plan to balance cut/fill? Distance of county source and/or disposal sites? Will be earthwork required due to hill. Likely have to haul off soil. Goal would be to reuse soil on site. Requirement for delivery team - cost implication? Does the county have a location nearby that could use extra soil?	(A) Excavated material moved off site and/or fill brought onto the site does not exceed 70% of total site soil handling. OR 100% of fill and excavated materials are sourced or reused within 25 mi/40 km of the site.	(A) Excavated material moved off site and/or fill brought onto the site does not exceed 50% of total site soil handling. OR 100% of fill and excavated materials are sourced or reused within 10 mi/16 km of the site.	(A) Excavated material moved off site and/or fill brought onto the site does not exceed 20% of total site soil handling. OR 100% of fill and excavated materials are sourced or reused within 5 mi/8 km of the site.	(A) The site is fully balanced. No earthwork is removed from the site and no earthwork is imported.	
	ENERGY	**RA2.1 Reduce Operational Energy Consumption**	A + B	A + B	A + B	A + B	Not Available
		Projected Level of Achievement (Low) **(6) 10% Energy Reduction** *Projected Level of Achievement (High)* **(6) 10% Energy Reduction**	(6) 10% Energy Reduction	(12) 30% Energy Reduction	(18) 50% Energy Reduction	(26) 70% Energy Reduction	
			(A) The project team determines the estimated annual energy consumption of the project. If annual energy consumption varies, the project team submits the range of estimated performance over the project life.				
		Baseline: Existing facility? or Equipment Alternatives? ***There is a calculator for this calculation*** **Notes:** This calculation may be based on equipment selection, showing that the selected alterative uses less energy than another seriously considered alternative. What are other operational energy uses? Lighting? What type of lighting is used in existing facility, i.e. fluorescent vs. LED? Will lighting type change due to project? Previously said more lighting will be added. - lighting - cooling options - HVAC Solids reduced by 50% resulting in less truck traffic and hauling costs (truck fuel would not be included in this credit.) CIP - Implement more effective technology that will be more energy efficient; Recover energy from the wastewater process - energy recovered in the form of methane may be utilized to power the ART fleet, reduce the Plant's energy footprint, and/or sold back into the power grid or to Washington Gas as renewable natural gas. Updates to Green Building Incentive Policy: Include baseline items that address specific **energy measures including energy** and water efficient appliances, electric vehicle charging, renewable energy, **ventilation performance**, refrigerant leakage, and energy benchmarking. Meet specified energy optimization criteria to ensure energy efficiency above the LEED baseline *incentivize exceptional energy efficient design and construction New prerequisites include renewable energy, electric vehicle charging, social equity, and other **energy** and community sustainability criteria.	(B) Operational energy is **reduced at least 10%.** Energy consumption of the project includes: • Energy purchased from the grid • Energy generated on site • Fuels used on site by the project Natural gas; ability to use natural gas being created. Makes more sense to sell the gas produced by the project (net exporting). Offsets fossil fuel 100% with the export.	(B) Operational energy is **reduced at least 30%.**	(B) Operational energy is **reduced at least 50%.**	(B) Operational energy is **reduced at least 70%.**	
		RA2.2 Reduce Construction Energy Consumption	A	A + B	A + B	A + B	Not Available
		Projected Level of Achievement (Low) **(4) At Least Two Reduction Strategies** *Projected Level of Achievement (High)* **(4) At Least Two Reduction Strategies**	(1) Identify Reduction Opportunities	(4) At Least Two Reduction Strategies	(8) At Least Four Reduction Strategies	(12) At Least Six Reduction Strategies	
			(A) The project team conducts one or more planning reviews to identify and analyze options for reducing energy consumption during construction.				
		There is a calculator for this calculation **Notes:** Discuss with client - planning session + discussion of strategies Envision workshop: - Mary – likes the idea of putting the goal in the specifications "at least 2" and then leaving it up to the contractor to choose how to implement them. - There is a truck idling policy.		(B) The project implements, or has written requirements to implement, **at least two (2)** energy reduction strategies.	(B) The project implements, or has written requirements to implement, **at least four (4)** energy reduction strategies.	(B) The project implements, or has written requirements to implement, **at least six (6)** energy reduction strategies.	

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Stakeholder	Need additional review

CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
		ALL CREDITS *- The team will decide whether or not to exclude a credit and must provide a clear justification if a credit is deemed not applicable to a project.*			LEVEL OF ACHIEVEMENT		
RESOURCE ALLOCATION	ENERGY	**RA2.3 Use Renewable Energy**	A	A	A	A	A
		Projected Level of Achievement (Low) **(24) Net Positive** *Projected Level of Achievement (High)* **(24) Net Positive**	(5) At Least 5%	(10) At Least 15%	(15) At Least 30%	(20) At Least 50%	(24) Net Positive
		There is a calculator for this calculation **Notes: **This credit is related to offsetting the PROJECT's energy needs through renewal energy** Engine generators - making energy on site via biogas - evaluating option May depend on where fuel goes - offset fossil fuels in transportation vehicles. Ask ISI about this question. Study - LCC - biggest value and best GHG reduction. Updates to Green Building Incentive Policy: Renewable Energy/Solar: The Policy update requires applicants to install on-site solar generation (or other acceptable forms of renewable energy) equal to at least 2.0 watts per square foot of roof area. For most buildings this would result in about 15-20% of the roof area being covered by solar panels. An off-site renewable purchase option is available. For buildings without sufficient solar exposure due to unavoidable shading, a contribution to the Green Building Fund ($4/ square foot or roof area) is permitted. This update supports Arlington's Community Energy Plan goal to increase Arlington's renewable energy resources with the installation and use of 160 megawatts (MW) of onsite solar electricity.	(A) The project meets: **5%** of energy needs (electricity and fuel) from renewable sources.	(A) The project meets: **15%** of energy needs (electricity and fuel) from renewable sources.	(A) The project meets: **30%** of energy needs (electricity and fuel) from renewable sources.	(A) The project meets: **50%** of energy needs (electricity and fuel) from renewable sources.	(A) The project generates a net positive amount of renewable energy.
		RA2.4 Commission & Monitor Energy Systems	A + B	A + B	A + B + C	A + B + C	Not Available
		Projected Level of Achievement (Low) **(6) Extensive Initial Commissioning** *Projected Level of Achievement (High)* **(6) Extensive Initial Commissioning**	(3) Basic Initial Commissioning	(6) Extensive Initial Commissioning	(12) Long-Term Commissioning	(14) Advanced Initial and Long-Term Commissioning	
		Notes: Monitoring at current plant - for energy? 100% Is commissioning required? Yes BI dashboard with all energy/electricity usage. Updates to Green Building Incentive Policy: Post-Occupancy Building Performance and Certification: Energy models are predictive and guide the design and construction of the building. However, they do not ensure that the building will operate to the specified level of energy efficiency. All building types must comply with post occupancy energy performance standards either through Energy Star certification or by demonstrating with utility data that the project meets the LEED approved energy model's predicted energy use.	(A) The project includes energy monitoring capabilities. Equipment and/or software are incorporated to allow detailed monitoring of performance during operation. The equipment is capable of independently monitoring all primary project functions, accounting for **at least 50%** of energy use/consumption. (B) The project conducts an initial commissioning of energy systems accounting for at least 50% of the total energy consumption/generation. Commissioning includes a detailed log of issues.	(A) The project includes energy monitoring capability. Equipment and/or software are incorporated to allow detailed monitoring of performance during operation. The equipment is capable of independently monitoring all primary project functions, accounting for **at least 75%** of energy use/consumption. (B) The project conducts an initial commissioning of energy systems accounting for at least 75% of the total energy consumption/generation. Commissioning includes a detailed log of issues.	(A) The project includes integrated energy management systems. Energy management software is incorporated to allow for detailed and centralized monitoring and reporting of performance. The equipment is capable of independently monitoring all primary project functions, accounting for **at least 90%** of energy use/consumption. (B) The project conducts an initial commissioning of energy systems accounting for at least 90% of the total energy consumption/generation. Commissioning includes a detailed log of issues. (B - Superior) The owner engages a third party or in-house commissioning agent not involved in the planning/design of the project. (B - Conserving) The owner engages an independent third-party commissioning agent. (C) A comprehensive plan is developed for ongoing periodic re-commissioning/review of energy systems throughout the expected life of the project.		
	WATER	**RA3.1 Preserve Water Resources**	A + B	A + B + C	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F
		Projected Level of Achievement (Low) **(5) Good Water Resource Management** *Projected Level of Achievement (High)* **(5) Good Water Resource Management**	(3) Increased Awareness of Watershed Issues	(5) Good Water Resource Management	(7) Wise Water Resource Management	(9) Total Water Management	(12) Positive Impact
		Notes: Site planning Use plant water vs. potable water when possible Reduce amount of lime trucked on site Comprehensive Plan - Stormwater MP, Chesapeake Bay preservation plan, Water Distribution MP; Watershed Retrofit Study MS4 permit compliance on site	(A) Assess the project's watershed context and the watershed-scale fresh water issues, including location, type, quantity, rate of recharge, and quality of water resources, as well as source and impacts of water used and the destination and impacts of wastewater. (B) Estimates of water usage and wastewater generation over the life of the project. (C) The project has features intended to reduce the identified negative impacts of water usage, and/or improve watershed-scale issues. (D) The project has a net-zero impact on the quantity and availability of fresh surface water and groundwater supplies without compromising water quality. (E) The project is part of, or contributes to, a watershed or regional water plan. (F) The project makes a direct and significant net-positive improvement to the watershed.				

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CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
RESOURCE ALLOCATION	WATER	**RA3.2 Reduce Operational Water Consumption**	A + B	A + B + C	A + B + C	A + B + C	A + B + C + D
		Projected Level of Achievement (Low) **None** *Projected Level of Achievement (High)* **None**	(4) At Least 25% Reduction	(9) At Least 50% Reduction	(13) At Least 75% Reduction	(17) 95% Reduction	(22) Water Purification
			(A) The project team conducts planning or design reviews to identify potable water reduction strategies during operation of the project. The team has considered using alternatives such as nonpotable water, reused water, recycled water, and stormwater.				
		Baseline: Existing facility? **Notes:** Using more water - likely wouldn't pursue.	(B) The project reduces potable water use by **at least 25%**.	(B) The project reduces potable water use by **at least 50%**. (C) Overall water use (potable and nonpotable) is reduced by **at least 20%**.	(B) The project reduces potable water use by **at least 75%**. (C) Overall water use (potable and nonpotable) is reduced by **at least 30%.**	(B) The project reduces potable water use by **at least 95%**. (C) Overall water use (potable and nonpotable) is reduced by **at least 40%**.	(B) The project reduces potable water use **by 100%**. (C) Overall water use (potable and nonpotable) is reduced by **at least 50%.** (D) The project not only reduces potable water consumption to zero, but also provides water that can be used by the community.
		RA3.3 Reduce Construction Water Consumption	A + B	A + B	A + B	A + B	Not Available
		Projected Level of Achievement (Low) **(1) Identify Consumption and Reduction Options** *Projected Level of Achievement (High)* **(1) Identify Consumption and Reduction Options**	(1) Identify Consumption and Reduction Options	(3) At Least Two Strategies	(5) At Least Four Strategies	(8) No Potable Water Consumption	
			(A) The project team conducts one or more planning reviews to identify and analyze options for reducing water consumption during construction.				
		Notes: Any opportunities to reduce construction water consumption? Would the project team conduct a planning review? Monitoring may be reasonable	(B) At least one (1) potable water conservation strategy is implemented.	(B) At least three (3) potable water conservation strategies are implemented.	(B) At least five (5) potable water conservation strategies are implemented.	(B) No potable water consumption, except for human consumption and hygiene, by means of implementing as many strategies as necessary.	
		RA3.4 Monitor Water Systems	A	A	A	A + B	Not Available
		Projected Level of Achievement (Low) **(3) Operations Monitoring** *Projected Level of Achievement (High)* **(3) Operations Monitoring**	(1) One-Time Monitoring	(3) Operations Monitoring	(6) Long-Term Monitoring	(12) Responsive Monitoring	
		Notes: Are systems in place in the current system(s) that monitor water quality and/or quantity? Will those be used by systems included in this project? Any upgrades or additions to monitoring?	(A) The project includes monitoring capabilities. Equipment and/or software are incorporated in the design to allow detailed monitoring of performance (quantity or quality). The equipment is capable of monitoring all primary project functions, accounting for **at least 50%** of water use.	(A) The project includes monitoring capabilities. Equipment and/or software are incorporated in the design to allow detailed monitoring of performance (quantity or quality). The equipment is capable of monitoring all primary project functions, accounting for **at least 75%** of water use.	(A) The project includes monitoring capabilities. Equipment and/or software are incorporated in the design to allow detailed monitoring of performance (quantity or quality). The equipment is capable of monitoring all primary project functions, accounting for **at least 95%** of water use.	(B) The project demonstrates that real-time water monitoring equipment and/or software has been incorporated along with a plan for using this data to improve water equality and efficiency, reduce leakage, and/or conserve water.	
		RA0.0 Innovate or Exceed Credit Requirements					
		Projected Level of Achievement (Low) **+2 points** *Projected Level of Achievement (High)* **+4 points** **Notes:** Updates to Green Building Incentive Policy: Electric Vehicle Charging: All projects will include electric vehicle charging stations and electric vehicle "ready" infrastructure to support anticipated future demand for electric vehicle charging. Biofuel analysis/study Energy analysis for process cooling needs	**(up to +10) Innovate or exceed credit requirements.** (A) Implement innovative methods, technologies, or processes that are novel either in their use, application, or within the local regulatory or cultural context. OR (B) Implement measures that exceed the highest existing requirements within one or more Resource Allocation credits. OR (C) Address additional aspects of sustainability not currently recognized in Envision				
					Maximum RA Points (w/o Innovation)	196	

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			LEVEL OF ACHIEVEMENT				
NATURAL WORLD	SITING	**NW1.1 Preserve Sites of High Ecological Value**	A + B	A + B	A + C	(A + C + D) or E	A + C + D + F
		Projected Level of Achievement (Low) **Not applicable** *Projected Level of Achievement (High)* **Not applicable** **Notes:**	(2) Improved Siting	(6) Full Mitigation	(12) Total Avoidance	(16) Habitat Protection	(22) Habitat Expansion
			(A) The project team identifies areas of high ecological value. (B) Mitigation measures, including avoidance, minimization, restoration, and offsets, fully compensate for project impacts to sites of high ecological value. Mitigation may occur off site.	(B) Mitigation measures including avoidance, minimization, restoration, and offsets, fully compensate for project impacts to sites of high ecological value. Mitigation is on site or an adjacent	(C) The project avoids developing or disturbing 100% of areas of high ecological value located on site.	(D) The project establishes effective protective buffer zones around areas of high ecological value. (E) The project team can demonstrate that the site was intentionally chosen to avoid development on or near sites of high ecological value.	
		NW1.2 Provide Wetland and Surface Water Buffers	A + B + C	A + B + C	A + B + C	(A + B + C) or D	A + B + C + E
		Projected Level of Achievement (Low) **Not applicable** *Projected Level of Achievement (High)* **Not applicable** **Notes:**	(2) Buffers	(5) Managed Buffers	(10) Mixed Buffers	(16) Natural Buffers	(20) Buffer Restoration
			(A) The project team identifies wetlands and surface water on or near the site, or with the potential to be impacted by the project. (B) The project team identifies the appropriate type and width of buffer zones for wetlands and surface waters. (C) The project provides vegetated or natural buffer zones around at least 90% of wetlands and surface waters on site. The remaining areas (<10%) are	(C) The project provides a buffer of managed vegetated zones around all wetlands and surface waters. Managed zones may include grass. The buffer	(C) The project provides a mixed buffer of managed vegetation and natural zones around all wetlands and surface waters. Natural areas are not managed and	(C) The project provides a buffer of natural zones around all wetlands and surface waters. The buffer is of sufficient width to slow surface runoff, and trap sediments, pesticides, and other pollutants. Minimum width is 200 ft/60 m unless otherwise justified under criterion B.	
		NW1.3 Preserve Prime Farmland	Not Available	A + B + C	A + B + C	(A + B) or D	A + B + E
		Projected Level of Achievement (Low) **Not applicable** *Projected Level of Achievement (High)* **Not applicable** **Notes:** Proposed facilities fit within existing plant site		(2) Less than 10% Disturbance	(8) Less than 5% Disturbance	(12) 100% Avoidance	(16) Restore Productive Farmland
				(A) The project team identifies soils designated as prime farmland, unique farmland, or farmland of importance. (B) **Less than 10%** of the project site is developed or disturbed prime farmland. (C) Farmland permanently damaged or disturbed as a result of the project is mitigated through offsets. Any farmland temporarily disturbed as a result of construction impacts is restored to a level that does not decrease the capacity of the preserved land.	(B) **Less than 5%** of the project site is developed or disturbed prime farmland.	(B) The project avoids developing or disturbing any prime farmland located on site. OR (D) The project team can demonstrate the site was intentionally chosen to avoid areas of prime farmland.	(E) In addition to 100% avoidance, the project includes protecting farmlands for posterity against future disturbance, or restoring previously developed areas to a contiguous,
		NW1.4 Preserve Undeveloped Land	A	A	A	A	A + B
		Projected Level of Achievement (Low) **(18) 100% Previously Developed** *Projected Level of Achievement (High)* **(18) 100% Previously Developed** **Notes:** Proposed facilities fit within existing plant site	(3) At Least 25% Previously Developed	(8) At Least 50% Previously Developed	(12) At Least 75% Previously Developed	(18) 100% Previously Developed	(24) Restore Natural Areas
			(A) **At least 25%** of the developed area of the project is located on previously developed land.	(A) **At least 50%** of the developed area of the project is located on previously developed land.	(A) **At least 75%** of the developed area of the project is located on previously developed land.	(A) **100%** of the developed area of the project is located on previously developed land.	(B) Return developed areas to a condition that supports, or could support, open space, habitat, or natural hydrology.
	CONSERVATION	**NW2.1 Reclaim Brownfields**	A	B + C	B + C	B + C	B + C + D
		Projected Level of Achievement (Low) **Not applicable** *Projected Level of Achievement (High)* **Not applicable** **Notes:**	(11) Reuse Former Brownfield	(13) Mitigate Exposure	(16) Passive Remediation	(19) Active Remediation	(22) Complete Remediation
			(A) The project is located on a site classified as a brownfield that has been remediated by others.	(B) The project is located on a site classified as a brownfield, or is known to contain contamination. (C) Minimum required capping and remediation is performed to reduce human exposure to safe levels. Contaminants remain generally on site at levels that can be addressed by engineering and/or institutional controls.	(C) Passive remediation is performed to reduce human exposure and to gradually remove or break down contamination on the site.	(C) Active remediation, or a combination of active and passive remediation, is performed to reduce human exposure and to remove or break down contamination on the site.	(C) Active remediation, or a combination of active and passive remediation, is performed to restore the entirety of site soils and/or groundwater back to regional background or unrestricted use levels. (D) The site is closed/deregulated by regulators,
		NW2.2 Manage Stormwater	A + B + C	A + B + C	A + B + C	A + B + C	A + B + C + D
		Projected Level of Achievement (Low) **None** *Projected Level of Achievement (High)* **None** **Notes:** County goal Compare criteria to what is required for permitting	(2) Expanded Options	(4) 85th percentile/2-year event	(9) 90th percentile/10-year event	(17) 95th percentile/50-year event	(24) 95th percentile/100-year event
			(A) Detain and treat 100% of the 85th percentile local 24-hour event. Ensure compliance with local requirements if stricter. (B) Do not exceed rate or quantity of runoff for the 24-hour rainfall event relative to the existing condition (greenfield, greyfield, or brownfield). Improved: 2-year | Enhanced: 2- and 5-year | Superior: 2-, 5-, and 10-year | Conserving: 2-, 5-, 10-, 25-, and 50-year | Restorative: 2-, 5-, 10-, 25-, 50-, and 100-year (C) The project includes an erosion, sedimentation, and pollutant control plan for construction activities.				(C) The project includes an erosion, sedimentation, and pollutant control plan for construction activities. (D) The project manages or treats stormwater from other sites according to criterion A, OR returns the site to a predevelopment hydrological condition.

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			LEVEL OF ACHIEVEMENT				
NATURAL WORLD	CONSERVATION	**NW2.3 Reduce Pesticide & Fertilizer Impacts**	A + B	A + B + C	A + B + C + D	C	C
			(1) Application Management	(2) Less Pesticide or Fertilizer	(5) Better Selection, Lower Use	(9) No Pesticide or Fertilizer Use	(12) Pesticide or Fertilizer Elimination

Projected Level of Achievement (Low)
(9) No Pesticide or Fertilizer Use
Projected Level of Achievement (High)
(9) No Pesticide or Fertilizer Use

Notes:
County policy or program for county properties??
Any landscaping? Around edge of facility
Stakeholder discussions - do they want to use the end product for other landscaping?

Envision workshop:
- Mary - Can be included in the specs now – plants shall not require pesticides or fertilizers
- Charles – Some of this should be included in the "public master plan"
- Lisa – Is there anything in Arlington's Landscaping contracts about reduced fertilizer?
- Mary – We should look through the contracts. We do require native plants, I believe, so it may be in there.

(A) Operational policies and programs are designed to control the application of pesticides and fertilizers so they are not over-applied.
(B) Runoff controls are put in place to minimize contamination of groundwater and surface water.
(C) Landscaping is designed to incorporate plant species that require **fewer** fertilizers/pesticides.
(D) When needed, pesticides and fertilizers with low toxicity, persistence, and/or bioavailability are specified.
Conserving: (C) Landscaping is designed with plant species that **do not** require pesticides or fertilizers.
Restorative: (C) Landscaping is designed with plant species that **do not** require pesticides or fertilizers. This includes eliminating the need for pesticides and/or fertilizers on sites with prior use of pesticides or fertilizers.

CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
NW2.4 Protect Surface & Groundwater Quality	A + B	A + B + C	A + B + C + D	A + B + C + D + E	A + B + C + D + E + F
	(2) New Pathway Avoidance	(5) Community Support	(9) Risk Reduction	(14) Public Reporting	(20) Quality Improvement

Projected Level of Achievement (Low)
(2) New Pathway Avoidance
Projected Level of Achievement (High)
(2) New Pathway Avoidance
Baseline: ________________ (needed for criterion F)

Notes:

(A) The project team determines potential impacts to surface water or groundwater quality, including temperature, during construction and operations.
(B) The project includes spill and leak diversion systems, spill prevention plans, and cleanup. The project does not create new direct pathways for surface water and/or groundwater contamination such as:
- Direct runoff into karst terrain;
- Untreated industrial or chemical discharge to unlined industrial ponds or lakes;
- Reinjection water wells unless water is treated to secondary levels, or local regulations, whichever is more stringent; or
- Chemical, byproduct, or fracking water, injection.

(C) Based on the types of impacts identified in criterion A, the project reduces the risk of quality degradation to surface water and/or groundwater. This should include water temperature.
(D) Adequate measures enable responsive surface water and/or groundwater quality monitoring and reporting mechanisms to provide the public with water quality data.
(E) The project has actively eliminated at least one source of hazardous and/or potentially polluting substances, or replaced them with nonhazardous or nonpolluting substances or materials.
(F) The project improves surface water and/or groundwater quality beyond existing conditions.

ECOLOGY

CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
NW3.1 Enhance Functional Habitats	A + B	A + B + (C, D, or E)	A + B + (C, D, or E)	A + B + C + D + E	A + B + C + D + E + F
	(2) Mitigate Impacts	(5) One Ecosystem Function	(9) Two Ecosystem Functions	(15) Three Ecosystem Functions	(18) Restore and Create Habitats

Projected Level of Achievement (Low)
Not applicable
Projected Level of Achievement (High)
Not applicable
Notes:

(A) The project team identifies existing habitat types on or near the project site. Efforts are made to avoid and minimize impacts to existing terrestrial habitats.
(B) Mitigation measures ensure that existing habitat functions as defined in criteria C, D, and E are maintained (i.e., not degraded or lost). Mitigation must occur on or adjacent to the site and follow a hierarchy that prioritizes avoidance, minimization, restoration, and compensation.
Conserving/Restorative: (B) The project ensures that no existing habitats are disturbed or damaged.
Enhanced: (C, D, or E) Enhance **one or more** ecosystem functions compared to existing conditions:
Superior: (C, D, or E) Enhance **two or more** ecosystem functions compared to existing conditions:
Conserving: (C, D, and E) Enhance **all three** ecosystem functions compared to existing conditions:
Restorative: (C, D, and E) Enhance all three ecosystem functions compared to existing conditions:

CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
NW3.2 Enhance Wetland & Surface Water Functions	A + B + (C, D, E or F)	A + B + (C, D, E or F)	A + B + (C, D, E or F)	A + B + C + D + E + F	A + B + C + D + E + F
	(3) Enhance One Ecosystem Function	(7) Enhance Two Ecosystem Functions	(12) Enhance Three Ecosystem Functions	(18) Enhance Four Ecosystem Functions	(20) Restore Ecosystem Function

Projected Level of Achievement (Low)
Not applicable
Projected Level of Achievement (High)
Not applicable
Notes:

(A) Project team identifies project impacts to hydrologic connection, water quality, aquatic habitat, and sediment transport.
(B) Efforts are made to avoid and minimize negative impacts to wetland and surface water functions and to compensate for remaining unavoidable losses. Mitigation measures must maintain net aquatic habitat quality and quantity and follow a hierarchy that prioritizes avoidance, minimization, restoration, and compensation.
Conserving/Restorative: (B) The project ensures that no existing wetlands or surface water functions are disturbed or damaged as a result of the project.
Improved: (C, D, E or F) Actively protect **one** ecosystem function.
- Hydrologic Connection (C)

Enhanced: (C, D, E or F) Actively protect **two** ecosystem functions.
Superior: (C, D, E or F) Actively protect **three** ecosystem functions.
Conserving: (C, D, E and F) Actively protect **four** ecosystem functions.
Restorative: (C, D, E and F) Actively protect **four** ecosystem functions.

CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
NW3.3 Maintain Floodplain Functions	A + B	A + B + C	A + B + C	(A + B + C) OR D	A + B + C + E
	(1) 75% Avoidance	(3) 85% Avoidance	(7) 95% Avoidance	(11) Floodplain Preservation	(14) Floodplain Restoration

Projected Level of Achievement (Low)
Not applicable
Projected Level of Achievement (High)
Not applicable

Notes:
It appears that most of the treatment plant is in the floodplain, but that none of the land that this project is on is shown in the floodplain.

(A) The project team identifies the 100-year or design frequency floodplain. Consideration is given to future floodplain scenarios.
(B) The project site maintains a net quantity of at least XX% (see above) of natural/vegetated area within the floodplain.
(C) Project mitigates impacts to floodplain functions including conveyance and storage. Overall floodplain functions are not diminished as a result of the project. Functions should be maintained both above and below the 10-year flood.
Applicability: Projects that are not within the floodplain ***and do not impact floodplain functions***, may apply to have this credit deemed not applicable with supporting documentation.
Conserving: OR
(D) The project team can demonstrate the site was intentionally chosen to avoid development on or near the 100-year or design frequency floodplain.
Restorative: (E) Structures are removed from the floodplain, or previously developed areas are restored to natural/vegetated zones in order to improve floodplain functions.

ISI ENVISION 3.0 CREDITS

**If the "Not Applicable" selection has an asterisk, it would be difficult to demonstrate that the credit is not applicable to a project - per the Envision v3 Guidance Manual.*

Stakeholder | Need additional review

ALL CREDITS *- The team will decide whether or not to exclude a credit and must provide a clear justification if a credit is deemed not applicable to a project.*

CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
NATURAL WORLD	ECOLOGY	**NW3.4 Control Invasive Species**	A	A + B	A + B + C	A + B + C + D + E	A + B + C + D + E + F
		Projected Level of Achievement (Low) **(2) Assessment and Prevention** *Projected Level of Achievement (High)* **(6) Program Controls**	(1) Prevention	(2) Assessment and Prevention	(6) Program Controls	(9) Minor Infestation Control	(12) Major Infestation Control
		Notes: Likely no invasive species on site - confirm. Envision workshop: - A and B are pretty easy to get. - Charles – Urban forest master plan may cover all of this. - Baseline – say "Enhanced" for now. - Consider conserving if documentation already exists.	(A) **Best practices should be used to prevent unintentional introduction** of known invasive species to the site. Landscaping utilizes only species known to be noninvasive. A construction management plan, or policies, includes provisions for preventing the introduction of invasive species (plant or animal). (B) **Identify, map and/or document invasive species infestations on site**, or collaborate with local, state/provincial, and/or federal agencies. (C) **Establish and implement a program that controls minor infestations** of invasive species on site **before and throughout construction**. (D) The project guards against future infestations by supporting the **establishment of native and/or noninvasive species.** (E) **Long-term controls** are in place through a minimum three-year management plan to prevent the introduction or reintroduction of invasive species and perform follow-up control actions if populations persist. (F) Additionally, the project implements similar programs for controlling major infestations on site, or aquatic invasive species.				
		NW3.5 Protect Soil Health	Not Available	A + B	A + B + C	A + B + C	A + B + C + D
		Projected Level of Achievement (Low) **None** *Projected Level of Achievement (High)* **None**		(3) Restore Soils	(4) Special Feature Plan	(6) Best Management Practices	(8) Soil Restoration
				(A) The project limits the area that is disturbed by development activities. (B) **100% of post-construction vegetated areas disturbed during construction are restored** for appropriate soil type, structure, and function to support healthy plant and tree growth.			
		Notes: Likely not to pursue			(C) A soil protection plan, or policies, are prepared and implemented. The plan/policies specifically include any special landscape features.	(C) A soil protection plan, or policies, are prepared and implemented. The plan/policies specifically include any special landscape features. The plan is expanded to comply with best management practices from a local soil conservation agency, or is reviewed or prepared under the guidance of a certified soil scientist.	
		Innovation	**(+10) Innovate or exceed credit requirements.** (A) Implement innovative methods, technologies, or processes that are novel either in their use, application, or within the local regulatory or cultural context. OR (B) Implement measures that exceed the highest existing requirements within one or more Natural World credits. OR (C) Address additional aspects of sustainability not currently recognized in Envision				
		Projected Level of Achievement (Low) **None** *Projected Level of Achievement (High)* **None** **Notes:**					
						Maximum NW Points (w/o Innovation)	232

ISI ENVISION 3.0 CREDITS

**If the "Not Applicable" selection has an asterisk, it would be difficult to demonstrate that the credit is not applicable to a project - per the Envision v3 Guidance Manual.*

Stakeholder | Need additional review

***ALL CREDITS** - The team will decide whether or not to exclude a credit and must provide a clear justification if a credit is deemed not applicable to a project.*

CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				

CATEGORY: CLIMATE AND RESILIENCE

SUB-CATEGORY: EMISSIONS

CR1.1 Reduce Net Embodied Carbon

Projected Level of Achievement (Low)
None
Projected Level of Achievement (High)
None

Baseline: ______________
Notes:
Likely would not pursue

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
Criteria	A + B + C	A + B + C	A + B + C	A + B + C	Not Available
Level	(5) At Least 5% Reduction	(10) At Least 15% Reduction	(15) At Least 30% R	(20) At Least 50% Reduction	
(C)	(C) The project team demonstrates **at least a 5%** reduction in total embodied carbon of materials over the life of the project compared to the baseline. Calculations should be in tons CO_2.	(C) The project team demonstrates **at least a 15%** reduction in total embodied carbon of materials over the life of the project compared to the baseline. Calculations should be in tons CO_2.	(C) The project team demonstrates **at least a 30%** reduction in total embodied carbon of materials over the life of the project compared to the baseline. Calculations should be in tons CO_2.	(C) The project team demonstrates **at least a 50%** reduction in total embodied carbon of materials over the life of the project compared to the baseline. Calculations should be in tons CO_2.	

(A) The project team identifies primary materials to be used on the project during construction and operation. The team determines which materials are the primary contributors to net embodied carbon (collectively >80%).
(B) Embodied carbon is calculated, or acquired by a validated source, for the primary materials identified in criterion A. Calculations include: Embodied carbon of production, including raw material extraction, refinement,

CR1.2 Reduce Greenhouse Gas Emissions

Projected Level of Achievement (Low)
(8) At Least 10% Reduction
Projected Level of Achievement (High)
(8) At Least 10% Reduction

Baseline: Existing condition (over a period equivalent to the operational life of the project)

Notes:
Solids reduced by 50% resulting in less truck traffic and hauling costs

Credit requirements sent to Miranda.

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
Criteria	A + B	A + B	A + B	A + B	A + B
Level	(8) At Least 10% Reduction	(13) At Least 25% Reduction	(18) At least 50% Reduction	(22) 100% Reduction	(26) Carbon Negative
(A)	(A) The project team demonstrates **at least a 10% reduction** in total CO2e over the operational life of the project compared to the baseline.	(A) The project team demonstrates **at least a 25% reduction** in total CO2e over the operational life of the project compared to the baseline.	(A) The project team demonstrates **at least a 50% reduction** in total CO2e over the operational life of the project compared to the baseline.	(A) The project team demonstrates a **100% reduction** in total CO2e over the operational life of the project compared to the baseline.	(A) The completed project is carbon negative (i.e., sequesters/removes more CO2e than it produces over the operational life).

(B) The project team maps and calculates the total annual greenhouse gas emissions of the final project design for reporting purposes. This includes direct and indirect greenhouse gas emissions and sequestration associated with project operations. Calculations must be in CO2e.

CR1.3 Reduce Air Pollutant Emissions

Projected Level of Achievement (Low)
(2) Exceeding Requirements
Projected Level of Achievement (High)
(2) Exceeding Requirements

Baseline: ______________
Notes:
Lower product odors
Solids MP - Appendix K Air Emissions Modeling Report

Credit requirements sent to Miranda.

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
Criteria	A + B	A + B + C	A + B + C + D	A + B + C + D	A + B + C + D + E
Level	(2) Exceeding Requirements	(4) Ongoing Monitoring	(9) VOC Minimization	(14) Air Pollutant Elimination	(18) Air Quality Improvement
(B)	(B) The project implements strategies to reduce air pollutant emissions during operations.	(B) The project reduces emissions through the use of best available control systems or best management practices.	(B) Air pollution controls are within the 95th percentile, or represent the lowest levels possible compared to projects of similar type.	(B) The project eliminates air pollutant sources in the design, chooses a non-polluting alternative, or achieves at least a 98% net reduction in air pollution emissions compared to the baseline.	

(A) The project meets all applicable air quality standards and regulations for air pollutants.
(C) Systems are in place for the ongoing monitoring of any direct sources of air pollution.
Processes are in place to identify and address changes in emissions in order to maintain performance targets.
(D) The project team assesses whether volatile organic compounds harmful to human health are material to the project and, if so, implement strategies to reduce their use during construction and/or within occupied spaces of the completed project.
(E) The project includes the direct removal of previously existing air pollutant sources, or captures and safely stores/ disposes of air pollutants for a net positive impact.

SUB-CATEGORY: RESILIENCE

CR2.1 Avoid Unsuitable Development

Projected Level of Achievement (Low)
Not applicable
Projected Level of Achievement (High)
Not applicable
Notes:

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
Criteria	A + B	A + B + C	A + B + C + D	A + B + C + E	A + B + C + F
Level	(3) Alternative Assessment	(6) Risk Mitigation	(8) Lowest Risk Alternative	(12) Unsuitable Development Avoided	(16) Strategic Retreat

(A) During planning and project siting, the project team identifies potential siting hazards and determines both the vulnerability of the project to the hazard and the potential for the project to exacerbate the hazard (e.g., creating impervious surfaces in a floodplain, building on potentially unstable hillsides). Potentially adverse sites include but are not limited to:
- Steep slopes (> 20 degrees)
- Permafrost
- Adverse geology (e.g., risk of liquefaction, subsidence, or sinkholes)
- Flood-prone areas
- At-risk coastline (coastal surges, coastal erosion)

(B) The project team assesses siting alternatives that avoid or minimize hazard exposure and/or project alternatives less vulnerable to, or likely to exacerbate, site hazards.
(C) The project includes specific strategies to mitigate the impact of site hazards on the project (e.g., elevating structures and equipment above flood levels), as well as the project development impacts on the site hazard (e.g., erosion controls on steep slopes). This may include monitoring and response plans.
(D) Based on alternatives identified in criterion C, the project team can demonstrate the selected project and site resulting in the lowest exposure to site risk while still meeting project objectives and requirements.
(E) The project is intentionally sited to completely avoid site hazards.
(F) The project intentionally modifies or removes existing structures from areas prone to frequent damage and/or at high risk of future damage in order to prevent losses.

CR2.2 Assess Climate Change Vulnerability

Projected Level of Achievement (Low)
(8) Project Vulnerability
Projected Level of Achievement (High)
(18) Community Vulnerability
Notes:
Comprehensive Plan - CEP, Climate Action Resolution, Climate Change, Energy and Environment Commission (C2E2)

	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
Criteria	A + B	A + B + C	A + B + C + D	A + B + C + D + E	Not Available
Level	(8) Project Vulnerability	(14) System Vulnerability	(18) Community Vulnerability	(20) Knowledge Sharing	

(A) The project team conducts, or relies on, an existing, comprehensive threat/hazard identification study, or assessment, due to climate change. Threats/hazards are classified by:
- Duration: acute shocks over hours and days, or chronic stressors over years and decades.
- Extent of effects: project site (e.g., localized stormwater overflow), infrastructure system wide, or community wide (e.g., changes in climate).

The assessment should account for climate change's impact on the frequency, duration, and severity of threats/hazards.
(B) The project team determines vulnerabilities and increased risk to the project, or performance, over its **operational life** due to climate change-related threats. This should include whether current design variables will continue to meet performance goals over the life of the project under changing operating conditions (i.e., climate, weather patterns, natural hazard frequency and intensity).
(C) The project team determines vulnerabilities and increased risk to the connected/related infrastructure system or network due to climate change-related threats. This should include how project vulnerabilities may impact system performance and how system vulnerabilities may impact the project. This should include direct and indirect impacts such as resource and service availability.
(D) The project team determines vulnerabilities and increased risk to the broader community due to climate change threats. This should include how project vulnerabilities may impact the broader community and how community vulnerabilities may impact the project.
(E) The project team or owner shares climate threat findings in order to support and facilitate community awareness and their inclusion in future projects.

ISI ENVISION 3.0 CREDITS

**If the "Not Applicable" selection has an asterisk, it would be difficult to demonstrate that the credit is not applicable to a project - per the Envision v3 Guidance Manual.*

Stakeholder | Need additional review

ALL CREDITS *- The team will decide whether or not to exclude a credit and must provide a clear justification if a credit is deemed not applicable to a project.*

CATEGORY	SUB-CATEGORY	CREDIT NAME	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
			LEVEL OF ACHIEVEMENT				
CLIMATE AND RESILIENCE	RESILIENCE	**CR2.3 Evaluate Risk and Resilience**	A + B + C + D + E	A + B + C + D + E	A + B + C + D + E	A + B + C + D + E + F	Not Available
		Projected Level of Achievement (Low) **(11) Project Evaluation** *Projected Level of Achievement (High)* **(18) System Evaluation** **Notes:**	(11) Project Evaluation	(18) System Evaluation	(24) Community Evaluation	(26) Integrated and Inclusive Approach	
			(A) The project team draws the assessment boundary for subsequent criteria (B, C, D, and E) around the project and its site.	(A) The project team draws the assessment boundary for subsequent criteria (B, C, D, and E) around the interdependencies of the project and its	(A) The project team draws the assessment boundary for subsequent criteria (B, C, D, and E) around the interdependencies of the project, its associated/connected infrastructure system/network, and the broader community.		
			(B) Understand the Asset: The project team identifies the objectives and performance goals of the project and related systems. It also identifies the critical assets, systems, and networks that are essential to meeting objectives and performance goals. This should include the associated dependencies and interdependencies within the system. (C) Identify Threats/Hazards: The project team identifies threats/hazards (natural hazards and human-induced threats). Project teams may reference existing studies or assessments if relevant to the project and its context. Threats should include both acute shocks and chronic stressors. (D) Identify Vulnerability: The project team identifies the vulnerabilities of the critical functions and dependencies of the infrastructure asset and its primary components identified in criterion B to the threats/hazards identified in criterion C. (E) Evaluate Risk: The project team evaluates the project risk by determining the likelihood/probability of a threat/hazard occurring and the associated consequences/impacts. Consequences and impacts should be classified as social, environmental, and/or economic/financial. (F) The project team conducts the risk evaluation with the owner and a diverse and integrated team of key stakeholders.				
		CR2.4 Establish Resilience Goals and Strategies	Not Available	A + B	A + B + C	A + B + C + D	Not Available
		Projected Level of Achievement (Low) **(20) Shared Community Goals** *Projected Level of Achievement (High)* **(20) Shared Community Goals** **Notes:** Biogas -		(8) Strategy Development	(14) Stakeholder Input	(20) Shared Community Goals	
				(A) The project team determines the performance goals of the project and the owner's acceptable level of risk. (B) The project team uses the results of a risk evaluation to develop risk management strategies that meet project performance goals and budget, and increase project resilience. The project team prioritizes strategies that result in the greatest reduction of risk within project cost constraints.			
					(C) The project team engages the owner and key stakeholders in developing or reviewing resilience goals and strategies.		
						(D) The project team aligns project resilience goals with broader community- or regionwide resilience goals and plans. OR If community resilience goals are lacking, the project team publicly shares its resilience goals in support of developing broader community goals.	
CLIMATE AND RESILIENCE	RESILIENCE	**CR2.5 Maximize Resilience**	A + B	A + B + C	A + B + C + D	A + B + C + D + E	Not Available
		Projected Level of Achievement (Low) **(11) Improved Resilience Performance** *Projected Level of Achievement (High)* **(15) Thorough Implementation** **Notes:**	(11) Improved Resilience Performance	(15) Thorough Implementation	(20) Ongoing Resilience Monitoring	(26) Quantifying Improvement	
			(A) The project team develops resilience goals and strategies (e.g., CR2.4) based on a detailed risk evaluation of the project (e.g., CR2.3). (B) The project team takes a comprehensive approach to implementing resilience strategies. (C) The project team periodically monitors the implementation of resilience strategies and revisits their effectiveness in addressing project risk throughout project development. (D) Resilience strategies are incorporated into the operations and maintenance of the project. Organization(s) responsible for the ongoing operation of the project have systems in place to maintain, grow, learn, and continually improve resilience capabilities (i.e., "plan, do, check, act"). (E) The project team establishes methods for measuring/quantifying the benefits of resilience strategies implemented (e.g., monetary savings from avoided damage or service loss, accelerated recovery time).				
		CR2.6 Improve Infrastructure Integration	A	A + B	A + B + C	A + B + C + D	A + B + C + D + E
		Projected Level of Achievement (Low) **(14) Community/Network Integration** *Projected Level of Achievement (High)* **(18) Information Integration** **Notes:**	(1) Internal Integration	(4) Risk Reduction	(8) Systems Integration	(14) Community/Network Integration	(18) Information Integration
			(A) The project increases internal systems integration in order to achieve efficiency or system diversity. (B) Integration strategies increase resilience and reduce the risk of systemic or cascading failures. (C) The project leverages its relationship within a larger infrastructure system in order to achieve efficiency or system diversity. (D) The project integrates networks of infrastructure systems (e.g., water and transportation) in order to achieve efficiency or system diversity. In certain cases, projects may substitute the community integration of non-physical social or economic systems. (E) The project integrates data or monitoring systems with reporting or preparedness systems in order to learn and improve performance over time.				
		Innovation *Projected Level of Achievement (Low)* **None** *Projected Level of Achievement (High)* **None** **Notes:** GHG Emission work - fit within CEP	**(+1-10) Innovate or exceed credit requirements.** (A) Implement innovative methods, technologies, or processes that are novel either in their use, application, or within the local regulatory or cultural context. OR (B) Implement measures that exceed the highest existing requirements within one or more Climate and Resilience credits. OR (C) Address additional aspects of sustainability not currently recognized in Envision				
						Maximum CR Points (w/o Innovation)	**190**

**** Not every credit has a restorative level. Therefore totals include the maximum possible points for each credit whether conserving or restorative.*

1,000 total pts + 50 extra = 1,050 TOTAL

Appendix C. Envision Credit Documentation Sources

Documentation to support the verification submission can come from all Program development phases (planning, design, construction, etc.), as well as external to the project, such as Arlington County policies and initiatives that can support Envision. The matrix in Appendix C provides a snapshot of potential Program phase or source of documents that may support each credit, depending on the pursued LOA.

The documentation sources identified in the matrix are identified as follows:

- **Owner:** The owner can be the organization/agency leading the project or any connected agencies that may have policies, standards, procedures, design guidelines, standard specifications, or regulations that impact project design, construction, or operation.
- **Planning/environmental:** This documentation may result from planning efforts, including an environmental assessment or environmental impact statement. Planning documents may extend beyond project planning to related master plans, capital plans, etc., developed by the owner or related organizations.
- **Designer:** These documents are produced by a designer, engineer, etc. and would be primarily project-specific, with the exception of organizational commitments. This could include documents like alternatives analyses and basis-of-design reports, but would explicitly include Program specifications, drawings, and related materials.
- **Contractor:** This documentation is provided by the construction contractor and would include items like a construction management plan, construction waste management plan, and site security plan, as well as information on organizational commitments.
- **External:** Because many Envision credits reference the Program's connections to community needs and goals, there may be documents external to the Program that can be used to support some credits. This could include community plans, climate action plans, strategic plans, databases, and ordinances or regulations. Research may also be conducted to support credits, such as using the U.S. Department of Agriculture Web Soil Survey to locate or disprove prime farmland within the project area.

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Envision Credit Documentation Sources

	Credit	Likely Documentation Source(s): Owner (Policy/Standards)	Planning/Environmental	Designer	Contractor	External
QUALITY OF LIFE	QL1.1 Improve Community Quality of Life		■	■		■
	QL1.2 Enhance Public Health and Safety	■	■	■		■
	QL1.3 Improve Construction Safety	■		■	■	
	QL1.4 Minimize Noise and Vibration	■	■	■		
	QL1.5 Minimize Light Pollution	■	■	■		
	QL1.6 Minimize Construction Impacts	■		■	■	
	QL2.1 Improve Community Mobility and Access	■	■	■		■
	QL2.2 Encourage Sustainable Transportation		■	■		
	QL2.3 Improve Access and Wayfinding	■	■	■		
	QL3.1 Advance Equity and Social Justice	■	■	■	■	
	QL3.2 Preserve Historic and Cultural Resources		■	■		
	QL3.3 Enhance Views and Local Character	■	■	■		■
	QL3.4 Enhance Public Space and Amenities		■	■		
LEADERSHIP	LD1.1 Provide Effective Leadership and Commitment	■	■	■	■	
	LD1.2 Foster Collaboration and Teamwork	■	■	■	■	
	LD1.3 Provide For Stakeholder Involvement		■	■		
	LD1.4 Pursue Byproduct Synergies		■	■		■
	LD2.1 Establish A Sustainability Management Plan	■	■	■	■	
	LD2.2 Plan For Sustainable Communities	■	■			■
	LD2.3 Plan For Long-Term Monitoring and Maintenance	■	■	■		
	LD2.4 Plan For End-of-Life	■		■		
	LD3.1 Stimulate Economic Prosperity and Development	■	■	■		
	LD3.2 Develop Local Skills and Capabilities	■	■	■	■	
	LD3.3 Conduct a Life-Cycle Economic Evaluation		■	■		■
RESOURCE ALLOATION	RA1.1 Support Sustainable Procurement Practices	■		■	■	
	RA1.2 Use Recycled Materials	■		■	■	
	RA1.3 Reduce Operational Waste	■			■	
	RA1.4 Reduce Construction Waste	■		■	■	
	RA1.5 Balance Earthwork On Site	■		■	■	
	RA2.1 Reduce Operational Energy Consumption	■		■	■	
	RA2.2 Reduce Construction Energy Consumption	■		■	■	
	RA2.3 Use Renewable Energy	■				■
	RA2.4 Commission and Monitor Energy Systems	■		■		
	RA3.1 Preserve Water Resources	■	■	■		
	RA3.2 Reduce Operational Water Consumption	■	■	■		
	RA3.3 Reduce Construction Water Consumption	■		■	■	
	RA3.4 Monitor Water Systems	■				
NATURAL WORLD	NW1.1 Preserve Sites of High Ecological Value		■	■	■	
	NW1.2 Provide Wetlands and Surface Water Buffers		■	■	■	
	NW1.3 Preserve Prime Farmland		■			
	NW1.4 Preserve Undeveloped Land	■	■			
	NW2.1 Reclaim Brownfields	■	■			
	NW2.2 Manage Stormwater	■		■	■	
	NW2.3 Reduce Pesticide and Fertilizer Impacts	■		■	■	
	NW2.4 Protect Surface and Groundwater Quality	■	■	■	■	
	NW3.1 Enhance Functional Habitats		■	■	■	
	NW3.2 Enhance Wetland and Surface Water Functions		■	■	■	
	NW3.3 Maintain Floodplain Functions		■	■	■	
	NW3.4 Control Invasive Species	■	■	■	■	■
	NW3.5 Protect Soil Health	■		■	■	
CLIMATE AND RESILENCE	CR1.1 Reduce Net Embodied Carbon		■	■	■	■
	CR1.2 Reduce Greenhouse Gas Emissions	■	■	■		
	CR1.3 Reduce Air Pollutant Emissions		■	■		■
	CR2.1 Avoid Unsuitable Development		■	■		
	CR2.2 Assess Climate Change Vulnerability	■	■	■		■
	CR2.3 Evaluate Risk and Resilience	■	■	■		
	CR2.4 Establish Resilience Goals and Strategies	■		■		
	CR2.5 Maximize Resilience	■		■	■	
	CR2.6 Improve Infrastructure Integration	■	■	■		

Appendix D. Envision Credit Documentation Examples

The Appendix D matrix builds on Appendix C to provide discrete examples of documentation that could be used to support project narratives, originating from the program owner, external or programmatic documentation, and project-specific documentation.

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Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
QL1.1 Improve Community Quality of Life	• Agency/org master plans • Agency/org Strategic plans • Agency process for reviewing community needs, goals, and issues • Feedback and endorsement as part of larger planning efforts • Meeting minutes with stakeholders as part of planning efforts • Social impact assessment as part of larger planning efforts	• Community planning documents • Comprehensive plans • Strategic plans • Meeting minutes with key stakeholders, community leaders, decision makers • Presentations • Letters/emails • Design Guidelines • Potentially EIS/EIR/EA, Environmental documents completed for larger program	• Alternatives Analysis • Comments and reactions from social media platforms • Committee reports • Communication plan • Communications with representatives of affected communities, i.e, letters, emails, comment forms • Community satisfaction surveys • EIS/EIR/EA, Environmental documents • EIS/EIR/EA, Environmental documents comments and letters • Examples of how the project meets the needs could be a matrix • Interviews with representatives of affected communities • Letters • Meeting minutes (including with key stakeholders, community leaders, decision makers) • Memos • Mitigation hierarchy form (HDR)" • Notes from design charrettes • Social impact assessment as part of environmental assessment or stand-alone" • Workshop/charrette presentations
QL1.2 Enhance Public Health and Safety	• Agency/org master plans • Agency/org Strategic Plans • Agency/org policies related to health and safety • Agency/facility permits, standards, etc.	• Community plans (less likely, but could have ties to overall • Community health and safety)	• Alternatives analysis • EIS/EIR/EA, Environmental documents • Project permits
QL1.3 Improve Construction Safety	• Agency/org health & wellbeing programs • Agency/org site safety and/or security policies • Agency/org standard feedback mechanisms to identify safety risk • An agency could consider noting in an agency-level policy or plan where monitoring is committed to and encourage improvement. • An agency could develop a foundational plan and modify it to fit specific project needs; determine if any requirements need to be added to general specifications. • An agency could document standard procedures followed by all projects • Consider implementing elements of the criteria and requesting information from contractors and/or consultants • Contractor training requirements (standard spec or other) • Requirement that the contractor develop a project safety plan/program • Standard specifications re: contractor health & safety • Typical or facility site security plan		• Contractor "lesson learned" reports • Contractor communication (e.g., agendas from daily briefings, etc.) • Contractor H&S training programs (e.g., agendas or presentations for toolbox trainings, firm policies for CPR, first aid, OSHA training, etc.) • Contractor injury management documentation/process • Contractor organization health & wellbeing programs • Contractor Safety/Security Trainings • Contractor site security plan • Health and/or well-being programs • Job Hazard Analysis • Project Execution Plan • Project safety plan/program • Safety rewards program" • Security Plan (Site and Project)
QL1.4 Minimize Noise and Vibration	• Agency/org master plan(s) • Agency/org policies related to noise and/or vibration during operation • Agency/org master plan(s) -stakeholder engagement/feedback	• Potentially - EIS/EIR/EA, Environmental documents completed for larger program • Community noise ordinance or regulation	• Alternatives analysis • EIS/EIR, Environmental documents • Letters/emails • Meeting minutes • Mitigation hierarchy form • Noise monitoring plan • Plans and specifications (indicating quieter or modified equipment, noise barriers, etc.) • Project-specific noise and/or vibration assessment • Public feedback • Public surveys
QL1.5 Minimize Light Pollution	• Agency could consider adding standard lighting specification to meet backlight, uplight, and glare requirements according to IES BUG rating standards. • Agency could specify a standard cutoff lens (or options) in lighting specification for exterior use. • Agency/org fixture standards • Facility master plan • If on an existing facility, facility lighting information / facility lighting plan	• City policy/ordinance • if multiple projects, program lighting assessment • if multiple projects, program lighting plan	• EIS/EIR, Environmental documents • Light fixture cut sheets • Lighting specs • Map showing existing lighting vs. implemented lighting • Mitigation hierarchy form (HDR) • Project lighting plan • Project-specific lighting assessment • Project site map with noted lighting needs and impacts • Site map indicating location and type of each lighting strategy deployed
QL1.6 Minimize Construction Impacts	• Agency management plan or policy related to construction impacts o with guidance re: noise/vibration) o with guidance re: safety and wayfinding) o with guidance re: public space access) o with guidance re: lighting) o with guidance re: monitoring and feedback) • Agency standard construction monitoring programs • Agency/org policy related to construction management • Standard specification with contractor requirements adressign construction impacts o construction lighting (i.e., nighttime work) o maintaining access to public space and amenities during construction o pedestrian and vehicle safety and wayfinding during construction. o minimizing construction noise and vibration (should meet or exceed accepted local practices)		• Construction management plan o addressing lighting during construction o addressing plan for feedback, working with affected neighbors o including noise/vibration sources, mitigation/minimization, monitoring, and corrective action • Information from feedback mechanisms • Project specifications o addressing construction lighting (i.e., nighttime work) o addressing how access to public space and amenities will be maintained during construction. o addressing pedestrian and vehicle safety and wayfinding during construction. • Public communication (e.g., website, emails, presentations, etc.)

Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
QL2.1 Improve Community Mobility and Access	• Agency master plan(s) • Agency Complete Streets policy	• Local/regional transportation plans • City Complete Streets policy • Local mobility studies	• Alternatives analysis • Basis of Design report • Diagrams/plans illustrating mobility and access • EIS/EIR/EA, Environmental documents • Reports, memos, meeting minutes of community meetings • Reports, memos, meeting minutes showing discussion of new connections/reconnections • Traffic analysis study (impact/improvement) • Transit/mobility assessment
QL2.2 Encourage Sustainable Transportation	• Agency master plan(s) • Agency/org transportation/transit policies (e.g., transit subsidies, bikeshare, carshare, etc.) • Agency programs related to EV charging	• Info on existing facilities, walkways, trails, and networks • Availability of non-motorized transportation facilities and policies for the users • Public transportation options: service maps/bus stops near project • Local/regional transportation plans	• Alternatives analysis • Basis of Design report • EIS/EIR/EA, Environmental documents • Map showing pedestrian proximity and accessibility to active, shared, or mass transportation • Mobility & Accessibility Map • Plans and specs • Public education plan & associated items (Display boards, social media) • Transit/mobility assessment
QL2.3 Improve Access and Wayfinding	• Agency emergency response policy/procedures • Agency org policy/standard re: universal design principles • Agency signage standards		• Communication examples • EIS/EIR/EA, Environmental documents • Map showing publicly accessible areas • Plans and specification o for signage o showing universal design o showing emergency access • Public meeting responses
QL3.1 Advance Equity and Social Justice	• Agency master plan(s) • Agency/ organizational policies and commitments concerning equity and social justice diversity & inclusion, pay equity, non-discrimination • Agency/org policies on stakeholder engagement	• Community planning documents	• Analysis of stakeholder engagement process • Basis of design • EIS/EIR/EA, Environmental documents • Evidence of key team member policies and commitments concerning equity and social justice diversity & inclusion, pay equity, non-discrimination • Examples of stakeholder communication • Examples of targeting underrepresented communities • Maps showing the key demographic data identified in the assessment of social impacts overlaid with areas likely to receive benefits or impacts of the project. • Meeting minutes • Mitigation Hierarchy form (HDR) • Programs to address equity and social justice • Project specific research on historical context • Project specific social risk and impact assessment • Qualifications of individuals responsible for managing the stakeholder engagement process. • Stakeholder mapping
QL3.2 Preserve Historic and Cultural Resources	• Agency/org policy on cultural resources • Agency master plan(s) • Facility master plan	• Databases and historical records • If multiple projects (program), program EIS/EIR/EA	• Alternatives Analysis • Cultural Resources Technical Report -Project assessment of cultural resources beyond National Registries (i.e. historic neighborhoods, places, events, natural features) • EIS/EIR/EA, Environmental documents • Meeting minutes • Project plans, specs; plans showing changes in plans due to feedback) • Presentations • SHPO letter(s) / communication • Site plan, plans, specs showing mitigation • Stakeholder feedback
QL3.3 Enhance Views and Local Character	• Agency/or design guidelines • Agency/org design/aesthetic guidelines • Agency/org land use and development policies • Agency/org policies and regulations regarding public views • Agency/org policy related to construction management • Standard specification with contractor requirements related to construction impacts	• Public/city policies and regulations regarding public views • Public/city design guidelines • Public/city land use policies	• Agency/Public comment • Alternatives analysis • Basis of Design • Construction management plan -identifies important natural or man-made features deemed important to views or local character and how they will be protected during construction. • EIS/EIR/EA, Environmental documents • Inventory of all natural landscape or manmade features to be protected. • Meeting Minutes • Meeting minutes -with stakeholders • Photos/renderings • Plans and specs; Plans/specifications noting protection of important features; site plan • Public presentations • Reports • Review board presentations • Stakeholder feedback • Tree protection plan
QL3.4 Enhance Public Space and Amenities	• Agency master plan(s) • Facility master plan	• Community plan(s) --showing community needs/goals • Articles	• Alternatives Analysis • EIS/EIR/EA, Environmental documents • Letters, memoranda, and meeting minutes with stakeholders showing stakeholder involvement • Maps • Photos/renderings • Project assessment of public space/amenities • Site plan/ plans showing public space/amenities • Stakeholder engagement plan • Stakeholder feedback/approval • Written approval from officials

Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
LD1.1 Provide Effective Leadership and Commitment	• Agency/org Sustainability management policy • Agency/org sustainability commitment/strategy/goals • Agency/Organizational sustainability policies/ reports • Annual Reports • Master Plan(s) • News Releases • Standard RFP language • Strategic Plan • Sustainability reports • Websites		• Agenda, presentation, meeting minutes from chartering session/kickoff • Evidence of commitments to sustainability from each of the key project team members • Meeting minutes • Project charter • Project org chart • RFP (includes sustainability) • Specifications (include sustainability) • Sustainability Management Plan • Sustainability Management Policy • Sustainability reports
LD1.2 Foster Collaboration and Teamwork	• Project control standards/ guidelines • Integrated design standard/ guidelines		• Envision workshop • Kick-off meeting / sustainability kick-off meeting/ chartering session • List of sutainability meetings • Meeting minutes • Meeting Presentations • Org chart • Plans/specifications • Project controls • Project management plan • Project org chart • Sustainability Management Plan
LD1.3 Provide For Stakeholder Involvement	• Agency/org master plan(s)	• Community planning documents	• Comment Reports • Community engagement (communications) plan/Public Participation Plan • Design Element Boards • EIS/EIR/EA, Environmental documents • Examples of design changes, i.e., rendering, plans, etc. before/after • Feedback mechanism documentation • Letters/email of support • Meeting Minutes • Plan Presentations • Presentations • Project Fact Sheets (public/shared) • Public meeting/open house materials • Public outreach summary • Results of collaboration, i.e., reports, program description, etc. • Review board presentations/ feedback/meeting minutes • Social media • Stakeholder engagement plans • Stakeholder mapping exercise
LD1.4 Pursue Byproduct Synergies	• Agency/org processes related to byproduct use	• Internet / Online databases	• Basis of design report • Letters/emails • Meeting minutes • O&M info/manual • Plans/specifications • Research, i.e., websites, meetings, presentations, etc.
LD2.1 Establish A Sustainability Management Plan	• Agency operational processes, monitoring and reporting • Agency/org sustainability policy/ strategy • Project control standards/ guidelines • Some agency or organizational processes would be incorporated into a program or project SMP	• Program-level organizational chart	• Contractor reporting forms • Organizational chart • Sustainability management plan -Assessment of project environmental, economic, and social aspects
LD2.2 Plan For Sustainable Communities	• Agency/org design guidelines • Agency/org sustainability strategy and/or goals • Agency/org master plan	• Community planning documents	• Alternatives analysis • Assessment of project's impacts to broader long-term community or regional sustainability • EIS/EIR/EA, Environmental documents • Project planning documents
LD2.3 Plan For Long-Term Monitoring and Maintenance	• Agency/org budget or capital maintenance program • Agency/org Capital Plan – funding • Employee training information • Established O&M plan or plan standards • Example of maintenance performed at other client-owned facilities • Maintenance Guidelines • Monthly inspection documentation • O&M Certification Forms • Operations and Maintenance (O&M) Plan • Operations Manual • Role description(s) for people tasked with monitoring		• Alternatives analysis • Budget or funding • Long-Term Monitoring & Maintenance Plan • Maintenance Guidelines • Meeting Minutes • Monthly inspection documentation • O&M Certification Forms • O&M org chart • Operations and Maintenance (O&M) Plan • Operations Manual • Planting plan – native and regionally adapted plants • Schedule for re-evaluating the monitoring and maintenance plan • Specifications (noting material durability; training requirements) • Specs/Brochures describing monitoring systems • Training agendas • Training information

Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
LD2.4 Plan For End-of-Life	• Agency/org design guidelines that require assessment of TBL end-of-life impacts		• Alternatives Analysis • Assessment of potential social, environmental, and economic end-of-life impacts; analysis of end-of-life costs and salvage value • BODR • End of life plan • Feasibility study for expansion • Feasibility study identifying key areas where increasing investment in extending useful life will offer a reasonable payback • Materials specs/brochures • Meeting minutes • Operations & Maintenance Plan -End of Life Plan • Photos • Potential expansion plans • Research/reports • Site materials for durability map showing materials and locations • Stakeholder engagement plan • Stakeholder feedback, i.e., letter, emails, comment cards
LD3.1 Stimulate Economic Prosperity and Development	• Agency/org master plan • Agency/org policy on DBE, local workers, training and development • Analysis performed regarding types of sustainable employment opportunities created by the project • Annual reports • Award submittals/Awards won • Owner project website	• Community planning documents	• Alternatives analysis • Analysis of jobs created during design, construction, and/or operation that benefit local economy • EIS/EIR/EA, Environmental documents (+Comments/letters) • Growth calculations • Job creation estimate • Letters/emails • Meeting minutes
LD3.2 Develop Local Skills and Capabilities	• Agency/org training policies and/or programs • Community Benefits Agreement • Community Jobs Program • Employment Agreement • Hiring specs directed at the project team	• Community Jobs Program	• Proposed education and training programs to be developed and implemented, and an explanation of the extent to which these programs will address identified community needs and improved community competitiveness, current and future • Job creation estimate • Tiger grant application • Hiring specs directed at the contractor
LD3.3 Conduct a Life-Cycle Economic Evaluation	• Agency/org master plan	• Community planning documents	• Alternatives analysis • Lifecycle cost analysis • Cost benefit analysis

Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
RA1.1 Support Sustainable Procurement Practices	• Agency/org Sustainable Procurement Policy/Program • Policies and criteria for supplier identification and selection		• Project Sustainable Procurement Policy/Program • Calculations • Materials inventory • Material/supplier tracking forms and/ or spreadsheets; receipts/ invoices. • Manufacturer documentation • Materials certifications
RA1.2 Use Recycled Materials	• Agency/or design guidelines that require use of recycled materials	• Program goal for using recycled materials	• Calculation • Inventory of materials (reused and recycled content)
RA1.3 Reduce Operational Waste	• Agency/org O&M plan includes standard operational waste reduction measures • Agency/org policies addresing operational waste • Agency/org Operational Waste Management Plan	• Program-level waste management program or diversion goals	• Project operational waste management plan • Inventory of waste streams • Calculation - total waste vs. diversion
RA1.4 Reduce Construction Waste	• Agency/org policy about development and implementation of construction management plans • Agency/org policy about waste diversion rate/target • Standard specifications re: contractor waste diversion		• Construction waste management plan, reports, logs • Specifications, plans • Contractor waste forms • Calculations of total waste reduction measures and percentage of materials diverted to recycling or reuse. • Load tickets/logs • Recycling tickets
RA1.5 Balance Earthwork On Site	• Agency/org policy or standard practices about balancing earthwork		• BODR • Plans, specifications > • Site plan • Grading/drainage plans • Earthwork calculations/ Earthwork balance spreadsheet • Spec sections for site clearing/top soil and finishing • Cut and fill drawing/design • Map showing source/destination of materials brought onsite for fill or transported off-site. Map should indicate distance(s) • Load tickets/logs
RA2.1 Reduce Operational Energy Consumption	• Agency/org policy or standard practices about energy reduction • Baseline information, if based on other agency facility		• Project energy use estimates • Alternatives Analsysis • Meeting minutes • Business case for green funding • Meeting minutes • Electrical Site Plan and Light Fixture Schedule • Spec for LED lighting • Documentation of feasibility and cost analyses and how energy reductions were incorporated in the design • Calculations - Energy consumption and energy reduction • Documentation describing baseline
RA2.2 Reduce Construction Energy Consumption	• Agency/org policy or standard practices about contractor energy consumption, i.e., Tier IV vehicles, reduced idling, prefabrication of design elements	• State mandates related to contractor energy consumption, i.e., Tier IV vehicles, reduced idling	• Meeting minutes • Review report(s) • Construction management plan
RA2.3 Use Renewable Energy	• Agency/owner Energy Plan • Agency/owner renewble energy portfolio • Purchased Power (PPA) Summary	*Project teams cannot attribute latent renewable energy within the grid to the project without a purchase agreement.*	• Project Energy Plan • Project's anticipated annual operational energy consumption broken down by source type • Renewable Energy Breakdown by Source Type • Purchased Power (PPA) Summary
RA2.4 Commission and Monitor Energy Systems	• Agency/owner overall or facility-wide O&M plan(s) • Contract with commissioning agent • O&M Plan" • Scope of services • Testing procedures		• Contract with commissioning agent, team resumes • Network architecture diagram / Piping and Instrumentation Diagram • Plans/Specs for data/control/ monitoring systems • Project O&M Plan • Scope of services • Spec section on start up and commissioning • Spec section on training • Startup and performance testing • Testing procedures
RA3.1 Preserve Water Resources	• Agency/owner master plan(s)	• Regional water plan • Watershed-level or regional water plan	• Calculations • EIS/EIR/EA, Environmental documents • Flow calculations • Geotech reports • Piping plan • Planting plan • Process diagrams • Site master plan • Stormwater drainage study • Surface water analytical results • Surface water sampling proposal • Wastewater Discharge Alternatives Study • Water availability assessment • Water demands spreadsheet • Water quality report • Water reuse plan drawings

Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
RA3.2 Reduce Operational Water Consumption			• Alternatives Analysis • BODR • Calculation • Irrigation plan • Landscape Plan • Meeting minutes • Plans and specs • Planting plan • Reports • Spec for plumbing fixtures and equipment
RA3.3 Reduce Construction Water Consumption	• Agency/org policy or standard practices about construction water use		• Construction management plan • Contractor programs and policies • Meeting minutes • Review report(s) • Spec for contractor water management plan
RA3.4 Monitor Water Systems	• Agency/owner overall or facility-wide O&M plan(s) • Agency/owner standard monitoring equipment and/or integration into existing system • Contract with commissioning agent • Operator Contract/RFP • Scope of services • Testing procedures		• Contract with commissioning agent, team resumes • Plans and specs • Project O&M Plan • Scope of services • Spec for data/control/ monitoring/metering systems • Spec section on training • Specs on start up and commissioning • Specs on water system • Specs or cut sheets of monitoring equipment • Startup and performance testing • Testing procedures

Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
NW1.1 Preserve Sites of High Ecological Value			• Alternatives Analysis • Construction management plan • Contractor standard operating procedures • Documentation signed by natural resources professional or regulatory body • EIS/EIR/EA, Environmental documents • Land use map • Landscape plan • Landscape planting table • Mitigation Hierarchy Form (HDR) • Mitigation plan • Photos • Site map • Site plan • Site selection study • Specs
NW1.2 Provide Wetlands and Surface Water Buffers			• Alternatives Analysis • BODR • Calculations • EIS/EIR/EA, Environmental documents • Land use map • Maps • Meeting minutes • Photos • Plans/specs • Plan/spec on site clearing • Reports • Site plan • Site selection study • Surface Water Analytical Results • Surface Water Sampling proposal
NW1.3 Preserve Prime Farmland		• USDA Soil Data Explorer Map - Farmland Classification For N/A: show GIS map showing USDA information on prime farmlands in relation to the project site. (or other related map)	• Alternatives Analysis • Calculations • Construction management plan • EIS/EIR/EA, Environmental documents • Grading/site clearing plan • Map • Mitigation Hierarchy Form (HDR) • Photos • Plans/specs • Site plan • Siting analysis
NW1.4 Preserve Undeveloped Land			• EIS/EIR/EA, Environmental documents • Alternatives Analysis • Siting analysis • Plans/specs • Photos
NW2.1 Reclaim Brownfields	• Brownfield designation • Agency/owner monitoring processes	• Brownfield designation • Regulatory agency monitoring processes	• Closure report • Construction management plan • Deed restrictions • EIS/EIR/EA, Environmental documents • Mitigation and remediation plan • O&M Plan • Record of decision (ROD) • Site management, monitoring, and inspection plan
NW2.2 Manage Stormwater	• Agency/owner policy or practice regarding SWPPP or ESCP • Agency/owner/facility stormwater management plan	• City/regional stormwater management plan	• BODR • Calculations • Drainage map • Drainage plan • Drainage reports • EIS/EIR/EA, Environmental documents • Erosion, sedimentation, and pollutant control plan • Plans/specs • Site plan • Stormwater Pollution Prevention Plan (SWPPP) or Erosion and Sedimentation Control Plan (ESCP)
NW2.3 Reduce Pesticide and Fertilizer Impacts	• Agency/owner Integrated Pest Management practices • Agency/owner O&M plans/programs • Agency/owner policy or practice regarding landscape design/plant selection • Agency/owner policy or practice regarding landscape maintenance /fertilizers and pesticides		• Construction management plan • Information on specific plants • Integrated Pest Management plan • Landscape Maintenance Guidelines • Landscape maintenance plan • Organic • Plan/specs • Plant List • Planting plan-native & regionally adapted plants • Product information on pesticides and fertilizers • Project O&M plan • Seeding detail and seeding spec • Specs • Spec re: fertilizer management approach

Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
NW2.4 Protect Surface and Groundwater Quality	• Agency/owner/facility O&M plan • Agency/owner-level water quality monitoring program(s) • Environmental Management Program • Photos • Spill Prevention, Control and Countermeasure (SPCC) Plans • Stormwater Pollution Prevention Plan (SWPPP)		• Alternatives Analysis • BODR • Construction Management Plan • Contamination management plan • Discharge permits • EIS/EIR/EA, Environmental documents • Environmental Management Program • Meeting minutes • O&M plan • Permits • Photos • Plans/specs • Potential Impact analysis report • Spill and leak prevention and response plans • Spill Prevention, Control and Countermeasure (SPCC) Plans • Stormwater drainage study • Stormwater Pollution Prevention Plan (SWPPP) • Water quality reports • Water Supply and Wastewater Discharge Alternatives Study
NW3.1 Enhance Functional Habitats		• Conservation easement • Information on native plants • Map showing connectivity to other sites • Protected habitats map • Rare, Threatened, and Endangered Species Lists	• Biologist statement saying this was addressed • Description of preventative measures/changes in design to support biodiversity • EIS/EIR/EA, Environmental documents • Landscaping Plan • List of species in habitat • Maps • Mitigation Hierarchy Form (HDR) • O&M Plan / Monitoring plan • Photos • Planting/seeding plans/ descriptions • Site photos • Site plan • Soil survey/resource report
NW3.2 Enhance Wetland and Surface Water Functions			• BODR • EIS/EIR/EA, Environmental documents • Habitat survey • Map of development • Maps • Mitigation Hierarchy Form (HDR) • Photos • Plans/specs • Pre-and Post-Development Topographic Maps • Pre-Construction Existing Conditions Map • Report(s) from qualified resource professional • Site paving plan • Soil Erosion and Sediment Control Plan • Stormwater management calculations
NW3.3 Maintain Floodplain Functions	• Agency/owner master plan • Agency/owner stormwater management plan	• FEMA floodplain map • External sources of climate change info	• Alternatives Analysis • Calculations • Drainage plan • EIS/EIR/EA, Environmental documents • Emergency plan specific to flooding • Erosion and sediment control plans • Grading Plan • Maps • Plans/specs • See also climate change info related to CR credits • Site map(s) • Site selection study • Stormwater management plan
NW3.4 Control Invasive Species	• Agency/owner environmental policy • Agency/owner landscape maintenance plan • Agency/owner master plans • Agency/owner species removal program • Agency/owner website	• Research/web - information about specified plant species • Status of Invasive Plants in area - university or extension website • Invasive Species of Concern in area	• Construction management plan • EIS/EIR/EA, Environmental documents • Landscape Details • Landscape Plan • Map(s) • Monitoring Plan • O&M Plan(s) • Park Landscape and Grounds Maintenance Plan • Plans/specs • Seeding specs • Site Plan • Species Removal Program • Treatment plan • Tree Protection Plan • Vegetation/Planting Plan
NW3.5 Protect Soil Health	• Agency/owner policy on restoring disturbed soils	• Local soil conservation agency best management practices	• Alternatives Analysis • Calcs showing 100% of disturbed soils have been restored • Construction management plan • Contractor documentation of soil restoration activities, areas of disturbance, and areas restored. • Disturbed Soils Calculations • Disturbed Soils map • Disturbed soils spec • EIS/EIR/EA, Environmental documents • Excavation spec • Landscape plan • Plans/specs • Site clearing spec • Site plans • Soil restoration plan • Topsoiling and finished grading spec

Envision Credit Documentation Examples

Credit	Owner Policy/Standard/Guideline	Other Broad Documentation Types (likely to cover multiple projects -- external or programmatic)	Project Specific
CR1.1 Reduce Net Embodied Carbon			• LCCA • Quantities spreadsheets or index of materials • Index of the embodied carbon calculations
CR1.2 Reduce Greenhouse Gas Emissions	• Baseline based on existing agency/owner facility		• Life-cycle carbon assessment • LCA Carbon Emissions Summary • SROI Study • Calculations • GHG reporting
CR1.3 Reduce Air Pollutant Emissions	• Agency/owner air quality standards/policy	• Local air quality standards and regulations	• Air permit • Air Permit application • EIS/EIR/EA, Environmental documents • Materials information • Monitoring plan • O&M Plan • Operational design document • Plans/specs • Plans/specs (control systems) • PTE Air Emission Calculations
CR2.1 Avoid Unsuitable Development		• Online resources	• Alternatives analysis • BODR • Borings Report • EIS/EIR/EA, Environmental documents • Environmental work plan • Landscape plan • Maps • Meeting minutes • Photos • Plans/specs
CR2.2 Assess Climate Change Vulnerability	• Agency/owner climate assessment • Agency/owner/facility master plan • Articles • Presentations (conference, public) • Evidence of collaboration • Webinar	• City, state, or regional climate impact assessment and adaptation plan • Climate change assessment - statewide - how it affects region around project	• Articles • Conference presentation • EIS/EIR/EA, Environmental documents • Meeting minutes • Project climate assessment • Project resiliency review (HDR) • Webinar
CR2.3 Evaluate Risk and Resilience			• EIS/EIR/EA, Environmental documents • Mapping graphic • Meeting minutes • Project climate assessment • Project resiliency review (HDR)
CR2.4 Establish Resilience Goals and Strategies		• Climate Impact Assessment and Adaptation Plan • Climate action/protection plan • Local/regional area plans/master plans	• EIS/EIR/EA, Environmental documents • Meeting minutes • Project climate assessment • Project resiliency review (HDR)
CR2.5 Maximize Resilience			• Calculations • EIS/EIR/EA, Environmental documents • Matrix of resilience goals and risk management strategies • Meeting minutes • Monitoring plan • O&M Plan(s) • Project climate assessment • Project resiliency review (HDR) • Reports • Risk Evaluation
CR2.6 Improve Infrastructure Integration	• Agency/org Master Plan(s) • Agency/org O&M guidelines • Maps	• Community planning documents • Maps • Related community policies	• Alternatives analysis • BODR • Design documents • Design workshop information • Meeting minutes • Plans/specs • Plans/specs – monitoring systems • Stakeholder comments • Utility plans

Technical Memorandum No. 18

Date:	December 14, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Arlington Re-Gen Program Greenhouse Gas Impact Analysis

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Appendices

1.0 Introduction

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary sludge (PS) and waste activated sludge (WAS) thickening, dewatering, and lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a thermal hydrolysis process (THP) and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The biosolids management improvements will affect the WPCP's operational greenhouse gas (GHG) emissions. Depending on which future scenario is selected, there are variable outcomes for GHG emissions from this biosolids treatment process, which have been evaluated in this technical memorandum (TM) in two analyses: a project-level GHG impact assessment and an energy use intensity (EUI) calculation for the biosolids facilities.

This TM is structured to provide some introductory information on GHG emissions and calculation protocols in Section 2.0. Project-specific methodology information is presented in Section 3.0, with calculated emissions and energy intensity metrics following in Sections 4.0 and 5.0.

2.0 Greenhouse Gas Fundamentals

A GHG impact assessment represents the GHG emissions associated with the activities of an entity or individual. GHGs are a group of compounds that have significant impacts on global warming and climate change based on their increasing presence in the atmosphere. The United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) has identified the following seven major compounds that contribute to the greenhouse effect in the atmosphere:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)
- Nitrogen trifluoride (NF_3)

The emissions of all of these chemicals are distilled into units of carbon dioxide equivalent (CO_2e) based on their relative level of impact and contribution to climate change and global warming. This variable is defined as the global warming potential (GWP) for each compound. Because these impacts are expressed in terms of CO_2e, they are often referred to as the "carbon footprint" of a project or facility; however, some GHG compounds do not include any carbon (i.e., SF_6), so this term is slightly misleading.

2.1 Global Warming Potential

These GWP values are used as reference factors when calculating the global warming impact for emissions of these identified compounds. GHG emissions are expressed in standardized units of CO_2e, typically as metric tons (MT). Table 1 lists the GHG compounds and their GWP values, as well as the atmospheric lifetime for each compound. These lifetimes can help researchers understand the impact of reducing emissions of a specific compound and compare strategies to reduce the overall greenhouse effect from these emissions.

Table 1. Global Warming Potentials of Greenhouse Gases

Chemical	Formula	Global Warming Potential (100 years)	Atmospheric Lifetime (years)
Carbon dioxide	CO_2	1	5–200
Methane	CH_4	25	12
Nitrous oxide	N_2O	298	121
Sulfur hexafluoride	SF_6	22,800	3,200
Nitrogen trifluoride	NF_3	17,200	740
Hydrofluorocarbons	HFC	Up to 14,800	Varies
Perfluorocarbons	PFC	Up to 17,340	Varies

Source: 40 CFR Appendix Table A-1 to Subpart A of Part 98: Global Warming Potentials, based on IPCC AR4 findings.[1]

For the Re-Gen Program, calculations were developed in alignment with the Greenhouse Gas Protocol[2] (GHG Protocol). GHG Protocol Guidelines are the standard for developing GHG emission inventories and are broadly applicable to most industries and processes. Several climate reporting frameworks are built on the GHG Protocol or point to the guidelines as a principal resource. Frameworks include:

- Carbon Disclosure Project (CDP)
- U.S. Environmental Protection Agency (EPA) Climate Leaders
- California Climate Action Registry
- Global Reporting Initiative (GRI)
- United States Agency for International Development (USAID) Greenhouse Gas Pollution Prevention Program
- Ceres Sustainable Governance Initiative
- Task Force on Climate-related Financial Disclosures (TCFD)

The GHG Protocol Guidelines are a joint venture between the World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD). The guidelines are updated regularly based on the latest climate science and have been used for GHG emissions accounting for more than 20 years. The guidelines consist of multiple guidance publications including the GHG Protocol Corporate Standard (2004), GHG Protocol for Project Accounting (2005), Corporate Value Chain (Scope 3) Standard (2011), and Product Life Cycle Standard (2011). Additional supplements for specific market sectors and industries have continually been added to the guidelines since their initial publication.

[1] 40 CFR Appendix Table A-1 to Subpart A of Part 98: Global Warming Potentials

[2] Greenhouse Gas Protocol Guidelines

2.2 Scopes of GHG Emissions

The GHG Protocol divides emissions into three “scopes” based on where emissions occur and what influences them. Figure 1 shows the following scopes and how they relate to the individual company or facility developing an emissions inventory:

- **Scope 1 emissions** are typically the simplest group of activities to quantify—they are the direct GHG emissions from a site (project or company) that encompass fuel combustion, process emissions, and on-site company vehicles and machinery. The facility directly controls these emissions.
- **Scope 2 emissions** are essentially all emissions that result from the purchase of grid power (or steam)—they are considered indirect because the emissions occur elsewhere from the facility (e.g., at a power plant), but the level of emissions coming from the power plant is driven partly by customer demand (a simple example is if the facility requires more electricity, more electricity would be generated and therefore more emissions). The facility does not directly control these emissions but does control the level of energy purchased.
- **Scope 3 emissions** are the most complex for carbon accounting, because they encompass GHG emissions from activities upstream and downstream of a facility in the supply chain. Emissions are generated by these activities, but varying degrees of data are available to attribute emissions to specific actions of the reporting company. The GHG Protocol considers 15 categories of emissions for Scope 3 evaluations, much of which focus on the supply-chain emissions associated with the production of goods.

For the Re-Gen Program, Scope 1, Scope 2, and the limited categories for Scope 3 that are applicable for analysis are discussed in later sections, with a list of specific activities for each scope presented in Table 3.

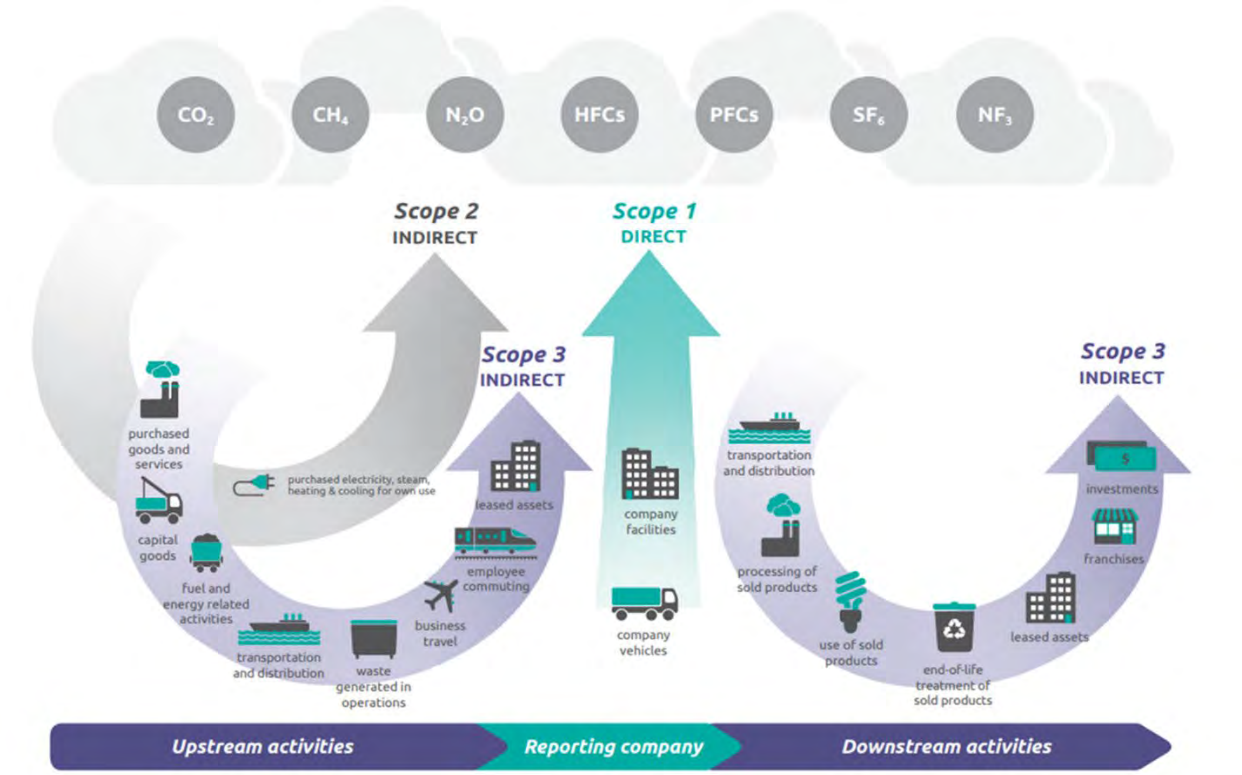

Figure 1. GHG Emission Scopes

Source: GHG Protocol Guidelines.

2.2.1 Carbon Sequestration

Downstream activities in Scope 3 include land application of biosolids. Carbon sequestration benefits from the land application of biosolids is an area of emerging research. The Biosolids Emission Assessment Model (BEAM), which was developed by the Canadian Council of Ministers of the Environment in 2009[3], and recently updated in 2022[4], provides estimates for GHG emissions from Canadian biosolids generators. BEAM was intended to help biosolids managers compare emissions from a range of biosolids management scenarios as agencies seek to become carbon neutral. BEAM includes emissions estimation methodologies for a variety of wastewater treatment activities and emission factors from a variety of sources.

With respect to carbon sequestration, the IPCC does not provide specific factors for carbon accumulation as a result of the use of organic soil amendments. Research is currently limited on the emission offsets for carbon sequestration.

Without more appropriate data for comparison to the local area surrounding the WPCP, no benefits from carbon sequestration should be included in the overall GHG impact calculation that could underrepresent the impacts from the Re-Gen Program.

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[3] Canadian Council of Ministers of the Environment - BEAM 2009

[4] BEAM*2022, https://www.BiosolidsGHGs.org. Accessed December 2022.

2.3 Biogenic Emissions

Biogenic emissions are any GHG emission that results from renewable resources or carbon that is already present in the short-term, natural carbon cycle. The assumption is that these biogenic emissions are produced by organic material that would end up in the atmosphere from natural processes (decomposition, off-gassing of organic material, etc.), whereas GHG emissions from fossil fuel–based sources draw carbon out of long-term sinks and add it to the atmosphere, accelerating climate change through increased atmospheric CO_2.

2.3.1 Carbon Cycles

The natural carbon cycle has been a key part of planetary and atmospheric balance throughout the lifespan of Earth. Carbon is present in all life forms, and through natural processes, is moved back and forth between the land, the ocean, and the atmosphere continuously. These various pathways include natural fluxes, human contributions, and long-term storage of carbon.

IPCC distinguishes between the **slow domain** of the carbon cycle, where turnover times exceed 10,000 years, and the **fast domain** (the atmosphere, ocean, vegetation, and soil), where vegetation and soil carbon have turnover times in the magnitude of 1–100 and 10–500 years, respectively. Fossil fuel transfers carbon from the slow domain to the fast domain, while renewable systems such as biogas operate within the fast domain. Historically, a relatively constant amount of carbon has been present in this fast domain cycle, which is responsible for keeping the planetary temperature at a habitable level through the atmospheric greenhouse effect; however, the increasing atmospheric carbon resulting from fossil fuel transfers from the slow domain is shifting the balance of the carbon cycle and increasing the atmospheric greenhouse effect, which increases the average global temperature.

2.3.2 Anthropogenic Global Warming

As the Industrial Revolution accelerated the use of fossil fuels around the globe, combustion of fossil fuels has released into the atmosphere carbon that was previously locked up in long-term carbon sinks in the ground for millions of years. These activities primarily include combustion of oil and coal, as well as natural gas, but also include other human activities like burning of forests and clearing of land. These added emissions increase the amount of carbon in the fast domain, exceeding the offsetting capacity of natural carbon sinks and thus contributing to climate change.

3.0 Calculation Methodology

This section describes the approach to the GHG impact assessment and EUI calculations. GHG calculations can be developed for a wide range of activities and entities, depending on the scale of the analysis. There are several methods, with varying degrees of accuracy, and these methods are divided into tiers based on the level of detail and complexity, as discussed below. EUI calculations focus on expressing energy use per unit of production or operation, which helps understand the balance of expanding business while simultaneously making efforts to increase efficiency, thereby reducing material usage, energy usage, and environmental impact. Both calculations rely on input data and calculation factors to produce a resultant emissions total or energy intensity. The quality of these data is directly correlated to the reliability of the analyses.

3.1 Tiers of Methodology

The IPCC defines three tiers of methodology for GHG emission calculations: Tier 1 is the basic method, Tier 2 is intermediate, and Tier 3 is the most demanding in terms of complexity, precision, and data requirements. These tiers are shown in Table 2.

Wherever possible, site-specific data (highest tier) that include data inputs from actual operations and detailed project outcomes (materials hauled and specific start/end points for that transportation, physical properties of the biosolids, detailed calculations on the composition of the biogas production, etc.) were used in the analysis.

In some areas, a combination of site-specific data and standard emission factors from EPA (i.e., natural gas fuel combustion is calculated with the actual therms of gas used multiplied by EPA's standard conversion for natural gas combustion to CO_2e) were used in the analysis.

No values in the calculations rely on national or regional default values (the lowest calculation tier). The lowest tier is not an invalid method, and often is the best estimate available because of the challenges of collecting data in some parts of the value chain. However, for this analysis, the calculations reflect this site specifically and are more refined than what may be produced with more generic estimation tools.

Table 2. IPCC Methodology Tiers

Tier	Description
3	Direct measurements, local data
2	Combination of some direct measurements, local data, and regional default values
1	National or regional default values

3.2 Emission Factor Sources

Wherever possible, this analysis opted for the highest tier of complexity and specificity for the calculation methodology. All data inputs were sourced from the WPCP's site-specific data (both existing operations data from 2020 and detailed projections of operational loads for the future case of 2037) and used the most detailed emissions factors available. The sources for emission factors include EPA's Emission Factors for GHG Inventories database (standard for items like fuel combustion and transportation), sourced data directly from Dominion Energy about emissions from power generation, and also incorporated factors from accepted best practices for the biosolids industry. Emission factors are all referenced within the calculations, attached to this TM as Appendix A.

3.3 Project Activities

For this GHG calculation, only the biosolids treatment processes and supporting activities were evaluated (see Table 3). This includes the direct and indirect GHG emissions from the project in Scopes 1 and 2 above, and some limited activities from Scope 3.

Table 3. Project Activities and Other Activities

	Biosolids Treatment (Project)	Other WPCP Facilities
Scope 1	• Fuel combustion for Solids Processing Building heat and steam generation • Production of biogas	• Fuel combustion in various other equipment • Other wastewater treatment
Scope 2	• Electricity use for solids-handling processes	• Electricity use not for solids-handling processes
Scope 3	• Transportation and production of chemicals for biosolids processing • Transportation of biosolids for land application	• Transportation and production of chemicals/materials for liquid treatment

3.4 Scope 1 Emissions

For the Re-Gen Program, the Scope 1 emissions that were analyzed include:

- Fuel combustion for building heating (natural gas)
- Fuel combustion for process steam generation (natural gas)

Baseline data for these activities were taken directly from current operational data from 2020 natural gas purchasing records. Default emission factors for natural gas combustion were applied to calculate the GHG emissions from this fuel combustion. For the future use cases, projected natural gas consumption was calculated based on the anticipated steam and building heat demands.

3.5 Scope 2 Emissions

As discussed above, Scope 2 emissions are emissions generated in the production of purchased energy. Scope 2 baseline emissions were calculated directly from electrical meter records for electricity at distribution center (DC) 7 and solids area motor control centers. Future emissions were estimated based on the expected electrical demand for the completed improvements. Multiple grid power scenarios were evaluated, beginning with quantifying the impact of Dominion Energy's projected increase in renewable energy in its portfolio as it targets carbon-free energy by 2050. Calculations were also done to show the impact of the County's goal to procure all purchased power from renewable resources by 2025.

3.6 Scope 3 Emissions

The GHG Protocol Guidelines contain 15 established Scope 3 categories, many of which are not applicable to the Re-Gen Program. Activities that were considered to be material for this analysis and affected by this project included:

- Purchased goods and services:
  - Production of chemicals (lime, polymer) that are used in the biosolids treatment processes or in the liquid treatment process as a result of the biosolids treatment (methanol)
- Fuel- and energy-related activities:
  - Transmission grid losses for purchased electricity
- Transportation and distribution:
  - Upstream transportation emissions for chemical deliveries
  - Downstream transportation emissions for biosolids hauling to land application

The Scope 3 emissions were calculated by evaluating current operational data. Baseline biosolids transportation emissions were calculated based on volumes present on 2020 shipping invoices, and an average round-trip distance to local fields for land application. Chemical delivery invoices were analyzed and baseline hauling emissions were estimated based on the size of the trucks, the number of deliveries, and the distance to the point of origin (including empty backhauling) for each chemical. Future emissions were estimated based on the projected increase or decrease of necessary chemical additives for the new biosolids handling and treatment process, in addition to the future amount of biosolids that would require transportation to land application. Transmission grid losses are roughly 5 percent of the energy transferred[5] (EPA 2021) and this factor is typically applied to Scope 3 emissions in GHG inventories.

Portions of land application activities are considered in the WPCP's Scope 3 emission calculations, including the transport of biosolids to the end point, the tractors that perform the application, and an estimate of emissions from the storage piles of biosolids prior to land application. At this time, the calculations do not quantify the carbon sequestration value of the land-applied biosolids or the potential benefit of offsetting conventional fertilizers. Generic information and emission factors are available through BEAM; however, those particular activities should be investigated locally to assess the applicability of the generic BEAM emission factors and assumptions.

3.7 Natural Gas Offsets

Biogas (a combination of primarily methane and carbon dioxide) will be produced as part of the new biosolids facilities. This biogas production results from the breakdown of organic materials within the wastewater. Carbon dioxide and other impurities will be removed from this biogas through a treatment process to produce pipeline-quality renewable natural gas (RNG). The RNG will likely be injected into the natural gas pipeline and sold to downstream users.

Use of the RNG by the downstream users will displace current use of fossil-fuel based natural gas, resulting in an offset of natural gas use. Emissions resulting from biogas treatment and the combustion of RNG are considered biogenic emissions at the point of combustion. The end user of the biogas would be able to claim a Scope 1 emission reduction for use of the RNG as a renewable fuel. These emission reductions are an important piece of the renewable focus of the Re-Gen Program but would not be reported as part of the WPCP's GHG inventory. The analysis presented below includes these emissions reductions as part of the overall comparison between existing and future GHG assessments.

4.0 Project GHG Assessment

To calculate the GHG impacts for the Re-Gen Program, a detailed assessment of current operational GHG emissions was performed, focusing on biosolids treatment only. The baseline GHG assessment was then expanded and revised to account for changes to the process as a result of the Re-Gen Program. The resulting future GHG impact assessment was then compared to the baseline to show the overall impact of the Re-Gen Program and its effect on GHG emissions.

[5] https://www.epa.gov/egrid/egrid-questions-and-answers#egrid5aa

4.1 Energy Value of Renewable Natural Gas Production

Based on operational projections for the WPCP, the amount of RNG produced at the mid-point of the Re-Gen Program (year 2037) has a heating value of 118,000 million British thermal units (MMBtu) per year (yr), which is roughly equivalent to 115 million standard cubic feet (MMscf) of conventional natural gas. This offset of fossil fuel with a renewable fuel saves 6,150 MT CO_2e from entering the atmosphere from long-term carbon sinks and replaces it with biogenic CO_2e, using carbon that is already present in the short-term (fast domain) carbon cycle. Table 4 below shows the equivalent GHG emissions from RNG produced.

Table 4. Equivalent GHG Emissions from RNG Produced

RNG Produced (2037)	GHG Compound	Emission Factor (kg/MMBtu)	GWP	MT CO_2e
118,000 MMBtu	CO_2	52.07	1	6,120
	CH_4	0.003	25	9
	N_2O	0.0006	298	21
			Total emissions	6,150

The maximum RNG production value of 118,000 MMBtu/yr assumes that all available biogas is refined into pipeline-quality RNG for distribution downstream and none of the biogas is used on site. This value of 6,150 MT CO_2e will be used in comparisons below to illustrate the impact of RNG production on the biosolids treatment facilities' GHG emissions.

4.2 Project Operational Scenarios

A variety of future scenarios were analyzed for year 2037 to show the differences in overall GHG emissions based on factors both within the control of the WPCP and beyond the control of the WPCP, including projections for added renewable energy for purchased power from Dominion Energy:

- **Continuation of current operations in future scenario:** if the Re-Gen Program is not completed and lime treatment continues
- **Future scenario 1:** estimate Scope 2 emissions with no added renewable energy
- **Future scenario 2:** estimate Scope 2 emissions with Dominion Energy projection for increased renewables as they move to carbon-free 2050
- **Future scenario 3:** estimate Scope 2 emissions assuming that Arlington County reaches its goal of 100 percent renewable energy sourcing by 2025
- **Future scenario 4:** estimate Scope 2 emissions with Dominion Energy projection for increased renewables as it moves to carbon-free 2050; use biogas on site for steam production in the boilers to offset conventional natural gas (reduces available biogas sent to pipeline)

Table 5 below presents each of these scenarios side by side for comparison. Note that if the current lime treatment continues, GHG emissions for all three scopes will increase in proportion to the expected increase in overall WPCP flow. There is a significant increase in Scope 1, 2, and 3 emissions for the transition to digestion and RNG production over the current lime treatment process; however, as discussed above, the RNG that is produced will offset conventional natural gas in the pipeline that would otherwise emit more than 6,000 MT CO_2e as shown in Section 4.1. **When compared with the current operations, this results in a GHG reduction range of 4,290 to 7,560 MT CO_2e per year, depending on the energy source.**

Table 5. Annual GHG Emissions for Future Scenarios (MT CO_2e)

Category	Baseline 2020: Limed Solids	Future 2037: Limed Solids	Future 2037: Digested Solids, Same Grid Power Emission Factors	Future 2037: Digested Solids Dominion Renewable Projection	Future 2037: Digested Solids Arlington County 100% Renewable	Future 2037: Digested Solids, Dominion Renewable Projection, Some RNG Combusted on Site
Scope 1	41	49	1,970	1,970	1,970	0
Scope 2	1,210	1,420	3,300	1,380	0	1,380
Scope 3	3,510	3,860	1,940	1,940	1,940	1,940
Total[a]	**4,760**	**5,340**	**7,210**	**5,290**	**3,910**	**3,320**
RNG offset	--	--	*(6,150)*	*(6,150)*	*(6,150)*	*(4,180)*
Adjusted total	--	--	*1,050*	*(860)*	*(2,240)*	*(860)*
Difference from future—limed	--	--	*(4,290)*	*(6,200)*	*(7,560)*	*(6,200)*

a. Rounded values may not sum consistently.

The benefits of the Re-Gen Program increase depending on the energy sources for the electricity used to produce the biogas. All three future digested solids scenarios have the same Scope 1 and Scope 3 emissions; however, the reductions in GHG emissions from purchased electricity (Scope 2) are included in future scenarios 2, 3, and 4. The result shows that the source of the purchased power does make a difference, and that even when electricity is generated with less-clean fuels, the benefits outweigh the costs when compared with the baseline scenarios.

As a final point of comparison, there is the potential to use the biogas on site to remove the need for purchased conventional natural gas for operating the biosolids treatment process. This beneficial use of the biogas would zero out the Scope 1 emissions for the Re-Gen Program by removing fossil fuel from the process but would also reduce the amount of available RNG to be sold into the pipeline. This scenario is still beneficial but may not provide the greatest financial return for the WPCP depending on market values. Please reference the *Arlington Re-Gen Biogas Utilization Report (HDR, November 2022)* for a detailed comparison of the various biogas utilization options that were considered for the WPCP.

5.0 Project Energy Intensity

To assess the potential energy benefits from the Re-Gen Program, the overall EUI for the production of RNG to offset conventional natural gas and the change from current operational EUI were both calculated. Energy usage was quantified in MMBtu for both the fuel combustion and the equivalent MMBtu in purchased electricity to standardize the amount of energy used for each component of the Re-Gen Program. Using a standard energy unit allows for a direct comparison of different energy sources.

As shown in Table 6 below, the WPCP will increase in flow between the baseline of 2020 and the future scenario in 2037 no matter which strategies are (or are not) implemented. The fuel combustion on site and electricity demand are projected to increase in proportion to the main WPCP flow increase, accounting for an overall energy increase of 2,800 MMBtu between the baseline and future cases.

The proposed improvements to create pipeline-quality RNG and produce Class A biosolids will require a significant increase in operational energy demand. However, the RNG that is produced has a much higher equivalent heating value than the energy that is required for production. The investment of some traditional energy to produce a larger volume of renewable energy creates a **beneficial energy balance** for the Re-Gen Program.

Table 6. Biosolids Treatment Energy Balance

Energy Source	Baseline 2020 Energy Use (MMBtu)	Future 2037 Limed Energy Use (MMBtu)	Future 2037 Digested Energy Use (MMBtu)
Fuel combustion	780	921	37,000
Purchased power	14,400	17,000	39,500
RNG produced	--	--	*(118,000)*
Total energy use	15,200	18,000	*(41,000)*

Conversion of power usage (kWh) to energy (MMBtu): 293 kWh = 1 MMBtu.

5.1 Energy Use Intensity

When this energy usage is normalized for the projected increase in biosolids that would be produced in the future as WPCP throughput grows, the resultant EUI factor is expressed as energy used over biosolids produced in Table 7, based on the values established in Table 6 above. Note that the limed biosolids EUI remains constant, as no processes would be changed for that scenario.

Table 7. Energy Use Intensity of Biosolids Treatment Options

Energy Source	Baseline 2020	Future 2037 Limed	Future 2037 Digested
Total energy use (MMBtu)	15,200	18,000	*(41,000)*
Produced biosolids (DT/year)	9,920	11,700	11,700
EUI (MMBtu/DT solids)	1.53	1.53	*(3.50)*

The project creates more energy than it consumes and uses the biosolids as a renewable resource. Energy usage does not factor in energy source (renewables or fossil) for grid power, but only shows the energy demand of the facilities. This yields an **overall energy-positive** result, as the **energy required to make the RNG fuel is less than the energy value of the RNG that is produced.**

5.2 EnergyStar Ratings for Comparative EUI

The EnergyStar program provides energy efficiency metrics and ratings for a range of applications. The rating is most commonly found on commercial appliances, which are ranked by ability to save energy by using less electricity and/or water throughout the lifetime of the equipment. The EnergyStar program has also been applied to commercial buildings with the same principles: buildings that are designed to require fewer resources and less energy are rated accordingly.

Some wastewater treatment plants have also been evaluated with the EnergyStar program and given a score based on their relative use of purchased power and other operational metrics. Energy usages are calculated and compared against other wastewater treatment facilities across the country in a database of survey information that has been compiled by the Water Research Foundation. From there, a facility can be assigned a rank within the database, which then corresponds to an assigned EnergyStar score.

Comparing the energy use of the Re-Gen Program to other wastewater treatment facilities is not recommended, as the EnergyStar rating system is intended to be used for entire wastewater treatment plant operations, rather than specific portions, such as biosolids processing. The rating system also does not account for differences in treatment requirements at various wastewater facilities, which can vary drastically depending on the location and water body to which a plant releases outflow. This difference in treatment requirements can mean that significantly more energy is needed to achieve treatment, and some plant designs inherently are more energy intensive. The rating system also does not account for differences in plant processes such as variations in chemical treatment applications, different biosolids treatment technologies, or different scales of operations. Figure 2 summarizes the differences between these two assessments, which both calculate an energy use metric, but use different methodologies.

Project-specific GHG assessment	EnergyStar rating/score
• Includes Scope 1, Scope 2, and Scope 3 GHG emissions relevant to the Program • Represents only the biosolids processing facilities affected by this Program • Calculated for this specific facility (WPCP) • Expressed as energy usage (kBtu) per dry tons of solids produced per day (tons)	• Energy usage only (no Scope 3), both electricity use (kWh) and combustion on site (kBtu) • Based on average influent flow (plant-wide) • Scores are based on comparisons to National Survey Data from AwwaRF in a lookup table • Expressed as energy usage (kBtu) per influent flow (gpd)

Figure 2. Methodology comparison for EnergyStar

6.0 Conclusions

The current WPCP biosolids treatment process produces solids for land application as a beneficial outcome. The proposed Re-Gen Program to implement a digestion process and create, capture, and clean biogas for sale as RNG provides a greater benefit than land application with lime stabilization alone. The reductions in CO_2e emissions by producing RNG as a renewable fuel offset conventional fossil fuel and reduce the need for extraction of fossil fuel from long-term carbon sinks. The GHG impact assessment of the biosolids treatment facilities at the WPCP shows an energy-positive result, meaning that the facility will generate more energy than it consumes, and this generated energy takes advantage of a renewable resource (wastewater) that will increase over time. The sustainability elements of the Re-Gen Program align with sustainability principles and support the County's larger sustainability goals, including prioritizing renewable fuel sources and reducing EUI for County operations.

Appendix A. Greenhouse Gas Emission Calculations

ARLINGTON COUNTY WPCP **GREENHOUSE GAS EMISSION CALCULATIONS**

Parameter	**Unit**	**Source/Note**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Flow	mgd	TM1	23	23.2	23.5	23.7	24.0	24.2
Existing Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	14,448	14,601	14,754	14,907	15,060	15,213
Power - DC7	kWh/yr	PowerBI (2020), proportion per flow	2,889,785	2,920,410	2,951,036	2,981,661	3,012,287	3,042,912
Power - Solids MCCs	kWh/yr	PowerBI (partial 2021), proportion per flow	1,343,355	1,357,592	1,371,829	1,386,065	1,400,302	1,414,539
Natural Gas	MMBtu/yr	Utility bill	780	788	797	805	813	821
Biosolids Produced	DT/year	TM1, data analysis	9,921	10,027	10,132	10,237	10,342	10,447
Biosolids Hauled	MT/year	Calculation	29,669	29,984	30,298	30,613	30,927	31,241
Polymer - Thickening	MT/year	Polymer deliveries	18	18	18	19	19	19
Polymer - Dewatering	MT/year	Polymer deliveries	42	42	43	43	44	44
Lime	MT/year	Lime tickets	1,484	1,499	1,515	1,531	1,547	1,562
Methanol	gal/yr	Methanol tickets	321,200	324,604	328,008	331,412	334,816	338,220
Existing Facilities GHG Emissions - Scope 1	MT CO2e/year	Baseline Factors	41	42	42	43	43	44
Existing Facilities GHG Emissions - Scope 2	MT CO2e/year	Baseline Factors	1,206	1,219	1,232	1,245	1,258	1,270
Existing Facilities GHG Emissions - Scope 3	MT CO2e/year	Baseline Factors	3,514	3,535	3,555	3,576	3,597	3,617
Existing Facilities GHG Emissions - Total	MT CO2e/year	Baseline Factors	**4,762**	**4,796**	**4,830**	**4,864**	**4,897**	**4,931**
New Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	-	-	-	-	-	-
Power	kWh/yr	Estimate load 2052, proportion per flow						
Natural Gas Consumed	MMBtu/yr	Gas utilization model	31,491	31,817	32,143	32,469	32,795	33,121
Biogas to Flare	MMBtu/yr	Gas utilization model	14,624	14,781	14,936	15,091	15,245	15,403
RNG Generated	MMBtu/yr	Gas utilization model	99,618	100,688	101,739	102,790	103,841	104,911
Biosolids Hauled	MT/year	TM1	14,600	14,755	14,909	15,064	15,219	15,374
Polymer - Pre-dewatering	MT/year	Match existing	42	42	43	43	44	44
Polymer - Final Dewatering	MT/year	Solids model	47	47	48	48	49	49
Lime	MT/year	None	-	-	-	-	-	-
Methanol	gal/yr	Methanol tickets+recycle	2342	2,367	2,392	2,417	2,442	2,467
Biogenic Emissions	*MT CO2e/year*	*Future (2037) Factors*	*765*	*774*	*782*	*790*	*798*	*806*
New Facilities GHG Emissions - Scope 1	MT CO2e/year	Future (2037) Factors	1,673	1,690	1,707	1,725	1,742	1,759
New Facilities GHG Emissions - Scope 2	MT CO2e/year	Future (2037) Factors - assume no grid mix change	-	-	-	-	-	-
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100% carbon-free 2050	-	-	-	-	-	-
		Future (2037) Factors - assume Arlington County meets 100% renewable energy purchasing goal	-	-	-	-	-	-
New Facilities GHG Emissions - Scope 3	MT CO2e/year	Future (2037) Factors	1,795	1,804	1,812	1,821	1,829	1,837
New Facilities GHG Emissions - Total	MT CO2e/year	Future (2037) Factors - assume no grid mix change	**3,468**	**3,494**	**3,519**	**3,545**	**3,571**	**3,597**
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100% carbon-free 2050	**3,468**	**3,494**	**3,519**	**3,545**	**3,571**	**3,597**
		Future (2037) Factors - assume Arlington County meets 100% renewable energy purchasing goal	**3,468**	**3,494**	**3,519**	**3,545**	**3,571**	**3,597**
Equivalent GHG Emissions from RNG Produced	MT CO2e/year	conventional natural gas offset	5,214	5,270	5,325	5,380	5,435	5,491
Energy Demand (Scope 1 and 2)								
Baseline	MMBtu/yr		15,228	15,389	15,550	15,712	15,873	16,034
Future	MMBtu/yr		(68,127)	(68,871)	(69,596)	(70,321)	(71,046)	(71,790)
Energy Intensity (per dry ton solids produced)*								
Baseline	MMBtu/DT produced	*assumes the same amount of biosolids are treated pre- and post-	1.53	1.53	1.53	1.53	1.53	1.53
Future	MMBtu/DT produced	project, scaled proportionally to plant flow	(6.87)	(6.87)	(6.87)	(6.87)	(6.87)	(6.87)

ARLINGTON COUNTY WPCP **GREENHOUSE GAS EMISSION CALCULATIONS**

Parameter	**Unit**	**Source/Note**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Flow	mgd	TM1	24.5	24.7	25.0	25.2	25.4	25.7	25.9	26.2
Existing Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	15,366	15,519	15,672	15,826	15,979	16,132	16,285	16,438
Power - DC7	kWh/yr	PowerBI (2020), proportion per flow	3,073,537	3,104,163	3,134,788	3,165,414	3,196,039	3,226,665	3,257,290	3,287,915
Power - Solids MCCs	kWh/yr	PowerBI (partial 2021), proportion per flow	1,428,775	1,443,012	1,457,249	1,471,485	1,485,722	1,499,959	1,514,195	1,528,432
Natural Gas	MMBtu/yr	Utility bill	830	838	846	854	863	871	879	887
Biosolids Produced	DT/year	TM1, data analysis	10,552	10,657	10,763	10,868	10,973	11,078	11,183	11,288
Biosolids Hauled	MT/year	Calculation	31,556	31,870	32,185	32,499	32,814	33,128	33,442	33,757
Polymer - Thickening	MT/year	Polymer deliveries	19	19	20	20	20	20	20	20
Polymer - Dewatering	MT/year	Polymer deliveries	45	45	46	46	46	47	47	48
Lime	MT/year	Lime tickets	1,578	1,594	1,609	1,625	1,641	1,657	1,672	1,688
Methanol	gal/yr	Methanol tickets	341,624	345,028	348,432	351,836	355,240	358,644	362,048	365,452
Existing Facilities GHG Emissions - Scope 1	MT CO2e/year	Baseline Factors	44	45	45	45	46	46	47	47
Existing Facilities GHG Emissions - Scope 2	MT CO2e/year	Baseline Factors	1,283	1,296	1,309	1,322	1,334	1,347	1,360	1,373
Existing Facilities GHG Emissions - Scope 3	MT CO2e/year	Baseline Factors	3,638	3,658	3,679	3,699	3,720	3,740	3,761	3,781
Existing Facilities GHG Emissions - Total	MT CO2e/year	Baseline Factors	**4,965**	**4,998**	**5,032**	**5,066**	**5,100**	**5,133**	**5,167**	**5,201**
New Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	-	35,974	36,329	36,683	37,038	37,393	37,748	38,103
Power	kWh/yr	Estimate load 2052, proportion per flow		10,540,264	10,644,253	10,748,243	10,852,232	10,956,222	11,060,211	11,164,200
Natural Gas Consumed	MMBtu/yr	Gas utilization model	33,447	33,773	34,099	34,425	34,750	35,076	35,402	35,728
Biogas to Flare	MMBtu/yr	Gas utilization model	15,557	15,712	15,867	16,024	16,179	16,334	16,488	16,646
RNG Generated	MMBtu/yr	Gas utilization model	105,961	107,012	108,063	109,133	110,184	111,235	112,286	113,355
Biosolids Hauled	MT/year	TM1	15,528	15,683	15,838	15,993	16,147	16,302	16,457	16,611
Polymer - Pre-dewatering	MT/year	Match existing	45	45	46	46	46	47	47	48
Polymer - Final Dewatering	MT/year	Solids model	50	50	51	51	52	52	53	53
Lime	MT/year	None	-	-	-	-	-	-	-	-
Methanol	gal/yr	Methanol tickets+recycle	2,491	2,516	2,541	2,566	2,591	2,616	2,640	2,665
Biogenic Emissions	*MT CO2e/year*	*Future (2037) Factors*	*814*	*822*	*830*	*839*	*847*	*855*	*863*	*871*
New Facilities GHG Emissions - Scope 1	MT CO2e/year	Future (2037) Factors	1,777	1,794	1,811	1,828	1,846	1,863	1,880	1,898
New Facilities GHG Emissions - Scope 2	MT CO2e/year	Future (2037) Factors - assume no grid mix change	-	3,004	3,034	3,063	3,093	3,123	3,152	3,182
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100%	-	1,260	1,272	1,285	1,297	1,309	1,322	1,334
		Future (2037) Factors - assume Arlington County meets 100% renewable energ	-	-	-	-	-	-	-	-
New Facilities GHG Emissions - Scope 3	MT CO2e/year	Future (2037) Factors	1,846	1,854	1,863	1,871	1,880	1,888	1,897	1,905
New Facilities GHG Emissions - Total	MT CO2e/year	Future (2037) Factors - assume no grid mix change	**3,622**	**6,652**	**6,708**	**6,763**	**6,818**	**6,874**	**6,929**	**6,985**
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100%	**3,622**	**4,908**	**4,946**	**4,984**	**5,023**	**5,061**	**5,099**	**5,137**
		Future (2037) Factors - assume Arlington County meets 100% renewable energ	**3,622**	**3,648**	**3,674**	**3,700**	**3,726**	**3,751**	**3,777**	**3,803**
Equivalent GHG Emissions from RNG Produced	MT CO2e/year	conventional natural gas offset	5,546	5,601	5,656	5,712	5,767	5,822	5,877	5,933
Energy Demand (Scope 1 and 2)										
Baseline	MMBtu/yr		16,196	16,357	16,519	16,680	16,841	17,003	17,164	17,326
Future	MMBtu/yr		(72,515)	(37,266)	(37,636)	(38,025)	(38,395)	(38,765)	(39,135)	(39,524)
Energy Intensity (per dry ton solids produced)*										
Baseline	MMBtu/DT produced	*assumes the same amount of biosolids are treated pre- and post-	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
Future	MMBtu/DT produced	project, scaled proportionally to plant flow	(6.87)	(3.50)	(3.50)	(3.50)	(3.50)	(3.50)	(3.50)	(3.50)

ARLINGTON COUNTY WPCP **GREENHOUSE GAS EMISSION CALCULATIONS**

Parameter	**Unit**	**Source/Note**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**
Flow	mgd	TM1	26.4	26.7	26.9	27.1	27.4	27.6	27.9	28.1
Existing Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	16,591	16,744	16,897	17,050	17,204	17,357	17,510	17,663
Power - DC7	kWh/yr	PowerBI (2020), proportion per flow	3,318,541	3,349,166	3,379,792	3,410,417	3,441,043	3,471,668	3,502,294	3,532,919
Power - Solids MCCs	kWh/yr	PowerBI (partial 2021), proportion per flow	1,542,669	1,556,905	1,571,142	1,585,378	1,599,615	1,613,852	1,628,088	1,642,325
Natural Gas	MMBtu/yr	Utility bill	896	904	912	921	929	937	945	954
Biosolids Produced	DT/year	TM1, data analysis	11,393	11,499	11,604	11,709	11,814	11,919	12,024	12,129
Biosolids Hauled	MT/year	Calculation	34,071	34,386	34,700	35,015	35,329	35,644	35,958	36,272
Polymer - Thickening	MT/year	Polymer deliveries	21	21	21	21	21	22	22	22
Polymer - Dewatering	MT/year	Polymer deliveries	48	49	49	50	50	50	51	51
Lime	MT/year	Lime tickets	1,704	1,719	1,735	1,751	1,767	1,782	1,798	1,814
Methanol	gal/yr	Methanol tickets	368,856	372,260	375,664	379,068	382,472	385,876	389,280	392,684
Existing Facilities GHG Emissions - Scope 1	MT CO2e/year	Baseline Factors	48	48	48	49	49	50	50	51
Existing Facilities GHG Emissions - Scope 2	MT CO2e/year	Baseline Factors	1,385	1,398	1,411	1,424	1,437	1,449	1,462	1,475
Existing Facilities GHG Emissions - Scope 3	MT CO2e/year	Baseline Factors	3,802	3,822	3,843	3,863	3,884	3,904	3,925	3,945
Existing Facilities GHG Emissions - Total	MT CO2e/year	Baseline Factors	**5,235**	**5,268**	**5,302**	**5,336**	**5,370**	**5,403**	**5,437**	**5,471**
New Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	38,458	38,813	39,168	39,523	39,878	40,233	40,587	40,942
Power	kWh/yr	Estimate load 2052, proportion per flow	11,268,190	11,372,179	11,476,169	11,580,158	11,684,148	11,788,137	11,892,127	11,996,116
Natural Gas Consumed	MMBtu/yr	Gas utilization model	36,054	36,380	36,706	37,032	37,358	37,684	38,010	38,336
Biogas to Flare	MMBtu/yr	Gas utilization model	16,800	16,955	17,110	17,267	17,422	17,576	17,731	17,889
RNG Generated	MMBtu/yr	Gas utilization model	114,406	115,457	116,508	117,578	118,629	119,680	120,730	121,800
Biosolids Hauled	MT/year	TM1	16,766	16,921	17,076	17,230	17,385	17,540	17,695	17,849
Polymer - Pre-dewatering	MT/year	Match existing	48	49	49	50	50	50	51	51
Polymer - Final Dewatering	MT/year	Solids model	54	54	55	55	56	56	57	57
Lime	MT/year	None	-	-	-	-	-	-	-	-
Methanol	gal/yr	Methanol tickets+recycle	2,690	2,715	2,740	2,765	2,789	2,814	2,839	2,864
Biogenic Emissions	*MT CO2e/year*	*Future (2037) Factors*	*879*	*887*	*895*	*904*	*912*	*920*	*928*	*936*
New Facilities GHG Emissions - Scope 1	MT CO2e/year	Future (2037) Factors	1,915	1,932	1,950	1,967	1,984	2,002	2,019	2,036
New Facilities GHG Emissions - Scope 2	MT CO2e/year	Future (2037) Factors - assume no grid mix change	3,211	3,241	3,271	3,300	3,330	3,360	3,389	3,419
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100%	1,347	1,359	1,372	1,384	1,396	1,409	1,421	1,434
		Future (2037) Factors - assume Arlington County meets 100% renewable energ	-	-	-	-	-	-	-	-
New Facilities GHG Emissions - Scope 3	MT CO2e/year	Future (2037) Factors	1,914	1,922	1,931	1,939	1,948	1,956	1,965	1,973
New Facilities GHG Emissions - Total	MT CO2e/year	Future (2037) Factors - assume no grid mix change	**7,040**	**7,096**	**7,151**	**7,206**	**7,262**	**7,317**	**7,373**	**7,428**
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100%	**5,175**	**5,214**	**5,252**	**5,290**	**5,328**	**5,367**	**5,405**	**5,443**
		Future (2037) Factors - assume Arlington County meets 100% renewable energ	**3,829**	**3,855**	**3,880**	**3,906**	**3,932**	**3,958**	**3,983**	**4,009**
Equivalent GHG Emissions from RNG Produced	MT CO2e/year	conventional natural gas offset	5,988	6,043	6,098	6,154	6,209	6,264	6,319	6,375
Energy Demand (Scope 1 and 2)										
Baseline	MMBtu/yr		17,487	17,648	17,810	17,971	18,132	18,294	18,455	18,617
Future	MMBtu/yr		(39,894)	(40,264)	(40,634)	(41,023)	(41,393)	(41,763)	(42,133)	(42,522)
Energy Intensity (per dry ton solids produced)*										
Baseline	MMBtu/DT produced	*assumes the same amount of biosolids are treated pre- and post-	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
Future	MMBtu/DT produced	project, scaled proportionally to plant flow	(3.50)	(3.50)	(3.50)	(3.50)	(3.50)	(3.50)	(3.50)	(3.51)

ARLINGTON COUNTY WPCP **GREENHOUSE GAS EMISSION CALCULATIONS**

Parameter	Unit	Source/Note	2042	2043	2044	2045	2046	2047	2048	2049
Flow	mgd	TM1	28.4	28.6	28.9	29.1	29.3	29.6	29.8	30.1
Existing Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	17,816	17,969	18,122	18,275	18,429	18,582	18,735	18,888
Power - DC7	kWh/yr	PowerBI (2020), proportion per flow	3,563,544	3,594,170	3,624,795	3,655,421	3,686,046	3,716,672	3,747,297	3,777,922
Power - Solids MCCs	kWh/yr	PowerBI (partial 2021), proportion per flow	1,656,562	1,670,798	1,685,035	1,699,272	1,713,508	1,727,745	1,741,982	1,756,218
Natural Gas	MMBtu/yr	Utility bill	962	970	978	987	995	1,003	1,011	1,020
Biosolids Produced	DT/year	TM1, data analysis	12,235	12,340	12,445	12,550	12,655	12,760	12,865	12,971
Biosolids Hauled	MT/year	Calculation	36,587	36,901	37,216	37,530	37,845	38,159	38,473	38,788
Polymer - Thickening	MT/year	Polymer deliveries	22	22	23	23	23	23	23	24
Polymer - Dewatering	MT/year	Polymer deliveries	52	52	53	53	54	54	54	55
Lime	MT/year	Lime tickets	1,830	1,845	1,861	1,877	1,892	1,908	1,924	1,940
Methanol	gal/yr	Methanol tickets	396,088	399,493	402,897	406,301	409,705	413,109	416,513	419,917
Existing Facilities GHG Emissions - Scope 1	MT CO2e/year	Baseline Factors	51	52	52	52	53	53	54	54
Existing Facilities GHG Emissions - Scope 2	MT CO2e/year	Baseline Factors	1,488	1,501	1,513	1,526	1,539	1,552	1,564	1,577
Existing Facilities GHG Emissions - Scope 3	MT CO2e/year	Baseline Factors	3,966	3,986	4,007	4,027	4,048	4,068	4,089	4,109
Existing Facilities GHG Emissions - Total	MT CO2e/year	Baseline Factors	**5,505**	**5,538**	**5,572**	**5,606**	**5,640**	**5,673**	**5,707**	**5,741**
New Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	41,297	41,652	42,007	42,362	42,717	43,072	43,427	43,782
Power	kWh/yr	Estimate load 2052, proportion per flow	12,100,106	12,204,095	12,308,084	12,412,074	12,516,063	12,620,053	12,724,042	12,828,032
Natural Gas Consumed	MMBtu/yr	Gas utilization model	38,662	38,987	39,313	39,639	39,965	40,291	40,617	40,943
Biogas to Flare	MMBtu/yr	Gas utilization model	18,043	18,198	18,353	18,510	18,665	18,819	18,974	19,132
RNG Generated	MMBtu/yr	Gas utilization model	122,851	123,902	124,953	126,023	127,074	128,124	129,175	130,245
Biosolids Hauled	MT/year	TM1	18,004	18,159	18,313	18,468	18,623	18,778	18,932	19,087
Polymer - Pre-dewatering	MT/year	Match existing	52	52	53	53	54	54	54	55
Polymer - Final Dewatering	MT/year	Solids model	58	58	59	59	60	60	61	61
Lime	MT/year	None	-	-	-	-	-	-	-	-
Methanol	gal/yr	Methanol tickets+recycle	2,889	2,913	2,938	2,963	2,988	3,013	3,038	3,062
Biogenic Emissions	*MT CO2e/year*	*Future (2037) Factors*	*944*	*952*	*961*	*969*	*977*	*985*	*993*	*1,001*
New Facilities GHG Emissions - Scope 1	MT CO2e/year	Future (2037) Factors	2,053	2,071	2,088	2,105	2,123	2,140	2,157	2,175
New Facilities GHG Emissions - Scope 2	MT CO2e/year	Future (2037) Factors - assume no grid mix change	3,449	3,478	3,508	3,537	3,567	3,597	3,626	3,656
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100	1,446	1,459	1,471	1,483	1,496	1,508	1,521	1,533
		Future (2037) Factors - assume Arlington County meets 100% renewable ener	-	-	-	-	-	-	-	-
New Facilities GHG Emissions - Scope 3	MT CO2e/year	Future (2037) Factors	1,981	1,990	1,998	2,007	2,015	2,024	2,032	2,041
New Facilities GHG Emissions - Total	MT CO2e/year	Future (2037) Factors - assume no grid mix change	**7,484**	**7,539**	**7,594**	**7,650**	**7,705**	**7,761**	**7,816**	**7,871**
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100	**5,481**	**5,519**	**5,558**	**5,596**	**5,634**	**5,672**	**5,710**	**5,749**
		Future (2037) Factors - assume Arlington County meets 100% renewable ener	**4,035**	**4,061**	**4,087**	**4,112**	**4,138**	**4,164**	**4,190**	**4,215**
Equivalent GHG Emissions from RNG Produced	MT CO2e/year	conventional natural gas offset	6,430	6,485	6,540	6,596	6,651	6,706	6,761	6,817
Energy Demand (Scope 1 and 2)										
Baseline	MMBtu/yr		18,778	18,939	19,101	19,262	19,423	19,585	19,746	19,908
Future	MMBtu/yr		(42,892)	(43,262)	(43,632)	(44,021)	(44,391)	(44,761)	(45,131)	(45,520)
Energy Intensity (per dry ton solids produced)*										
Baseline	MMBtu/DT produced	*assumes the same amount of biosolids are treated pre- and post-	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
Future	MMBtu/DT produced	project, scaled proportionally to plant flow	(3.51)	(3.51)	(3.51)	(3.51)	(3.51)	(3.51)	(3.51)	(3.51)

ARLINGTON COUNTY WPCP **GREENHOUSE GAS EMISSION CALCULATIONS**

Parameter	Unit	Source/Note	2050	2051	2052
Flow	mgd	TM1	30.3	30.6	30.8
Existing Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	19,041	19,194	19,347
Power - DC7	kWh/yr	PowerBI (2020), proportion per flow	3,808,548	3,839,173	3,869,799
Power - Solids MCCs	kWh/yr	PowerBI (partial 2021), proportion per flow	1,770,455	1,784,692	1,798,928
Natural Gas	MMBtu/yr	Utility bill	1,028	1,036	1,045
Biosolids Produced	DT/year	TM1, data analysis	13,076	13,181	13,286
Biosolids Hauled	MT/year	Calculation	39,102	39,417	39,731
Polymer - Thickening	MT/year	Polymer deliveries	24	24	24
Polymer - Dewatering	MT/year	Polymer deliveries	55	56	56
Lime	MT/year	Lime tickets	1,955	1,971	1,987
Methanol	gal/yr	Methanol tickets	423,321	426,725	430,129
Existing Facilities GHG Emissions - Scope 1	MT CO2e/year	Baseline Factors	55	55	55
Existing Facilities GHG Emissions - Scope 2	MT CO2e/year	Baseline Factors	1,590	1,603	1,616
Existing Facilities GHG Emissions - Scope 3	MT CO2e/year	Baseline Factors	4,130	4,150	4,171
Existing Facilities GHG Emissions - Total	MT CO2e/year	Baseline Factors	**5,774**	**5,808**	**5,842**
New Facilities	MMBtu/yr	convert electricity to equivalent energy in MMBtu	44,137	44,492	44,846
Power	kWh/yr	Estimate load 2052, proportion per flow	12,932,021	13,036,011	13,140,000
Natural Gas Consumed	MMBtu/yr	Gas utilization model	41,269	41,595	41,921
Biogas to Flare	MMBtu/yr	Gas utilization model	19,286	19,441	19,599
RNG Generated	MMBtu/yr	Gas utilization model	131,296	132,347	133,417
Biosolids Hauled	MT/year	TM1	19,242	19,397	19,551
Polymer - Pre-dewatering	MT/year	Match existing	62	62	63
Polymer - Final Dewatering	MT/year	Solids model	0	0	0
Lime	MT/year	None	-	-	-
Methanol	gal/yr	Methanol tickets+recycle	3,087	3,112	3,137
Biogenic Emissions	*MT CO2e/year*	*Future (2037) Factors*	*1,009*	*1,017*	*1,026*
New Facilities GHG Emissions - Scope 1	MT CO2e/year	Future (2037) Factors	2,192	2,209	2,227
New Facilities GHG Emissions - Scope 2	MT CO2e/year	Future (2037) Factors - assume no grid mix change	3,686	3,715	3,745
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100%	1,546	1,558	1,570
		Future (2037) Factors - assume Arlington County meets 100% renewable ener	-	-	-
New Facilities GHG Emissions - Scope 3	MT CO2e/year	Future (2037) Factors	1,554	1,558	1,563
New Facilities GHG Emissions - Total	MT CO2e/year	Future (2037) Factors - assume no grid mix change	**7,432**	**7,483**	**7,534**
		Future (2037) Factors - assume grid mix change per Dominion forecast to 100%	**5,292**	**5,326**	**5,360**
		Future (2037) Factors - assume Arlington County meets 100% renewable ener	**3,746**	**3,768**	**3,790**

Equivalent GHG Emissions from RNG Produced	MT CO2e/year	conventional natural gas offset	6,872	6,927	6,983

Energy Demand (Scope 1 and 2)					
Baseline	MMBtu/yr		20,069	20,230	20,392
Future	MMBtu/yr		(45,890)	(46,260)	(46,650)
Energy Intensity (per dry ton solids produced)*					
Baseline	MMBtu/DT produced	*assumes the same amount of biosolids are treated pre- and post-	1.53	1.53	1.53
Future	MMBtu/DT produced	project, scaled proportionally to plant flow	(3.51)	(3.51)	(3.51)

ARLINGTON COUNTY WPCP **GREENHOUSE GAS EMISSION CALCULATIONS**

FACTOR	UNIT	SOURCE	VALUE
Global Warming Potentials			
CO2	GWP	Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007	1
CH4	GWP	Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007	25
N2O	GWP	Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007	298
Emission Factors - Scope 1			
Stationary Combustion, Natural Gas	kg CO2/MMBtu	EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	53.06
Stationary Combustion, Natural Gas	kg CH4/MMBtu	EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	0.001
Stationary Combustion, Natural Gas	kg N2O/MMBtu	EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	0.0001
Stationary Combustion, Biogas (flared)	kg CO2/MMBtu	EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	52.07
Stationary Combustion, Biogas (flared)	kg CH4/MMBtu	EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	0.003
Stationary Combustion, Biogas (flared)	kg N2O/MMBtu	EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	0.0006
Emission Factors - Scope 2			
Purchased Power Emissions, 2020	MT CO2e/MWh	https://sustainability.dominionenergy.com/assets/pdf/metrics/dominion-energy-environmental-metrics-2019.pdf	0.285
Purchased Power Emissions, 2037	MT CO2e/MWh	Projected Renewable Grid Mix - Dominion Energy Forecast, targeting 100% Carbon Free by 2050	0.120
Purchased Power Emissions, 2037	MT CO2e/MWh	Arlington County Goal of 100% Renewable Energy Sourcing	0.000
Emission Factors - Scope 3			
2019 Transmission Loss (Virginia)	% Loss	US Energy Information Administration (EIA) State Profile Data; https://www.eia.gov/electricity/state/virginia/	5.14%
Transportation and Distribution, Material Transport (calculated Upstream)	MT CO2e	Assume: diesel medium/heavy duty trucks; EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	0.211
Transportation and Distribution, Material Transport (calculated Downstream)	MT CO2e	Assume: diesel medium/heavy duty trucks; EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	0.000002
			0.0000049
Transportation and Distribution, Material Transport (Backhaul)	MT CO2e	Assume: diesel medium/heavy duty trucks; EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	1.407
Transportation and Distribution, Material Transport (Backhaul)	MT CO2e	Assume: diesel medium/heavy duty trucks; EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	0.000013
		Assume: diesel medium/heavy duty trucks; EPA, Emission Factors for Greenhouse Gas Inventories, April 2021	0.000033
Average Trip Distance, Lime Delivery	miles one-way	Assume: Greer Lime Company, 1088 Germany Valley, Limestone Rd, Riverton, WV 26814	166
Average Trip Distance, Polymer Delivery	miles one-way	Assume: Polydyne, Inc., 1 Chemical Plant Rd, Riceboro, GA 31323	600
Average Trip Distance, Methanol Delivery	miles one-way	Assume: Colonial Chemical Solutions, Inc., 916 West Lathrop Avenue, Savannah, GA 31415	571
Average Trip Distance, Biosolids Land Application, 2020	miles one-way	Biosolids tickets	92.97
Average Trip Distance, Biosolids Land Application, 2037	miles one-way	Estimated reduction of radius	72.91
Polymer Manufacturing	Mg CO2eq/Mg polymer	BEAM v1.3, Carnegie Mellon Green Design Inst. (http://www.eiolca.net/accessed March 2010)	9.0
Lime Manufacturing	Mg CO2eq/Mg lime produced	BEAM v1.3, Carnegie Mellon Green Design Inst. (http://www.eiolca.net/accessed March 2010)	0.9
Land Application			
Applying biosolids to land	MT CO2e/day	Baseline fuel usage, application time, load size	0.15
Applying biosolids to land	MT CO2e/day	Future fuel usage, application time, load size	0.09
CO2 Emissions equivalents from released CH4 (Mg/day)	MT CO2e/day	Baseline limed solids parameters, BEAM v1.3 (Mg CO2e/day)	0.37
CO2 emissions equivalents from released N2O (Mg/day)	MT CO2e/day	Baseline limed solids parameters, BEAM v1.3 (Mg CO2e/day)	0.26
CO2 Emissions equivalents from released CH4 (Mg/day)	MT CO2e/day	Future digested solids parameters, BEAM v1.3 (Mg CO2e/day)	0.37
CO2 emissions equivalents from released N2O (Mg/day)	MT CO2e/day	Future digested solids parameters, BEAM v1.3 (Mg CO2e/day)	0.26

PROJECTED BIOSOLIDS COMPOSITION	
Lime	15%
Existing Cake	32%

UNIT CONVERSIONS	
kilograms to metric tons	0.001
kwh per MMBtu	293

ARLINGTON COUNTY WPCP **GREENHOUSE GAS EMISSION CALCULATIONS**

Data from Biosolids Emission Assessment Model (BEAM), 2009

Carbon Sequestration				**Project Estimate**	
From biosolids applied to soil (Mg CO_2/day)	MT CO2e/day	Baseline limed solids parameters, BEAM v1.3 (Mg CO2e/day)	-6.50	-2374	*Baseline 2020*
From biosolids applied to soil (Mg CO_2/day)	MT CO2e/day	Future digested solids parameters, BEAM v1.3 (Mg CO2e/day)	-3.89	-1421	*Future 2037*
Fertilizer Off-set Credits					
From nitrogen applied to soil (Mg CO_2/day)	MT CO2e/day	Baseline limed solids parameters, BEAM v1.3 (Mg CO2e/day)	-3.12		
From phosphorus applied to soil (Mg CO_2/day)	MT CO2e/day	Baseline limed solids parameters, BEAM v1.3 (Mg CO2e/day)	-0.62		
From nitrogen applied to soil (Mg CO_2/day)	MT CO2e/day	Future digested solids parameters, BEAM v1.3 (Mg CO2e/day)	-3.12		
From phosphorus applied to soil (Mg CO_2/day)	MT CO2e/day	Future digested solids parameters, BEAM v1.3 (Mg CO2e/day)	-0.59		
Calcium Carbonate Debit					
From $CaCO_3$ applied to soil (Mg CO_2/day)	MT CO2e/day	Baseline limed solids parameters, BEAM v1.3 (Mg CO2e/day)	1.72		
From $CaCO_3$ applied to soil (Mg CO_2/day)	MT CO2e/day	Future digested solids parameters, BEAM v1.3 (Mg CO2e/day)	0		

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Technical Memorandum No. 19

Date:	February 9, 2023
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Centrifuge Equipment Evaluation

Contents

Tables

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Figures

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1.0 Introduction

This introductory section presents the background and purpose of this project and the centrifuge evaluation, followed by a description of the centrifuge evaluation approach.

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary solids (PS) and waste activated solids (WAS) thickening, dewatering, and lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a thermal hydrolysis process (THP) and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The purpose of this centrifuge evaluation is to further assess and compare centrifuge alternatives. The results of this evaluation will inform and validate a final decision on which centrifuge manufacturer(s) will be chosen to replace the existing centrifuges.

1.2 Evaluation Approach

A suite of alternatives using various centrifuges was developed. Conceptual process sizing, configurations, site layouts, and conceptual costs for centrifuges were prepared. The project team attended 1-hour virtual workshops with each manufacturer to learn about the specific details of each manufacturer and ask questions. Centrifuge options were presented and reviewed at the December 8, 2021, project workshop with the County. Workshop participants screened and selected a short list of preferred centrifuges. In this evaluation, the shortlisted technologies are further evaluated and compared based on conceptual operations and maintenance (O&M) cost estimates and non-cost considerations, site layout, and space requirements.

2.0 Summary of Existing Facilities and Processing

A process flow diagram for existing solids handling at the WPCP is shown in Figure 1. Solids are thickened using gravity thickeners for PS and dissolved air flotation thickeners for WAS. Thickened solids are blended in solids storage tanks and dewatered using centrifuges. Liquid centrate from the centrifuges is returned to the head of the WPCP. Lime is added to the dewatered solids to achieve Class B pathogen and vector attraction reduction. Lime-stabilized biosolids are hauled off site for beneficial use through bulk land application.

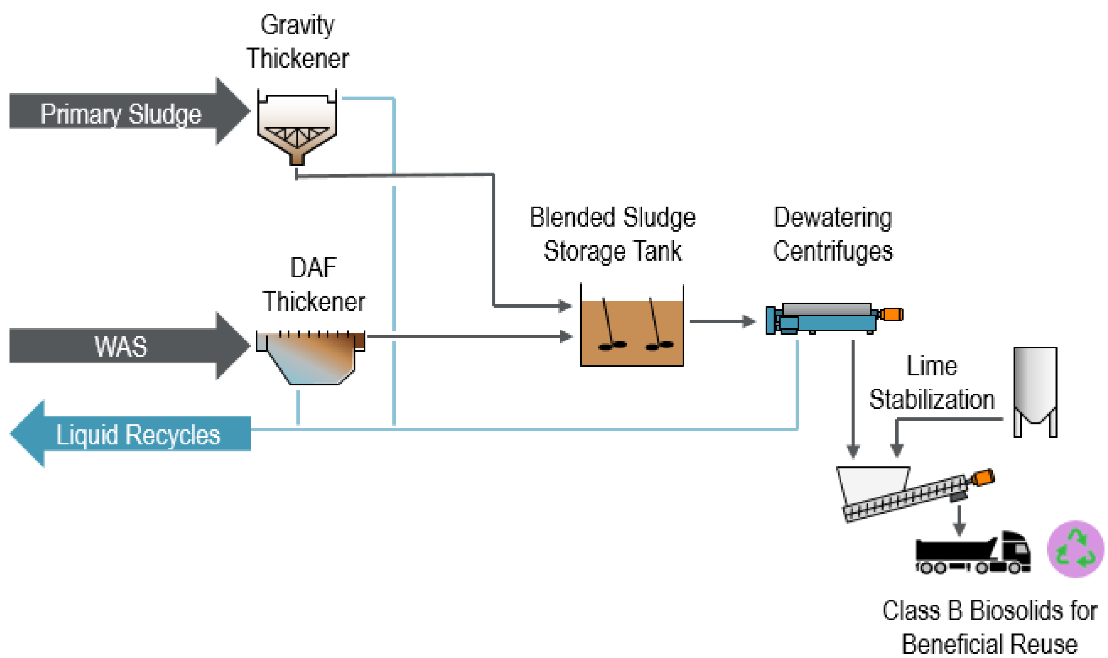

Figure 1. Existing PS and WAS Process Flow Diagram

The new solids handling process will include two dewatering steps, as shown in Figure 2: a pre-dewatering process to provide the appropriate solids concentration to feed the THP and subsequent digestion process, and a final dewatering process for creation of the dewatered cake for beneficial use. The equipment evaluations for both dewatering processes, indicated in the blue dashed area in the figure, were included in the dewatering equipment technical memorandum.

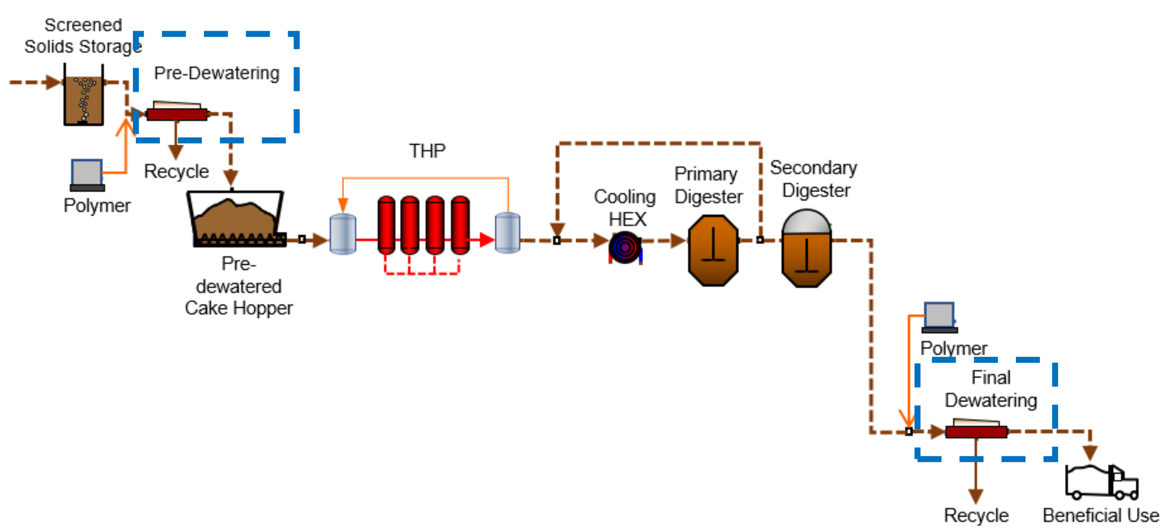

Figure 2. Future Solids Handling Process Dewatering Locations

3.0 Design Criteria

Three design loading conditions were considered for the centrifuge evaluation:

- **23.0 million gallons per day (mgd):** 2020 current conditions
  - Annual average loading was considered for "minimum" operating conditions and as a baseline for annual O&M costs
- **30.8 mgd:** 2052 projected conditions
  - Used as the basis for equipment sizing and number of units required for the Facilities Plan
- **40.0 mgd:** final/buildout conditions
  - Used to establish total footprint requirements and dewatering facility sizing with space reserved for potential future equipment

Process equipment selections and facility concepts were based on a 30.8 mgd design condition for equipment sizing and a 40.0 mgd buildout condition for overall facility sizing.

For ease of maintenance and interchangeability of parts, manufacturers were asked to provide the same model of centrifuge for pre-dewatering and final dewatering. Manufacturers were also asked to provide centrifuges with a 29- to 30-inch-diameter scroll for consistency in comparison. This size machine is appropriate for use in both pre-dewatering and final dewatering applications, where there will be two centrifuges in service and one centrifuge in service, respectively.

3.1 Pre-Dewatering

Peak 3-day solids loadings were used for sizing the pre-dewatering process. The pre-dewatering process is intended to operate 24 hours per day, 7 days per week, to provide a continuous flow of solids to THP. The pre-dewatering feed solids concentration is assumed to be 4.3 percent with a PS:WAS ratio of 70:30. THP is required to be fed at 15 to 18 percent solids; however, it is understood that any of the pre-dewatering systems being evaluated will dewater to a higher solids concentration, and additional dilution will be required prior to feeding THP. The anticipated flows and loads for pre-dewatering are summarized in Table 1.

Table 1. Pre-Dewatering Design Criteria

Design Condition	Average Conditions		Peak 3-Day	
	Flow (gpm)	TSS Load (lb/hr)	Flow (gpm)	TSS Load (lb/hr)
23.0 mgd	120	2,700	210	4,400
30.8 mgd	170	3,600	280	5,900
40.0 mgd	215	4,600	358	7,700

Note: flows are based on an assumed feed concentration of 4.3% solids.
gpm = gallons per minute; lb/hr = pounds per hour.

Three centrifuges are proposed for the pre-dewatering process (two duty, one standby) at the 30.8 mgd design condition. Therefore, to meet the peak 3-day flow and load, the centrifuges' capacity must be at least 140 gallons per minute (gpm) and 2,950 pounds per hour (lb/hr) total suspended solids (TSS).

3.2 Final Dewatering

Peak 14-day solids loadings were used for sizing final dewatering processes because of the equalization capacity provided by the secondary anaerobic digester as well as upstream cake and thickened solids storage. The final dewatering process is sized to operate 24 hours per day, 5.5 days per week at peak 14-day loading conditions. The feed solids concentration is anticipated to be 4.6 percent, and the target solids concentration is 30 percent solids or greater. The anticipated flows and loads to final dewatering are summarized in Table 2.

Table 2. Final Dewatering Design Criteria

	Average Conditions		Peak 14-Day	
Design Condition	Flow (gpm)	TSS Load (lb/hr)	Flow (gpm)	TSS Load (lb/hr)
23.0 mgd	70	1,600	100	2,300
30.8 mgd	100	2,200	140	3,100
40.0 mgd	125	2,900	180	4,000

Note: flows are based on an assumed feed concentration of 4.3% solids.

Two centrifuges are proposed for the final dewatering process (one duty, one standby) at the 30.8 mgd design condition. Therefore, the centrifuges will be sized for a capacity of 140 gpm and 3,100 lb/hr TSS.

4.0 Manufacturer Evaluation

This section describes the results from the following centrifuge manufacturers applicable to the Arlington WPCP:

- Alfa Laval
- Andritz
- Centrisys
- Flottweg
- GEA

For each manufacturer, the following information is presented:

- Technical criteria and survey findings
- Approach for centrifuge replacement in the dewatering building
- Feedback from lunch-and-learns and preferred manufacturers
- Findings from site visits to operating installations

4.1 Specifications

The following criteria were used to evaluate each centrifuge manufacturer:

- Footprint/geometry
- Beach angle

- Throughput capacity
- Manufacturer experience/reliability
- Installation number
- Lubrication system
- Gearbox
- Materials of construction: bowl/scroll
- Drive type
- Controls
- Manufacturer support

Table 3 presents general specifications of the equipment. The existing centrifuges have the solids feed on the centrate end of the unit. If the existing dewatering building is reused, the solids feed piping will have to be rerouted to the opposite side of the centrifuge room for units with solids feed on the solids end (Alfa Laval and Centrisys), because the centrifuge orientation must align with the existing cake discharge location due to the reuse of the cake bins on the floor below. For more details on the orientation and placement of the centrifuges, refer to Section 4.2.

Table 3. General Centrifuge Specifications

Parameter	Alfa Laval	Flottweg	Andritz	Centrisys	GEA
Current Model	G3-125	C8E	D7LL	CS30-4	CF8000
Number of wastewater installations (current model)	21	2	35	0	7
Number of wastewater installations of similar size (older model(s))	16 (G2-125[a] and others)	0	0	0	34 (CA755, CD755[b])
Bowl diameter (in)	29	30	29	30	30
Frame material	Galvanized mild steel	Powdered coated carbon steel	Painted steel	Carbon steel	Epoxy-coated carbon steel
Cover material	316 SST	316 SST	FRP or 316L SST	304 SST	316 SST and duplex
Solids feed location	Solids end	Centrate end	Centrate end	Solids end	Centrate end
Bowl material	Duplex SST	Duplex SST	Cast duplex SST	Cast duplex SST	Duplex SST
Scroll feed location	Mid-scroll	Mid-scroll	Centrate end	Solids end	Mid-scroll

in = inches; SST = stainless steel.

a. The G2-125 centrifuge is an older version of the G3-125 centrifuge.

b. The CA755 and CD755 centrifuges are part of the older CA and CD series, respectively. They use forced-oil lubrication with water-cooled heat exchangers.

Table 4 presents bearing and drive specifications of the equipment.

Table 4. Bearings/Drives Specifications

Parameter	Alfa Laval	Flottweg	Andritz	Centrisys	GEA
Main bearing lubrication	Grease	Oil	Forced oil	Air/oil	Air/oil mist
Scroll bearing lubrication	Grease	Grease	Forced oil	Air/oil	Grease

Main drive type	VFD	VFD	VFD	VFD	VFD
Main drive motor (hp)	125	200	150–200	150	100–150
Scroll drive type	VFD	VFD	VFD	Hydraulic	VFD
Scroll drive motor (hp)	50	60	50	60	50
Gearbox	Multistage planetary	Planetary	Cycloidal (CYCLO®-Sumitomo) and planetary	N/A	Multistage planetary

hp = horsepower; VFD = variable-frequency drive.

Table 5 presents wear protection and beach angle specifications of the equipment.

Table 5. Wear Protection and Beach Angle Specifications

Parameter	Alfa Laval	Flottweg	Andritz	Centrisys	GEA
Beach angle (degrees)	10	15	13	15	15
Full vs. partial length tiles on scroll	Partial length	Both are available	Full	Both are available	Full
Wear strips in bowl	20	18	8	16	24 – as an optional offering (grooves are standard)
Wear part guarantees	8,000 hr/ 1 yr (with extended warranty option)	15,000 hr	15,000 hr	15,000 hr	15,000 hr

yr = years.

Table 6 presents specifications for programmable logic controllers (PLCs) and variable-frequency drives (VFDs).

Table 6. PLC and VFD Specifications

Parameter	Alfa Laval	Flottweg	Andritz	Centrisys	GEA
PLC manufacturer	Allen-Bradley	Customer preference	Allen-Bradley CompactLogix or ControlLogix	Allen-Bradley CompactLogix	Rockwell, Allen-Bradley, Modicon, GE, Siemens
VFD manufacturer	ABB	Customer preference	Allen-Bradley PowerFlex Series 755	ABB	ABB, Danfoss, Schneider, Rockwell
Clean-in-place procedures	Yes	Yes	Yes	Yes	Yes
Power loss ride through	Yes	Yes	Yes	Optional	Yes

4.2 Layouts

The following figures display the existing centrifuges and potential centrifuges in plan and section, with green indicating existing piers and yellow indicating new piers. The layouts are based on the models presented in Table 3 above. Note that figures are relevant only for pre-dewatering centrifuges in the “renovate dewatering building” option. If the “decommission dewatering building” option is chosen, the pre-dewatering centrifuges will be located in a new building.

If the existing dewatering building is reused, the solids feed piping will have to be rerouted to the opposite side of the centrifuge room for units with solids feed on the solids end (Alfa Laval and Centrisys), because the centrifuge orientation must align with the existing cake discharge location. The solids discharge outlet on each centrifuge must align with the existing solids chute location to allow conveyance of solids.

Figure 3, Figure 4, and Figure 5 present the plan and section of the existing centrifuges with the piers and centrate discharge pipe outlined in green.

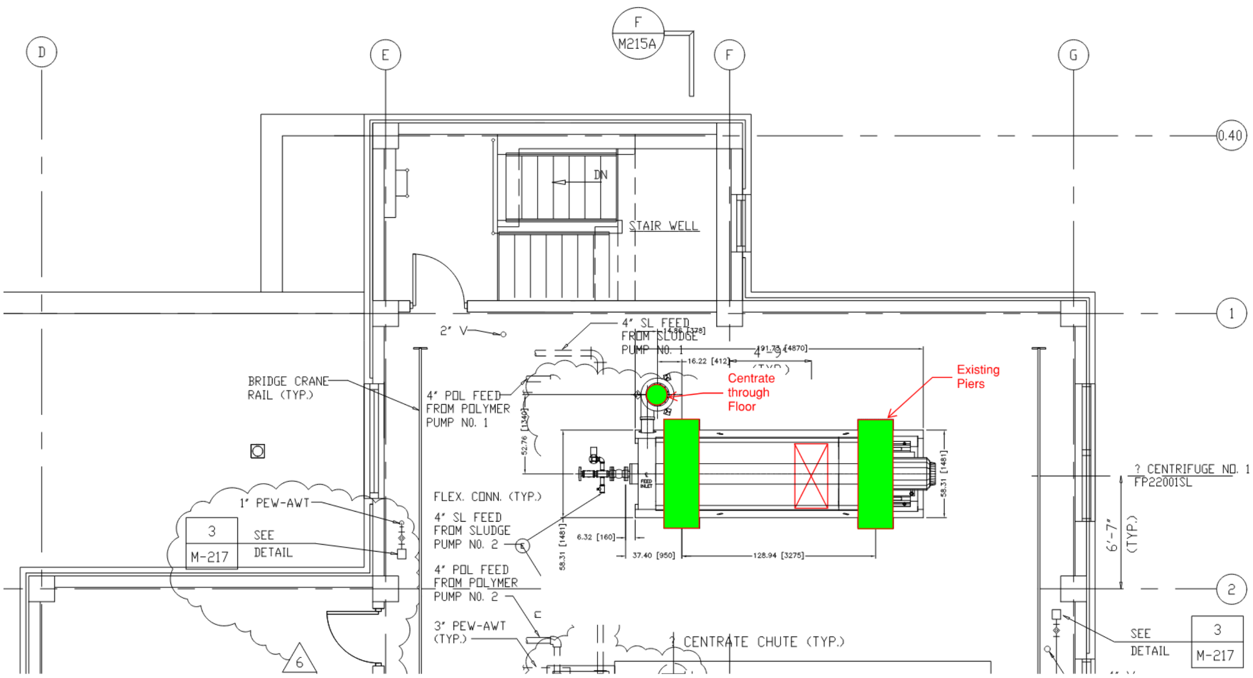

Figure 3. Existing Centrifuges Plan

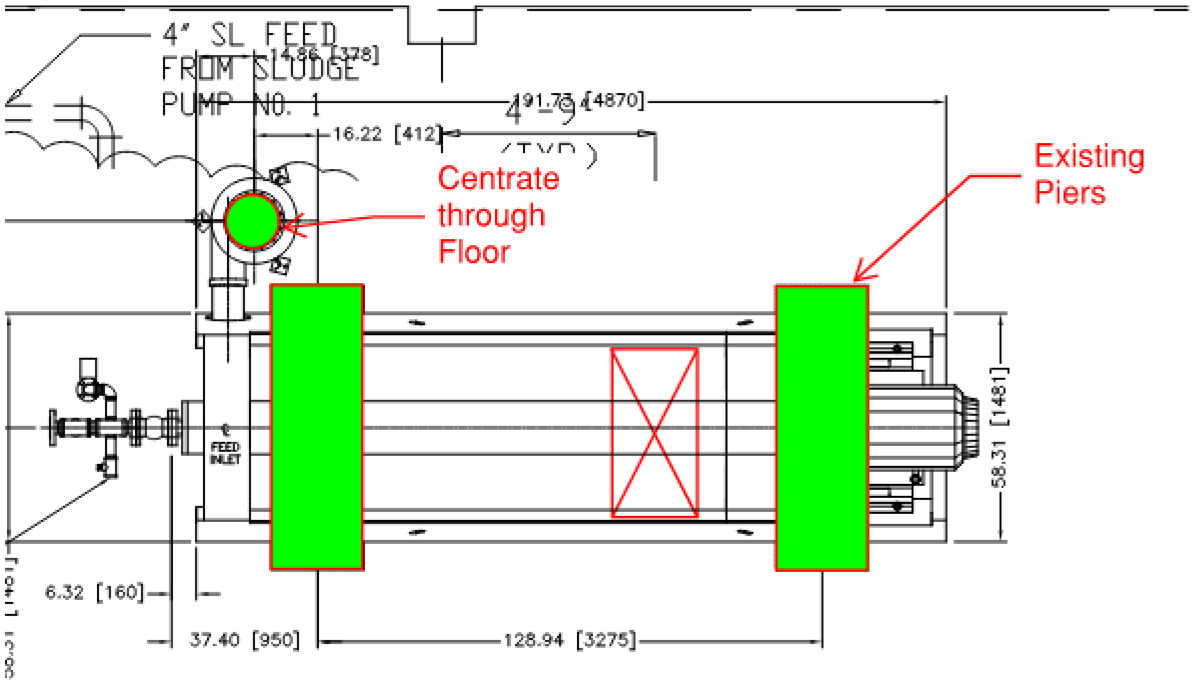

Figure 4. Existing Centrifuges Plan Zoomed

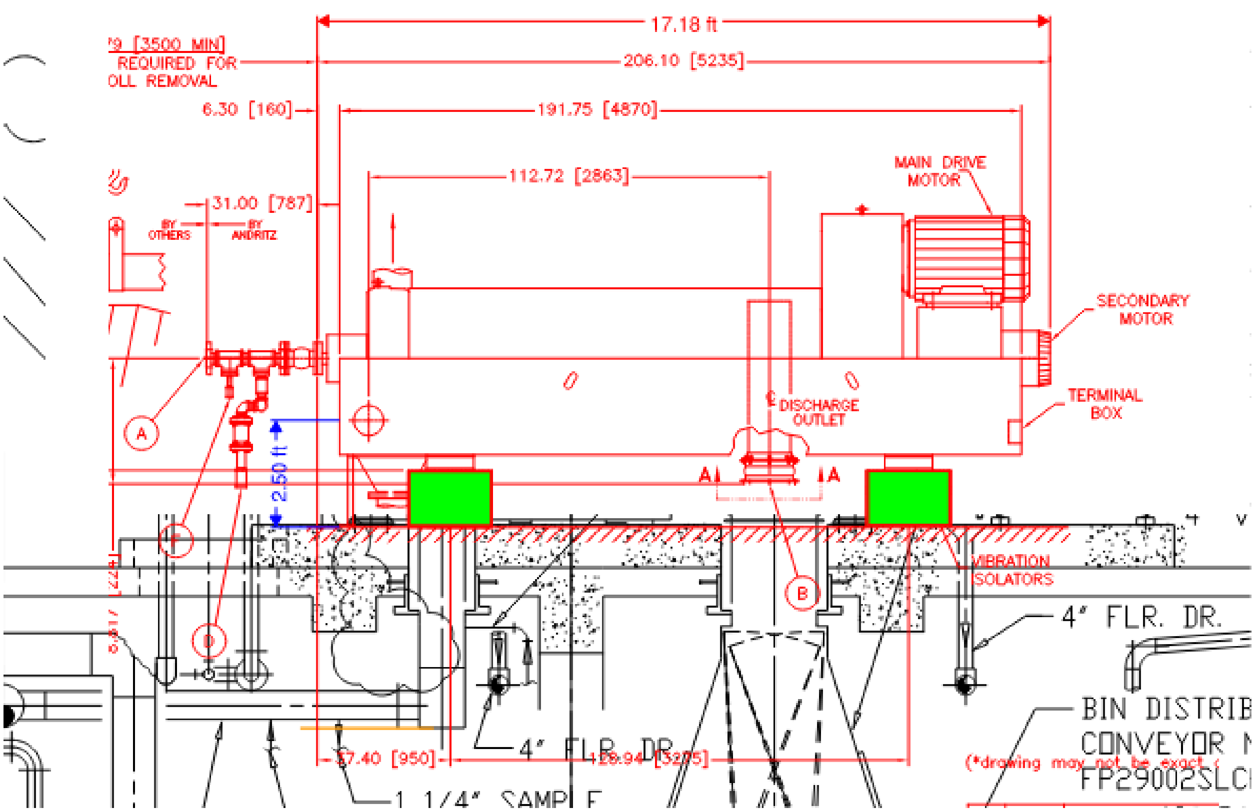

Figure 5. Existing Centrifuges Section

Figure 6, Figure 7 and Figure 8 present the plan and section for the GEA centrifuge. The solids feed is on the same side as the existing centrifuge, so no rerouting is required. New pier locations (in yellow) are required to support this centrifuge.

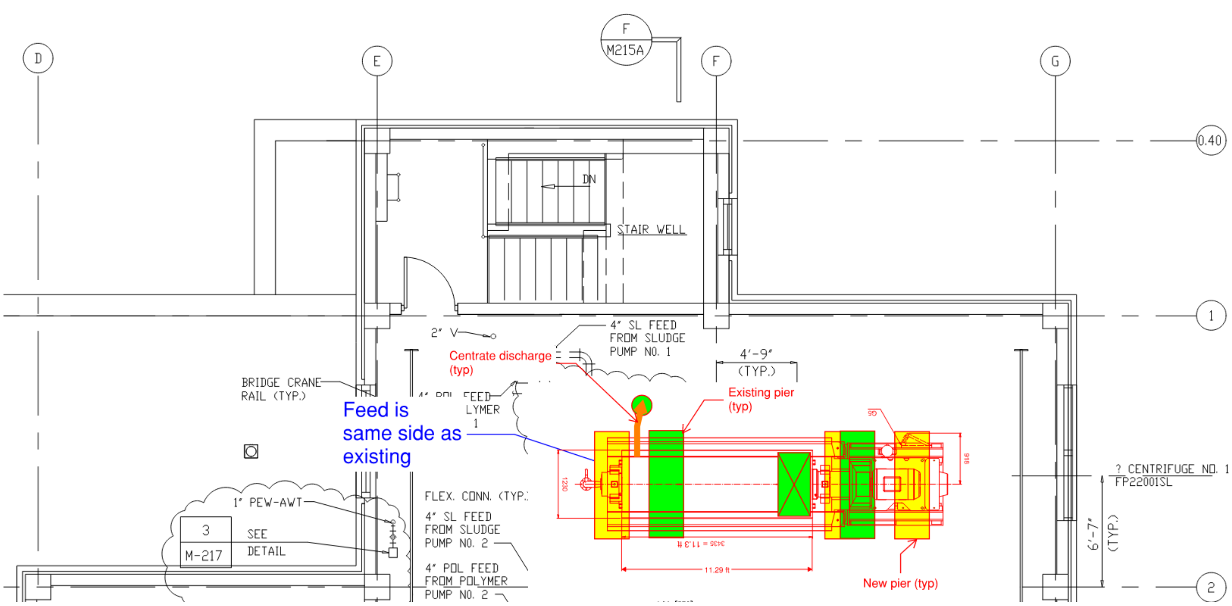

Figure 6. GEA Centrifuges Plan

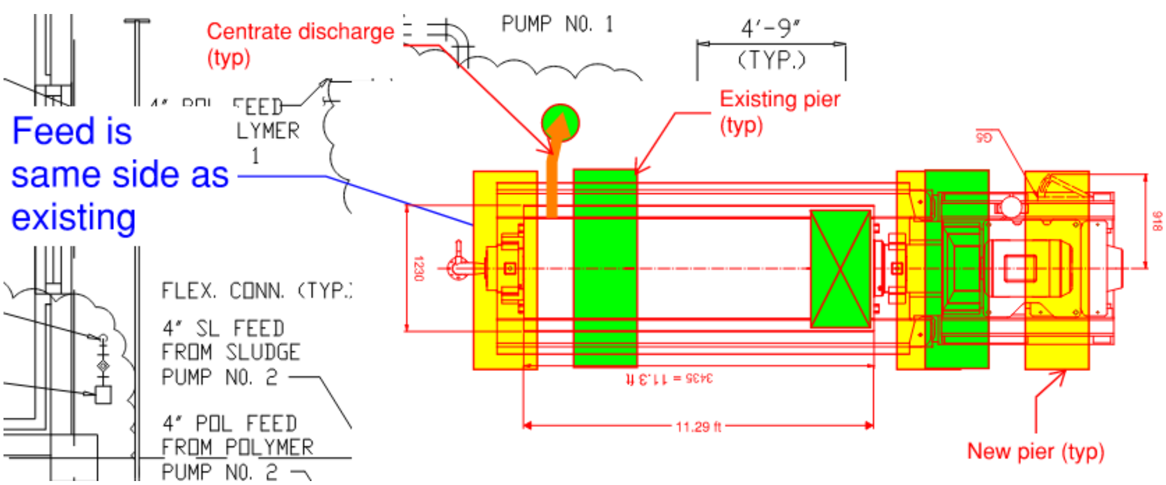

Figure 7. GEA Centrifuges Plan Zoomed

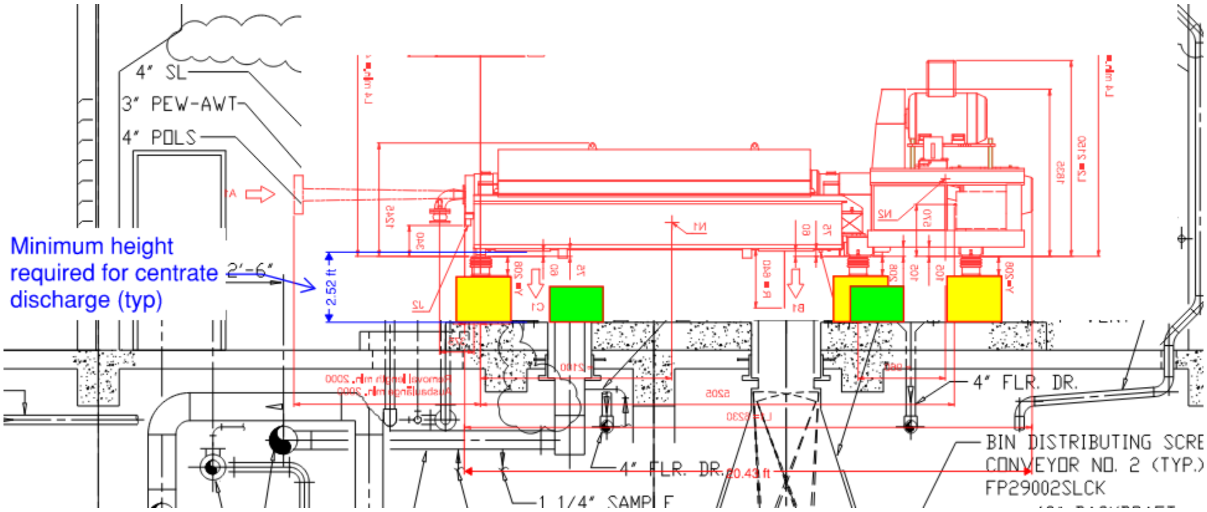

Figure 8. GEA Centrifuges Section

Figure 9, Figure 10, and Figure 11 present the plan and section for the Alfa Laval centrifuge. The solids feed is on the opposite side as the existing centrifuge, so rerouting of the solids feed to the opposite side of the centrifuge is required. New pier locations (in yellow) are required to support this centrifuge.

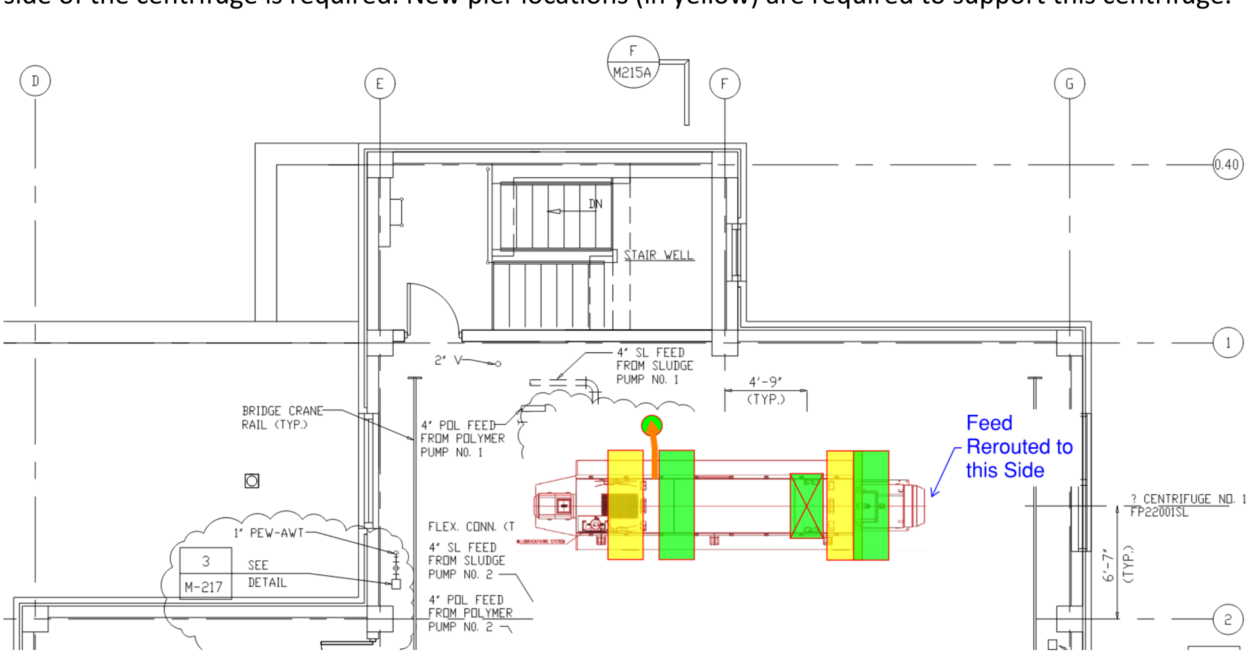

Figure 9. Alfa Laval Centrifuges Plan

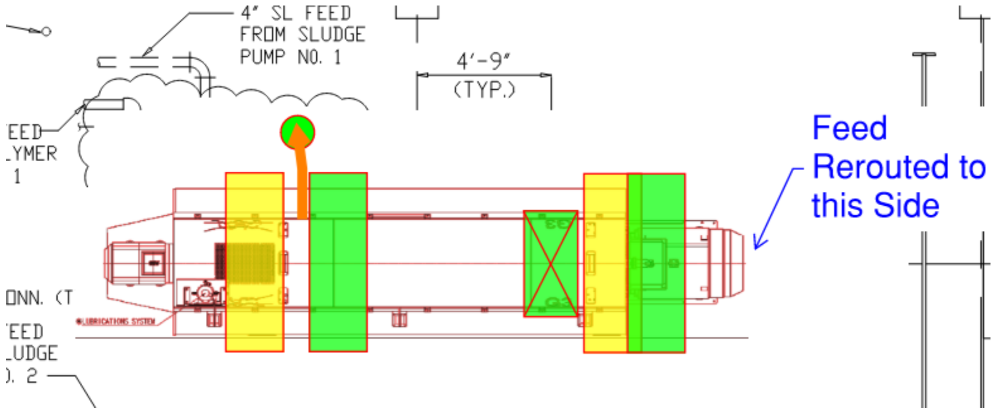

Figure 10. Alfa Laval Centrifuges Plan Zoomed

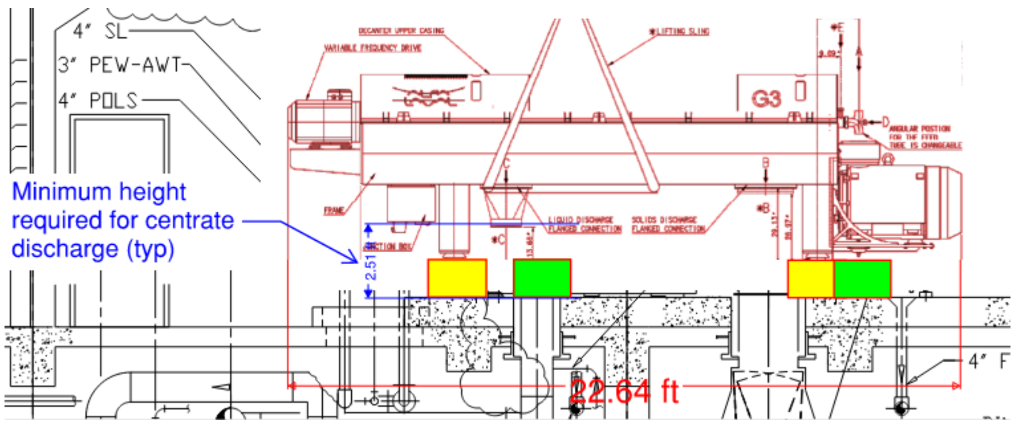

Figure 11. Alfa Laval Centrifuges Section

Figure 12, Figure 13 and Figure 14 present the plan and section for the Andritz centrifuge. The solids feed is on the same side as the existing centrifuge, so no rerouting is required. New pier locations (in yellow) are required to support this centrifuge.

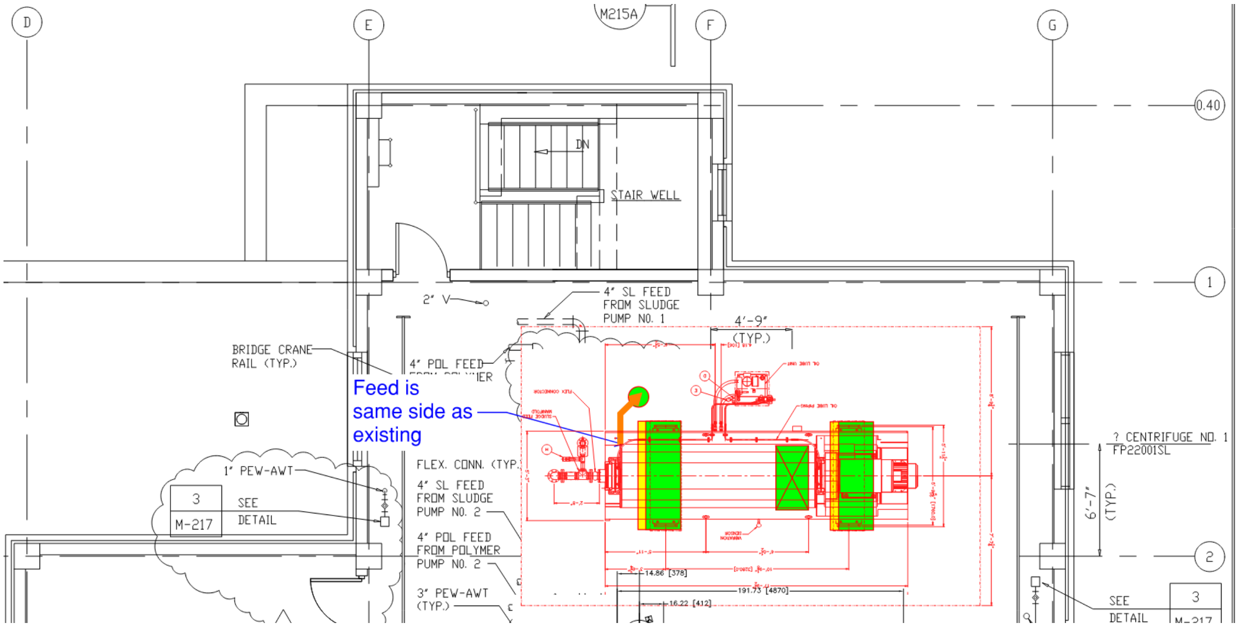

Figure 12. Andritz Centrifuges Plan

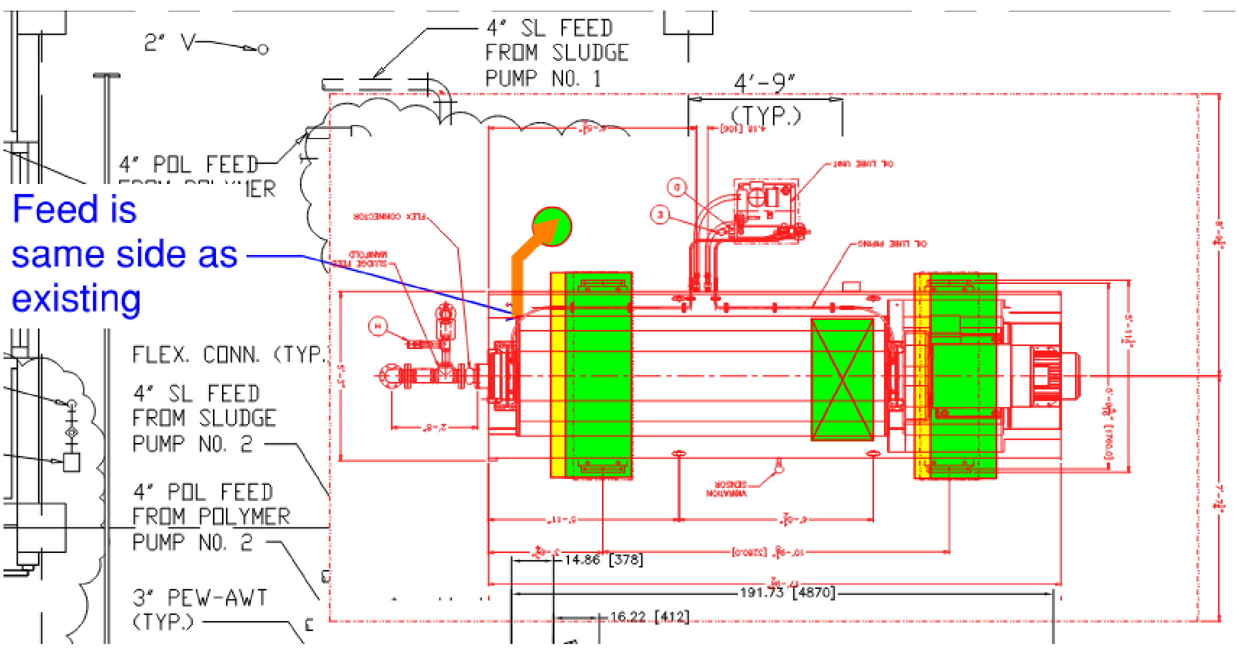

Figure 13. Andritz Centrifuges Plan Zoomed

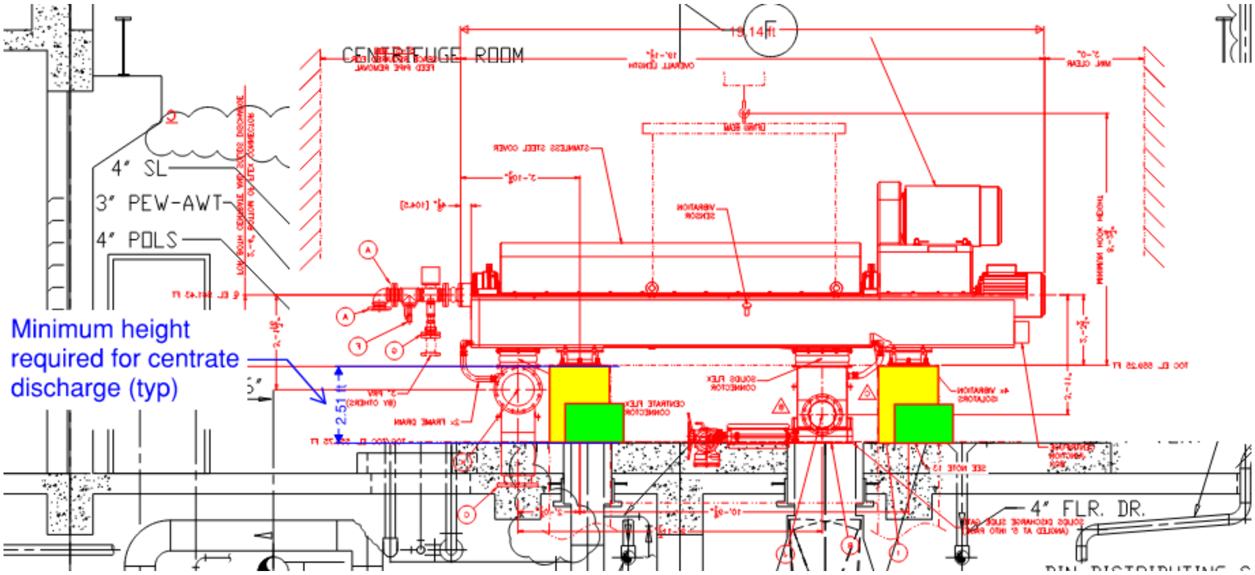

Figure 14. Andritz Centrifuges Section

Figure 15, **Error! Reference source not found.**Figure 16 and Figure 17 present the plan and section for the Centrisys centrifuge. The solids feed is on the opposite side as the existing centrifuge, so rerouting of the solids feed to the opposite side of the centrifuge is required. New pier locations (in yellow) are required to support this centrifuge.

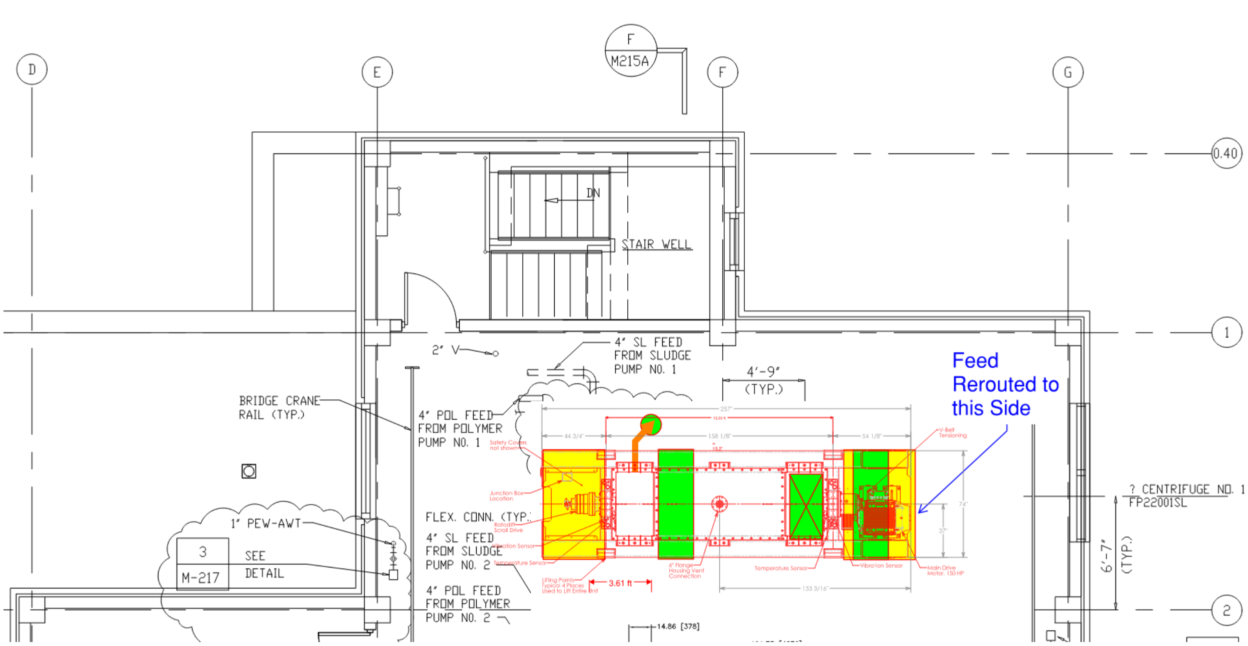

Figure 15. Centrisys Centrifuges Plan

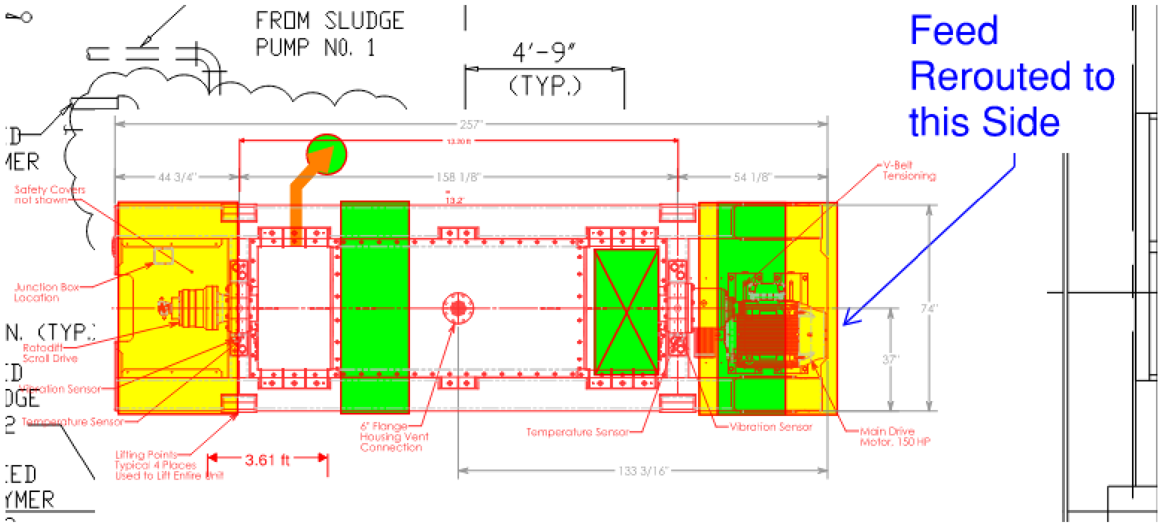

Figure 16. Centrisys Centrifuges Plan Zoomed

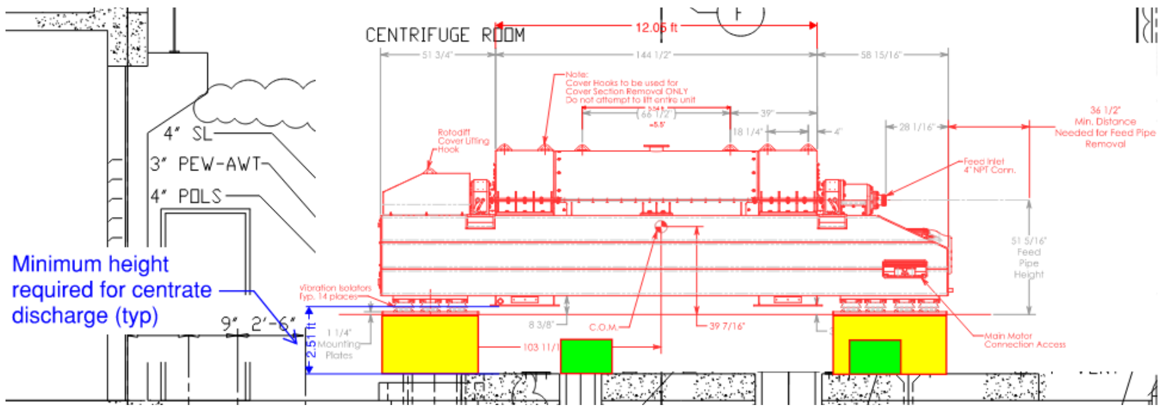

Figure 17. Centrisys Centrifuges Section Zoomed

Figure 18, Figure 19, and Figure 20 present the plan and section for the Flottweg centrifuge. The solids feed is on the same side as the existing centrifuge, so no rerouting is required. New pier locations (in yellow) are required to support this centrifuge.

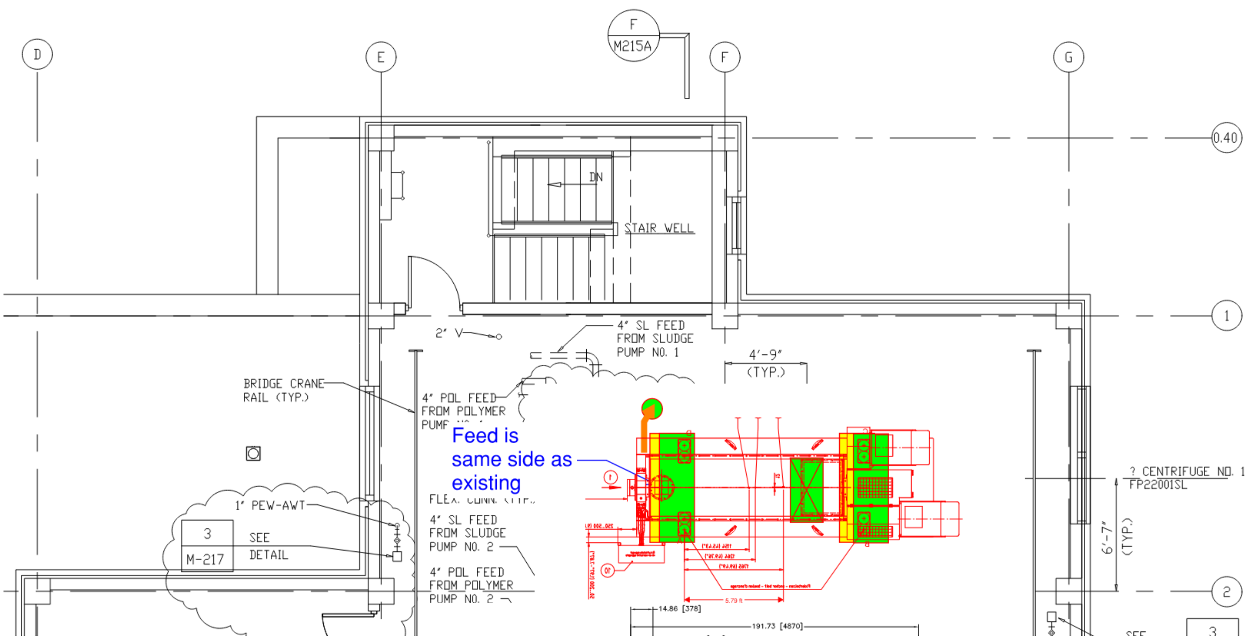

Figure 18. Flottweg Centrifuges Plan

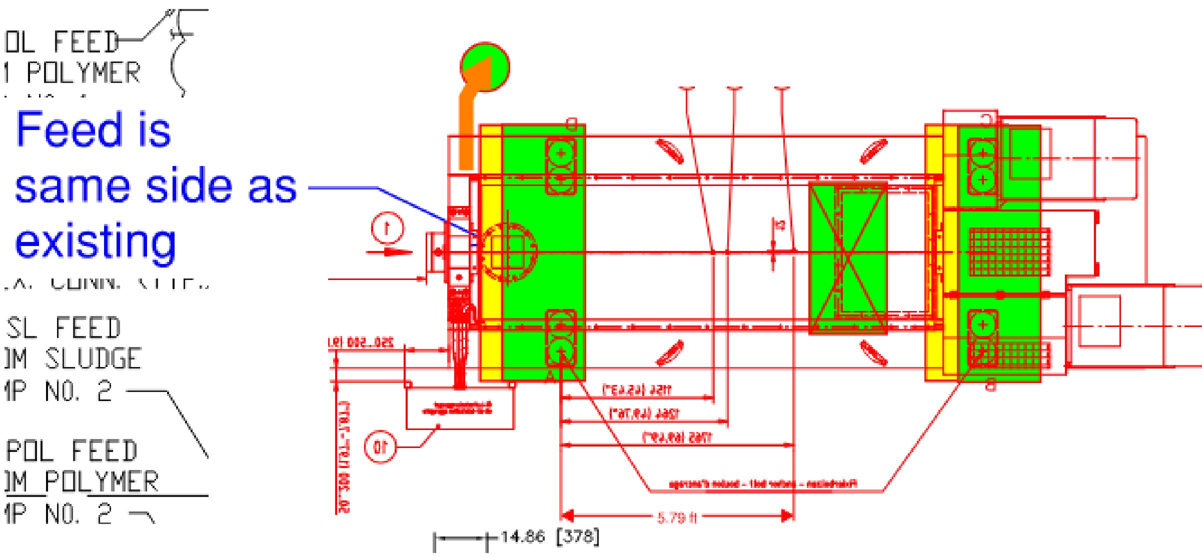

Figure 19. Flottweg Centrifuges Plan Zoomed

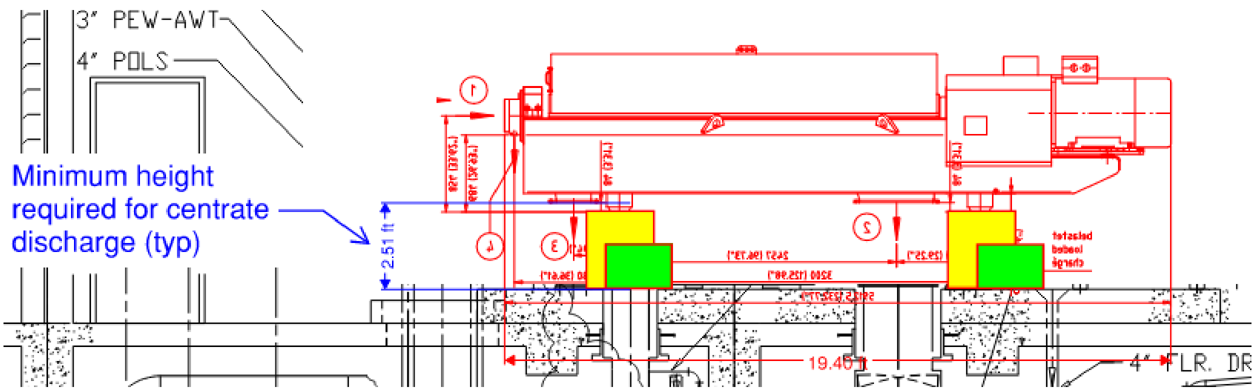

Figure 20. Flottweg Centrifuges Section

4.3 Installation and Service

Table 7 summarizes the municipal installations provided by each centrifuge manufacturer for the models presented in Table 3 above. The installations provided include facilities that process digested sludge (similar to the Arlington WPCP after completing the upgrades) as well as those that process unstabilized sludge. For manufacturers that have an older-generation model of similar size, the number of installations is provided in a separate column. Generally, Alfa Laval, Andritz, and GEA have the most municipal experience for centrifuges with the 29-30-inch-diameter bowl size proposed for this project.

Table 7. Centrifuge Installations

Manufacturer	Current Model	Installations	Comparable Model Installations
Alfa Laval	G3-125	21	16 (G2-125[a])
Flottweg	C8E	2	0
Andritz	D7LL	35	0
Centrisys	CS 30-4	0	0
GEA	CF8000	7	34 (20 of CA755, 14 of CD755[b])

a. The G2-125 centrifuge is an older version of the G3-125 centrifuge.

b. The CA755 and CD755 centrifuges are part of the older CA and CD series, respectively. They use forced-oil lubrication with water-cooled heat exchangers.

Table 8 summarizes each manufacturer's storage location for routine parts and non-routine parts. "Routine parts" are components that are regularly replaced over the life of the unit, including wear bars, scroll tiles, motors, VFDs, and gearboxes. "Non-routine parts" are components that are considered to last several years or the lifetime of a unit, such as frames, covers, bowls, and scrolls. Some manufacturers noted that a local shop typically carries most parts, but some parts might be stocked in a warehouse elsewhere in the United States.

Table 8. Centrifuge Part Locations

Manufacturer	Main Warehouse	Routine Parts at Main Warehouse	Other Routine Parts not at Main Warehouse?	Local Shop	Non-routine Parts
Alfa Laval	Indianapolis, Indiana	All parts		Suffolk, Virginia	Poland
Flottweg	Independence, Kentucky	Wear bars, tiles, gearboxes	Motors, VFDs: U.S.-sourced		Germany
Andritz	Arlington, Texas	Wear bars, tiles	Motors, VFDs, gearboxes: U.S.-sourced	Scott Depot, West Virginia	Austria
Centrisys	Kenosha, Wisconsin	All parts			Kenosha, Wisconsin
GEA	Naperville, Illinois	Wear bars, tiles, gearboxes	Motors, VFDs: job-by-job basis	Northvale, New Jersey	Germany

All manufacturers claim to have all routine maintenance parts available in the United States. With the exception of Centrisys, all manufacturers fabricate and store non-routine parts in Europe.

Rebuild times are summarized in Table 9. These estimates were provided by the manufacturers and have not been verified independently.

Table 9. Centrifuge Rebuild Times

Manufacturer	Rebuild Time
Alfa Laval	6–8 weeks
Flottweg	3–4 weeks offsite
Andritz	8–10 weeks typical 12–16 weeks if beyond normal wear and tear
Centrisys	2–4 weeks (minor) 4–6 weeks (major)
GEA	4–6 weeks

4.4 Reference Installations

Table 10 summarizes the number of contacts for each manufacturer. Manufacturers were asked to provide contact information for centrifuge reference installations.

Table 10. Reference Installation Contact Summary

Manufacturer	Contacts Received	Contacts Attempted	Contact Responses
Alfa Laval	6	6	1
Flottweg	4	4	2
Andritz	5	5	2
Centrisys	4	4	1
GEA	6	6	2

Notable responses from reference plants are listed below for each manufacturer:

- For **Andritz**, one plant that responded indicated that Andritz is slow to respond to maintenance requests. Another plant indicated oil leak issues, AC issues, and communication card issues.

- For **Alfa Laval**, the plant indicated that the G3-125 had much lower power consumption than the old DS-706 machine. The plant had to switch centrifuges because of a catastrophic failure with the old DS-706. The performance was found to be fairly equivalent between the DS-706 and G3-125.
- For **Centrisys**, the one plant that responded indicated loose and corroded connections, but this plant trucks its centrifuge between plants, which may be the cause of the issues. The plant also indicated some human-machine interface (HMI) and computer problems.
- For **Flottweg**, both plants that responded indicated satisfaction with centrifuge performance, but only 22.5-inch machine references were available. Maintenance service was quick and well-regarded. The small pads on the discharge of the cake were the location of the most wear.
- For **GEA**, one plant indicated issues with controls that required a full wipe of programming to reset the system by a technician from Germany. The plant also indicated some premature wear on the feed zone. Another plant experienced maintenance service issues that were slow enough to cause the plant to stop paying invoices to GEA until maintenance was performed.

4.5 Equipment Cost

Table 11 presents the cost per unit of each centrifuge, which includes only the equipment cost without installation or piping costs.

Table 11. Centrifuge Equipment Cost Summary

Manufacturer	Model	Cost per Unit	Cost Expressed as Percentage of Lowest Cost
Alfa Laval	G3-125	$550,000	100%
Flottweg	C8E	$710,000	130%
Andritz	D7LL	$650,000	120%
Centrisys	CS 30-4	$897,200	160%
GEA	CF8000	$650,000	120%

5.0 Analysis

Arlington County and HDR conducted workshops and site visits to further review centrifuge manufacturers and preferences. The following preferences were identified through these workshops and site visits:

- **Number of installations:** several installations of similar-sized units, preferably the exact same model unit
- **PLCs:** Allen-Bradley and ABB preferred because of familiarity with the products
- **VFDs:** Allen-Bradley PowerFlex preferred because of familiarity with the product
- **Scroll tiles:** partial length tiles preferred so that tiles are only installed where necessary.
- **Lubrication:** forced oil lubrication not preferred

6.0 Summary and Conclusions

Table 12 displays a comparison between client preferences and each centrifuge manufacturer's specifications. PLC and VFD specifications were not included in the table because all manufacturers have Allen-Bradley or ABB options.

Table 12. Manufacturer Preference Comparison

Parameter	Client Preference	Alfa Laval	Flottweg	Andritz	Centrisys	GEA
Number of municipal installations with same model of unit (installations with similar-sized unit)	Many	21 (16)	**2 (0)**	35 (0)	**0 (0)**	7 (34)
Full vs. partial length tiles on scroll	Partial length	Partial length	Both are available	**Full**	Both are available	**Full**
Main bearing lubrication	Not forced oil	Grease	Oil	**Forced oil**	Air/oil	Air/oil mist
Scroll bearing lubrication	Not forced oil	Grease	Grease	**Forced oil**	Air/oil	Grease
Scroll drive type	None	VFD	VFD	VFD	Hydraulic	VFD
Gearbox	None	Multistage planetary	Planetary	Cycloidal (CYCLO®-Sumitomo) and planetary	N/A (hydraulic drive)	Multistage planetary
Typical rebuild time, weeks	Shorter is better	**6–8**	3–4	**8–10**	4–6	4–6
Routine parts locations	USA	USA	USA	USA	USA	USA
Non-routine parts locations	USA	**Poland**	**Germany**	**Austria**	USA	**Germany**

A centrifuge sole-source selection is not deemed to be necessary. However, based on site visits and discussion with Arlington County engineering, operations, and maintenance staff, the County has expressed a preference for the following centrifuge manufacturers:

- Alfa Laval
- Centrisys
- GEA

Appendix B

Biogas Utilization Report

Appendix B Contents

ARLINGTON RE-GEN

Arlington County Water Pollution Control Plant

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Executive Summary

Updated November 2022

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Introduction

Arlington County (County) is implementing new biosolids management facilities at the Arlington County Water Pollution Control Plant (Plant). Arlington Re-Gen (Program) is part of the Arlington County Water Pollution Control Bureau's commitment to protecting public health and the environment, while recovering valuable resources with innovative processes that will also reduce our carbon footprint. This comprehensive biosolids program, adopted by the County Board in 2018, includes a new thermal hydrolysis process followed by anaerobic digestion as the main treatment processes. Thermal hydrolysis treats the biosolids under high pressures and temperature to break down the solids and remove pathogens. To achieve these high pressures and temperatures, steam boilers are required. Anaerobic digestion uses microbes to digest the solids in the absence of oxygen, which stabilizes and reduces the quantity of the biosolids, while also reducing odors of the finished product. These upgrades will produce a high quality marketable biosolids product.

Biogas, comprised of approximately 60% methane and 40% carbon dioxide, is also a product of the digestion process. Beneficial use of the biogas can have a significant impact on the County's sustainability goals, as it is estimated to have an energy content of 120 billion British thermal units (Btu) per year and the capability to reduce greenhouse gas emissions by up to 3,500 metric tons per year.

The objective of this gas utilization evaluation is to look at all feasible alternatives for the beneficial use of the biogas to assist in meeting Arlington County's sustainability goals while also reliably meeting the Plant's heating (steam generation) and electrical needs. Monetary, non-monetary, and sustainability evaluations were completed to determine the recommended alternative for the County.

Overall Biogas Recommendations

Based on the analyses presented below, the Arlington County Water Pollution Control Bureau recommends proceeding with the production of renewable natural gas (RNG) as the selected biogas utilization approach. The basis for this recommendation is as follows:

- The RNG alternatives have the lowest net present value (i.e., lowest total cost to the County over the life of the equipment) for the baseline conditions using conservative capital and operating costs.
- Injecting RNG into the local utility pipeline scored the highest in the County's non-financial scoring. In particular, the County found that the RNG alternatives would be less complex to maintain and would result in fewer localized impacts

such as noise and emissions than the combined heat and power (CHP) alternatives.
- A sensitivity analysis concluded that when considering multiple variables, including RIN market volatility and changes in electrical rates, injecting RNG into the local utility pipeline had a very high likelihood of being more financially advantageous than generating electricity through CHP.
- The County has the ability to retain greenhouse credits if the biogas is used within Arlington County for transportation purposes.
- Benefits of on-site CHP are limited because the CHP size would not be sufficient to power the entire Plant, which is already protected with two independent power feeds and backup generators. In addition, the use of CHP onsite will generate new, localized air emissions.

Biogas Utilization Alternatives

The range of feasible alternatives includes using the biogas for one or a combination of the following:

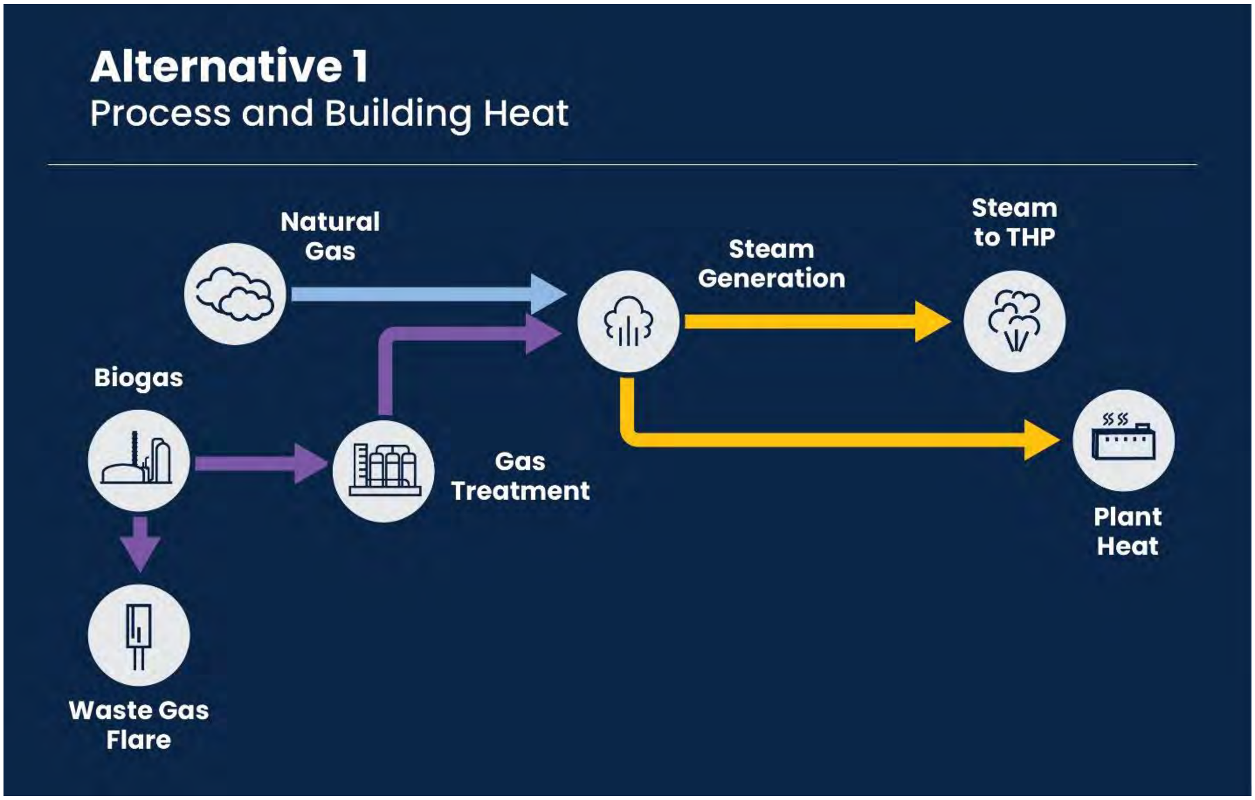
- On-site use for process and building heating
- Production of electrical power and recovery of waste heat (CHP)
- Production of RNG for use offsite through pipeline injection or as CNG for direct use as vehicle fuel.

From these potential biogas uses the following alternatives and sub-alternatives were identified for the evaluation. An energy balance was used to develop preliminary sizing of the equipment and summarize any energy production and heat recovered as well as the energy purchase requirements and biogas flared.

Alternative 1 – Process and Building Heating

In this alternative, shown schematically in Figure 1, the biogas produced during digestion would be used to fuel steam boilers to satisfy the process and building heating requirements. However, the steam demand for the Thermal Hydrolysis Process (THP) would use only about 30 percent of the biogas produced, leaving 70 percent as excess, which would be flared. **Because this alternative does not fully utilize the biogas, it is not a viable biogas utilization option, but it is included in the analysis as the minimum required to meet process needs.**

Figure 1. Alternative 1 – Process and Building Heat

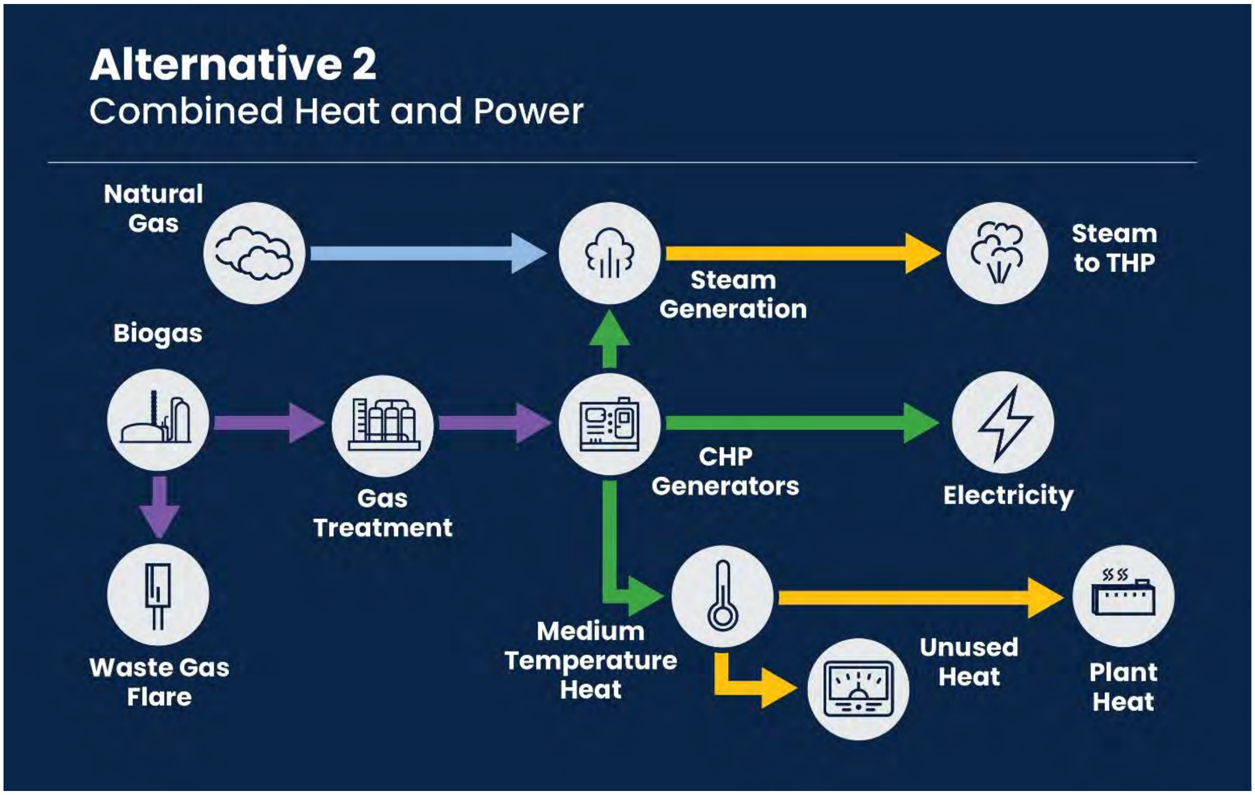


Alternative 2 – CHP

In this alternative, shown schematically in Figure 2, the biogas would be used as fuel for engines to produce electrical power. Recovered heat from the engines would be used for production of steam for process needs and building heat. Multiple types of power generation equipment are available, each with its own electrical and heat transfer efficiencies, so this alternative was divided into the following two sub-alternatives:

- **Alternative 2A – CHP with Engines:** Internal-combustion engines would produce more power at the site but would recover less heat. As supplemental heat would be required to meet process needs, some of the biogas would be bypassed around the engines to fire directly in the boiler and provide the steam for THP.
- **Alternative 2B – CHP with Gas Turbine:** A gas turbine engine would produce less power but would recover more steam. The heat recovered would satisfy process needs.

Figure 2. Alternative 2 – Combined Heat and Power

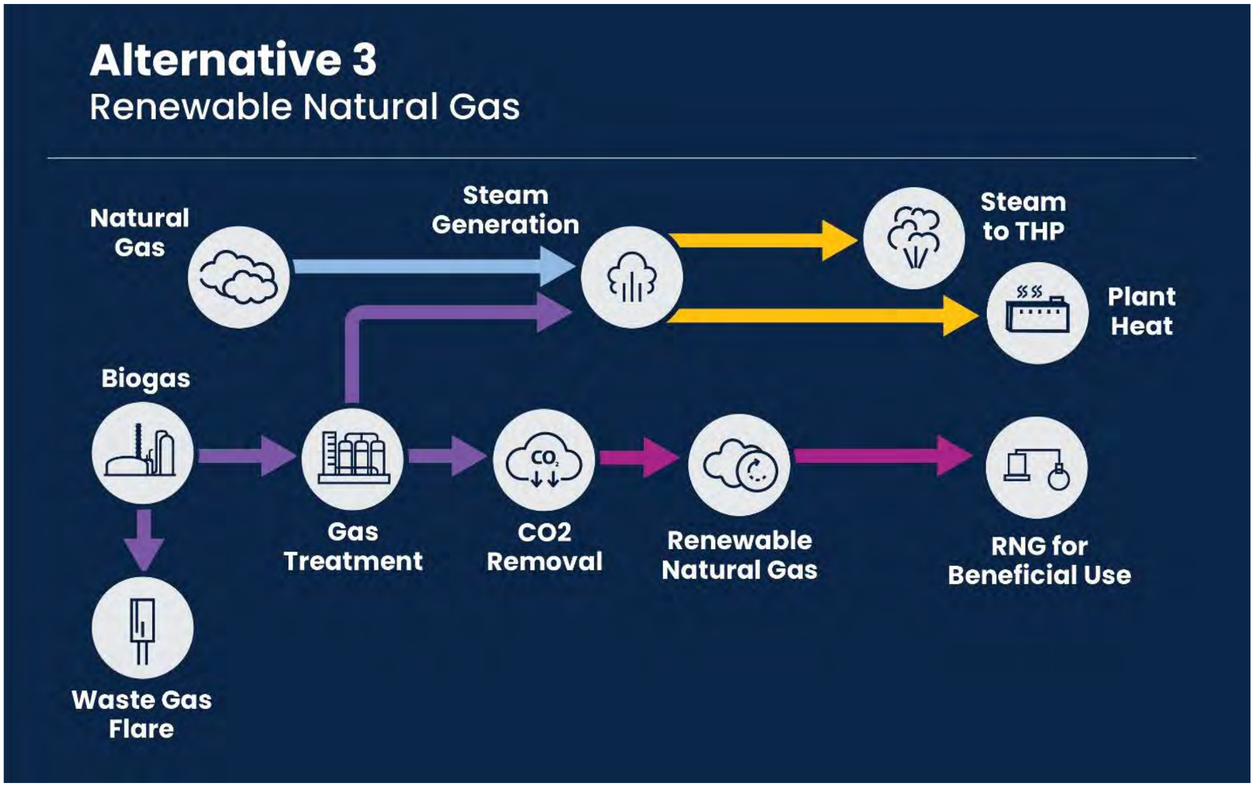


Alternative 3 – RNG

In this alternative, shown schematically in Figure 3, all of the biogas would be conditioned to RNG quality for use off site. The facility heating requirements would be met using steam boilers fueled by natural gas or from biogas onsite. There are two potential points of entry into the natural gas system so this alternative was divided into the following two sub-alternatives:

- **Alternative 3A – RNG Injected into the Natural Gas Pipeline:** In this alternative, all of the RNG would be injected into the local natural gas pipeline for off-site use as vehicle fuel.
- **Alternative 3B – RNG Used as Compressed Natural Gas (CNG):** In this alternative, the RNG would be sent to local CNG stations for use directly at those stations. This alternative is similar to Alternative 3A, but instead of injecting the RNG into the natural gas pipeline, it would be used across the road to fuel CNG buses operated by Arlington Transit and the Washington Metropolitan Area Transit Authority.

Figure 3. Alternative 3 – Renewable Natural Gas

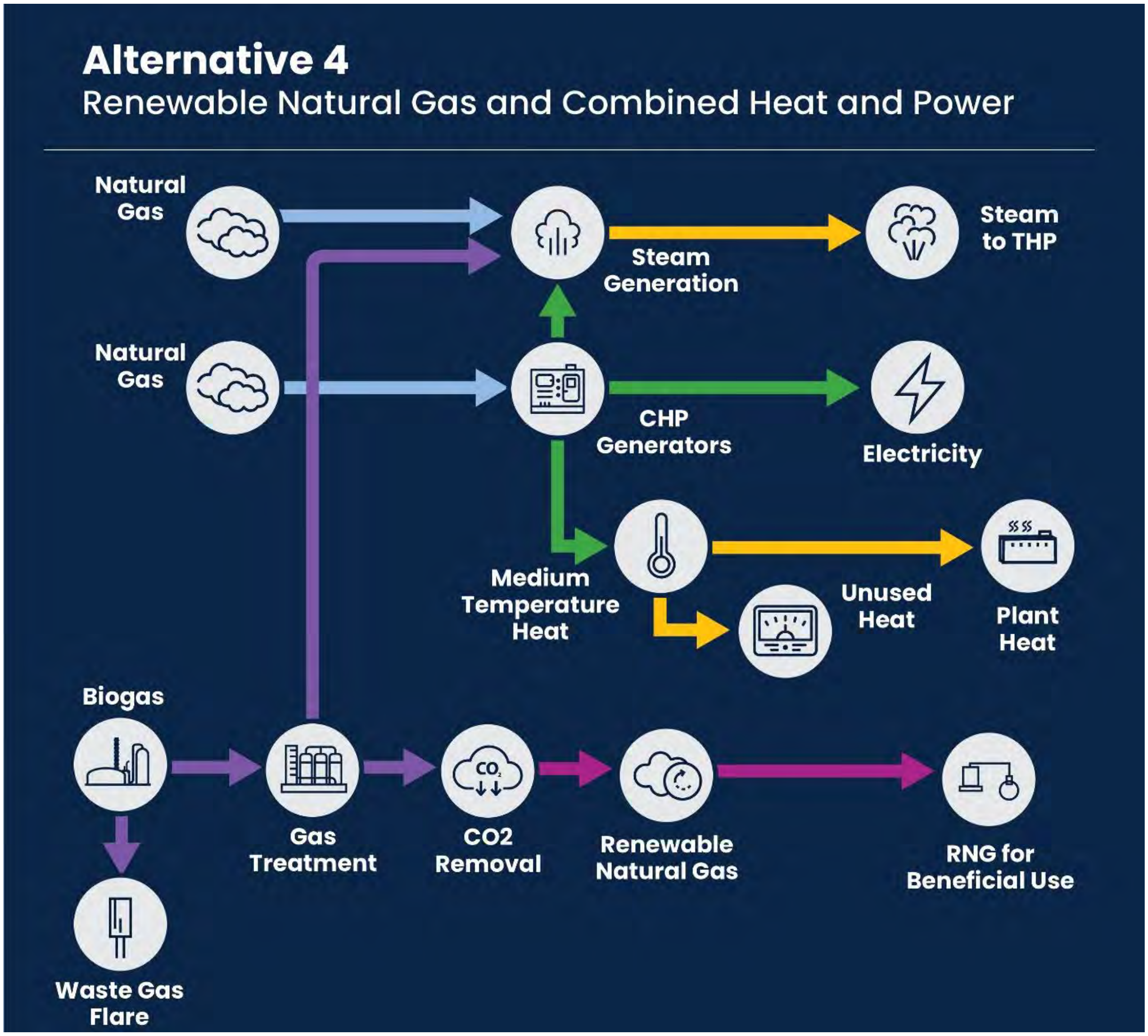


Alternative 4 – RNG and CHP

This alternative, shown schematically in Figure 4, would combine using the biogas to produce RNG as described above with using CHP fueled by natural gas for electricity and heat production. Similar to the CHP Alternative, there are two different engine options, so this alternative was divided into the following two sub-alternatives:

- **Alternative 4A – RNG and CHP with Engines:** Larger internal-combustion engines would be provided to produce all of the supplemental heat required to provide the steam for THP.
- **Alternative 4B – RNG and CHP with Gas Turbine**: Smaller gas turbine engines would produce less power but would recover more steam. The heat recovered would satisfy process needs.

Figure 4. Alternative 4 – Renewable Natural Gas and Combined Heat and Power



Alternatives Evaluations

The alternatives described above were developed and sized using the projected biogas production (approximately 120 billion Btu/year) and steam demands (approximately 35 billion Btu/year) and then evaluated using the following methods:

- **Financial analysis:** A present value of each alternative was developed from conceptual capital costs, operations and maintenance costs, energy production offsets, and RNG revenue.
- **Non-financial analysis:** A non-financial analysis was used to reflect such criteria in the overall alternatives analysis. Examples of non-financial criteria include noise production, facility aesthetics, and Plant safety.
- **Sustainability criteria:** The environmental and sustainability benefits (carbon emissions reductions) were monetized using an industry standard approach.
- **Sensitivity analysis:** To reflect future market and pricing unknowns and risks, multiple approaches were used to illustrate the sensitivity of the major assumptions.

The financial analysis considered the change in solids production and costs of electricity, natural gas, and equipment operations and maintenance over time to develop a net present value for each alternative. Based on discussions with the County, a 25-year planning period following construction was selected. With construction anticipated to finish in 2027, the planning period for this study runs from 2027 to 2052. The target year of 2052 was selected for when the design flows and loads are anticipated to be reached, resulting in a design solids production loading of approximately 40 tons per day. To illustrate the energy balance and economic analysis results presented in the subsequent sections, an evaluation year of 2037 was selected as it is close to the midpoint of the planning period and falls on one of the 5-year increments developed.

Financial Analysis

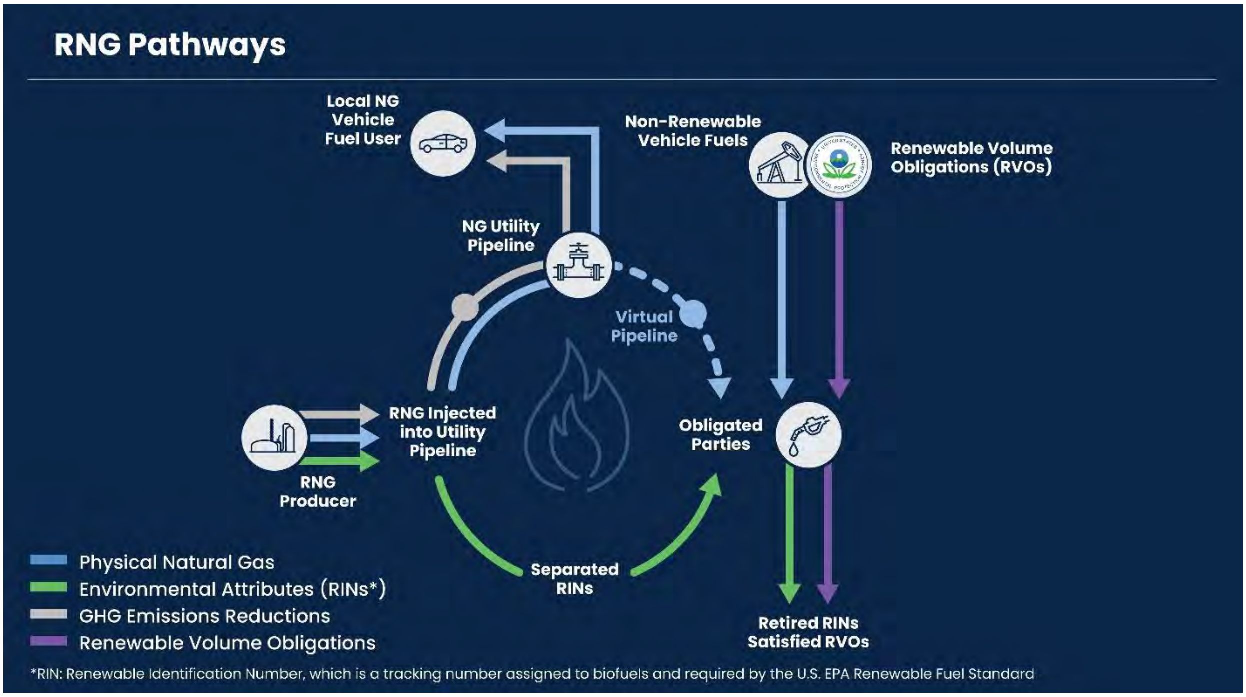
For each alternative, conceptual capital costs of the process heating, CHP, and biogas conditioning systems were developed. In addition, annual operations and maintenance costs and potential energy savings or revenues were summarized and totaled for each year of the 25-year planning period. The present value of each alternative was then developed.

For the alternatives that include CHP, it is likely that the County could either sell Renewable Energy Credits (RECs) for the electricity produced or defer purchase of RECs for other County needs. The County currently purchases RECs at a cost of $4,500/kWh and it is assumed that all CHP alternatives would be able to sell RECs for all of the electricity produced at that value.

For the alternatives that include the off-site sale of RNG, the RNG revenues were developed from the commodity value of natural gas and the historical and anticipated values of the environmental attributes of the RNG in the U.S. Environmental Protection Agency (EPA) Renewable Fuel Standard (RFS). This program is specifically for renewable fuels for transportation programs. Therefore, the fuel must ultimately be used as a transportation fuel for the renewable attribute to be recognized. In addition to the EPA's RFS, similar state programs exist such as the California Low Carbon Fuel Standard (LCFS). These state programs could be pursued by Arlington County but are not currently included in the financial metrics.

The production and sale of RNG and environmental attributes like Renewable Identification Numbers (RINs) through the RFS occurs via two pathways: the physical pathway for the commodity value and the contractual pathway for the attributes. The physical pathway is the sale of the RNG by the producer to an end user of the actual gas via the natural gas grid. The gas can be sold either to the current gas supplier or to another party directly. The contractual pathway for the environmental attributes (RINs) is separate and handled by a third party that verifies that the RNG produced complies with the RFS and markets the attributes to Obligated Parties (any refiner or importer of gasoline or diesel fuel in the United States). Note that these two pathways are independent of carbon credit programs. The County will be able to take credit for the reduction of greenhouse gases (GHGs) in its internal accounting independently of the sale of RINs as long as the gas is used within Arlington County. The valuation of RINs and GHG credits are treated separately in this report. The various physical, contractual, and greenhouse gas pathways are shown schematically on Figure 5.

Figure 5. RNG Pathways



In the RFS, RINs include a "D code" that identifies the type of biofuel based on the feedstock used. Each D code has a different market value in the RFS program. RNG generated from wastewater biosolids qualifies as a D3 RIN (cellulosic biofuel), which have historically traded at the highest value. Historical RIN values are provided in Figure 6. The base RIN value used in the financial analysis was $1.15/RIN or $15 per 1 million British thermal units (MMBtu). This value is also represented on Figure 6. The October 2021 D3 RIN value was approximately $38/MMBtu[1]. The value of the RNG environmental attributes greatly impacts the results of the financial analysis, which is why a sensitivity analysis was performed to further characterize the financial risks associated with RNG. The results of the sensitivity analysis are summarized later in this section.

[1] https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rin-trades-and-price-information#regulatory-categories

Figure 6. Historical RIN Pricing

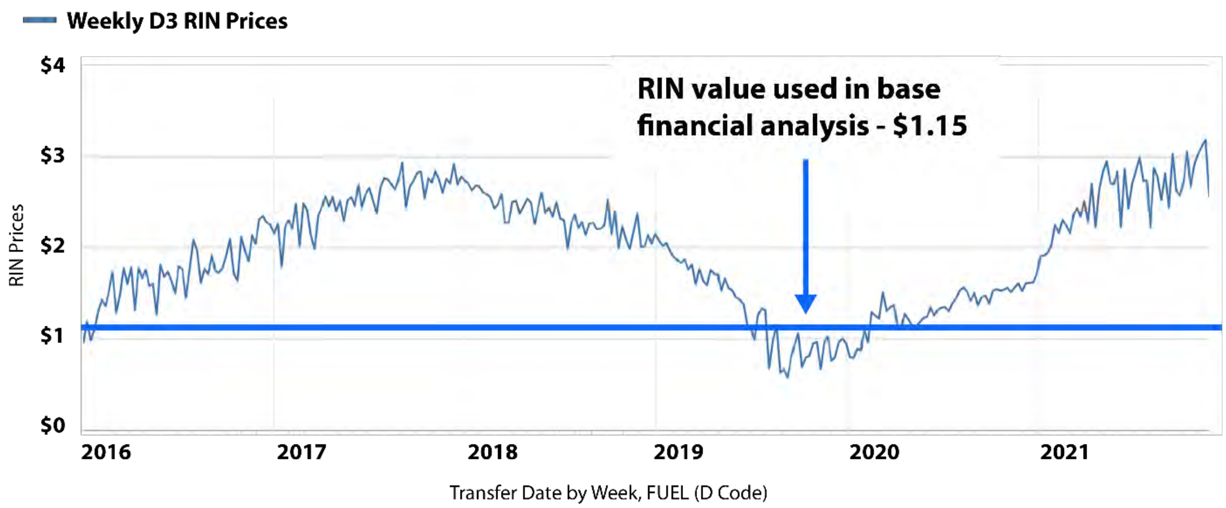
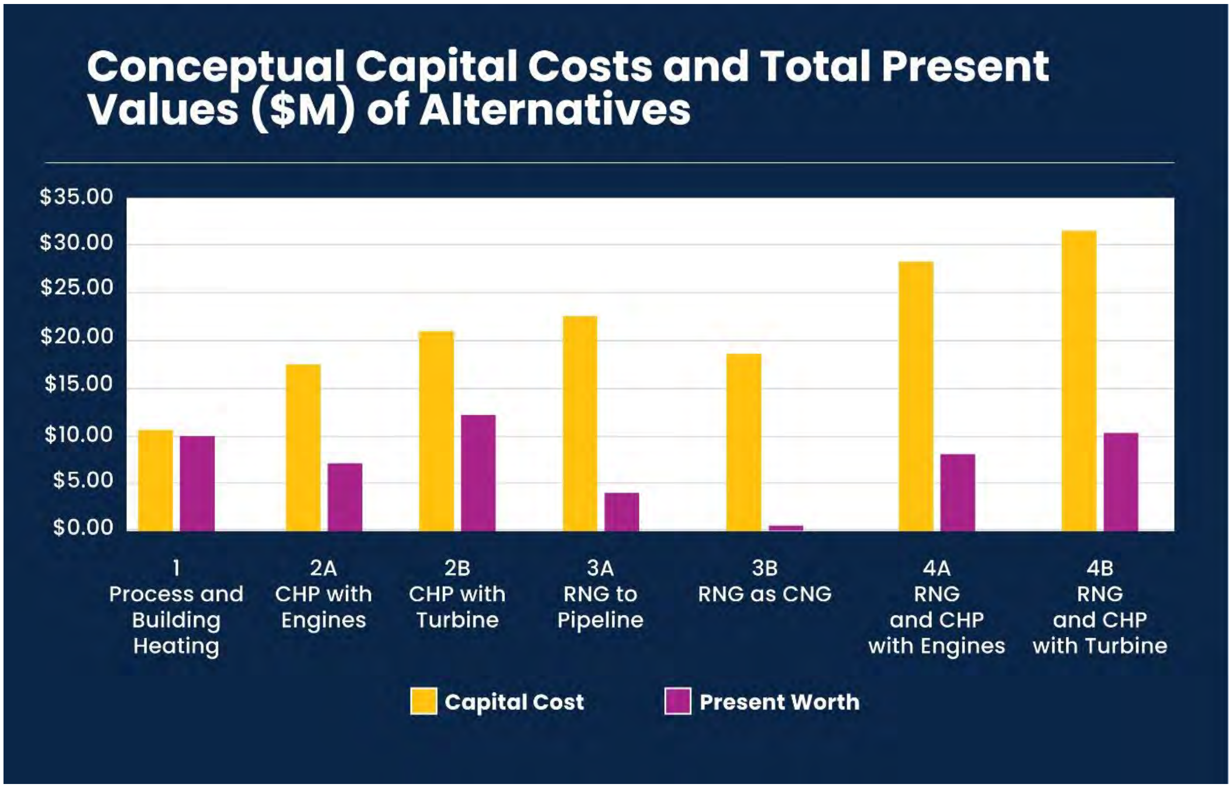


Figure 7 shows the conceptual capital costs and total present value for all alternatives. In this analysis, the cost of electricity was assumed to be $0.077 per kilowatt-hour (kWh) as this is the current average rate paid by Arlington County and energy prices are projected to remain stable.

The base cost analysis indicates that although the RNG alternatives (Alternatives 3A and 3B) do not have the lowest capital cost, they do have the lowest cost when taking into account the entire life cycle of the gas handling equipment to develop a total present-value cost, primarily because the value of the RINs offsets the initial capital investment. In comparison, the RNG and CHP alternatives (Alternatives 4A and 4B) would entail larger capital costs and comparable present-value costs to CHP alternatives (Alternatives 2A and 2B).

Figure 7. Conceptual Capital Costs and Total Present Values ($M) of Alternatives



The initial present-value analysis supported eliminating Alternatives 4A and 4B (RNG and CHP alternatives) from further consideration because of high capital costs, high overall complexity, significant use of natural gas to run the engines, and comparable present financial values to Alternatives 2A and 2B (CHP alternatives). The remaining alternatives were further analyzed for risk and non-financial factors, sustainability, and sensitivity to changing market conditions.

Non-Financial Analysis

Non-financial criteria were developed and weighted using input from County stakeholders. A description of the non-financial criteria and the weights established by the County for those criteria are presented in

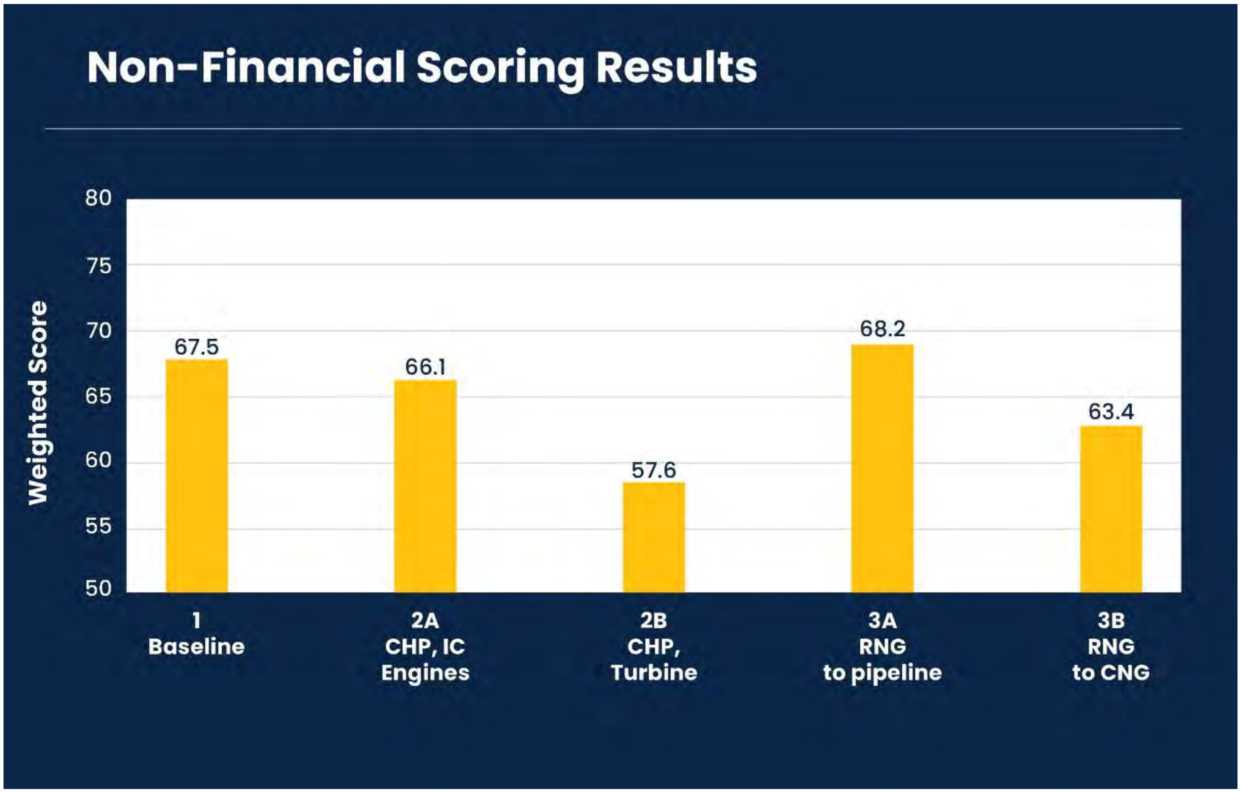
Table 1.

Table 1. Non-Financial Criteria

Criterion	Description	Weight
Localized emissions	Produces emissions at Plant site that may negatively impact air permitting requirements, cause neighborhood issues, or result in poor air quality in immediate area	8.0%
Noise	Generates excess noise that may impact neighbors or result in costly noise reduction measures	8.4%
Visual aesthetics	Is acceptable to the neighbors and general Arlington County community from a visual aesthetics standpoint	4.1%
Footprint	Sufficient space for operations and maintenance; does not take land space from current needs or potential future add-ons	6.9%
Potential for flaring	Provides multiple outlets for use of biogas or redundancy options to minimize the amount of biogas sent to the waste flare	8.4%
Operational complexity	Complexity of equipment and facilities in operation	11.8%
Maintenance complexity and reliability	Reliability of equipment and facilities, ongoing maintenance requirements, annual downtime for maintenance, and number of components that could fail, resulting in failure of system	11.8%
Safety	Risks for operation of system, including leaks, pressures, number of components, etc.	22.5%
Resilience	Provides for additional resilience benefits for the Plant and solids handling systems	8.8%
Future opportunities	Maintains flexibility for modifying approach should market conditions change	9.3%

The remaining alternatives (excluding Alternatives 4A/4B – RNG and CHP) were then scored based on this criteria to develop a non-financial score. With this methodology higher scores are better. Figure 8 presents the average scores for each alternative carried forward. Alternative 3A (RNG into pipeline) had the highest average non-financial score at 68.2, followed by Alternative 1 (Process and Building Heat) at 67.5. As stated previously, Alternative 1 is not a viable biogas utilization option, but it is included in the analysis as the minimum required to meet process needs. Alternative 1 scored well in the non-financial analysis as it is generally less complex than the other alternatives. Alternative 2B (CHP with Turbines) had the lowest non-financial score of 57.6.

Figure 8. Non-Financial Scoring Results



The main differentiators between the RNG alternatives (Alternatives 3A/3B) and CHP alternatives (Alternatives 2A/2B) were that the RNG alternatives had:

- Lower localized emissions
- Reduced noise
- More outlets for beneficial use of the biogas and ability to reduce flaring
- Lower maintenance complexity and reliability
- Ease of adaptability to other gas utilization alternatives in the future

Sustainability Criteria

Table 2 presents net change in GHG (namely carbon dioxide [CO_2]) emissions for each of the sources of energy for 2037. The net GHG change presented in Table 2 is solely for the gas utilization equipment, not the entire biosolids upgrade program. Alternatives 2A and 2B (CHP alternatives) result in emissions reductions from the offset of purchased power, while Alternatives 3A and 3B (RNG alternatives) result in emissions reductions because of the reduction in use of petroleum-based natural gas. Overall, Alternatives 2A (CHP with Engines) and 3A/B (RNG =alternatives) have greater GHG reductions than Alternative 1 (Process and Building Heating) and Alternative 2B (CHP with Turbines).

GHG reductions for Alternatives 2A and 2B (CHP alternatives) are based on the current Dominion Energy CO_2 emission profile, which includes a combination of fossil-fuel and renewable energy sources. Electricity for Arlington County operations is projected to be 100 percent renewable by 2025 through separate power purchase agreements, in which case the GHG reduction for net electricity production would be zero. However, the generation of renewable power at the Plant may allow for currently forecasted renewable sources to be used elsewhere and the financial analysis assumes that the County would be able to sell RECs for these alternatives.

Table 2. Total Change in Net CO_2 Emissions (Metric Tons) in Year 2037

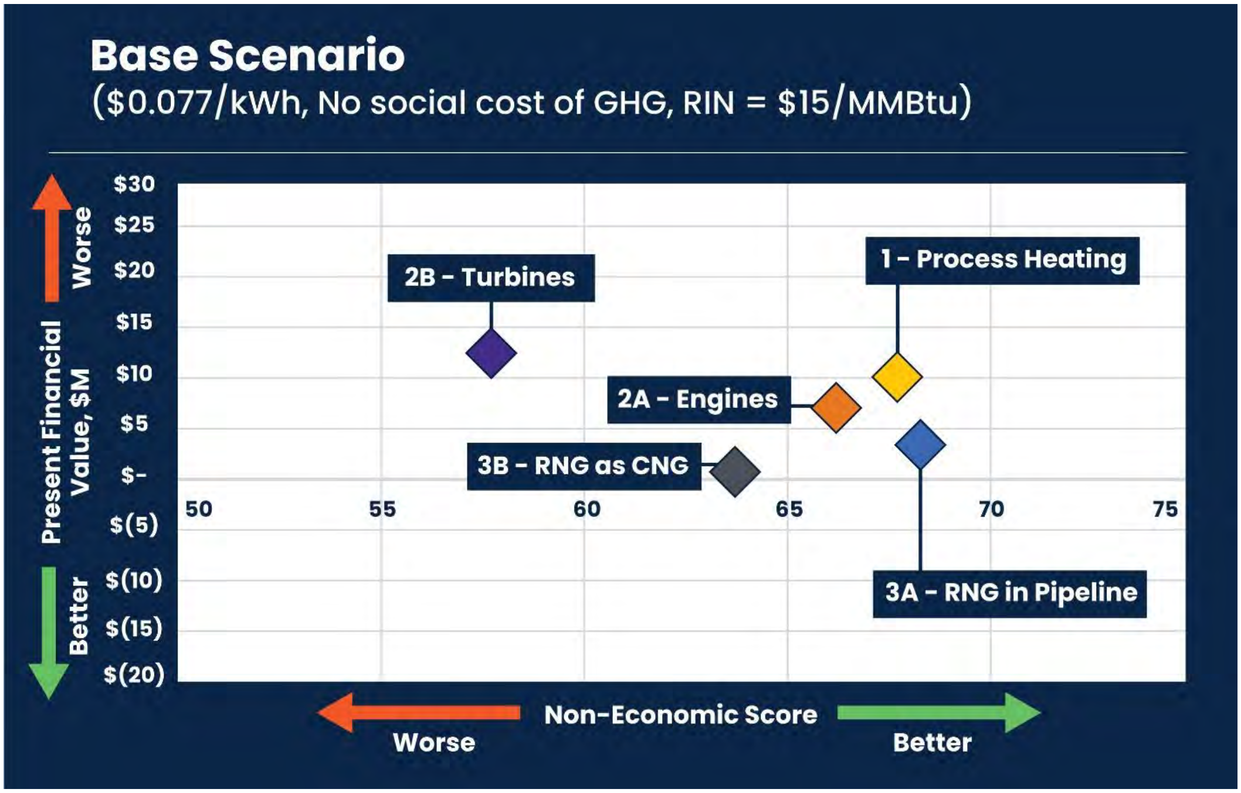
Alternative	Net Electricity Use of Biogas Utilization	Biogas Production (Offsets Natural Gas Purchases)	Natural Gas Purchased	Total Change in Emissions
1: Process and Building Heat	80	-40	0	40
2A: CHP with Engines	-3,330	-40	0	-3,370
2B: CHP with Turbines	-2,310	-40	0	-2,350
3A: RNG to Pipeline	770	-6,240	1,970	-3,500
3B: RNG Used as CNG	770	-6,240	1,970	-3,500

Note: Negative values are emissions reductions and positive values are emissions increases.

Composite Results

Figure 9 presents a composite result of the financial and non-financial scores using the base financial conditions (namely current electrical price of $0.077/kWh and average RIN market value of $15/MMBtu). The non-financial score is presented on the x-axis, the present financial value is presented on the y-axis, and the size of the bubble represents the conceptual capital cost. For this base condition, without considering the social cost of GHG, Alternative 3A (RNG to Pipeline) had the highest non-financial score and the second-lowest present financial value.

Figure 9. Base Scenario ($0.077/kWh, No social cost of GHG, RIN = $15/MMBtu)



Several alternative scenarios were run to test the sensitivity to key parameters.

Figure 10 provides the same analysis including the social cost of GHG and the average RIN value for the past six years of $23.35/MMBtu. This RIN value furthers the financial advantage of the RNG alternatives.

Figure 10. Average RIN Scenario ($0.077/kWh, Includes social cost of GHG, RIN = $23.35/MMBtu)

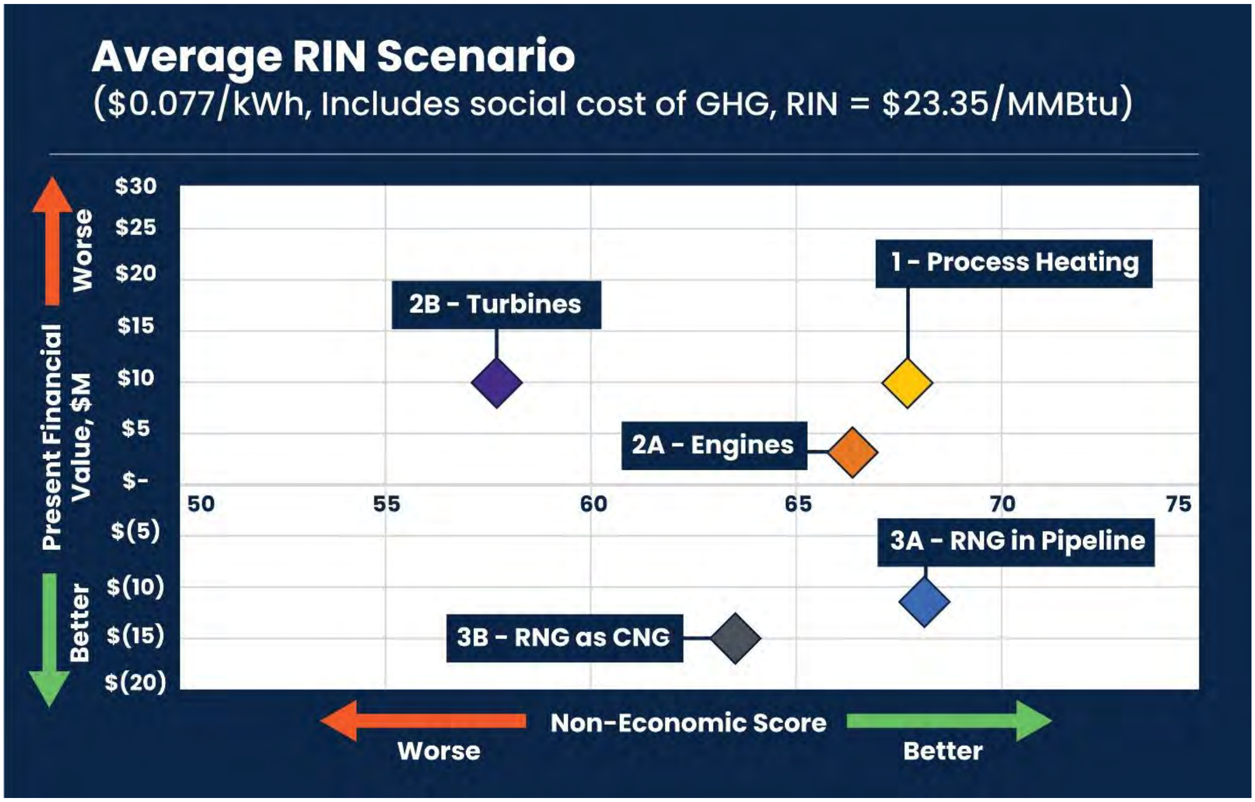


Figure 11 provides the same analysis including the social cost of GHG and the lowest weekly RIN value over the last six years of $6.38/MMBtu. In this scenario, Alternative 2A (CHP with Engines) becomes more financially advantageous.

Figure 11. Lowest RIN Scenario ($0.077/kWh, Includes social cost of GHG, RIN = $6.38/MMBtu)

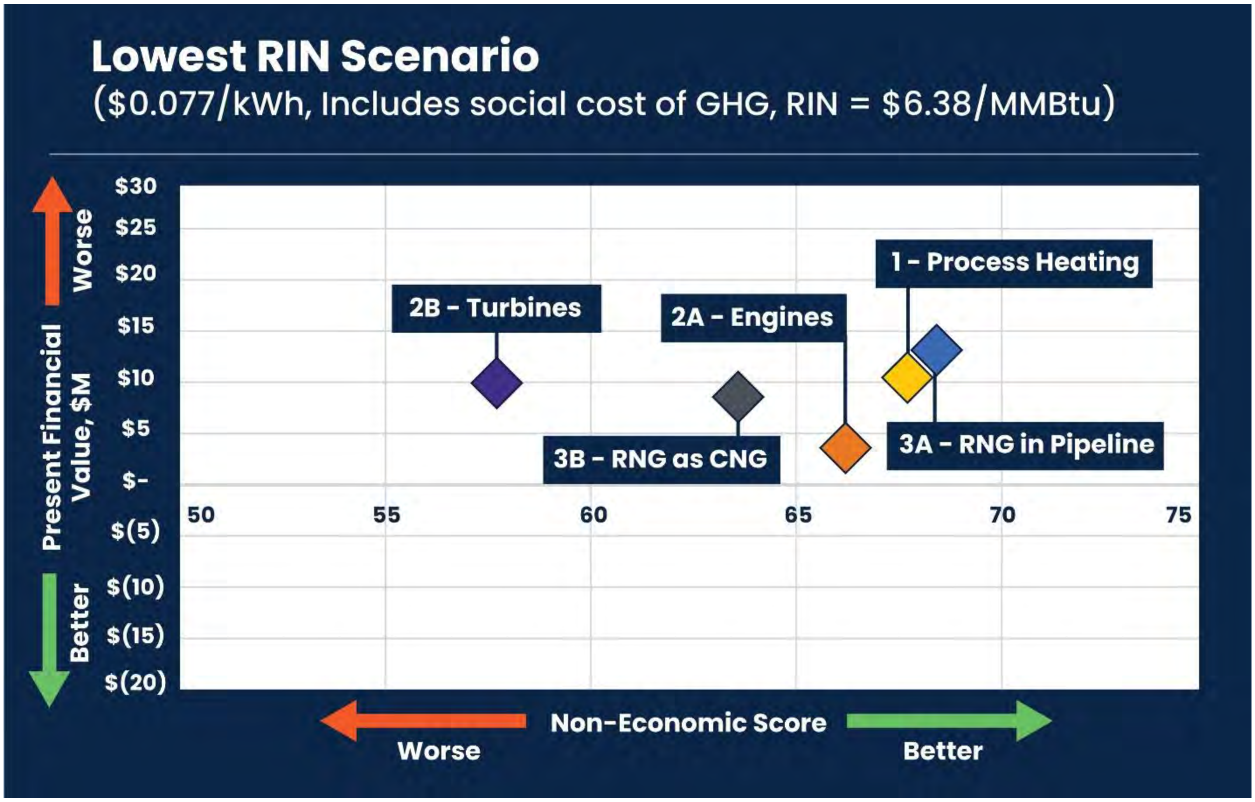
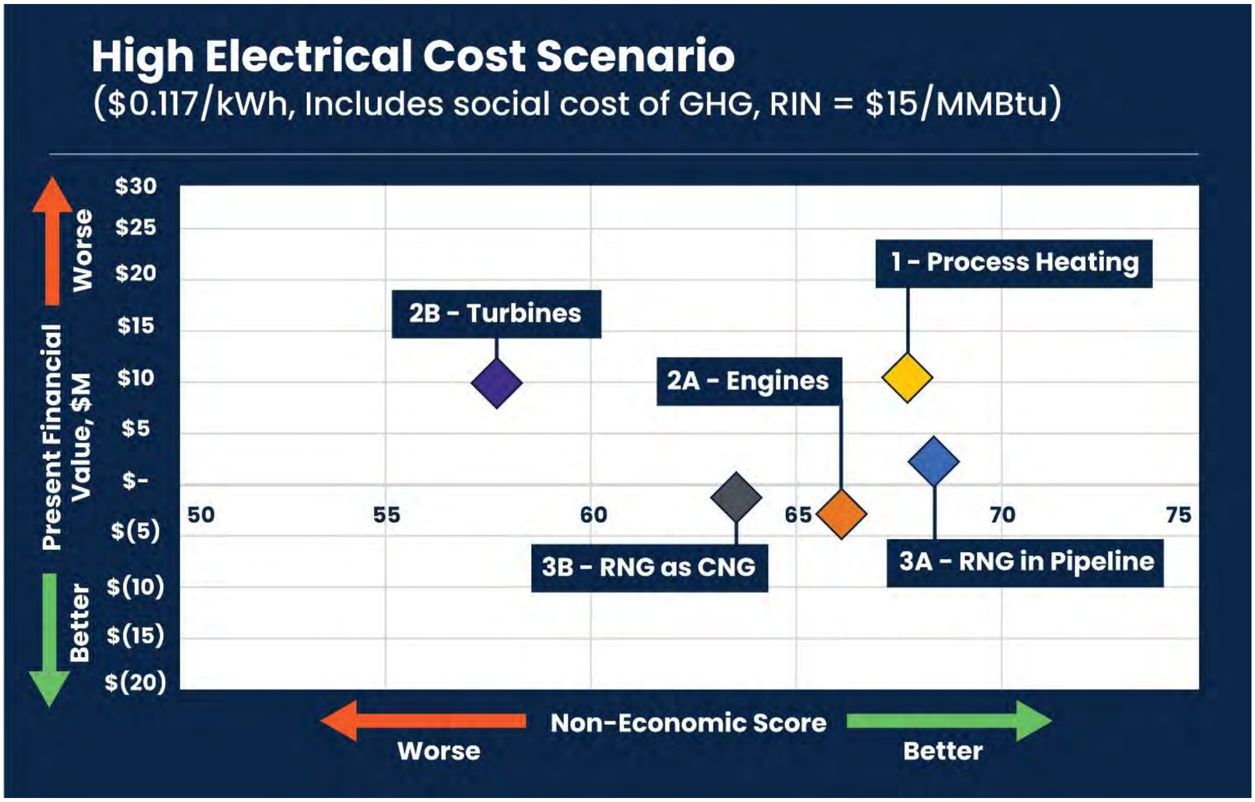


Figure 12 provides the analysis including the social cost of GHG and higher electricity cost of $0.117/kWh. In this scenario, the CHP alternatives become more financially favorable than the RNG alternatives.

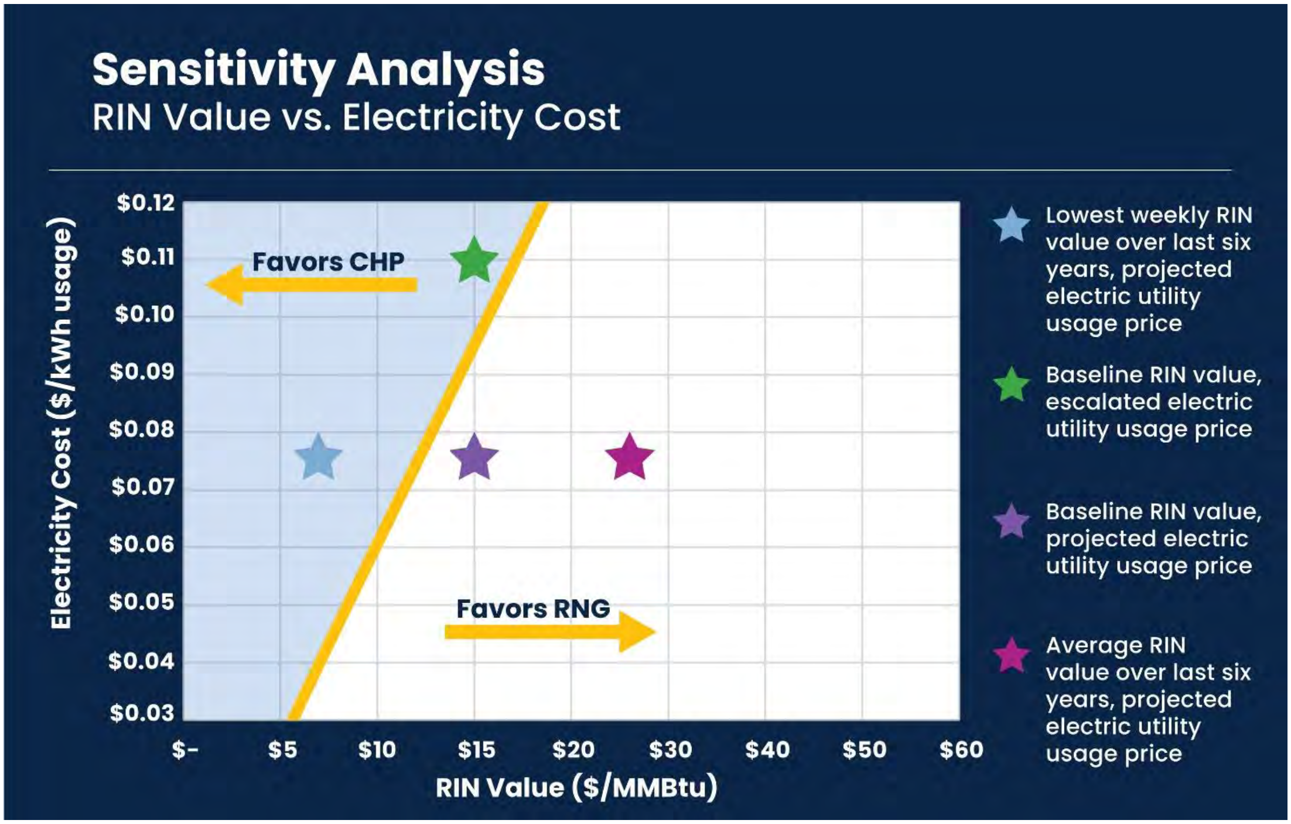
Figure 12. High Electrical Cost Scenario ($0.117/kWh, Includes social cost of GHG, RIN = $15/MMBtu)



Sensitivity Analysis

The financial analysis makes it clear that the main drivers in the comparison are the cost of electricity and the value of the RIN market. A break-even analysis was completed to identify the point at which Alternative 2A (CHP with Engines) is financially equal to Alternative 3A (RNG into Pipeline). This break-even analysis is shown on Figure 13, with the scenarios completed above identified.

Figure 13. Sensitivity Analysis of RIN Value vs. Electricity Cost



Additional detailed computer simulations were completed and these simulations confirmed the very high likelihood (greater than 90%) that the RNG alternatives will be more financially advantageous to Arlington County than the CHP alternatives.

Biogas Utilization Conclusion

Based on the analyses presented, the Arlington County Water Pollution Control Bureau recommends proceeding with Alternative 3 (RNG) as the selected biogas utilization approach. The basis for this recommendation is as follows:

- Alternative 3 (RNG) has the lowest net present value (i.e., lowest total cost to the County over the life of the equipment) for the baseline conditions using conservative capital and operating costs.
- Alternative 3A (RNG into Pipeline) scored the highest in the County's non-financial scoring. In particular, the County found that the RNG alternatives would be less complex to maintain and would result in fewer localized impacts such as noise and emissions than the CHP alternatives.
- A sensitivity analysis concluded that when considering multiple variables, including RIN volatility and changes in electrical rates, Alternative 3A (RNG into Pipeline) had a very high likelihood of being more financially advantageous than Alternative 2A.
- The County has the ability to retain GHG credits if the biogas is used within Arlington County for transportation purposes.
- Benefits of on-site CHP are limited because the CHP size would not be sufficient to power the entire Plant, which is already protected with two independent power feeds and backup generators. In addition, the use of CHP onsite will generate new, localized air emissions.

The County's current preference is for Alternative 3A (RNG into Pipeline) over Alternative 3B (RNG as CNG) due to the uncertain future of Arlington Transit and Washington Metropolitan Area Transit Authority fueling stations and the lack of a match between fueling times and gas production times (resulting in the need for additional storage). However, the final decision to inject RNG into the natural gas utility pipeline or to use CNG will be made in the future as more discussions with the stakeholders are conducted.

ARLINGTON RE-GEN

Biogas Utilization Final Report

HDR

November 18, 2022

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Abbreviations

°F	degree(s) Fahrenheit
AD	anaerobic digestion
ART	Arlington Transit
Btu	British thermal unit(s)
CDF	cumulative density function
CF	cubic foot/feet
CH_4	methane
CHP	combined heat and power
CI	carbon intensity
CIP	Capital Improvement Program
CNG	compressed natural gas
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
County	Arlington County
d	day(s)
Dominion	Dominion Energy
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
EQ	Exceptional Quality
Facilities	solids handling processes
FOG	fats, oils, and greases
gCO_2e	gram(s) carbon dioxide equivalent
GHG	greenhouse gas
H_2S	hydrogen sulfide
HDR	HDR Engineering, Inc.
hp	horsepower
hr	hour(s)
HRSG	heat recovery steam generator
IC	internal combustion
IWG	Interagency Working Group
kg	kilogram(s)
kW	kilowatt(s)
kWh	kilowatt-hour(s)
lb	pound(s)
lbm	pound(s) mass
LCFS	Low Carbon Fuel Standard
LHV	low heating value
MAD	mesophilic anaerobic digestion
MBH	1,000 British thermal units per hour

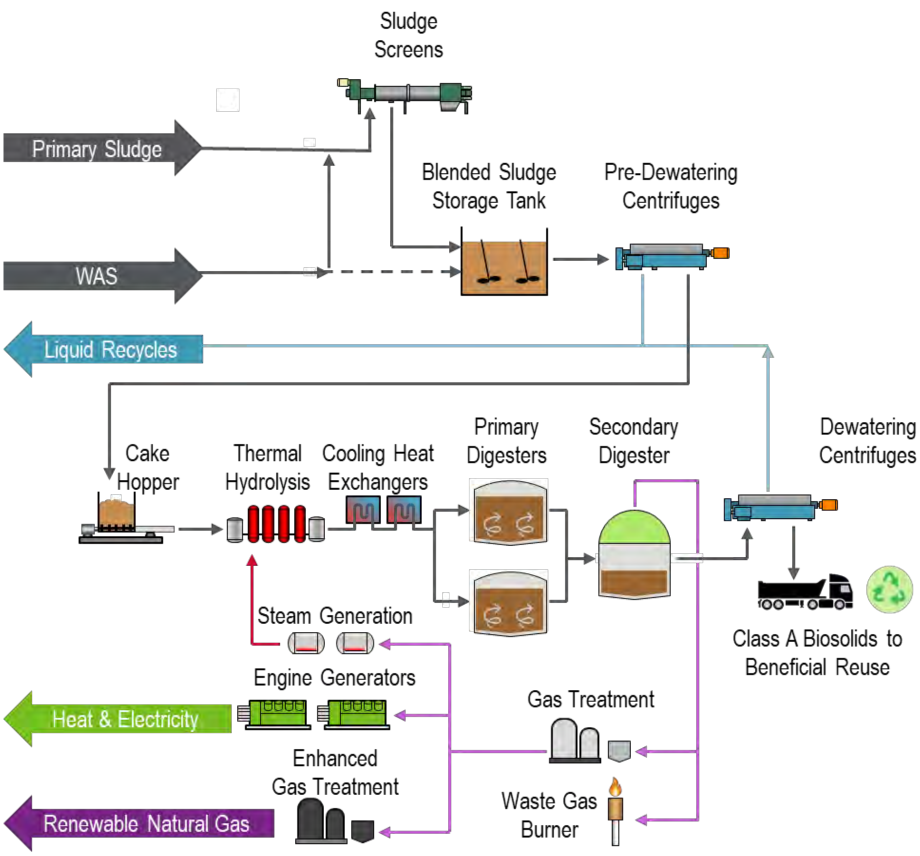
MBtu	1,000 British thermal units
MMBtu	1 million British thermal units
mgd	million gallons per day
MJ	megajoule(s)
MMscf	million standard cubic feet
MT	metric ton(s)
MW	megawatt(s)
MWh	megawatt-hour(s)
N/A	not applicable
N_2	nitrogen
NG	natural gas
O_2	oxygen
O&M	operations and maintenance
O&P	overhead and profit
PDF	probability density function
Plan	Arlington County Water Pollution Control Plant Solids Master Plan
ppm	part(s) per million
Program	Arlington County Water Pollution Control Plant Re-Gen/Biosolids Program
psig	pound(s) per square inch gauge
QA	quality assurance
REC	Renewable Energy Credit
RFP	request for proposals
RFS	Renewable Fuels Standard
RIN	Renewable Identification Number
RNG	renewable natural gas
RTO	regenerative thermal oxidizer
RVO	Renewable Volume Obligation
S	sulfur
scf	standard cubic foot/feet
scfm	standard cubic foot/feet per minute
SF	square foot/feet
THP	thermal hydrolysis process
TM	technical memorandum
VOC	volatile organic compound
WMATA	Washington Metro Area Transit Authority
WPCB	Water Pollution Control Bureau
WPCP	Water Pollution Control Plant
yr	year(s)

1 Introduction and Goals

1.1 Introduction

Arlington County (County) is implementing new biosolids management facilities at the Arlington County Water Pollution Control Plant (WPCP). The Arlington County WPCP Re-Gen/Biosolids Program (Program) is a comprehensive program that will include the engineering, design, construction, maintenance, startup, and operation necessary to add sustainable equipment and systems to effectively recover the County's renewable resources, produce a Class A biosolids product, and most efficiently utilize the biogas. The new solids handling processes (Facilities) will entail upgrades or replacement of nearly all existing solids handling processes. A thermal hydrolysis process (THP) followed by anaerobic digestion (AD) form the backbone of the new treatment train. The THP process uses temperature and pressure to breakdown the solids and remove pathogens, while the AD process stabilizes the solids and generates a methane (CH_4) rich biogas. The solids end product is a marketable Class A biosolids product. The overall process flow diagram for the Facilities is shown in Figure 1.

Figure 1: New Solids Handling Processes Flow Diagram



1.2 Program Mission Statement

A mission statement can be a valuable tool to help set the tone for a program during internal meetings and workshops. The Program's mission statement is as follows:

Upgrade resource recovery facilities to produce Class A biosolids and renewable energy, maximizing sustainability and community acceptance. Collaborate with team members to select and implement processes that are safe, reliable, and financially responsible throughout planning, design, construction, operations and maintenance.

1.3 Program Goals

Building on the mission statement and related drivers for the Program, below are the Program goals developed by the County:

1. **Produce a Class A Exceptional Quality (EQ) end product:** high-quality, low-odor product suitable for beneficial use and reduced risk of regulatory impact for land application
2. **Recover biogas for beneficial use:** recovering and beneficially using renewable resources to help achieve County-wide sustainability goals
3. **Provide ease of maintenance and repairs:** easy to work with equipment, updated technology with high efficiency and long-term ability to find replacement parts
4. **Keep safety in mind:** throughout process, design, construction, and ongoing operations
5. **Apply proper process selection and configuration:** appropriate choice of processes, well-designed and coordinated across the entire system, reliable with adequate redundancy
6. **Implement an open, transparent, and collaborative process between all team members**
7. **Achieve and maintain community acceptance:** maintain "good neighbor" status, including construction, and produce an outcome that is an asset to the community
8. **Implement cost-effective solutions:** make the most out of the investment
9. **Develop operator-friendly solutions:** comprehensive training on reliable and accessible equipment with clear operations and maintenance (O&M) and troubleshooting guidance
10. **Design for long-term reliability:** eliminate nuisance-causing, aging equipment and processes
11. **Actively engage staff throughout process:** during design, construction, startup, and training

12. **Ensure that staff are well prepared to operate and maintain the new processes:** via comprehensive training, ample transition time, and appropriate staffing levels for new systems

This Biogas Utilization Report is intended to provide more clarity on achieving Goal 2 (recover biogas for beneficial use). The following chapters summarize biogas production and energy needs at the WPCP, and evaluate several alternatives based on financial, non-financial, and sustainability criteria to recommend a biogas utilization approach that is consistent with the remaining Program goals listed above.

2 Background

2.1 Previous Reports

Several previously completed Arlington County planning reports and documents serve as a foundation for the Program evaluations:

- Arlington County Community Energy Plan (2019)
- Arlington County WPCP Foul Air Study (2017)
- Arlington County Sanitary Sewer Study (2020)
- Arlington County WPCP Condition Assessment (2019)
- Arlington County WPCP Solids Master Plan (2018)

The most relevant previous report for the biogas utilization analysis is the Arlington County WPCP Solids Master Plan (Plan) authored by CDM Smith. Additional descriptions of the Plan goals and recommendations are provided in the next sections.

2.1.1 Arlington County WPCP Solids Master Plan

The Plan, dated March 2018, evaluated several solids handling alternatives and developed a recommendation that addressed several needs of the WPCP. The overall goals of the Plan are listed below:

- Replace failing and end-of-life equipment
- Mitigate the risk of potential future regulatory changes to the current practice of recycling Class B biosolids through application to agricultural land
- Provide a solution that reduces the energy and greenhouse gas (GHG) footprint of the WPCP
- Achieve additional County-wide sustainability goals
- Develop a solids management strategy that offers long-term reliability
- Establish an implementation plan compatible with County Capital Improvement Program (CIP) funding

The alternatives evaluated in the Plan to achieve these goals included continuing lime stabilization, mesophilic anaerobic digestion (MAD), THP followed by MAD, and MAD followed by heat drying. The evaluation took into consideration 19 criteria, including the energy balance of each alternative. The energy balances are presented in Figures 10-10a, 10-10b, and 10-10c of the Plan.

The recommended alternative from the Plan was THP followed by MAD and a key aspect of the selection of this alternative was the energy value of the biogas produced. Section 12.4 of the Plan discusses the potential for future biogas utilization alternatives, but no formal recommended biogas use was made. Text from Section 12.4 of the Plan is shown below.

12.4 Biogas Utilization

In addition to the equipment and processes described, the County will continue to evaluate opportunities for biogas utilization. Opportunities identified include utilization of the biogas on-site through a combined heat and power system or cleaning and exporting the gas as a biomethane.

A combined heat and power system would include a combustion engine generator that produces electrical power for use on-site or potential metering the electrical utility. A heat recovery system for the engines and exhaust would allow heat to be captured for potential uses in building or process heating (e.g., steam generation). A biogas cleaning system is recommended for the system. The cleaning system would remove contaminants in the biogas such as hydrogen sulfide, siloxanes, and moisture that could impact engine wear and performance.

The opportunity to purify and export biogas as a biomethane may also be considered. Biomethane production involves increasing the energy content of the gas as well as removing contaminants including carbon dioxide, hydrogen sulfide, and moisture. Multiple technologies exist for producing biomethane. Opportunities to inject the biomethane into the natural gas distribution system or pipeline can be explored. The County may also consider a partnership with the Arlington Rapid Transit's CNG (compressed natural gas) fueling station located adjacent to the WPCP.

As the County moves ahead with implementation of thermal hydrolysis and anaerobic digestion, biogas utilization opportunities can be explored.

This Biogas Utilization Report does not seek to revisit the previous Arlington County Board-adopted decision to proceed with THP followed by MAD, but rather to evaluate the biogas utilization alternatives to meet the biogas utilization goal of recovering and beneficially using renewable resources to help achieve County-wide sustainability goals.

2.1.2 Planning Period

The planning period is important for this study as the financial analysis needs to consider the change in solids production and costs of electricity, natural gas (NG), and equipment O&M over time to develop a net present value for each alternative. Based on discussions with the County, a 25-year planning period following construction was selected. With construction anticipated to finish in 2027, the planning period for this study runs from 2027 to 2052. The target year of 2052 was selected for when the design flows and loads are anticipated to be reached, resulting in a design solids production loading of approximately 40 tons per day. Based on the current solids production of 30.7 tons per day, it is anticipated that the solids production will increase linearly by approximately 0.37 ton per year, or roughly 1.0 percent per year based on anticipated population growth. To illustrate the energy balance and economic analysis results presented in the subsequent chapters, an evaluation year of 2037 was selected as it is close to the midpoint of the planning period and falls on one of the 5-year increments developed.

2.2 Process Requirements

The energy required to achieve the WPCP process requirements was calculated to develop the overall energy balance of the WPCP and determine the best use of the biogas. The sections below summarize the solids production, heating requirements, and biogas production throughout the planning period.

2.2.1 Solids Production

Current and future solids production were determined as part of the review of historical WPCP data and the resulting mass balance as presented in Technical Memorandum (TM) No. 1, *Solids Production and Design Criteria*. The three sizing scenarios are based on loadings in 2020 at 23.0 million gallons per day (mgd), a year 2052 design condition at 30.8 mgd, and ultimate capacity at 40.0 mgd. Solids production and corresponding energy needs and biogas production are assumed to increase at a linear rate between now and the design year. Table 1, Table 2, and Table 3 below present the biosolids total solids; volatile solids; and primary scum and fats, oils, and greases (FOG) volatile solids loadings, respectively, over the planning period in 5-year increments.

Table 1: Biosolids Total Solids Loading to Pre-dewatering, dry lb/d

Parameter	2027	2032	2037	2042	2047	Design 2052
Average	65,872	69,122	72,371	75,621	78,870	82,120
30-day max	86,190	90,442	94,694	98,946	103,197	107,449
14-day max	93,892	98,524	103,156	107,788	112,419	117,051
7-day max	99,391	104,294	109,197	114,099	119,002	123,905
3-day max	109,423	114,821	120,219	125,616	131,014	136,412

Table 2: Biosolids Volatile Solids Loads to Pre-dewatering, dry lb/d

Parameter	2027	2032	2037	2042	2047	Design 2052
Average	50,865	53,374	55,883	58,392	60,901	63,410
30-day max	66,085	69,170	72,400	75,780	79,317	83,020
14-day max	71,980	75,341	78,858	82,539	86,393	90,426
7-day max	76,190	79,747	83,470	87,367	91,446	95,715
3-day max	83,904	87,821	91,921	96,213	100,705	105,406

Table 3: Primary Scum and FOG Volatile Solids Loads to Digestion, dry lb/d

Parameter	2027	2032	2037	2042	2047	Design 2052
Average	4,625	4,854	5,082	5,310	5,538	5,766
30-day max	6,244	6,552	6,860	7,168	7,476	7,784
14-day max	6,752	7,086	7,419	7,752	8,085	8,418
7-day max	7,123	7,474	7,825	8,177	8,528	8,879
3-day max	7,955	8,348	8,740	9,132	9,525	9,917

2.2.2 Biogas Production

Future biogas production is based on the same assumptions as presented in TM No. 1, which included 95 percent solids capture in the pre-dewatering system, 60 percent volatile solids reduction for primary and secondary biosolids, and 90 percent volatile solids reduction of primary scum and FOG. The assumed biogas yield is 17 standard cubic feet (scf) of biogas produced per pound (lb) of volatile solids destroyed.

Table 4 below presents the biogas production values for the planning period in 5-year increments. The average values for each year are used for the financial analysis in Chapter 4.

Table 4: Biogas Production, scfm

Parameter	2027	2032	2037	2042	2047	Design 2052
Average	388	408	428	445	466	486
30-day max	511	536	562	587	612	637
14-day max	556	584	611	639	666	693
7-day max	589	618	647	676	705	734
3-day max	649	681	713	745	777	809

The above biogas production values were used with an energy content of 580 British thermal units (Btu)/scf (low heating value [LHV]) to develop the biogas energy production in thousands of British thermal units (MBtu) per hour (MBH) in Table 5 below. LHV is the energy produced from combustion excluding the latent heat of vaporization. The efficiencies of combustion equipment such as boilers and engines are stated based on the LHV of the fuel inputs.

Table 5: Biogas Production, MBH

Parameter	2027	2032	Used 2037	2042	2047	Design 2052
Average	13,500	14,200	14,900	15,500	16,200	16,900
30-day	17,800	18,700	19,500	20,400	21,300	22,200
14-day	19,400	20,300	21,300	22,200	23,200	24,100
7-day	20,500	21,500	22,500	23,500	24,500	25,500
3-day	22,600	23,700	24,800	25,900	27,100	28,200

2.2.3 Steam Demand

The THP system consumes 1.0 ton of steam for each ton of solids processed. In the 2037 evaluation year that equals an annual average steam demand of 3,020 pounds per hour (lb/hr) or 3,490 MBH. That is an average steam demand, but the batch nature of THP requires higher peak flows of steam reaching more than 10,000 lb/hr. The average demand was used for the financial analysis, whereas the peak demand of 10,000 lb/hr was used for sizing steam boilers. Table 6 below presents the steam required for the planning period in 5-year increments.

Table 6: Steam Required, lb/hr

Parameter	2027	2032	Used 2037	2042	2047	Design 2052
Average	2,740	2,880	3,020	3,150	3,290	3,420
30-day	3,590	3,770	3,950	4,120	4,300	4,480
14-day	3,910	4,110	4,300	4,490	4,680	4,880
7-day	4,140	4,350	4,550	4,750	4,960	5,160
3-day	4,560	4,780	5,010	5,230	5,460	5,680

Table 7 presents the steam requirements above as energy required in MBH.

Table 7: Steam Required, MBH

Parameter	2027	2032	Used 2037	2042	2047	Design 2052
Average	3,170	3,330	3,490	3,640	3,810	3,960
30-day	4,150	4,360	4,570	4,770	4,980	5,180
14-day	4,520	4,760	4,980	5,190	5,410	5,650
7-day	4,790	5,030	5,260	5,500	5,740	5,970
3-day	5,280	5,530	5,800	6,050	6,320	6,570

2.3 Other Energy Requirements

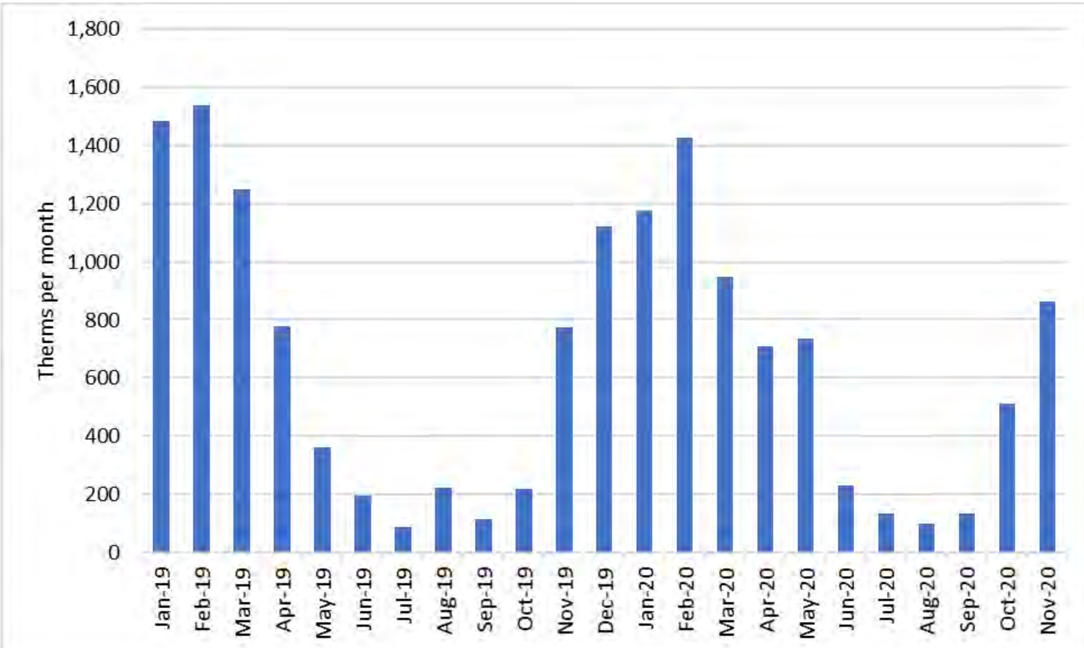
In addition to process heating requirements described above, the Arlington WPCP has other energy requirements, including providing heat for buildings and overall WPCP electrical demands. These energy requirements are summarized in the sections below.

2.3.1 Building Heating

Current building heating requirements were based on existing NG bills for the period between January 2019 and November 2020.

Figure 2 shows the monthly NG usage. Based on these data the average annual NG usage is 7,800 therms per year (780 million British thermal units per year [MMBtu/yr]) or 89 MBH and a heating load of 71 MBH at 80 percent efficiency. Building heating needs will likely change over time and will be refined as the building modifications are refined throughout the Program. For now, building heating needs are assumed to be constant through the duration of the planning period.

Figure 2: Monthly Natural Gas Usage



2.3.2 WPCP Electrical Usage

Similar to natural gas, current and future WPCP electrical requirements were based on existing power bills for the period between January 2019 and November 2020.

Figure 3 shows the monthly power usage in kilowatt-hours (kWh) per month. Based on these data the average annual power usage is approximately 29,624,000 kWh/yr, or a 3.38-megawatt (MW) average load. Assuming a similar usage increase as the flows and loads, the future electrical usage can be developed and is shown in Table 8.

Figure 3: Monthly Electrical Usage

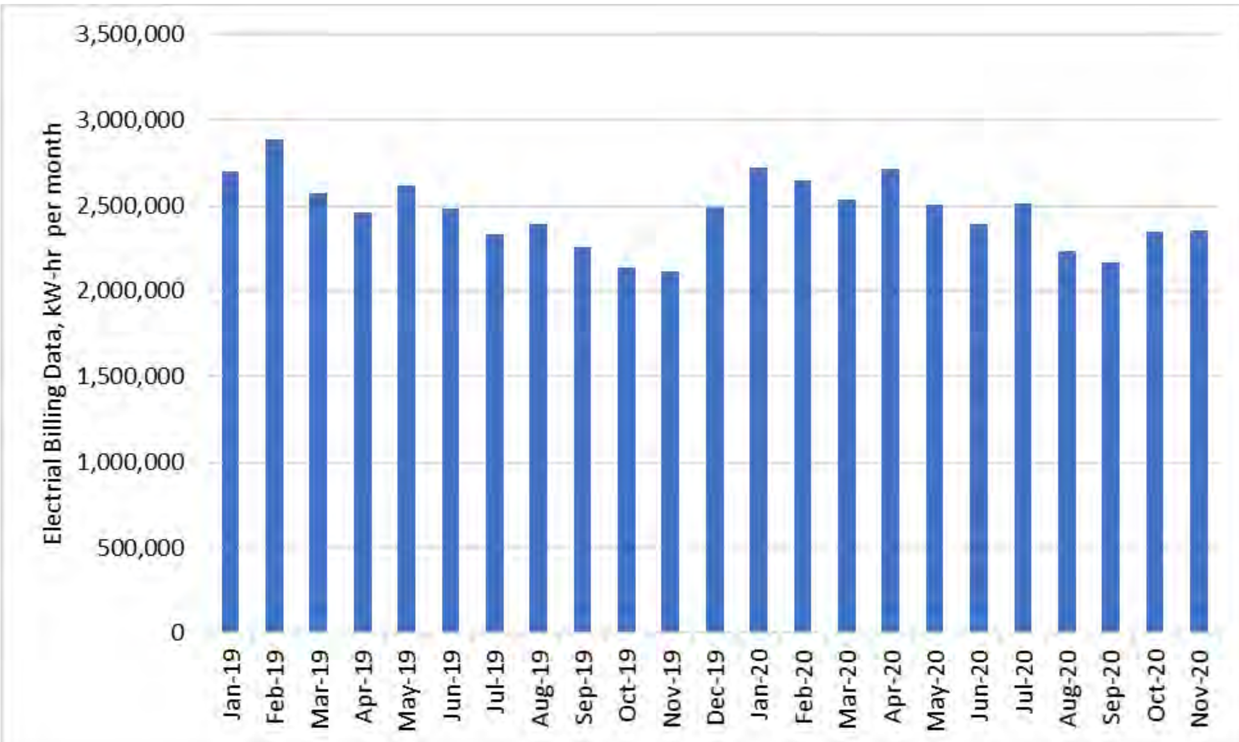


Table 8: Facility's Electrical Usage Forecast

Parameter	Actual 2020	2022	2027	2032	Used 2037	2042	2047	Design 2052
kWh/yr	29,624,000	30,252,000	31,822,000	33,391,000	34,961,000	36,531,000	38,101,000	39,670,400
MBH	11,500	11,800	12,400	13,000	13,600	14,200	14,800	15,500
MW	3.38	3.45	3.63	3.81	3.99	4.17	4.35	4.53

2.4 Renewable Natural Gas Market Summary and Potential Values

Biogas produced from anaerobic digestion has historically been used on site at wastewater facilities to provide fuel for process and building heating or by generating electricity and recovering waste heat for process and building heating. Over the last decade, the option of conditioning the biogas to NG quality and using the renewable natural gas (RNG) off site as vehicle fuel has become a viable third potential use of the biogas. The major drivers of this biogas utilization option are federal programs, like the U.S. Environmental Protection Agency (EPA) Renewable Fuels Standard (RFS), and state incentive programs, like the California Low Carbon Fuel Standard (LCFS), that encourage the use of renewable fuels to lower the use of petroleum products. Summaries of the EPA RFS and California LCFS are provided below.

2.4.1 EPA Renewable Fuels Standard

The United States Congress created the RFS through the Energy Policy Act of 2005 and revised the program with the Energy Independence and Security Act in 2007. The RFS is a renewable-fuels program within the Clean Air Act that mandates that large fossil-fuel producers and blenders (Obligated Parties) must include within their fuel mix a growing portion of renewable fuels. The quotas required of the Obligated Parties are referred to as Renewable Volume Obligations (RVOs) and are established and tracked by EPA through the use of renewable credits, also known as Renewable Identification Numbers (RINs). The original program was designed to increase the RVOs until 2022 and then level off beyond that point unless Congress issued another amendment. EPA can lower or raise the RVOs up to the maximum RVO quota set for 2022 but Congressional action would be required to eliminate the RFS program. The RFS program has pressure against it from the oil and gas industry, but also has strong support from the corn ethanol industry, which represents half of the RIN market.

As part of EPA's RFS, RVOs are developed by categorized RIN types based on their environmental benefit and the production pathway. These categories, D3 through D7, encompass lower-value biofuels like corn-based ethanol (D6) up to high-value biofuels like cellulosic biodiesel or ethanol (D3). Refer to Figure 4 for classifications of the RIN types.

The biogas produced from the digestion of municipal biosolids is considered D3 cellulosic and has the highest market value. However, any biogas produced by the co-digestion of municipal solids with hauled-in or high-strength wastes will be considered D5 advanced, unless each individual feedstock has a 75 percent or higher cellulosic content. Hauled-in wastes are defined as any wastes brought to the WPCP by truck, not the sewer, and these wastes are typically not considered cellulosic as they are not woody or starchy by nature. The exception to this requirement is hauled-in septage, which is still considered cellulosic. At this point the County does not intend to receive any wastes by truck.

Figure 4: EPA RFS Nested RIN Categories and Volumes

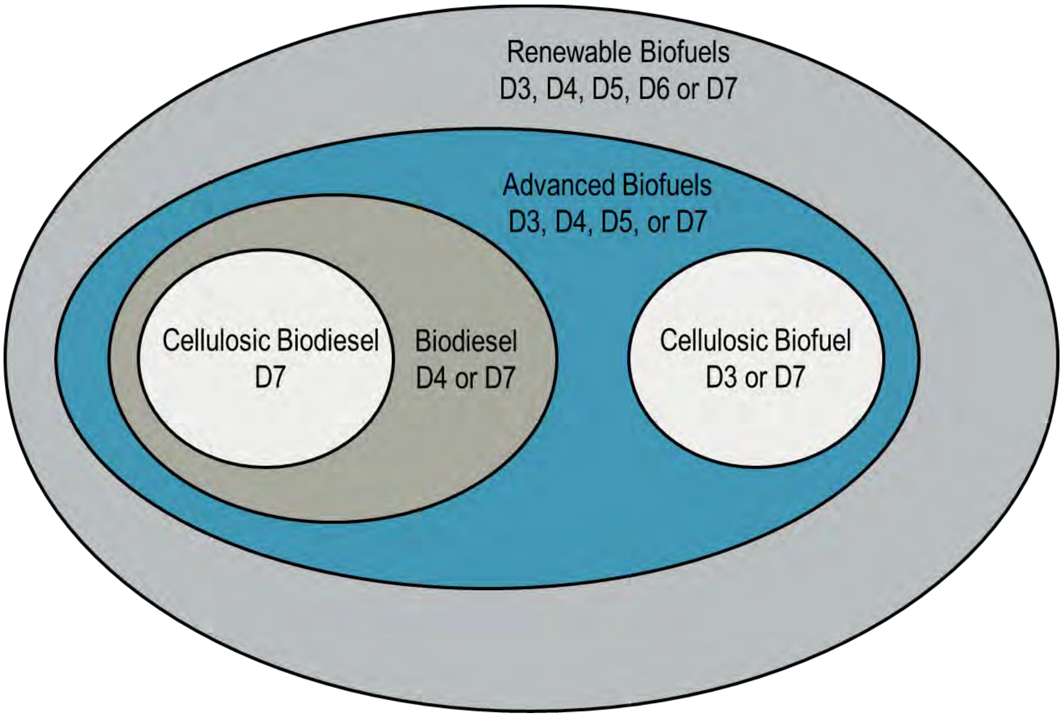


Figure 5 presents the historical RIN values as reported by EPA from 2015 through June 2022 (https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rin-trades-and-price-information). Note, there are 13 RINs per 1 MMBtu, so a RIN price of $1.00 equates to $13/MMBtu.

Figure 5: EPA RFS RIN Historical RIN Values

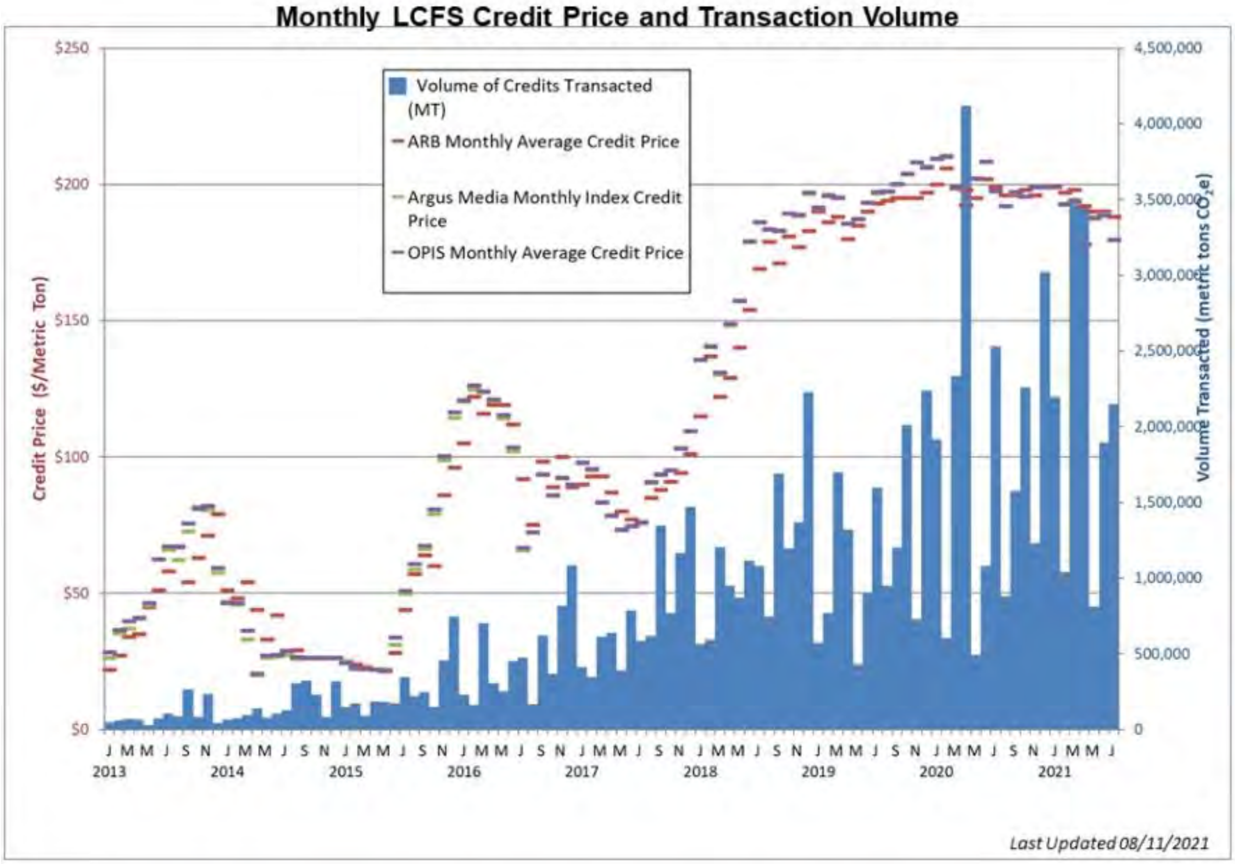
As shown in Figure 5, all RIN market values peaked in late 2017 and continued to fall through 2019 with a market rebound occurring in 2020 through 2022. The drop in market values in 2018 and 2019 was due to two major short-term factors:

- **Small refinery exemptions:** EPA administration at the time was allowing this hardship exemption to be used by large blenders, reducing their obligation for RINs.
- **Carry-over bank:** The program allows Obligated Parties to carry more than 20 percent of their obligation to the next year. In 2018 and 2019 Obligated Parties were using this carry-over allowance, but they are not allowed to do that year over year, so demand for all RINs returned in 2020.

2.4.2 Low Carbon Fuel Standard

In addition to RINs, carbon offset credits are available through California's LCFS program. The LCFS has become a healthy market with more transactions and higher values throughout the last 8 years (see Figure 6) and the program is currently slated to run through 2032. It could be renewed to extend past that date. LCFS credits can be obtained in addition to RIN credits as long as the renewable fuel is contracted for sale to an Obligated Party with end use in California. The value of RNG in the LCFS market is dependent on the carbon intensity (CI) score of the RNG produced as determined by the LCFS program requirements. The CI score takes into account the net carbon reductions achieved by producing the RNG including the energy required for processing and transporting the RNG to the end use. Typical wastewater treatment CI scores are in the range of 20 to 40 grams carbon dioxide equivalent per megajoule (gCO_2e/MJ). The current credit price of $180 per metric ton (MT) is equivalent to $12.30/MMBtu at an average CI score of 30 gCO_2e/MJ. This value can be added to the values of the RINs from the RFS. Arlington County would be eligible to participate in the LCFS program. However, it is a highly competitive program. It is attractive to producers of biogas generated from animal manure, as that biogas has a lower CI score.

Figure 6: California LCFS Market History

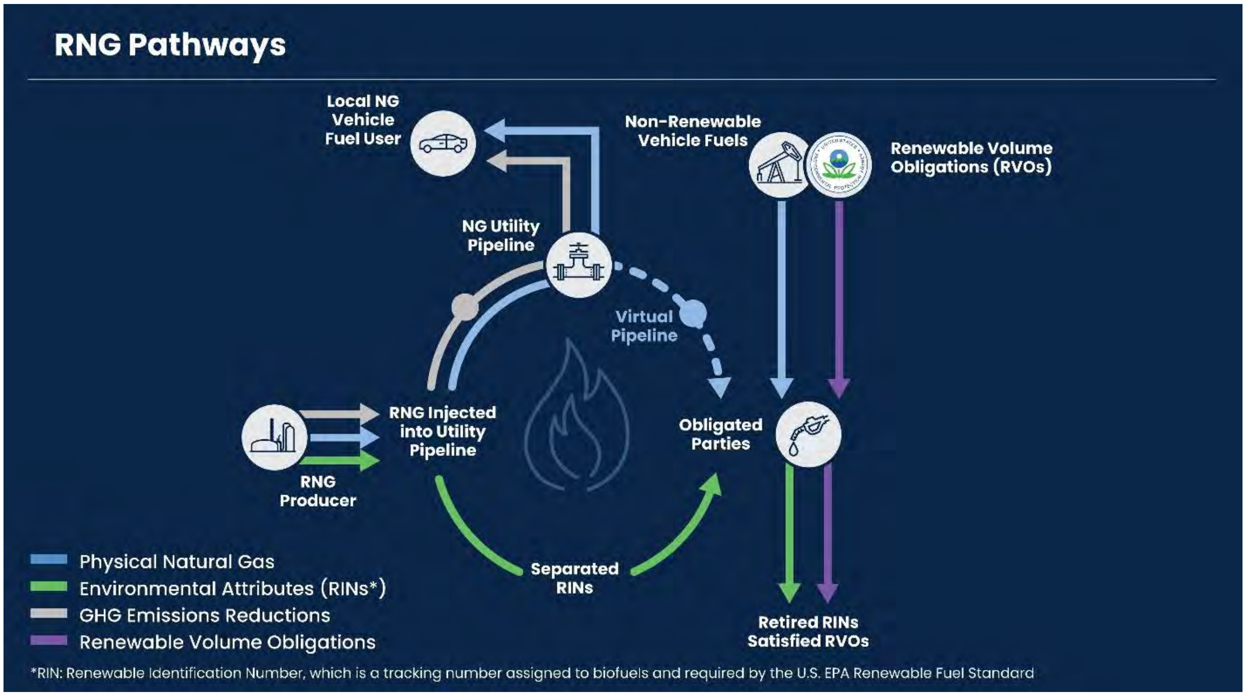


2.4.3 Pathways and Requirements

Both the RFS and LCFS are specifically for renewable fuels for transportation programs. Therefore, the fuel must ultimately be used as a transportation fuel for the renewable attribute to be recognized. A renewable-fuel producer is not required to explicitly find a transportation end user of the fuel it produces; however, at some point along the fuel supply pathway, it must be capable of being used as a transportation fuel so that an Obligated Party can claim the RIN and/or the LCFS credit and meet its obligation with EPA or California.

The production and sale of RNG and environmental attributes, like RINs through the RFS, occurs in two pathways: the physical pathway and the pathway for the separated environmental attributes. The physical pathway is the sale of the RNG by the producer to an end user of the actual gas via the NG Utility. The gas can be sold to the current gas supplier or to another party directly. The pathway for the separated environmental attributes (RINs) is handled by a third party that verifies that the RNG produced complies with the RFS and markets the attributes to Obligated Parties to satisfy their Renewable Volume Obligations (RVOs) in the RFS. Figure 7 illustrates the two pathways of RNG and RIN/LCFS sales. Note that the molecules of natural gas do not actually have to be used as vehicle fuel, but the physical pathway from the point of injection to the vehicle fueling point needs to be verified by a third-party RIN developer or broker.

Figure 7: Physical and Contractual Pathways for RNG



These two pathways are independent of GHG emissions reductions and local greenhouse gas accounting. The County will be able to take credit for the reduction of GHGs in its internal accounting, independently of the sale of RINs, as long as the gas is used for transportation purposes in Arlington County. The valuations of RINs and carbon credits are treated separately in this report.

2.4.4 RNG Value Considerations

The value of RNG should take the following factors into account:

1. The value of the RNG as natural gas based on the NG commodity market
2. The value of environmental attributes obtained through the RFS (D3 or D5)
3. The value of environmental attributes obtained through the LCFS (CI score)
4. The cost of compliance with the RFS and LCFS
5. The cost of marketing the environmental attributes to Obligated Parties

Items 1 through 3 should be considered as ranges (low, average, high) to account for the variability in future market values. The biogas revenues at the WPCP need to be designated as either D3 (highest market value) or D5 categories. The biogas produced in the anaerobic digesters handling municipal biosolids will produce D3 RNG, but biogas produced from the co-digestion of FOG or other high-strength waste will be D5. Discussions are occurring currently at EPA regarding how to account for the RIN designation of biogas produced at wastewater plants where FOG and high-strength wastes are also digested. For facilities that wish to receive and digest these organics, the recommended approach is that they be sent to one specific D5 digester with the remaining digesters designated as D3 to maintain the high-value biogas designation. Biogas metering is needed on all digesters to quantify the D3 and D5 RNG quantities separately to meet the RFS program requirements. There is the potential that EPA may allow a blended D3/D5 approach in the future where the biogas production from biosolids is designated D3 with the additional biogas produced from hauled-in wastes designated D5, even if these materials are digested together in the same digester. However, there is currently no indication of if, or when, EPA might consider these changes. The current Program does not include facilities to receive and process high-strength wastes in the new digesters, but provisions will be included to add such a facility in the future if it is deemed appropriate by the County.

Items 4 and 5 are included to reflect the cost of bringing the gas to market within the environmental attribute programs. The RFS is highly regulated, so market RIN values are typically reduced by 15 percent and the LCFS values by 15 to 30 percent to account for the third-party cost of compliance and marketing the environmental attributes to Obligated Parties. The third parties are either gas marketing companies or the Obligated Parties themselves and are typically selected by the RNG producer through a request for proposals (RFP) process. The resulting contractual arrangement specifies that the County's share be based on either a fixed price or percentage of total revenue and the term of the agreement. The third party will qualify the RINs with EPA, qualify with California for LCFS credits, develop quality assurance (QA) programs for certification, and administer the program. The County is then paid by the third party for both the NG commodity value and the associated environmental attributes on a monthly or quarterly basis.

Table 9 comparatively presents the range of RNG market values of the RFS program. Cellulosic RINs (D3) have the highest value and have been valued from a minimum of \$0.50/RIN to a maximum of \$3.26/RIN between January 2016 and July 2021 with an average value of \$1.96/RIN over that time frame. The ranges shown in Table 9 are based on a tighter range of values because the markets for RNG are anticipated to become more mature and less variable than they have been over the last 5 years. The statistical distribution of historical RIN prices is discussed below in Section 5.4. The net

D3 RIN values are calculated by converting the $/RIN to $/MMBtu by multiplying by 13 RIN/MMBtu (LHV) and 85 percent to account for the cost of marketing the RINs and regulatory compliance. The RFS value is combined with the commodity price of natural gas, which is currently approximately $2.70/MMBtu (LHV). If the renewable fuels are sold into the California fuels market, LCFS is also available and is worth approximately $12.30/MMBtu (based on CI of 30 gCO_2e/MJ and $180/MT).

Table 9: RINs and Carbon Market Comparative Values: March 29, 2021

RIN and Carbon Market	County Share of Environmental Attributes	Conservative	Moderate	Aggressive
Commodity price of RNG ($/MMBtu)	100%	$2.70	$2.70	$2.70
D3 market value ($/RIN)		$0.55	$1.25	$2.25
D3 market value ($/MMBtu)		$7.15	$16.25	$33.75
Net D3 RIN ($/MMBtu)	85%	$6.10	$13.80	$24.90
Total for D3 + commodity ($/MMBtu)		$8.80	$16.50	$27.60
Net LCFS ($/MMBtu)	70%	$0.00	$4.00	$10.00
Total for D3 + commodity + LCFS ($/MMBtu)		$8.80	$20.50	$37.60

A RIN value of $15/MMBtu has been used in this Biogas Utilization Report for the base financial analyses. This is reflective of a conservative value for RINs only and does not include any potential value from the LCFS. Sensitivity analyses are also included to address potential volatility of the RIN market, and these are described in Section 5.4.

2.4.5 Anticipated RNG Specifications

There are two major ways to use RNG produced at the Arlington WPCP as vehicle fuel, and each method has different RNG quality requirements. The most common method is to inject the RNG into an NG utility pipeline. This allows the environmental attributes of the RNG, the RINs and LCFS credits, to be sold to Obligated Parties across the country, providing the largest market of potential buyers. NG utilities have stringent specifications and monitoring requirements for the RNG injected into their pipelines—with the largest market comes the highest RNG standards. A less common method is to use the RNG in a dedicated fleet fueling station. If an RNG producer is located near, or has access to, a fleet of CNG vehicles, the RNG could be directly used to fuel that fleet without having to be injected into the NG pipeline. This method is less common because of challenges related to matching supply and demand and making sure that all the RNG produced will be used. The benefit of this option is that fleet fueling typically has lower standards for RNG quality as the only limit is what is needed by the vehicles, not other uses on a pipeline. The Arlington WPCP is located across the street from two transit bus facilities, Arlington Transit (ART) and Washington Metro Area Transit Authority (WMATA), and these fleets currently have the fueling needs necessary to use all the RNG produced. The Arlington County Transit Bureau is currently completing a study for the County bus fleets, including electrification and resiliency alternatives. Supply of RNG to these facilities may be limited or eliminated in the future based on the pace of bus electrification.

2.4.5.1 Pipeline Injection

The American Biogas Council has developed a recommended RNG-quality specification for pipeline injection, which is presented in Table 10 below.

Table 10: Anticipated RNG Pipeline Specification

Parameter Maximum (unless noted otherwise)	Unit	Acceptable Limit	Typical Raw Biogas
Minimum high heating value	Btu/scf	960	580–680
H_2S	ppm	0.0057	300–1,000
Total sulfur	ppm	0.458	300–1,200
CO_2	Percentage by volume	2.0%	32%–42%
O_2	Percentage by volume	0.4%	<1.0%
Total inerts	Percentage by volume	5.0%	33%–45%
Water	lb/MMscf	7.0	~2,000
Siloxanes	ppm	1.0	5–20
Dust, gum, bacteria, and pathogens	Filter microns	Commercially free	N/A
Minimum and maximum limits of acceptable temperature range	°F	50–120	90–110

2.4.5.2 Compressed Natural Gas Bus Fleet Fueling

Preliminary discussions have been conducted with ART to use the RNG produced as fuel for compressed natural gas (CNG) buses within its system. Table 11 below provides a summary of the major parameters for RNG used for bus fueling at the ART facility. The complete anticipated fuel specification for the ART bus facility is included in Appendix A . These limits are less restrictive than the pipeline specification described above. The minimum LHV of 16,100 Btu per pound mass (lbm) is roughly equivalent to an RNG product gas with 89 percent methane, 10 percent carbon dioxide (CO_2), and less than 1 percent oxygen (O_2) and nitrogen (N_2).

Table 11: Anticipated CNG Bus Gas Specification

Parameter Maximum (unless noted otherwise)	Unit	Requirements
Minimum CH_4 number[a]	MN	65/75
Minimum LHV	Btu/lbm	16,100
Hydrogen	ppm	300
H_2S	ppm	6
Sulfur (S)	ppm	10
Siloxanes	ppm	3
CO_2	Percentage by volume	3.0%
N_2	Percentage by volume	4.0%

a. Methane number is the calculated knock resistance of a fuel used by engine manufacturers to ensure that the fuel does not combust automatically on temperature and pressure.

3 Alternatives Development

3.1 Biogas Utilization Alternatives

There are several options for the beneficial use of the biogas produced in anaerobic digestion, each with its own advantages and disadvantages including biogas conditioning requirements, capital cost, O&M requirements, financial benefits, sustainability impacts, and GHG emissions.

The objective of this analysis is to look at all feasible alternatives for the beneficial use of the biogas while reliably meeting the WPCP's heating and electrical needs and then perform monetary, non-monetary, and sustainability evaluations to determine the recommended alternative for the County.

The range of feasible alternatives includes using the biogas for one or a combination of the following:

- On-site use for process and building heating
- Producing electrical power and recovering wasted heat (combined heat and power [CHP])
- Production of RNG for use off site through pipeline injection or as CNG for direct use as vehicle fuel.

From these potential biogas uses the following four major alternatives were developed:

- **Alternative 1:** process and building heating
- **Alternative 2:** CHP
- **Alternative 3:** RNG
- **Alternative 4:** RNG and CHP

For each of the alternatives, Sankey diagrams (depiction of energy balance) were developed to help illustrate the sources and flows of energy purchased and produced. These diagrams show the process and building heating requirements, electrical power requirements and production, equipment efficiencies, NG purchase, and biogas flaring for each alternative. Note the following regarding the Sankey diagrams:

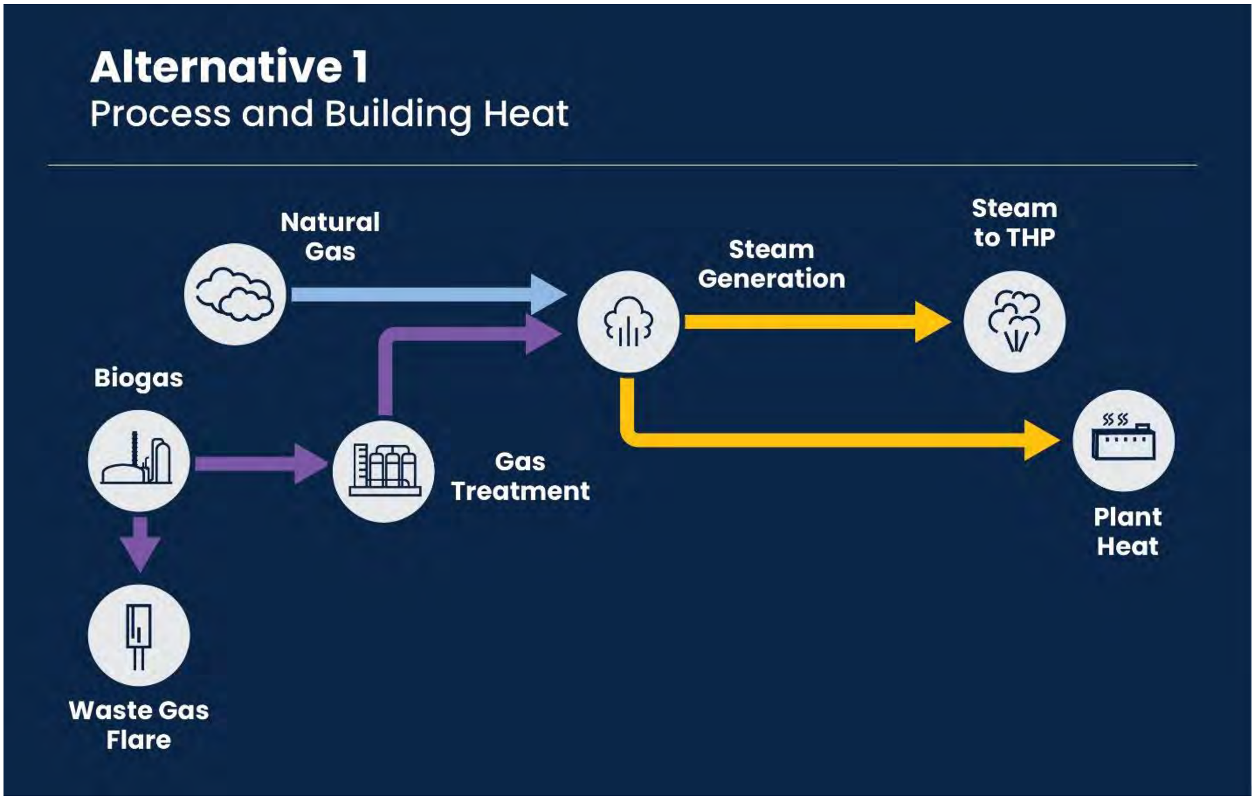
- The diagrams are based on anticipated 2037 operating conditions.
- The diagrams represent the annual average total energy flow, not capacity or peak conditions.
- The units of the diagrams are represented in MBH.

It is assumed that all methane generated at the WPCP is combusted, whether through beneficial use on site, beneficial use off site, or combusted through a flare. A description of each of the alternatives and the corresponding Sankey diagrams are provided in the following sections.

3.1.1 Alternative 1: Process and Building Heating

The simplest and least expensive way to beneficially use the biogas produced in the digesters would be to fuel the boilers that produce steam for the THP system, as shown schematically in Figure 8. The THP steam demand would consume only about 30 percent of the biogas produced, leaving 70 percent as excess, which would be flared in a waste gas flare. Note, all alternatives would require a waste gas flare for flaring during equipment maintenance or downtime. However, Alternative 1 is the only option where biogas would constantly be flared.

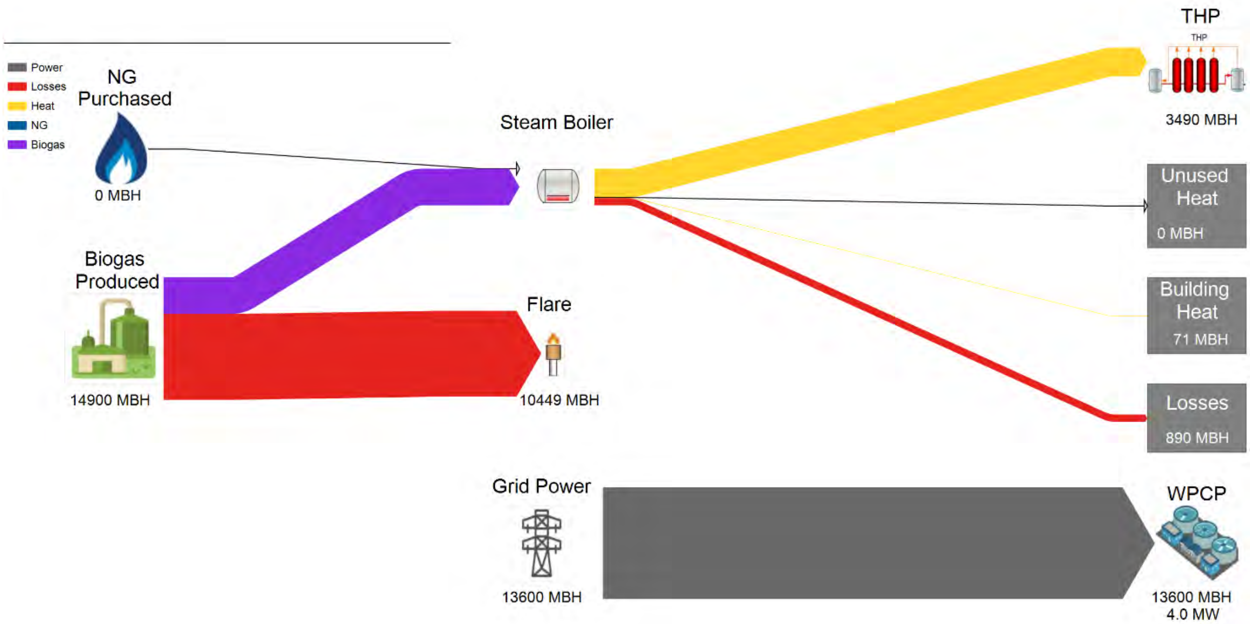
Figure 8: Alternative 1: Process and Building Heating



Alternative 1 was developed for comparison against the alternatives that target higher beneficial use of biogas. **Because this alternative does not fully utilize the biogas, it is not a viable biogas utilization option, but it is included in the analysis as the minimum required to meet the process needs.**

For the 2037 condition, the anticipated biogas production is 14,900 MBH and the THP steam requirement is 3,020 lb/hr or 3,490 MBH with 200 pounds per square inch gauge (psig) steam. In addition, the building heating requirement is 71 MBH, which results in a total heating requirement of 3,560 MBH. The assumed boiler heating efficiency for all alternatives is 80 percent, so 4,450 MBH of biogas is needed to produce the steam needed for THP and building heating demands. This leaves 10,450 MBH of biogas production that must be flared. These values are illustrated graphically in the Sankey diagram for Alternative 1, shown in Figure 9.

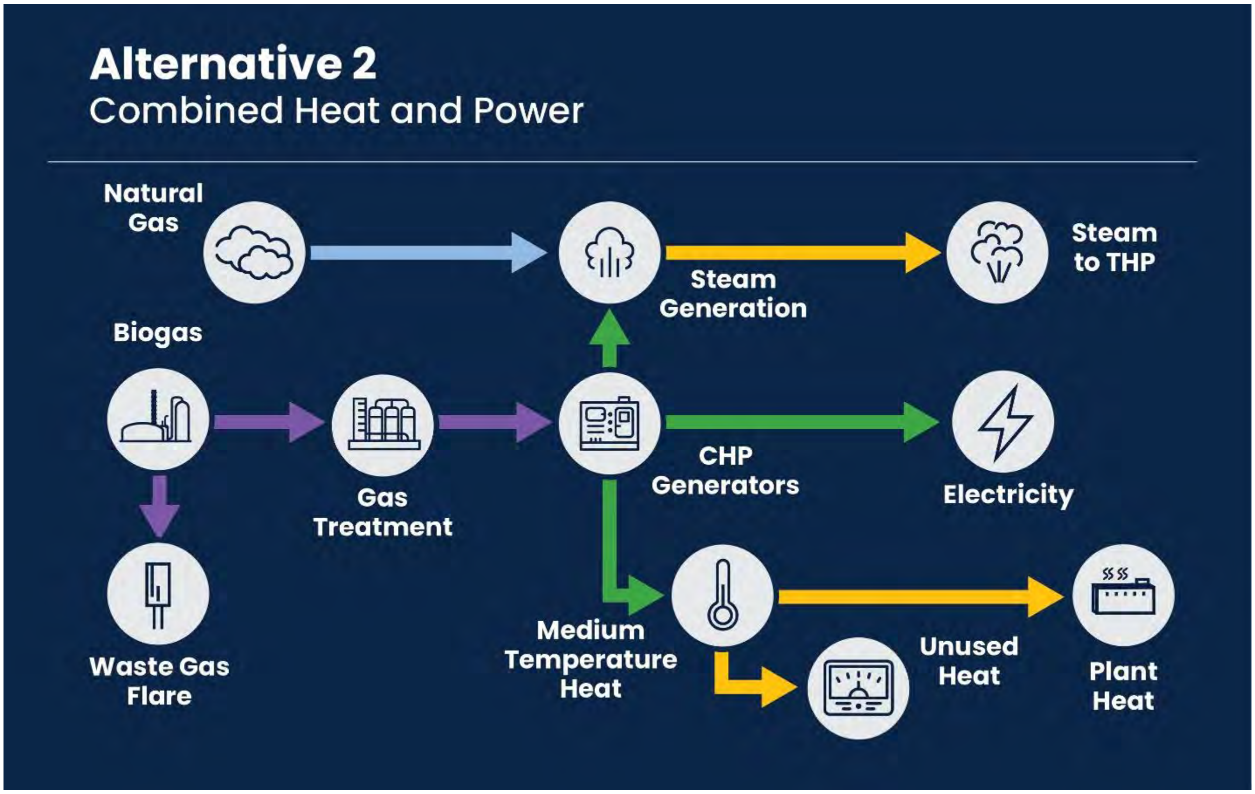
Figure 9: Alternative 1: Process and Building Heating



3.1.2 Alternative 2: Combined Heat and Power

CHP includes any options that use a fuel to produce electrical power and recover the wasted heat from the electrical generating equipment for beneficial use. The goal of the CHP options, shown schematically in Figure 10, is to balance the power produced and heat recovered from the biogas with the heating needs of the WPCP. As discussed previously, the primary heating need for the Facilities is steam production for the THP process.

Figure 10: Alternative 2: Combined Heat and Power



CHP is a popular option for wastewater facilities because it is more efficient than heat production only and more of the biogas can be used while still meeting the heat requirements of the WPCP. There are three major types of CHP combustion equipment for electrical production: internal-combustion (IC) engines, microturbines, and gas turbines. Microturbines were discussed as part of the initial workshops, but a preliminary analysis showed that the electrical and heat recovery efficiencies are similar to internal-combustion engines but at an increased capital and O&M cost. Therefore, microturbines are not presented specifically in the subsequent analysis, but would be considered like the engine options. The sections below describe the engine and gas turbine CHP sub-alternatives in more detail.

3.1.2.1 Alternative 2A: Internal-Combustion Engines

Internal-combustion engines have been standard combustion equipment used in wastewater CHP systems. These engines have a fuel train that blends a stoichiometric ratio of biogas and air prior to entering the cylinders for combustion. Older styles of engines were derived from large marine or locomotive diesels, converted to use spark ignition. These were inefficient, large, and slow, capable of burning raw biogas. However, modern engines need to meet tighter emissions standards, which has resulted in more efficient, smaller engines requiring a higher quality of biogas for fuel with strict standards for hydrogen sulfide (H_2S), moisture, and siloxane content. The electrical efficiency used for this analysis is 35 percent based on the LHV of methane. New engines may have up to 39 percent electrical efficiency, but an engine's efficiency typically drops as it ages. Figure 11 shows a typical engine installation for a CHP system at a wastewater treatment facility.

Figure 11: Typical Engine Installation

Heat recovered from internal-combustion engines comes from two sources, the exhaust and the engine cooling system. The heat from the exhaust is considered high-value heat (greater than 500 degrees Fahrenheit [°F]) and can be used for steam generation in a composite boiler. The engine cooling system recovers a low-value heat (less than 500°F) that cannot be used for steam generation, but it can produce hot water for other uses at the WPCP, such as building heat. The high- and low-value heat recovery efficiencies for the engines are 18 and 24 percent, respectively, for a total maximum CHP efficiency of 77 percent.

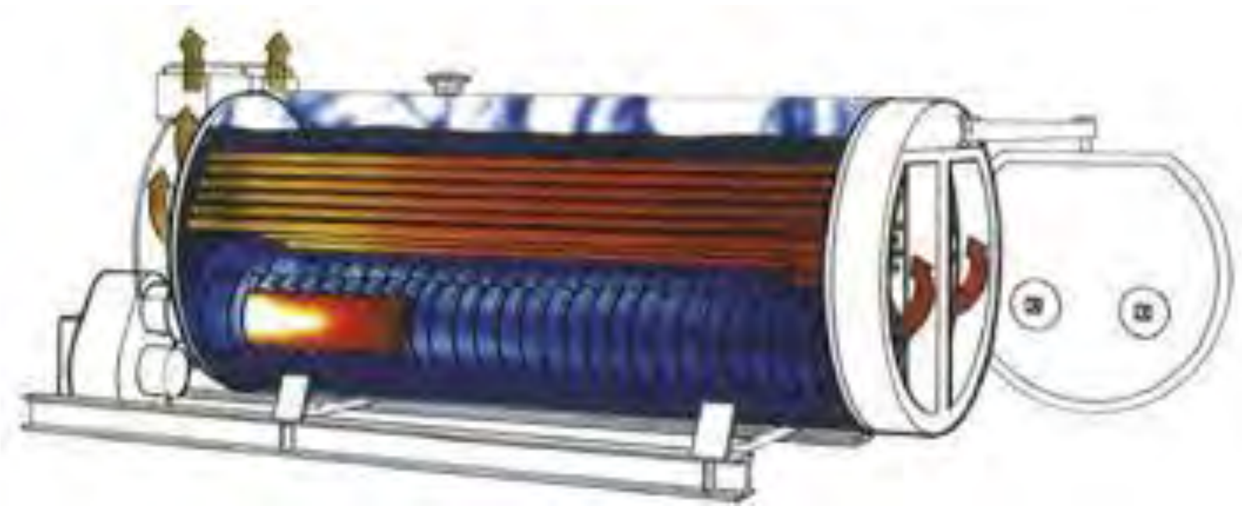
The same 2037 condition was used with a biogas production of 14,900 MBH, 3,490 MBH of steam, and 71 MBH of building heating. If all the biogas was used in the engines 5,215 MBH or 1.53 MW of electricity would be produced, 2,682 MBH of high-value heat would be recovered as steam, and 3,576 MBH of low-value heat would be recovered as hot water. Therefore, the anticipated steam production does not meet the heating values needed by the THP and supplemental heating is required either through the use of purchased natural gas or diverting some of the biogas from the engine directly to a boiler.

Another factor that should be considered in this analysis is the uptime of engines. For the engine alternative, the uptime was assumed to be 90 percent for each engine and a total 95 percent system uptime based on providing two engines sized to provide 70 percent of the needed capacity. This means that for 10 percent of the time during a typical year, one of the engines is offline and only 70 percent of the biogas can be used in the engine for power production. During these periods the excess biogas would be used in a boiler or flared if necessary. When the downtime is taken into consideration 522 MBH of biogas is flared.

3.1.2.2 Composite Boiler

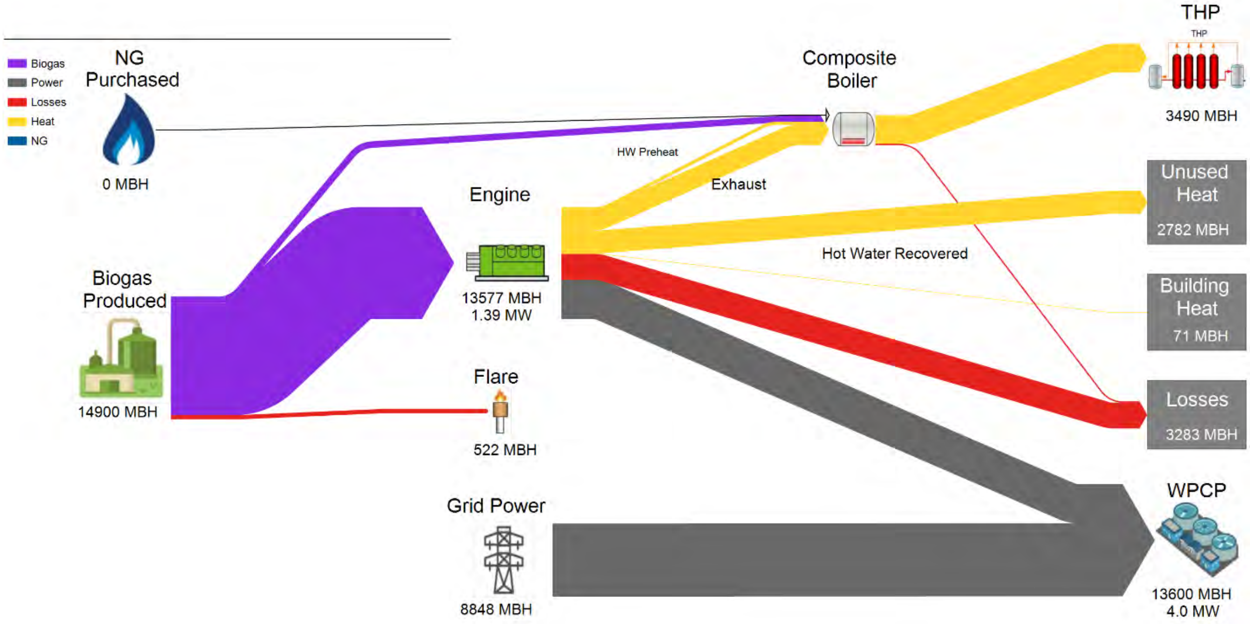
To address the lack of high-value heat recovered, maximize the use of biogas, and minimize flaring, a composite boiler would be used to recover heat from the exhaust and also provide supplemental heating. A composite boiler is a fire tube–style boiler that can recover the heat from the exhaust, but also has a direct-fired burner that can be fueled with biogas or natural gas as shown in Figure 12. To provide the supplemental heating for steam production when both engines are operating, a small percentage of biogas would be sent directly to the burner. Also, when one engine is down for maintenance, additional biogas would be sent to the burner to meet the heat demand and minimize flaring.

Figure 12: Composite Boiler Configuration



The energy balance is presented graphically in Figure 13. This balance takes into consideration the efficiencies of the engine and heat recovery, uptime for the engines, and supplemental heating needed for the steam demand.

Figure 13: Alternative 2A: CHP with Engines



Note: The unused heat is low-value hot water that can be recovered from the engine. If it is not used, the heat produced will be wasted through a radiator.

3.1.2.3 Alternative 2B: Gas Turbines

Gas turbines are the standard combustion equipment in the power generation industry. These turbines combust compressed air-fuel mixtures to produce hot gases that rotate a high-speed turbine to produce power and waste heat. The turbines operate at much higher pressures and speeds than internal-combustion engines and are more similar to a jet engine than a diesel engine. A gas turbine is shown in Figure 14. Gas turbines are often used in high-capacity electrical production applications, but there are suppliers that provide smaller sizes for wastewater treatment plants. Gas turbines are electrically less efficient than engines at only 25 percent electrical efficiency but produce a greater amount of high-value heat at approximately 50 percent efficiency. This heat can be recovered to produce steam for additional electrical production (combined-cycle generator) or process heating.

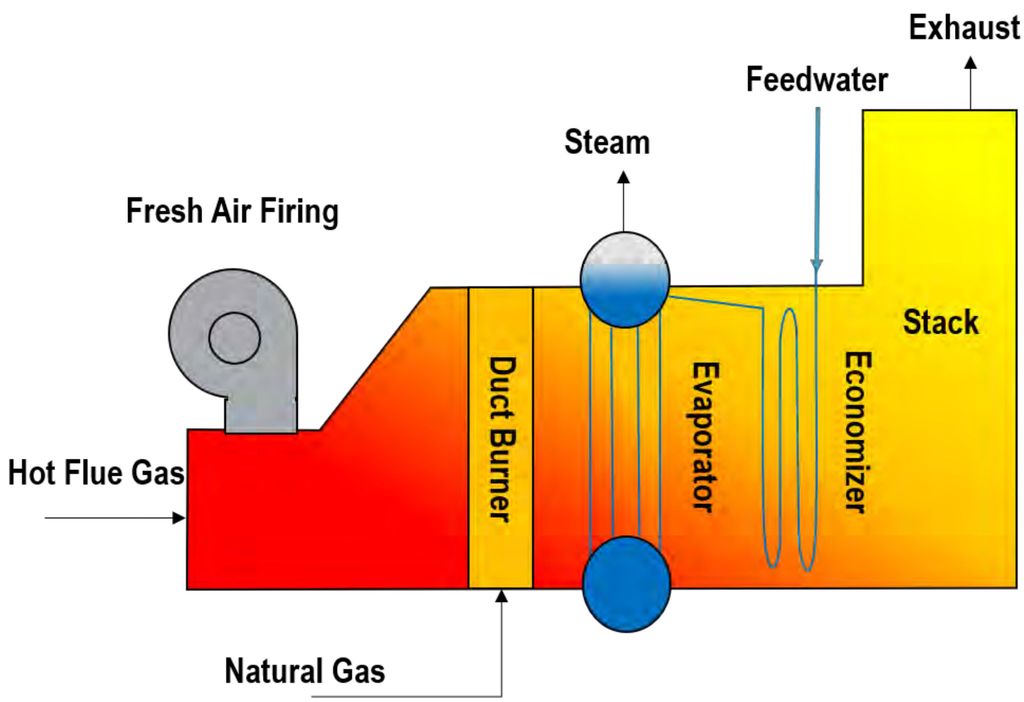
Figure 14: Example Gas Turbine

For the same evaluation condition, if all the biogas was used in the turbine, 3,725 MBH or 1.1 MW of electricity would be produced, and 7,450 MBH of high-value heat would be available, which would meet the steam demand. However, because of their cost, gas turbine systems are usually sized with one turbine sized for the desired capacity. This reduced redundancy is reflected in an assumed uptime of 90 percent. This means that during a typical year 90 percent of the biogas would be directed to the turbine and during the remaining time the biogas would need to go to a boiler or the flare. This reduces the electrical output of the turbine to an annual average production of 0.98 MW.

3.1.2.4 Heat Recovery Steam Generator

Similar to composite boilers, gas turbine systems are often installed with heat recovery steam generators (HRSGs) on the exhaust to recover heat and produce steam. HRSGs are water tube boilers that, like composite boilers, can include a duct burner to supplement heating requirements or bypass the turbine during downtime, as shown in Figure 15.

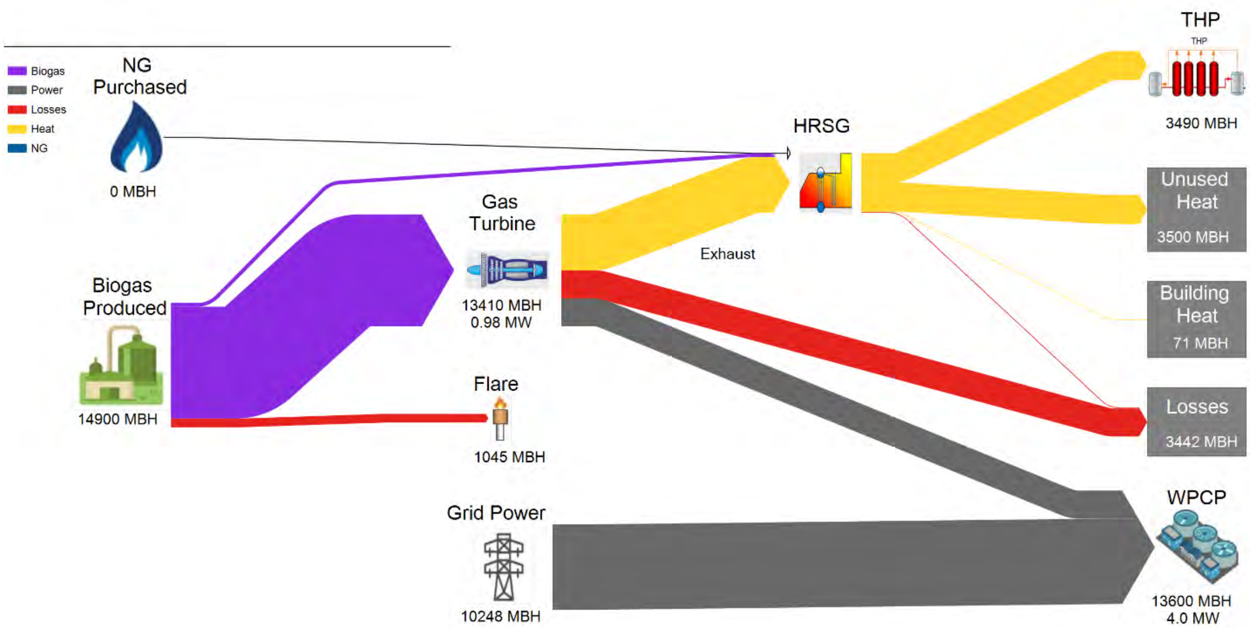
Figure 15: Heat Recovery Steam Generator



To minimize biogas flaring, it was assumed that during gas turbine downtimes, the biogas would be directed to the HRSG to maintain steam production. A summary of the energy balance for the gas turbine option is presented in Figure 16. The gas turbine option produces less electrical power than the engine option, but sufficient high-value heat for steam production without any biogas bypass when the turbine is operating. The biogas bypass shown is only for when the turbine is down for maintenance. However, the significant amount of high-value heat is not entirely used by the THP system, and 2,427 MBH is left unused.

When the downtime is taken into consideration 1,045 MBH of biogas is flared.

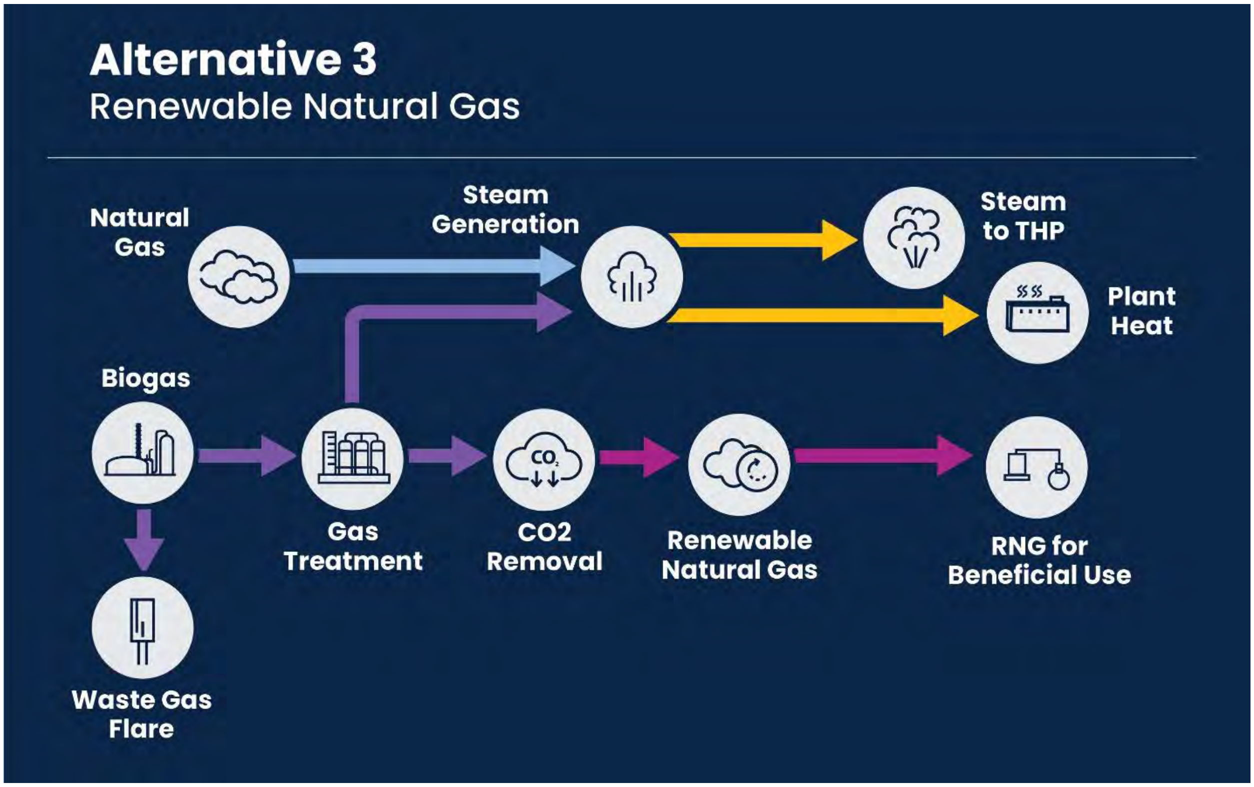
Figure 16: Alternative 2B: CHP with Gas Turbine



3.1.3 Alternative 3: Renewable Natural Gas

For Alternative 3, shown schematically on Figure 17, all the biogas produced would be conditioned to RNG quality for use off site. The production of RNG from biogas requires treatment of the biogas to remove contaminants such as hydrogen sulfide, moisture, siloxanes, volatile organic compounds (VOCs), and carbon dioxide. A discussion on the technologies available to accomplish this treatment is presented in Appendix D . For this alternative, it was assumed that all of the biogas would be conditioned and used off site and natural gas would be purchased and used in boilers to meet the process and building heating needs in order to maximize the amount of RINs.

Figure 17: Alternative 3: Renewable Natural Gas



The energy balance for Alternative 3 does not distinguish between injecting the RNG into the NG utility pipeline or piping the RNG directly to bus fleet fueling. However, these two options will have different costs, risks, and potential future revenues. Therefore, Alternative 3 will have two sub-alternatives. Alternative 3A represents injecting the RNG into the NG utility pipeline and Alternative 3B represents piping the RNG directly for bus fleet fueling.

The removal of contaminants from the raw biogas, regardless of the technology used, results in some loss of methane to the waste biogas stream, or tail gas. The disposal of the tail gas is site-specific and dependent on air quality regulations and sustainability goals as it contains a small amount of methane as well as some hydrogen sulfide and other contaminants. For this evaluation it was assumed that the tail gas was combusted in a regenerative thermal oxidizer (RTO) designed to oxidize low-Btu gas streams, effectively converting methane to carbon dioxide and other contaminants to oxidized states. The overall methane capture is technology-dependent but is generally in the range of 95 to 98 percent. For this evaluation a methane capture rate of 95 percent was used and the 5 percent leaving in the tail gas is oxidized and shown as directed to the RTO.

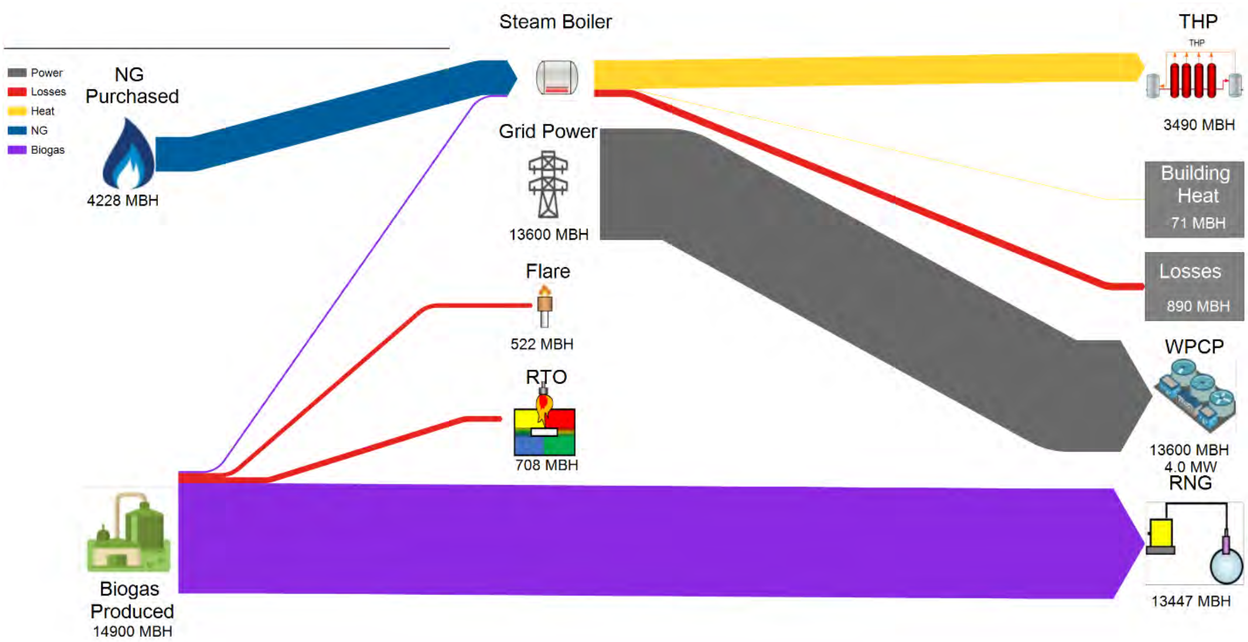
Similar to the CHP alternatives, the RNG conditioning equipment will have downtime for maintenance. During these periods it was assumed that the biogas would be diverted directly to the boilers to minimize flaring. The uptime for the RNG options was assumed to be 95 percent.

For the 2037 evaluation condition, 14,900 MBH of biogas is produced. The biogas conditioning system has a 95 percent uptime and 5 percent downtime. Accounting for the 95 percent methane capture in the conditioning equipment, this results in 708 MBH ending up in the tail gas and combusted in the RTO. During the 5 percent downtime, approximately 30 percent of the biogas or 223 MBH can be diverted and used in the boiler. The remaining 70 percent would go to the flare. On an annual basis, this results in an average 522 MBH flared because of downtime. The total amount not beneficially used is 1,230 MBH.

During RNG production, natural gas is used in the boiler for process and building heating. This heating requires 3,561 MBH of heat production or 4,451 MBH of natural gas. When the 5 percent downtime biogas diversion is subtracted from this amount, an annual amount of 4,228 MBH of natural gas to be purchased results. Figure 18 illustrates the energy balance for the RNG and boiler alternatives.

Note, it is possible to use RNG in the boiler for process and building heating such that no NG purchase is required. However, in this case more biogas would be used on site and less RNG would be sent to others as a replacement for fossil fuel–based natural gas. The production of RNG does not change the quantity or type of uses for natural gas. Because there are economic benefits to sending RNG off site, the analysis presented below assumes that all biogas is being upgraded to RNG. If this alternative is chosen, the system would be piped to use either natural gas or biogas in the boiler.

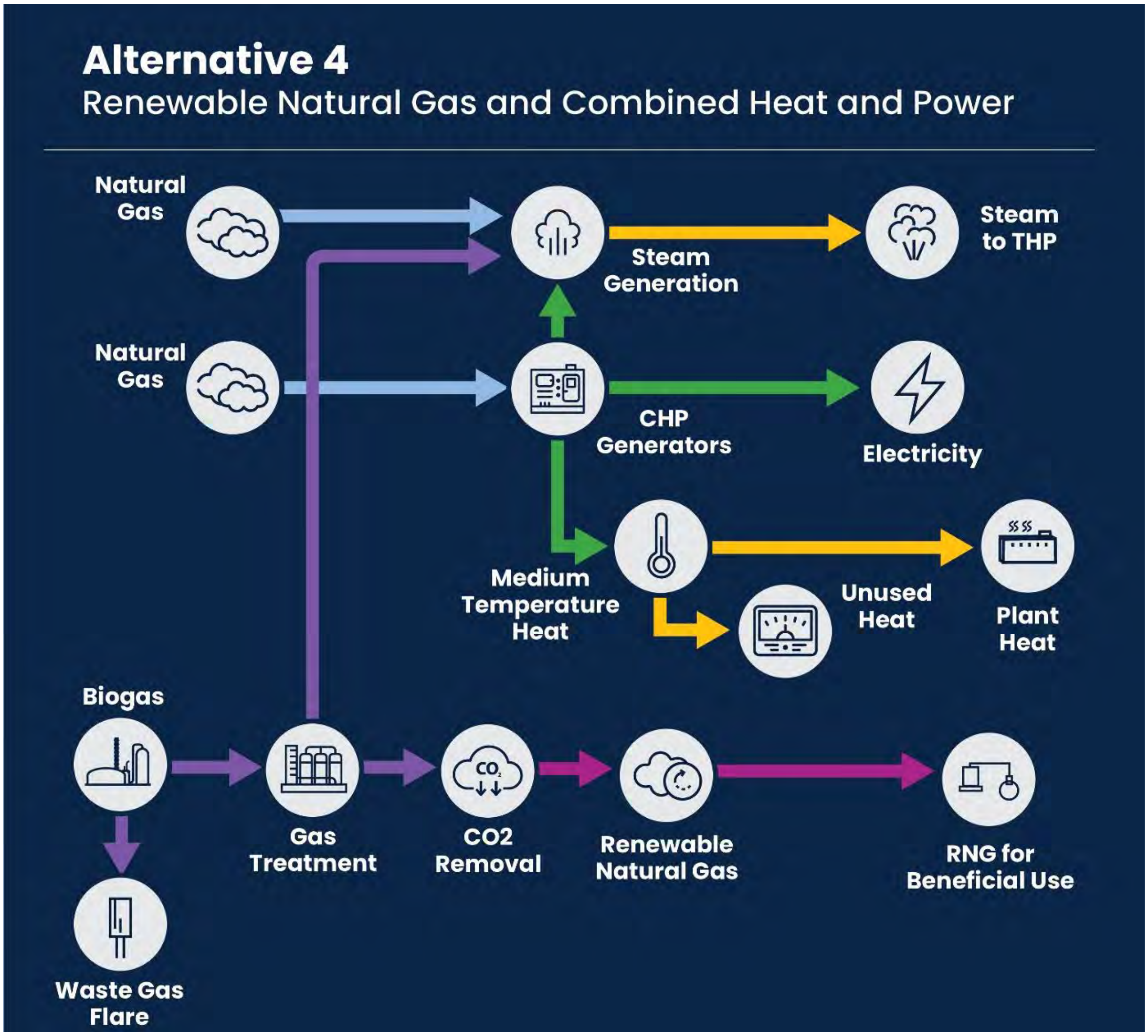
Figure 18: Alternatives 3A and 3B: RNG



3.1.4 Alternative 4: RNG and CHP

Alternative 4, as shown schematically in Figure 19, combines using the biogas as RNG for vehicle fuels with an NG–fueled CHP system to produce power and recover heat. Similar to Alternative 2, the CHP could be provided with internal-combustion engines or gas turbines. The CHP sizing is based on providing the process and building heating necessary. Similar to Alternative 3, during the RNG system downtime, biogas would be diverted to the CHP system to minimize flaring and NG purchases. The downtimes for the CHP are also similar to Alternative 2, so that when the CHP system is down, natural gas is diverted directly to the composite boiler or HRSG depending on the CHP system.

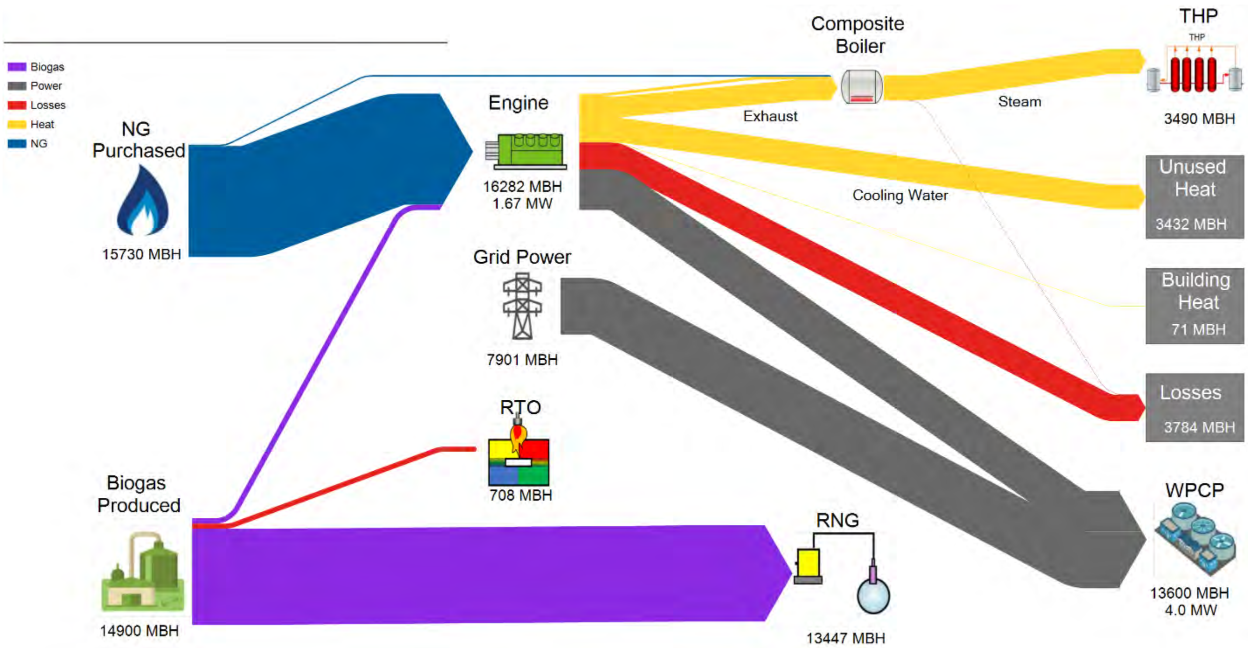
Figure 19: Alternative 4: Renewable Natural Gas and Combined Heat and Power



3.1.4.1 Alternative 4A: RNG with Engines

The energy balance for Alternative 4A is shown in Figure 20 and results in 13,447 MBH of RNG production, similar to Alternative 3. The energy production from the engines is sized to meet the heating requirement and results in 1.67 MW of power production, which is slightly higher than Alternative 2A. The natural gas required to fuel the engines during cogeneration and the composite boiler when an engine is offline is 15,730 MBH.

Figure 20: Alternative 4A: RNG with Engines

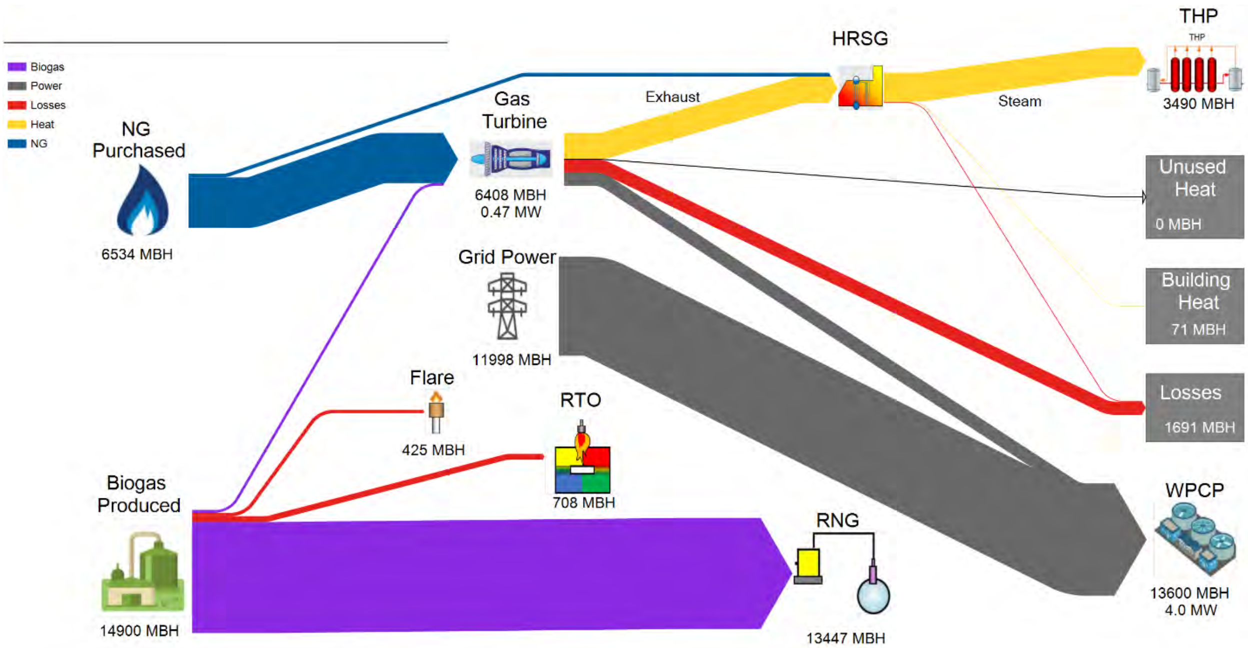


3.1.4.2 Alternative 4B: RNG with Gas Turbine

The energy balance for Alternative 4B is shown in Figure 21 and results in 13,447 MBH of RNG production, similar to Alternative 3. The energy production from the turbines is sized to meet the heating requirement and results in 0.47 MW of power production, which is lower than Alternative 2B because the turbine capacity is reduced to match the heat recovered with the steam production. The natural gas required to fuel the turbine during cogeneration and the HRSG when the turbine is offline is 6,534 MBH.

Biogas is conditioned to RNG quality with an equipment uptime of 95 percent. During periods of downtime biogas is used in the gas turbine. However, the biogas production exceeds the design capacity of the gas turbine and only 43 percent of the biogas diverted during the RNG downtime can be used effectively for CHP. The remaining 57 percent during that 5 percent per year is flared. Therefore, the flared amount due to downtime is 425 MBH and the amount flared in the tail gas is 708 MBH for a total flared amount of 1,133 MBH.

Figure 21: Alternative 4B: RNG with Gas Turbine



3.2 Biogas Utilization Alternative Summary

A summary of the energy balances for each alternative/sub-alternative is presented in Table 12. A more detailed breakdown of the energy balances is provided in Appendix B .

Table 12: Alternatives Energy Summary

Alternative		1	2A	2B	3A/3B	4A	4B
Description		Process and building heating	CHP with engines	CHP with gas turbine	RNG	RNG with engines	RNG with gas turbine
Energy source/use	Unit						
Heat required total	MBH	3,561	3,561	3,561	3,561	3,561	3,561
Steam (hot)	MBH	3,064	3,064	3,064	3,064	3,064	3,064
Hot water							
Building	MBH	71	71	71	71	71	71
Boiler preheat	MBH	427	427	427	427	427	427
Steam total	MBH	3,490	3,490	3,490	3,490	3,490	3,490
Biogas production	MBH	14,900	14,900	14,900	14,900	14,900	14,900
Biogas used							
Boiler total	MBH	4,452	801	445	222	0	0
CHP	MBH	0	13,577	13,410	0	745	320
RNG	MBH	0	0	0	13,447	13,447	13,447
Waste gas flare	MBH	10,449	522	1,045	522	0	426
Tail gas combusted	MBH	0	0	0	708	708	708
Heat production	MBH	3,561	6,343	7,061	3,561	6,993	3,561
Boiler total	MBH	3,561	641	356	3,561	154	357
CHP							
Steam	MBH	0	2,444	6,705	0	2,931	3,204
Hot water	MBH	0	3,258	0	0	3,908	0
Capacity CHP	MBH	0	13,577	13,410	0	16,282	6,408
NG purchased, total	MBH	0	0	0	4,230	15,730	6,534
Boiler	MBH	0	0	0	4,230	193	446
CHP	MBH	0	0	0	0	15,537	6,088
Heating losses, total	MBH	712	3,283	3,442	712	3,783	1,691
Boiler	MBH	712	160	89	712	39	89
CHP	MBH	0	3,123	3,353	0	3,745	1,602
Unused heat	MBH	0	2,782	3,500	0	3,431	0
WPCP Electricity required	MBH	13,600	13,600	13,600	13,600	13,600	13,600
Electricity produced	MBH	0	4,752	3,353	0	5,699	1,602
Equivalent cap. CHP	MW	0.00	1.39	0.98	0.00	1.67	0.47
Electricity purchased	MBH	13,600	8,848	10,248	13,600	7,901	11,998

3.3 Biogas Conditioning

The level of biogas conditioning required is directly related to the end use of the biogas. Using the biogas on site as an NG replacement for building and process heating would likely require treatment for H_2S prior to use in boilers for heating and other uses. The CHP alternatives will require moisture and siloxane removal in addition to H_2S removal, and any of the RNG alternatives will require treatment to NG quality, which includes the treatments above plus CO_2 removal, volatile organic compound (VOC) removal, compression, and tail gas disposal. Finally, all the biogas utilization alternatives will require a waste gas flare to combust the biogas as a backup should all beneficial uses be offline or over capacity. Table 13 presents a summary of the biogas conditioning equipment needed for each of the end uses being considered.

These conditioning technologies were used to develop the capital costs and O&M costs that inform the life-cycle cost analysis presented in this Biogas Utilization Report. Appendix D presents an overview of biogas treatment and conditioning systems available to meet the intended end-use requirements.

Table 13: Biogas Conditioning Equipment Requirements

Alternative/	Removal Equipment						Pressure Boosting	Tail Gas Disposal	Waste Gas Flare
	H_2S[a]	Moisture (Drying)	Siloxanes	VOCs	CO_2	$O_2 + N_2$			
Alternative 1	✓	✓							✓
Alternative 2A	✓	✓	✓				✓		✓
Alternative 2B	✓	✓	✓				✓		✓
Alternative 3A	✓	✓	✓	✓	✓	✓	✓	✓	✓
Alternative 3B	✓	✓	✓	✓	✓	✓	✓	✓	✓
Alternative 4A	✓	✓	✓	✓	✓	✓	✓	✓	✓
Alternative 4B	✓	✓	✓	✓	✓	✓	✓	✓	✓

a. H_2S concentrations at the WPCP are anticipated to be low because of the amount of ferric chloride currently being added for phosphorus removal but could be needed in the future if this practice changes.

4 Financial Analysis

The present financial value analysis presented in this section includes the anticipated capital costs, O&M costs, avoided costs from electricity generation, and RNG revenues for each alternative. These are summarized for each alternative along with the major assumptions in the sections below.

4.1 Conceptual Capital Costs

Conceptual capital cost estimates for the different biogas utilization alternatives are based on a combination of equipment quotes, estimates based on similar projects, building type, and building square footage. The costs are in 2021 dollars. The conceptual capital costs accounted for are not meant to be detailed cost estimates but are meant to capture the relative differences in costs between the alternatives.

4.1.1 Equipment Costs

The development of the capital cost estimates starts with the major equipment costs for each alternative. These costs are summarized below. All the costs reflect providing a redundant steam supply for the THP. This includes a redundant boiler for CHP alternatives as well as redundant deaerators, which preheat and condition the boiler feed water to remove oxygen and prevent corrosion in the boiler and steam piping systems.

4.1.1.1 Alternative 1: Process and Building Heating

The equipment costs for Alternative 1, summarized in Table 14, include two 350-horsepower (hp) steam boilers, two deaerator and feed pump packages, and H_2S and drying biogas treatment.

Table 14: Alternative 1 Equipment Costs

Item	Cost	Quantity	Subtotal
Boiler	$205,000	2	$410,000
Deaerator	$90,000	2	$180,000
Biogas conditioning	$2,000,000	1	$2,000,000
Total			**$2,590,000**

4.1.1.2 Alternative 2A: CHP with Engines

The equipment costs for Alternative 2A, summarized in Table 15, include two 847-kilowatt (kW) CHP generators; one 350 hp composite boiler; one 350 hp boiler; two deaerator and feed pump packages; and H_2S, siloxane, and drying biogas treatment.

Table 15: Alternative 2A Equipment Costs

Item	Cost	Quantity	Subtotal
CHP engines	$425,000	2	$851,000
Composite boiler	$690,000	1	$690,000
Boiler	$205,000	1	$205,000
Deaerator	$90,000	2	$180,000
Biogas conditioning	$3,000,000	1	$3,000,000
Total			**$4,926,000**

4.1.1.3 Alternative 2B: CHP with Gas Turbine

Alternative 2B equipment, summarized in Table 16, includes one 1,204 kW turbine CHP generator with HRSG; one 350 hp boiler; two deaerators and feed pump package; and H_2S, siloxane, and drying biogas treatment.

Table 16: Alternative 2B Equipment Costs

Item	Cost	Quantity	Subtotal
Turbine with HRSG	$3,810,000	1	$3,810,000
Boiler	$205,000	1	$205,000
Deaerator	$90,000	2	$180,000
Biogas conditioning	$3,000,000	1	$3,000,000
Total			**$7,195,000**

4.1.1.4 Alternative 3A: RNG into the NG Pipeline

Alternative 3A equipment, summarized in Table 17, includes two 350 hp steam boilers; two deaerator and feed pump packages; H_2S, siloxane, moisture, and CO_2 removal biogas treatment; and a connection to the NG utility. For this analysis it is assumed that the CO_2 removal is performed with a membrane treatment system, which is likely the most conservative and highest-cost system.

Table 17: Alternative 3A Equipment Costs

Item	Cost	Quantity	Subtotal
NG utility interconnect	$5,000,000	1	$5,000,000
Boiler	$205,000	2	$410,000
Deaerator	$90,000	2	$180,000
Biogas conditioning	$5,000,000	1	$5,000,000
Total			**$10,590,000**

4.1.1.5 Alternative 3B: RNG with CNG

Alternative 3B equipment, summarized in Table 18, includes two 350 hp steam boilers; two deaerator and feed pump packages; H_2S, siloxane, moisture, and CO_2 removal biogas treatment; and a connection to ART and/or WMATA. The equipment costs for Alternative 3B are roughly $4 million less expensive than those for Alternative 3A because of the savings on the interconnect to the NG utility. It is not known at this time what improvements, if any, would be required at the bus depots to effectively use all the RNG, and all such improvements are excluded from this evaluation. Such improvements could include additional fueling stations, compression, and storage.

Table 18: Alternative 3B Equipment Costs

Item	Cost	Quantity	Subtotal
ART/WMATA interconnect	$1,000,000	1	$1,000,000
Boiler	$205,000	2	$410,000
Deaerator	$90,000	2	$180,000
Biogas conditioning	$5,000,000	1	$5,000,000
Total			**$6,590,000**

4.1.1.6 Alternative 4A: RNG and CHP with Engines

Alternative 4A equipment, summarized in Table 19, includes two 1,141 kW CHP gensets; one 350 hp composite boiler; one 350 hp steam boiler; two deaerators and feed pump package; H_2S, siloxane, moisture, and CO_2 removal biogas treatment; and a connection to the NG utility.

Table 19: Alternative 4A Equipment Costs

Item	Cost	Quantity	Subtotal
NG utility interconnect	$5,000,000	1	$5,000,000
CHP engines	$502,000	2	$1,004,000
Composite boiler	$690,000	1	$690,000
Boiler	$205,000	1	$205,000
Deaerator	$90,000	2	$180,000
Biogas conditioning	$5,000,000	1	$5,000,000
Total			**$12,079,000**

4.1.1.7 Alternative 4B: RNG and CHP with Gas Turbine

Alternative 4B equipment, summarized in Table 20, includes one 1,204 kW turbine CHP genset with HRSG; one 350 hp steam boiler; two deaerators and feed pump package; H_2S, siloxane, moisture, and CO_2 removal biogas treatment; and a connection to the NG utility.

Table 20: Alternative 4B Equipment Costs

Item	Cost	Quantity	Subtotal
NG utility interconnect	$5,000,000	1	$5,000,000
Turbine with HRSG	$3,810,000	1	$3,810,000
Boiler	$205,000	1	$205,000
Deaerator	$90,000	2	$180,000
Biogas conditioning	$5,000,000	1	$5,000,000
Total			**$14,195,000**

4.1.2 Building Costs

Building layouts and footprints were developed for each alternative/sub-alternative. Alternative 1 has the lowest building cost, which consists of a 4,000-square-foot (SF) building to house the boilers, a 288 SF slab on grade for biogas drying and compression, and two 12-foot-diameter slabs on grade for H_2S vessels. Alternative 3 has the same footprint but with the addition of a 500 SF slab on grade for CO_2 removal. The CHP Alternatives 2 and 4 require a larger, 6,000 SF building to house the CHP equipment and standby boilers. Alternatives 2A and 2B have the same biogas treatment footprint as Alternative 1 while Alternatives 4A and 4B have the same biogas treatment footprint as Alternative 3.

For pricing buildings during this planning phase, a simplified price per square foot method was used. For the buildings a price of $1,150/SF was used and is meant to include all building systems. The slabs on grade are assumed to be $50/SF. The building costs for the various alternatives are summarized in Table 21.

Table 21: Summary of Building Costs

Item	Alternative 1	Alternatives 2A and 2B	Alternatives 3A and 3B	Alternatives 4A and 4B
Building structure (SF)	4,000	6,000	4,000	6,000
H_2S and siloxane treatment slab (SF)	226	226	226	226
Biogas drying and compression slab (SF)	288	288	288	288
CO_2 treatment slab (SF)	0	0	504	504
Total cost	**$4.6 million**	**$6.9 million**	**$4.7 million**	**$7.0 million**

4.1.3 Total Conceptual Construction Costs

The multipliers listed in Table 22 were used for total conceptual construction cost.

Table 22: Construction Multiplier Summary

Item	Multiplier
Contractor overhead and profit	15.0%
Contingency	20.0%
Mobilization, staging, bonds, and insurance	8.0%

For each alternative the multipliers are applied to the sum of the building and equipment costs.

Table 23 below shows the conceptual construction costs for each alternative with the multipliers applied. The capital costs in the table are for the equipment for each alternative (CHP, boilers, and biogas treatment equipment) and a building space to house the equipment.

Table 23: Total Conceptual Construction Costs

Alternative	Cost
1: Process and building heating	$10.8 million
2A: CHP with engines	$17.7 million
2B: CHP with gas turbine	$21.1 million
3A: RNG injected into the NG pipeline	$22.7 million
3B: RNG used as CNG	$18.7 million
4A: RNG and CHP with engines	$28.4 million
4B: RNG and CHP with gas turbine	$31.5 million

Alternative 1—using the biogas to generate steam for process and building heating—can be considered the lowest-cost investment to beneficially use a portion of the biogas. However, this alternative uses only 30 percent of the biogas produced by the digesters, while the rest is flared, which does not meet the goals of the Program.

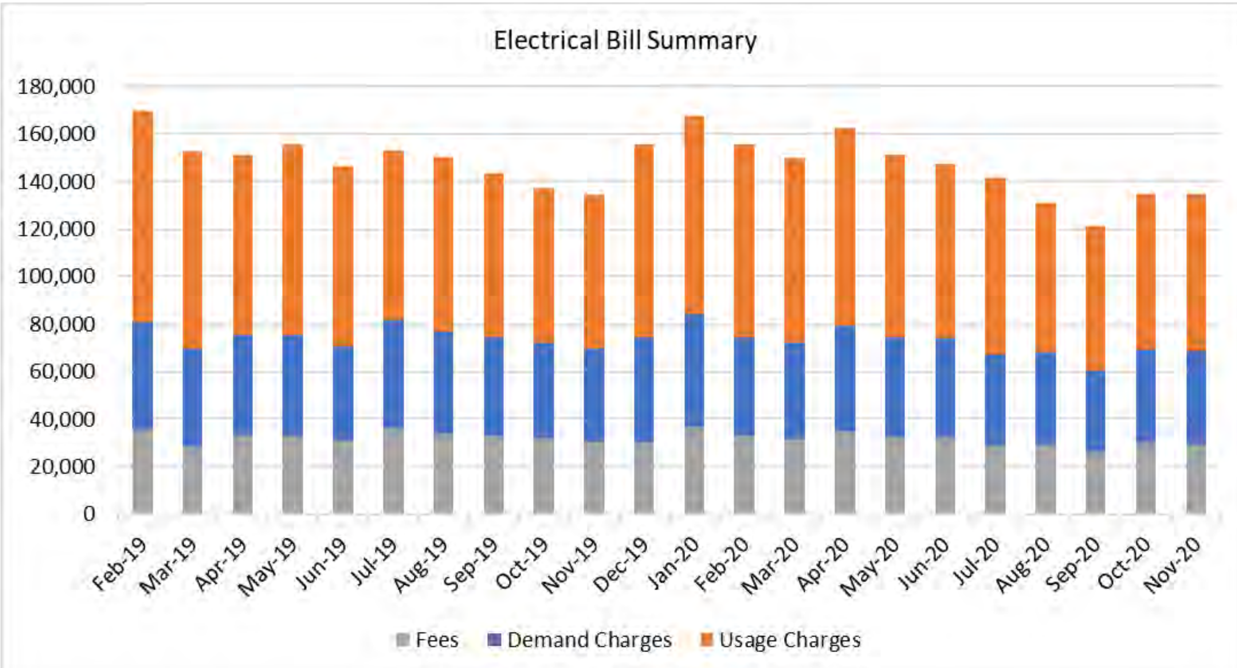
4.2 Electrical Costs

The production of electrical power through CHP will result in a reduction of electricity purchased from the power utility. To adequately account for these reductions, an understanding of the current electrical rate structure is needed.

4.2.1 Electrical Billing Rate Structure

Figure 22 below illustrates the breakdown of the WPCP electrical charges from February 2019 to November 2020. The usage charges, shown in orange, are the portion of the bill that is proportional to consumption. The demand charge, shown in blue, is based on a peak demand during the billing cycle and minimally fluctuates. The fees, shown in gray, are fixed with little variation. The total historical monthly amount paid for electricity divided by the usage comes to $0.06/kWh. Because of the billing rate structure of the existing Dominion Energy (Dominion) service, only about $0.03/kWh is linked to usage.

Figure 22: Electrical Billing Summary

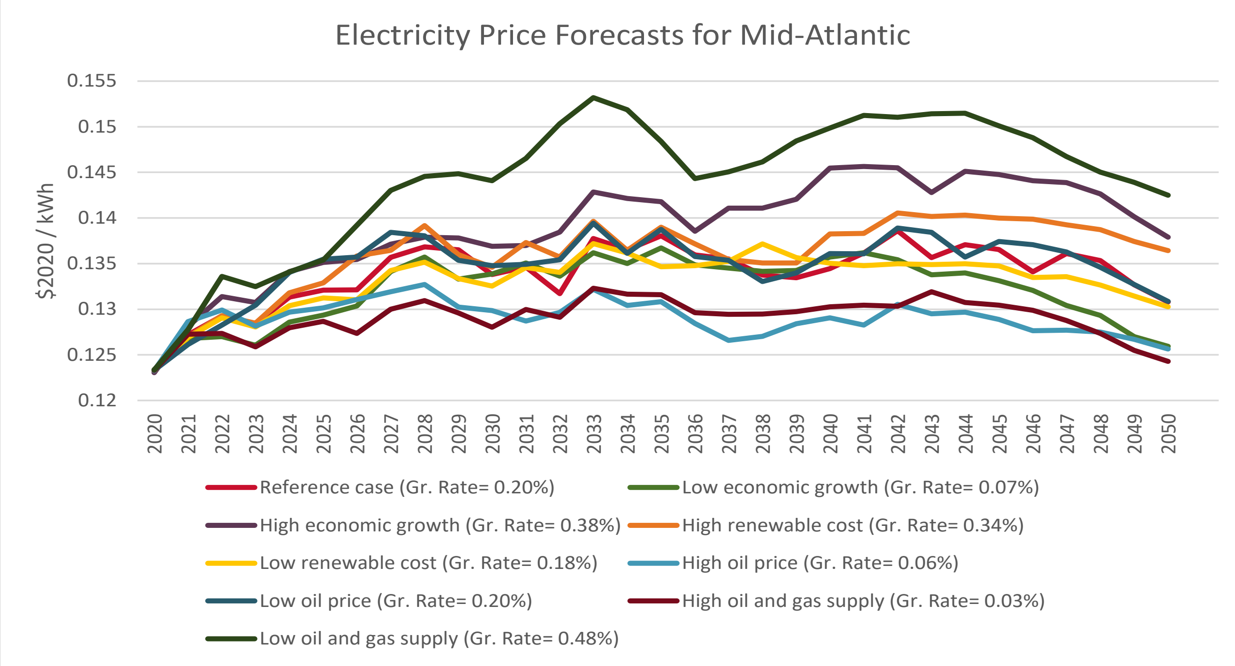


With the current billing rate structure, the CHP alternatives would be offsetting electricity at a rate of $0.03/kWh. To maximize the financial benefit of CHP electrical production the Facilities would want to enter a billing rate structure that is 100 percent based on consumption. Note: in early 2022 the County was notified that there would be an approximately 30 percent increase in total electrical costs from Dominion for Arlington County, which would raise Arlington County's average electrical cost at the WPCP to $0.078/kWh. For purposes of this Report, it is assumed that the rate structure with Dominion could be changed to consumption-only at a rate of $0.078/kWh.

4.2.2 Electricity Price Forecast

Various factors cause electricity prices to vary over time including macroeconomic conditions, fuel stock costs and supplies, technological innovations, and policies. The U.S. Energy Information Administration (EIA) is the key federal source for modeling electricity pricing forecasts. EIA develops alternative forecasts from different scenarios of future conditions, such as high and low economic growth, oil and gas supplies, renewable energy costs, and other factors. Figure 23 presents several of EIA's real price forecasts (in terms of year 2020 dollars per kWh, without adjusting for potential inflation) for the Mid-Atlantic region through 2050. In all scenarios, prices are expected to rise at least through the next 10 years. From that point, prices could rise (e.g., low oil and gas supply), remain flat (e.g., high renewable energy costs), or potentially decline (other scenarios). Through 2050, annualized growth rates could range from 0.03 percent to 0.48 percent, reflecting EIA's high and low oil and gas supply scenarios, respectively. The prices shown on Figure 23 are average retail pricing. Arlington County benefits from negotiated pricing through the Virginia Energy Purchasing Governmental Association and should expect to pay substantially less than the retail forecasts. As noted above, Arlington County's current electrical rate is assumed to be $0.078/kWh. The projected price escalation forecasts from EIA were used in model simulations starting from the County's current electrical rate.

Figure 23: Forecasts of Real Electricity Prices, EIA



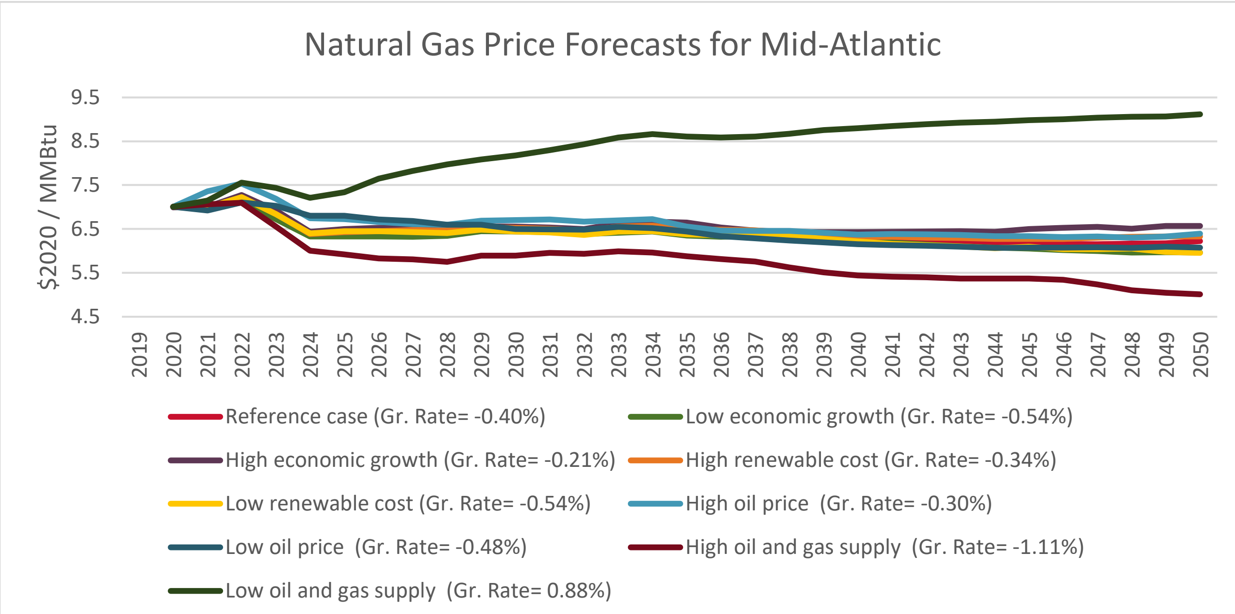
Source: U.S. Energy Information Administration.

4.3 RNG Revenue

As discussed in Section 2.4.4, the revenues from the sale of RNG will likely be a combination of environmental attributes as well as the commodity value of natural gas. The composite value of the environmental attributes is in the range of $5/MMBtu to $25/MMBtu, with 15 percent deducted for marketing the RNG, plus a commodity value of $2.50/MMBtu.

Similar to electricity prices described above, EIA also produces scenario-based forecasts for gas prices. Figure 24 presents EIA's real gas price forecasts (in year 2020 dollars per MMBtu) for the Mid-Atlantic region through 2050. The price shown reflects commodity and transportation costs (as compared to commodity value only in Table 9). In most scenarios, prices are expected to rise in 2022, then drop significantly through 2024. Real prices would then generally remain flat for at least a decade before potentially declining. However, two extreme cases of low and high oil and gas supply would tell a different story. Low supplies could directly drive up prices while high supplies would have the opposite effect. Considering these extreme cases in oil and gas supply, real annual price changes through 2050 could range from a 1.11 percent decline to a 0.88 percent increase. Other scenarios are also possible within these boundaries.

Figure 24: Forecasts of Real Gas Prices (EIA)



Source: U.S. Energy Information Administration.

Table 24 shows the RNG revenue for select years through the life of the Program based on the anticipated range of RNG values. This revenue uses an RNG inflation rate of 0.0 percent and an NG inflation rate of -0.3 percent.

Table 24: Anticipated Range of RNG Revenues at Various Environmental Attribute (RIN) Values

Parameter	2028	2037	2052
RNG produced, MBH	12,400	13,400	15,200
RNG produced, MMBtu/yr	108,000	118,000	133,000
$5/MMBtu	$730,000	$800,000	$900,000
$10/MMBtu	$1,190,000	$1,300,000	$1,470,000
$15/MMBtu	$1,650,000	$1,800,000	$2,040,000
$20/MMBtu	$2,110,000	$2,300,000	$2,600,000
$25/MMBtu	$2,570,000	$2,800,000	$3,170,000

4.4 Renewable Energy Credits

For the alternatives that include CHP (Alternatives 2 and 4), it is likely that the County could either sell Renewable Energy Credits (RECs) for the electricity produced or defer purchase of RECs for other County needs. The County currently purchases RECs at a cost of $4,500/kWh and it is assumed that all CHP alternatives would be able to sell RECs for all of the electricity produced at that value.

4.5 O&M Costs

Each alternative has a cost to operate and maintain. Generally, the simpler a system is, the less it costs to maintain. Factoring in the O&M cost and comparing for each alternative is important for a thorough comparison. The annual O&M costs presented in this section are all expressed in 2020 dollars. These O&M costs are based on historical trends in the industry normalized to capacity. The electrical demand and other O&M costs all scale proportionally with the biosolids production. The Monte Carlo analysis in Section 5.4.1 illustrates how different inflation and discount rates affect the O&M costs. In this case, the discount rate refers to the interest rate used in a discounted cash flow analysis to determine the present value of future cash flows. Each yearly cash flow is discounted by this rate compounded annually by the number of years from present.

4.5.1 Alternative 1: Process and Building Heating

Alternative 1, which would use biogas to fuel boilers to produce steam for THP, has the lowest O&M cost. The key assumptions used for the O&M costs of Alternative 1 are as follows:

- Maintenance costs averaged year to year of $15,000/year in 2020 dollars. This cost includes periodic fire tube replacement.
- Operating costs are based on boiler electrical usage (burners and feed water pumps).
- Biogas conditioning cost for boilers of $0.63/MMBtu for operations, and maintenance and $0.15/MMBtu for electricity.

The O&M breakdown for Alternative 1 for select years is shown in Table 25.

Table 25: Alternative 1: Boiler and Process Heat Annual O&M

Item	2028	2037	2052
Natural gas	N/A	N/A	N/A
Electrical	$20,000	$23,000	$26,000
Boiler maintenance	$15,000	$15,000	$15,000
Biogas conditioning	$23,000	$25,000	$28,000
Total	**$58,000**	**$63,000**	**$69,000**

4.5.2 Alternatives 2A/B: CHP

Engine and turbine CHP systems are complex with high-speed, moving components that wear out and require periodic replacement and overhauls. For engines this maintenance would occur on site and would include removal of the heads, replacement of the cylinder liners, and new piston rings. Turbine overhaul would occur off site in a shop certified by the manufacturer and without a redundant turbine the facility would flare 70 percent of the biogas produced during this exercise. The following assumptions were used for CHP O&M costs:

- Maintenance costs for engines of $0.025/kWh in 2020 dollars.
- Avoided electrical costs are credited at $0.06/kWh assuming a consumption-based rate structure.
- Biogas conditioning cost for boilers of $0.63/MMBtu for operations, and maintenance and $0.15/MMBtu for electricity.
- Natural gas is $0.85/therm in 2020 dollars. For Alternative 2A, it is assumed that a fraction of the biogas bypasses CHP to fire the boiler directly instead of purchasing natural gas to supplement the CHP heat.

Table 26 and Table 27 present Alternative 2A engine O&M costs and Alternative 2B gas turbine O&M costs, respectively.

Table 26: Alternative 2A: CHP with Engine Annual O&M

Item	2028	2037	2052
Natural gas	N/A	N/A	N/A
Electrical offset	($844,000)	($937,000)	($1,098,000)
Electrical RECs	($48,000)	($52,000)	($59,000)
Electrical usage	$36,000	$40,000	$47,000
Engine maintenance	$266,000	$289,000	$328,000
Boiler maintenance	$15,000	$15,000	$15,000
Biogas conditioning	$72,000	$78,000	$89,000
Total	**($503,000)**	**($567,000)**	**($678,000)**

Table 27: Alternative 2B: CHP with Gas Turbine Annual O&M

Item	2028	2037	2052
Natural gas	N/A	N/A	N/A
Electrical offset	($627,000)	($696,000)	($815,000)
Electrical RECs	($32,000)	($36,000)	(40,000)
Electrical usage	$36,000	$40,000	$47,000
Turbine maintenance	$178,000	$193,000	$219,000
Boiler maintenance	$15,000	$15,000	$15,000
Biogas conditioning	$68,000	$74,000	$84,000
Total	**($362,000)**	**($408,000)**	**($490,000)**

4.5.3 Alternatives 3A/B: RNG

Removal of carbon dioxide from the raw biogas is required to create RNG. The removal of carbon dioxide increases the concentration of methane, thus increasing the specific energy of the biogas from 580 Btu per cubic foot (CF) to a near-NG level of 1,000 Btu/CF. The financial analysis assumes that this step is performed by a membrane treatment system. A more detailed analysis of different treatment options is provided in Appendix D .

The main O&M costs for an RNG membrane biogas upgrading system are electricity, natural gas, and the NG upgrading. The breakdown of the biogas upgrading O&M cost is shown below in Table 28.

Table 28: RNG Equipment Annual O&M

Item	O&M Cost
H_2S, siloxane, and drying treatment excluding electricity	\$0.63/MMBtu
Electricity for H_2S, siloxane, and drying treatment	\$0.15/MMBtu
Electricity for boosting	\$1.07/MMBtu
Other	\$0.73/MMBtu

The total H_2S, siloxane, and drying O&M cost is the same \$0.78/MMBtu used for the boiler and CHP treatment alternatives. The comparatively high \$1.07/MMBtu additional cost for electricity reflects the energy-intensive biogas compression required for CO_2 removal and pipeline injection. The \$0.73/MMBtu other cost represents the cost for labor, general maintenance, and media replacement. Note that these costs are represented per MMBtu of biogas processed.

The following additional assumptions were used for RNG O&M costs:

- Natural gas purchased is \$0.85/therm (\$8.50/MMBtu) in 2020 dollars
- RNG commodity (sale) price of \$2.50/MMBtu
- RNG environmental attributes of \$15.00/MMBtu
- County share of environmental attribute of 85 percent to account for broker assistance

Table 29 shows the breakdown of the revenue for Alternatives 3A and 3B.

Table 29: Alternatives 3A and 3B: RNG Annual O&M

Item	2028	2037	2052
Natural gas	\$282,000	\$298,000	\$320,000
Electrical used	\$207,000	\$230,000	\$269,000
Boiler maintenance	\$15,000	\$15,000	\$15,000
Biogas conditioning	\$140,000	\$152,000	\$172,000
RNG revenue	(\$1,642,000)	(\$1,778,000)	(\$2,002,000)
Total	**(\$998,000)**	**(\$1,083,000)**	**(\$1,226,000)**

4.5.4 Alternative 4A/B: RNG with CHP

The O&M costs for Alternatives 4A/B include purchase of natural gas for running the engines, electricity offsets for the generation of electricity, and other O&M costs included in Alternatives 2 and 3, as appropriate.

Table 30 shows the breakdown of the revenue for Alternative 4A.

Table 30: Alternative 4A: RNG and Engine Annual O&M

Item	2028	2037	2052
Natural gas	$1,049,000	$1,106,000	$1,194,000
Electrical offset	($1,058,000)	($1,174,000)	($1,376,000)
Electrical RECs	($60,000)	($66,000)	($74,000)
Electricity used	$207,000	$230,000	$269,000
Engine maintenance	$333,000	$363,000	$412,000
Boiler maintenance	$15,000	$15,000	$15,000
Biogas conditioning	$140,000	$152,000	$172,000
RNG revenue	($1,642,000)	($1,778,000)	($2,002,000)
Total	**($1,016,000)**	**($1,151,000)**	**($1,390,000)**

Table 31 shows the breakdown of the revenue for Alternative 4B. Alternative 4B would generate less power than Alternative 4A but also would use less natural gas.

Table 31: Alternative 4B: RNG and Gas Turbine O&M

Item	2028	2037	2052
Natural gas	$427,000	$460,000	$486,000
Electrical offset	($294,000)	($333,000)	($382,000)
Electrical RECs	($17,000)	($18,000)	($21,000)
Electricity used	$207,000	$230,000	$269,000
Turbine maintenance	$93,000	$103,000	$114,000
Boiler maintenance	$15,000	$15,000	$15,000
Biogas conditioning	$140,000	$152,000	$172,000
RNG revenue	($1,642,000)	($1,778,000)	($2,002,000)
Total	**($1,071,000)**	**($1,169,000)**	**($1,349,000)**

4.6 Results of Analysis

A first-stage analysis of all alternatives focuses on the financial costs only over a 6-year period of construction and 25-year period of subsequent operations. Table 32 presents the original conceptual construction cost (inclusive of contractor overhead and profit [O&P], mobilization and other preliminary costs, and contingency), and total present value of all capital and net operating costs through 2052, assuming a 3 percent discount rate.

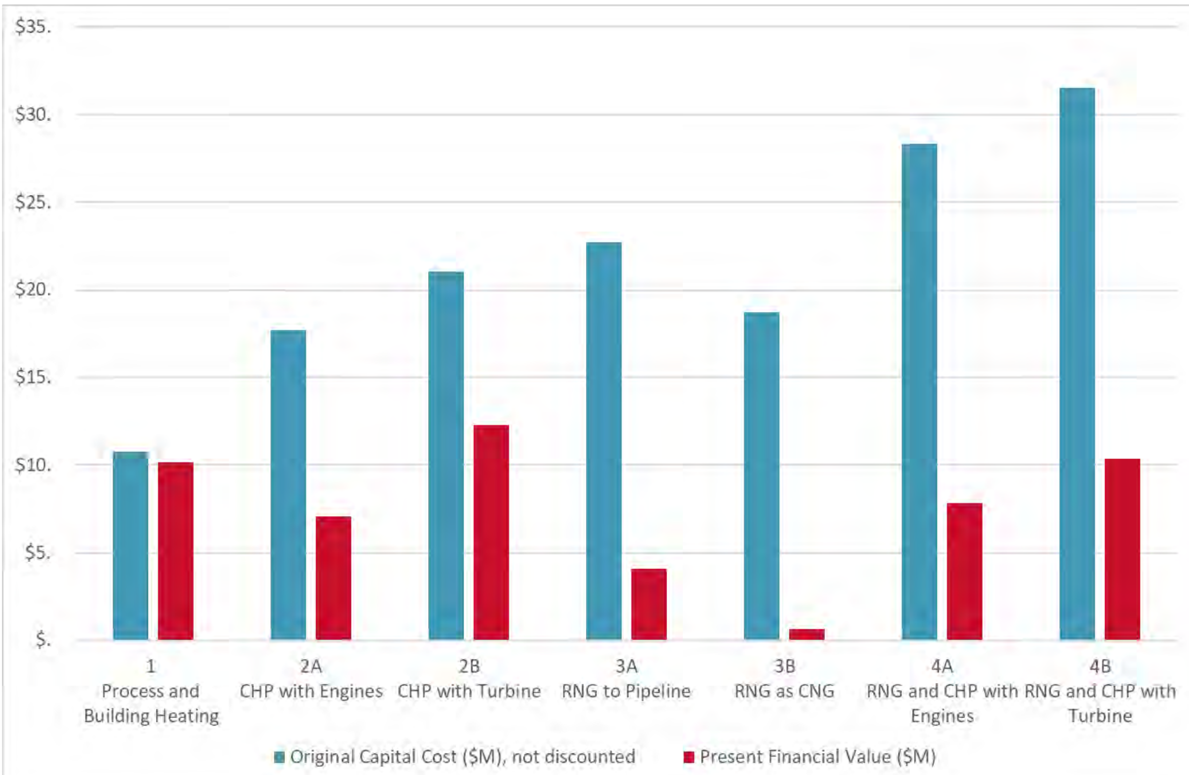
Table 32: Financial Analysis Results

Alternative	1 Process and Building Heating	2A CHP with Engines	2B CHP with Turbine	3A RNG into the NG Pipeline	3B RNG with CNG	4A RNG and CHP with Engines	4B RNG and CHP with Turbine
Conceptual construction cost, $M	$10.8	$17.7	$21.1	$22.7	$18.7	$28.4	$31.5
	Present Financial Value ($M)						
Capital cost	$9.3	$15.3	$18.2	$19.6	$16.2	$24.5	$27.2
Equipment O&M	$0.8	$6.1	$4.6	$5.7	$5.7	$10.9	$7.1
NG cost	$0.0	$0.0	$0.0	$4.2	$4.2	$15.8	$6.4
Electrical offset and RECs	$0.0	($14.2)	($10.5)	$0.0	$0.0	($17.8)	($5.0)
RNG revenue	$0.0	$0.0	$0.0	($25.5)	($25.5)	($25.5)	($25.5)
Total present value	$10.1	$7.1	$12.3	$4.1	$0.6	$7.9	$10.3

Figure 25 shows a comparison of these results graphically.

The base cost analysis indicates that although Alternatives 3A and 3B (RNG alternatives) do not have the lowest capital cost, they do have the lowest total present-value cost due to the anticipated value of the RNGs. In comparison, Alternatives 4A and 4B (RNG and CHP alternatives) would entail larger capital costs and comparable present-value costs when compared to Alternatives 2A and 2B (CHP alternatives).

Figure 25: Capital Costs and Total Present Values ($M) of Alternatives



4.7 Alternatives Selected for Further Review

The initial present-value financial analysis supports eliminating Alternatives 4A and 4B for future consideration because of high capital costs, high overall complexity, significant use of natural gas, and comparable present financial values to Alternatives 2A and 2B. Alternatives 2A, 2B, 3A, and 3B are further analyzed for risk and non-financial factors in the following sections.

5 Shortlisted Alternatives Analyses

5.1 Non-Financial Analysis

The selection of a biogas utilization option is not driven solely by the financial analysis, as the new facilities will need to be operated and maintained by the County. In addition, the facilities could impact local stakeholders in different ways. To account for these factors, a comprehensive non-financial analysis was completed, as described in this section for the shortlisted alternatives.

5.1.1 Evaluation Criteria

The evaluation criteria for the non-financial analysis were developed in conjunction with County staff as part of Workshop 3.2 on May 10, 2021.

Table 33 presents the criteria and descriptions that were used in the subsequent weighting and scoring of the biogas utilization alternatives.

Table 33: Non-Financial Criteria Descriptions

Criterion	Description
Localized emissions	Produces emissions at WPCP site that may negatively impact air permitting requirements, cause neighborhood issues, or result in poor air quality in immediate area
Noise	Generates excess noise that may impact neighbors or result in costly noise reduction measures
Visual aesthetics	Is acceptable to the neighbors and general Arlington County community from a visual aesthetics standpoint
Footprint	Sufficient space for operations and maintenance; does not take land space from current needs or potential future add-ons
Potential for flaring	Provides multiple outlets for use of biogas or redundancy options to minimize the amount of biogas sent to the waste flare
Operational complexity	Complexity of equipment and facilities in operation
Maintenance complexity and reliability	Reliability of equipment and facilities, ongoing maintenance requirements, annual downtime for maintenance, number of components that could fail resulting in failure of system
Safety	Risks for operation of system, including leaks, pressures, number of components, etc.
Resilience	Provides for additional resilience benefits for the WPCP and solids handling systems

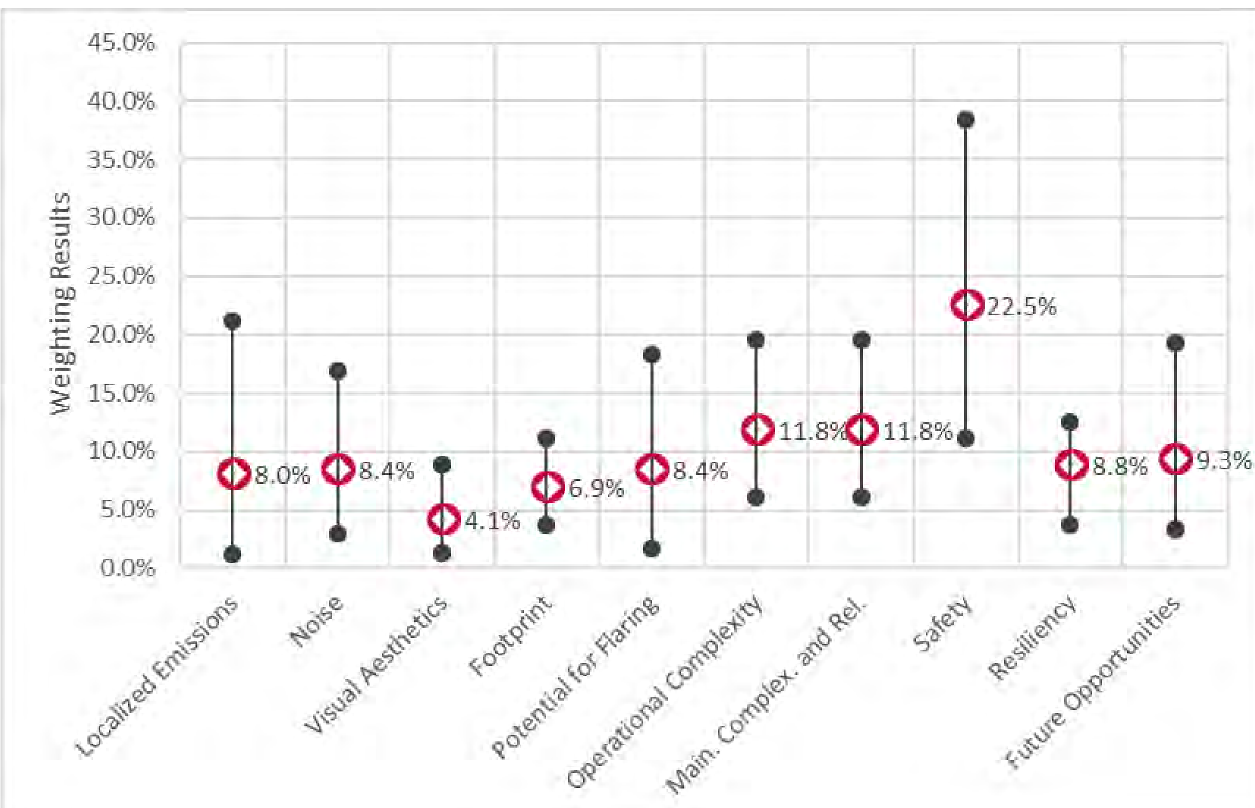
Criterion	Description
Future opportunities	Maintains flexibility for modifying approach should market conditions change

5.1.1.1 Weighting

During Workshop 3.2 on May 10, 2021, the HDR team introduced the alternatives summary sheets and scoring worksheets and provided instructions for completing a pairwise scoring comparison. In the pairwise analysis, participants compared “pairs” of criteria and selected which of those criteria was more important. For example, for evaluating biogas utilization alternatives, is “safety” more important than “operational complexity”? Each participant made a subjective selection, and then compared the remaining pairs. For this exercise, 14 County employees participated in the scoring exercise.

The results of the non-financial criteria weighting are presented in Figure 26. The percentage listed represents the geometric mean for that criterion of all the participants scores. The range bars represent the range of individual weights for each criterion.

Figure 26: Non-Financial Criteria Weighting



5.1.1.2 Alternatives Scoring

Participants were then asked to weight each biogas utilization alternative for effectiveness in achieving a particular evaluation criterion. For example, is Alternative 2A, CHP with engines, more effective than Alternative 3B, RNG sent to ART/WMATA, for achieving “long-term resilience?” Scoring values, from a scale of 1 (very low) to 5 (very high), were made for all five alternatives and for each evaluation criterion. The summary sheets were distributed electronically to all participants, with guidance for each scoring value listed for each criterion, to assist them in making a subjective selection. Guidance for the scoring of the criteria is presented in Table 34.

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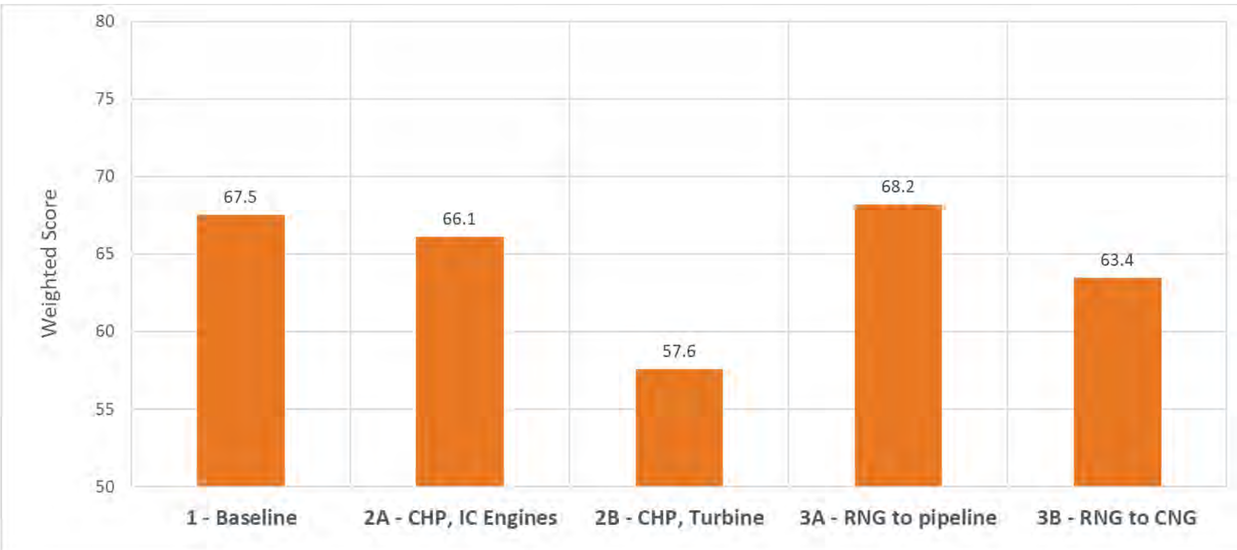
Table 34: Non-Financial Criteria Scoring Guidelines

Title	Characteristics	1 - Very Low	2 - Low	3 - Moderate	4 - High	5 - Very High
Localized Emissions	Produces emissions at plant site that may negatively impact air permitting requirements, cause neighborhood issues, or result in poor air quality in immediate area.	Visual emissions impact to existing communities, puts project at risk.	Known emissions are modeled with some impacts to surrounding areas but permitable.	Community understanding of approach and emissions.	Minimal increase in local emissions.	No increase in local emissions.
Noise	Generates excess noise that may impact neighbors or result in costly noise reduction measures	Noise leaving plant site 24/7.	Increase in noise leaving plant site intermittently.	Noise impacts are mittigatable through additional cost. May be periodic excess noise during maintenance activities.	No mitigation impacts required. May be periodic excess noise during maintenance activities.	No excess noise leaving plant site.
Visual Aesthetics	Is acceptable to the neighbors and general Arlington County community from a visual aesthetics standpoint.	Industrial nature, seen as factory with visible emissions.	Industrial nature, but no visible emissions.	Screened from one side but industrial from Route 1. Exposed piping throughout.	All new facilities are screened. Exposed piping throughout.	All facilities inside and/or enclosed. No exposed visible piping.
Footprint	Sufficient space for operations and maintenance, does not take land space from current needs or potential future add ons.	Overly constrained site, not adaptable to other site requirements, prevents future add ons.	Tight site for operations and maintenance, not adaptable to other site requirements and limits future opportunities.	Adequate space for operations and maintenance but still constrains site for future opportunities and lacks site synergies.	Adequate space for all new facilities and takes advantages of site synergies, but limited space for future opportunities.	Small footprint, able to take advantages of site synergies, allows for future opportunities.
Potential for Flaring	Provides multiple outlets for use of biogas or redundancy options to minimize the amount of biogas sent to the waste flare.	All biogas except that used for boiler is flared.	Biogas is benefically used in areas other than boiler but equipment failures and lack of redundancy result in significant flaring.	Biogas is beneficially used in areas other than boiler with flaring for offspec gas and systems offline. No additional outlets.	Biogas is beneficially used with flaring for offspec gas but is minimized through equipment redundancy.	Biogas has multiple outlets and only is flared when all outlets fail.
Operational Complexity	Complexity of equipment and facilities in operation.	Highly complex systems with multiple control points and sensors. Requires external resources to operate.	Complex systems with multiple control points and sensors with some annual downtime and/or Requires specialized training and some reliance on external resources to maintain operation.	Complex systems with multiple control points and sensors with some annual downtime. Requires specialized training but no external resources to maintain operation.	Less complex operational systemswith fewer control points. Minimal training and current staff can operate.	Standard systems with standard operational requirements. Current staff have the skillsets to operate all equipment.
Maintenance Complexity and Reliability	Reliability of equipment and facilities, ongoing maintenance requirements, annual downtime for maintenance, number of components that could fail resulting in failure of system.	Systems with non-standard maintenance requirements and limited redundancy, leading to downtime and system failures.	Non-standard maintenance requirements and some annual downtime. Requires external resources to operate and/or maintain all new gas handling systems.	Non-standard maintenance and some annual downtime. Systems other than boiler requires specialized staff to operate and maintain but no external resources.	Generally standard maintenance requirements. Systems other than boilers require some specialized training that current staff can take to operate and maintain.	Standard maintenance requirements. Current staff have the skillsets to operate and maintain all equipment.
Safety	Risks for operation of system, including leaks, pressures, number of components, etc.	Multiple high pressure systems(>100 psi) with multiple locations of potential failures.	Single high pressure system (>100 psi) with fewer locations for potential failures.	Single high pressure system with limited length of pressurized lines.	Lower pressure gas system with fewer components and potential leakage points.	Standard gas systems with safety components in place.
Resiliency	Provides for additional resiliency benefits for the WPCP and solids handling systems.	No change in gas or electrical resiliency.	Provides only natural gas resiliency to Solids Area	Provides only electrical resiliency to Solids area	Provides natural gas resiliency to multiple areas or both electric and natural gas resiliency to solids area	Provides electrical resiliency to multiple areas.
Future Opportunities	Maintains flexibility for modifying approach should market conditions change.	Locks-in treatment and biogas utilization options with no ability to adapt in the future	Provides limited treatment and biogas utilization flexibility in the future - may be possible but would require significant rework of infrastructure put in place.	Flexibility to add new end uses but at significant cost beyond the new technology.	Flexibility to add new end uses without paying a premium	Has multiple end uses now and flexibility to pivot should markets change.

At Workshop 4.2 on June 24, 2021, the scoring of each alternative was discussed to develop consensus. The participants discussed each criterion and their perspective on scores to develop the consensus. Figure 27 presents the average scores for each alternative. The average score is represented by multiplying the consensus score by the average weighting results presented in Figure 26. Alternative 3A had the highest non-financial score at 68.2, followed by Alternative 1 at 67.5. Alternative 2B had the lowest non-financial score of 57.6.

Figure 27: Non-Financial Scoring Results



The main differentiators between the RNG alternatives (Alternatives 3A/3B) and CHP alternatives (Alternatives 2A/2B) were that the RNG alternatives had:

- Lower localized emissions
- Reduced noise
- More outlets for beneficial use of the biogas and ability to reduce flaring
- Lower maintenance complexity and reliability
- Adaptability to future opportunities

5.2 Sustainability Criteria

In addition to financial and non-financial considerations, the Program is tasked with reviewing the sustainability, or environmental impact, of the alternatives identified. This was accomplished using the anticipated reductions of GHG emissions (namely CO_2) for each alternative and using a social cost of GHG approach to monetize the reductions. Note, this social cost of GHG is a monetization of the social impacts of the GHG emissions based on economic loss over time—it does not represent a true financial value to the County. However, by monetizing the value of the GHG offsets, the results can be combined with the financial and non-financial results to develop a composite comparison for each.

5.2.1 Basis of Greenhouse Gas Evaluation

A comparative greenhouse gas summary was developed for the biogas utilization alternatives. The summary in the sections below includes only the emissions from electricity and NG utilization associated with the biogas portion of the Program (regardless of where the end user of the biogas is located) including reductions from avoided electricity purchase or avoided fossil fuel-based NG usage. A complete comprehensive GHG emissions evaluation including biosolids hauling and chemical usage will be provided in a separate TM.

5.2.1.1 Electrical Use

The Arlington WPCP buys its electrical power from Dominion. From Dominion's Sustainability Report, included in Appendix C , the GHG emissions (expressed as MT carbon dioxide equivalent [CO_2e] per net MWh) from Dominion-provided power in Virginia has been steadily decreasing from 0.637 MT/net megawatt-hours (MWh) in 2000 to 0.285 MT/net MWh in 2019, as shown in Figure 28. This is due to the gradual reduction in power production from coal to more renewable sources and natural gas. The breakdown of Dominion's energy sources in 2019 is presented in Figure 29.

Figure 28: Dominion Emissions Trend

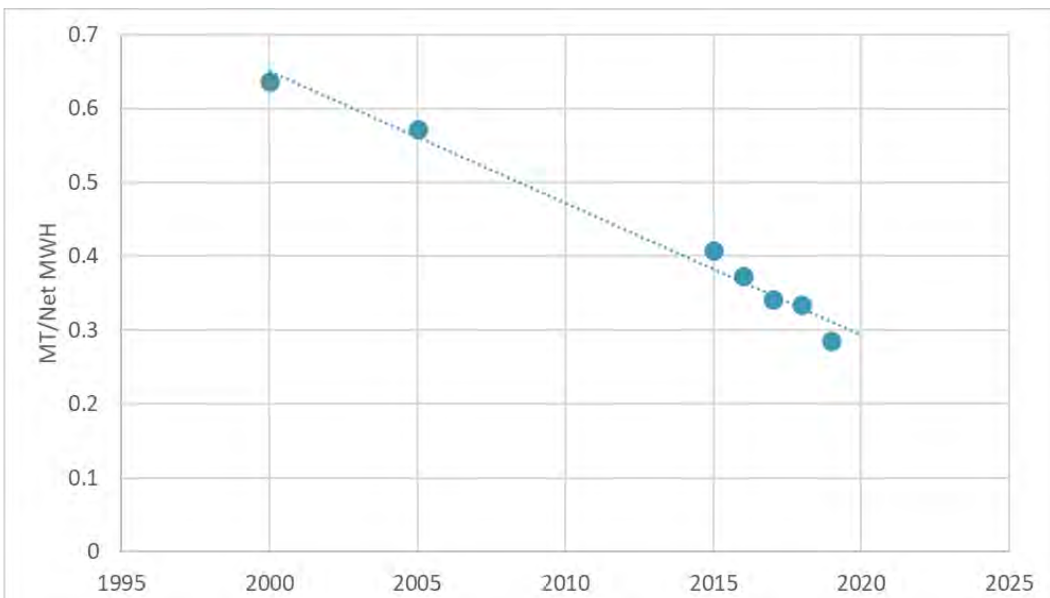
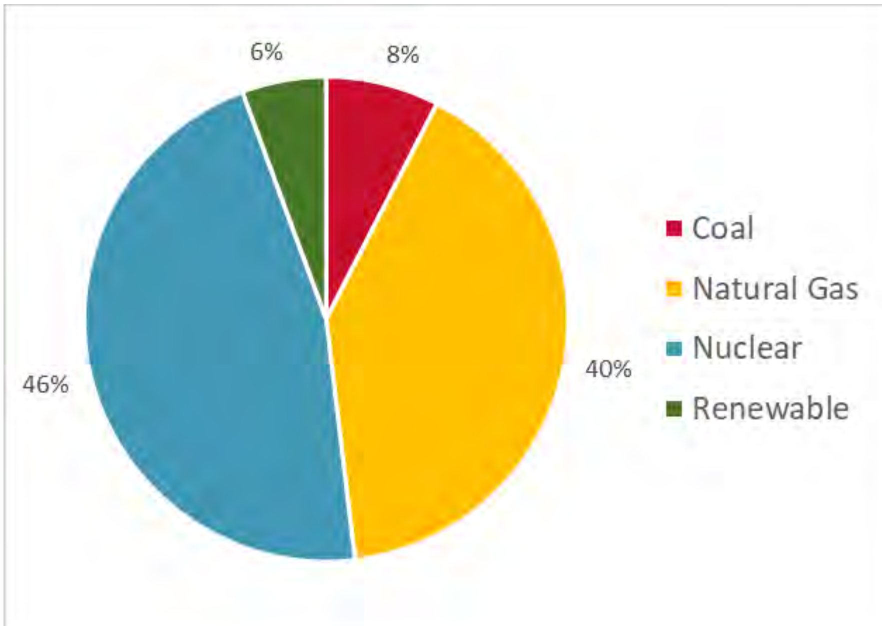


Figure 29: Dominion Energy Sources, 2019



5.2.1.2 Natural Gas Use

As summarized in Section 2.3.1, the WPCP currently uses approximately 7,800 therms or 780 MMBtu of natural gas per year. From EIA, the combustion of natural gas results in 53.07 kilograms (kg) of carbon dioxide per MMBtu. Therefore, the GHG emissions from NG use at the WPCP are approximately 40 MT/yr.

5.2.2 Changes in GHG Emissions

In addition to differences in energy production and costs, each biogas utilization alternative results in a different amount of total net GHG emissions. The net GHG change presented herein is solely for the biogas utilization equipment, not the entire Re-Gen/Biosolids Program. Table 35 below provides a breakdown of what areas contribute to GHG additions and offsets for the various components of each alternative:

Table 35: Impacts of Alternatives on Net GHG Emissions

Alternative	Electricity Use	Electricity Production	NG Used On Site for Steam Production	Biogas Displaces Fossil Fuel-Based NG On Site	Biogas Displaces Fossil Fuel-Based NG Off Site
1: Process and building heat	+			-	
2A: CHP with IC engines	+	-		-	
2B: CHP with turbines	+	-		-	
3A: RNG to pipeline	+		+		-
3B: RNG used as CNG	+		+		-

GHG emissions from removal of carbon dioxide in the biogas, combustion of biogas on site for steam generation, combustion on site in CHP, or flaring are not included, as the carbon dioxide being emitted is biogenic.

With Alternative 1, steam generation would be solely through using biogas in boilers. This would also eliminate current combustion of fossil fuel-based NG and thus reduce emissions by 40 MT/yr. However, this alternative also would require an increase in electricity use over current usage, which would lead to 80 MT/yr of additional GHG emissions. Therefore, a net increase over current emissions of 40 MT/yr would result.

For Alternative 2A the biogas would be used to produce 1.39 MW of electricity or 12,185 MWh/yr. Combined with additional electricity use for this alternative, GHG emissions for electricity would be reduced by 3,330 MT/yr based on the current Dominion Energy CO_2 emission profile. Steam generation for THP will come solely from heat recovery from the engines or biogas combustion. In addition, the heat recovery from the engines would eliminate current fossil fuel-based NG consumption and the corresponding emissions of 40 MT/yr. Therefore, the total GHG emissions reduction of 3,370 MT/yr.

Because of the lower efficiency of the gas turbine, Alternative 2B would produce only 0.98 MW of electricity or 8,585 MWh/yr, reducing GHG emissions by 2,310 MT/yr. Similar to Alternative 2A, the heat recovery from the turbine would reduce NG purchases by another 40 MMBtu/yr, resulting in a total net GHG emission reduction of 2,350 MT/yr.

Alternatives 3A and 3B, which involve selling all the biogas produced as RNG, would generate the most emissions reductions, even though some natural gas would be purchased for the steam boiler. Alternatives 3A and 3B result in an emissions reduction of 6,240 MT/yr from the displacement of fossil-fuel based NG off site. The use of NG on site in steam boilers would result in an additional 1,970 MT/yr of emissions. The additional electrical usage for the biogas conditioning system results in 770 MT/yr of additional emissions. When these are added together, the total net GHG emissions reductions for these alternatives amount to 3,500 MT/yr in 2037.Table 36 presents net change in GHG emissions for each of the sources of energy for 2037. Overall, Alternatives 2A, 3A, and 3B have greater emissions reductions than Alternatives 1 and 2B.

Table 36: Total Change in Net GHG Emissions (MT CO_2e) in Year = 2037

Alternative	Net Electricity Use	Biogas Production (Offsets NG Purchases)	NG Purchased	Total Change in Emissions
1: process and building heat	80	-40	0	40
2A: CHP with IC engines	-3,330	-40	0	-3,370
2B: CHP with turbines	-2,310	-40	0	-2,350
3A: RNG to pipeline	770	-6,240	1,970	-3,500
3B: RNG used as CNG	770	-6,240	1,970	-3,500

Note: Negative values are reductions and positive values are increases in emissions.

Note, GHG reductions for Alternatives 2A and 2B are based on the current Dominion Energy emission profile, which includes a combination of fossil-fuel and renewable energy sources described above. Electricity usage for Arlington County operations is projected to be 100 percent renewable by 2025, in which case the GHG reduction for net electricity production would be zero. However, the generation of renewable power at the WPCP may allow for currently forecast renewable sources to be used elsewhere.

5.2.3 Environmental Value of Greenhouse Gas Emission Savings

Annual GHG emissions reductions can be converted into monetary terms by applying the dollar values per metric ton that have been established by the Interagency Working Group (IWG) on Social Cost of Greenhouse Gases of the U.S. government.[1] The IWG analysis accounts for a wide range of climate change impact studies that assess losses to the U.S. and world economies over time. These future losses are discounted to the present and normalized on a per metric ton of CO_2 emissions basis.

Results of the analysis are formalized in tables and charts. Because of uncertainty in future impacts and uses of the results, several dollar values are produced. Generally, monetary values can be combined with a change in GHG emissions to reveal the benefits of a change.[2] Table 37 presents two sets of dollars per ton by year to illustrate the range of values. The "most likely" value represents the best estimate for potential

[1] Interagency Working Group on Social Cost of Greenhouse Gases (IWG). February 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. United States Government Publication. (Link)

[2] Note that if emissions increase, the monetary value would be considered a loss or "negative" benefit.

damage caused by GHG emissions, given the analyses considered by the IWG. A high value is also computed and represents a much more significant level of future economic damage from GHG emissions.[3] The analysis of emissions reduction for the Program applies the most likely values.

Table 37: Social Cost of GHG, per Metric Ton of CO_2, by Year, at a 3% Discount Rate

Year	$/MT (Most Likely Value)	$/MT (High Value)
2020	$51	$152
2025	$56	$169
2030	$62	$187
2035	$67	$206
2040	$73	$225
2045	$79	$242
2050	$85	$260

The value of net GHG emissions reductions is presented in Table 38. The first column shows the same forecast value of GHG emissions reductions from Table 37 above. Next to it on the right is the corresponding monetary value of these reductions for year 2037, which have an estimated value of $69.34/MT for that year. The second set of columns to the right show the discounted total value of all GHG emissions reductions over a 25-year period of operations. These results show that reductions from Alternatives 3A, 3B, and 2A are all similar in total value with Alternatives 3A and 3B, with the highest at $3.62 million. The total discounted monetary value of emissions reductions can be combined with capital and financial costs to determine a total project value.

Table 38: Total Net CO_2 Emissions Reductions Value, $Millions

Alternative	Tons Reduced, Year 2037 Only	Most Likely Value Reduced, Year 2037 Only	Total Value, 25-Year Total (Discounted at 3%)
1	40	-$0.003	-$0.04
2A	-3,370	$0.23	$3.5
2B	-2,350	$0.16	$2.4
3A	-3,500	$0.24	$3.6
3B	-3,500	$0.24	$3.6

[3] Technically, this high value characterizes damage levels for which there is only a 5% chance that the future could be any worse. At this more extreme level of potential damage, the dollar value is correspondingly higher than an average damage condition in the future.

5.2.4 GHG Offsets

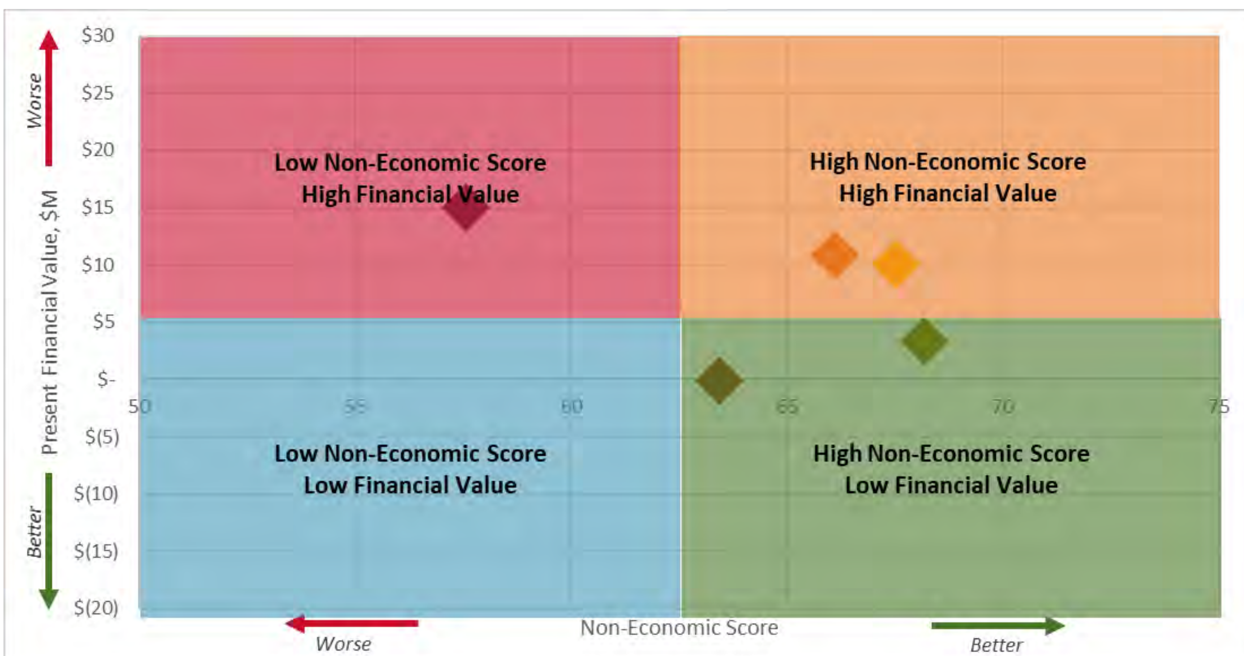
As discussed in Section 2.4.3, the GHG emission reductions associated with RNG will likely be realized by the ultimate purchaser of the RNG for use as transportation fuel. If that purchaser is within Arlington County, these emission reductions could be counted toward Arlington County's Carbon Neutrality goals.

However, if that purchaser is outside of Arlington County, the County might want to consider using some of the revenue brought in from RNG to purchase carbon credits on the open market. At the current market rate of approximately \$15/MT of CO_2e, it would cost Arlington approximately \$100,000 per year to purchase GHG credits equivalent to those attributable to the RNG. This purchase would not materially impact the financial evaluations presented.

5.3 Composite Results

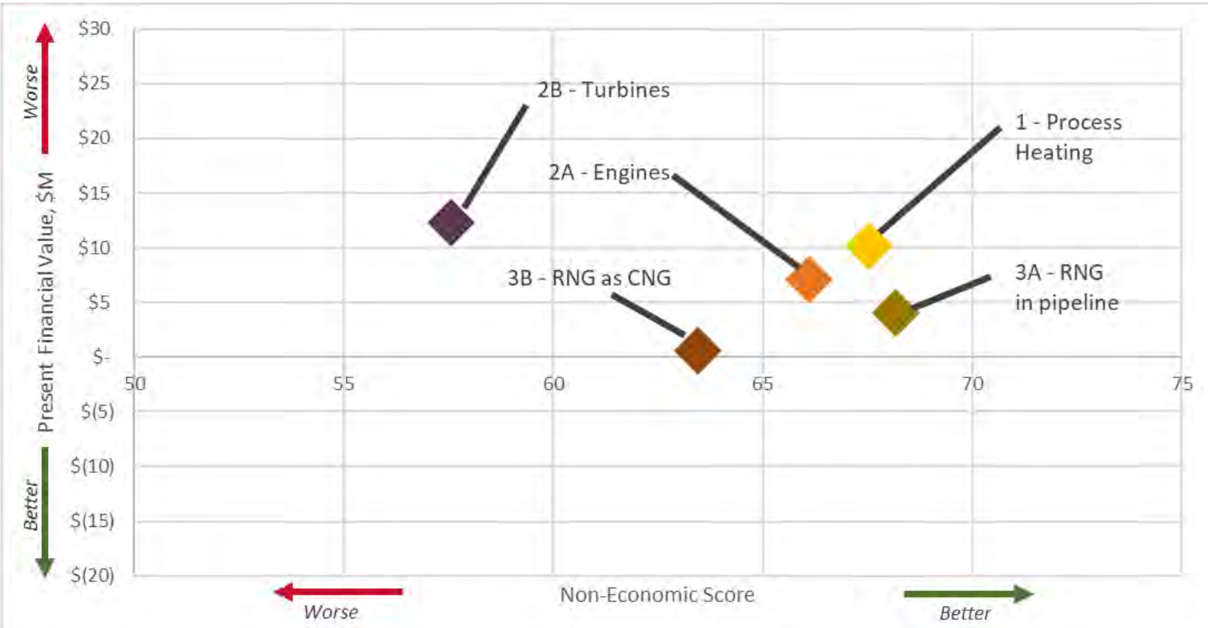
To further evaluate the financial results and non-financial scoring, the results of both efforts are combined into plots to illustrate the composite results for each alternative. By plotting the non-financial scores on the x-axis and the present financial values on the y-axis, a clearer picture of the most beneficial alternative can be achieved. With this approach alternatives that are located in the lower-right quadrant have higher non-financial scores and lower present financial values (better). Conversely, alternatives in the upper left quadrant have lower non-financial scores and higher present financial values (worse). Figure 30 illustrates this methodology.

Figure 30: Composite Scoring Methodology



When the non-financial scores from Figure 27 above are combined with the present financial values from Figure 25, the composite results can be developed; see Figure 31. These results represent the current electrical price of $0.078/kWh and an average RIN market value of $15/MMBtu, and do not include any social cost of carbon.

Figure 31: Base Scenario ($0.078/kWh, No GHG, RIN = $15/MMBtu)



For this base scenario, without considering the social cost of carbon, Alternative 3A had the highest non-financial score and the second lowest present financial value.

The results of several other scenarios were developed to help illustrate the potential impact of electrical costs, social cost of carbon, and RNG pricing on the composite results. The conditions and present financial values for each of these scenarios are presented in Table 39. The low RIN value represents the lowest weekly RIN value seen in the market over the last 6 years. The high RIN value represents the average weekly RIN value seen in the market over the last 6 years. The RIN market value as of October 2021 was $38/MMBtu. A high electrical scenario, with electricity at $0.117/kWh (50% over current), was also developed to reflect the impact of potential higher electric prices, although no such jump increase is forecast by the EIA projections.

Table 39: Present Financial Values for Other Scenarios

Condition	Base Scenario	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Original Capital Cost ($M), Not Discounted
Electrical, $/kWh	$0.078	$0.078	$0.078	$0.078	$0.117	
GHG value	0	Most-Likely	Most-Likely	Most-Likely	Most-Likely	
RIN market value, $/MMBtu	$15	$15	$23.35 (average)	$6.38 (min)	$15	
Alternative	Present Financial Value ($M)					
1	$10.2	$10.2	$10.2	$10.2	$10.3	$10.8
2A	$7.1	$3.6	$3.6	$3.6	$1.6	$17.7
2B	$12.3	$9.9	$9.9	$9.9	$8.4	$21.1
3A	$4.1	$0.5	($11.5)	$12.8	$1.0	$22.7
3B	$0.6	($3.0)	($15.0)	$9.4	($2.5)	$18.7

Figure 32 shows the Scenario 1 composite results when the most-likely value for the social cost of carbon (GHG value) is included. The main impact is that Alternative 1 becomes less attractive because of the present value of the other alternatives being lowered. The relative differences between the other alternatives remain the same.

Figure 32: Scenario 1 ($0.078/kWh, Most-Likely GHG, RIN = $15/MMBtu)

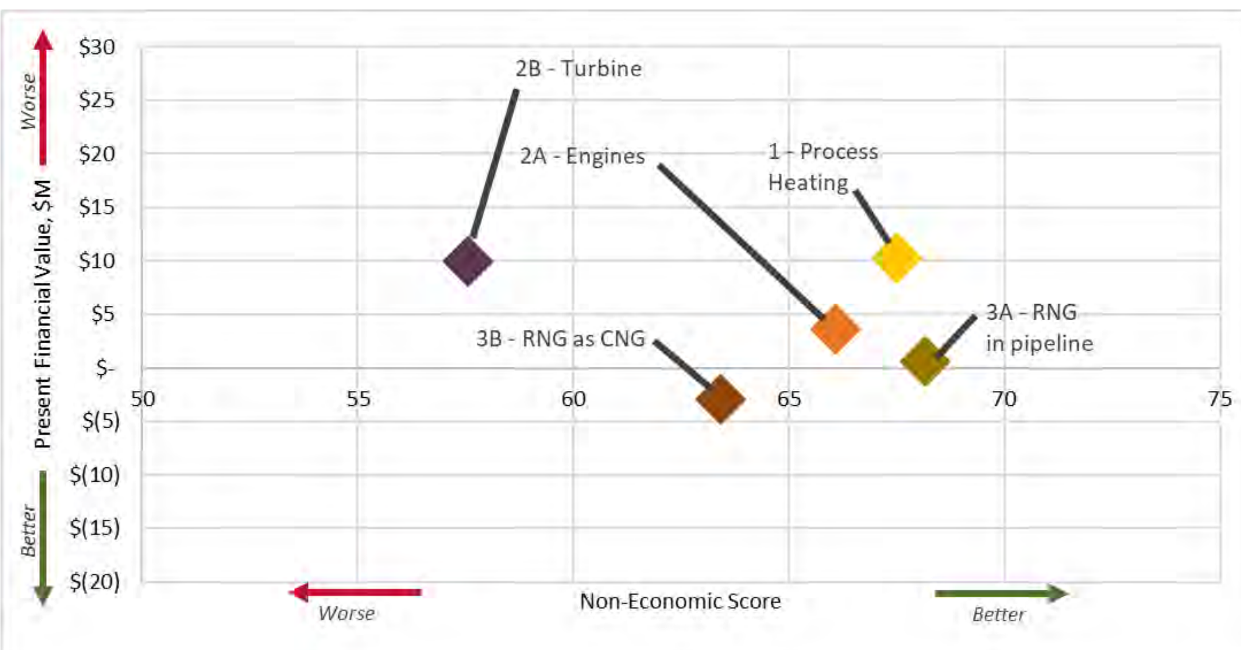


Figure 33 shows the Scenario 2 results including the social cost of GHG and the average RIN value for the past 6 years of $23.35/MMBtu. This RIN value furthers the financial advantage of the RNG alternatives.

Figure 33: Scenario 2 ($0.078/kWh, Most-Likely GHG, RIN = $23.35/MMBtu)

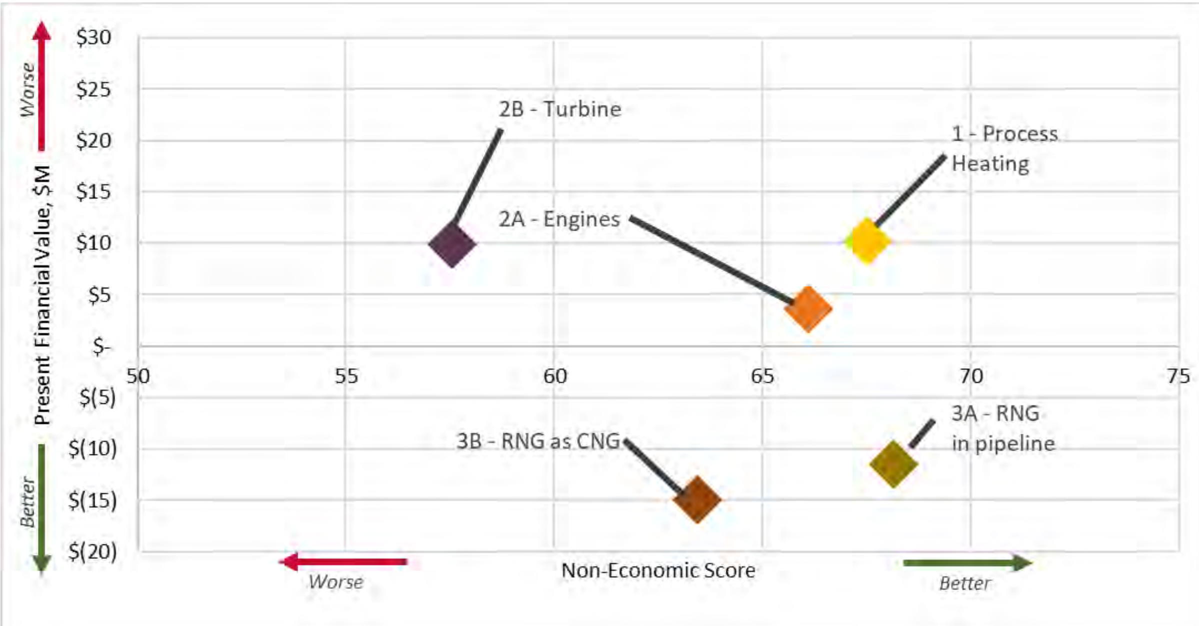
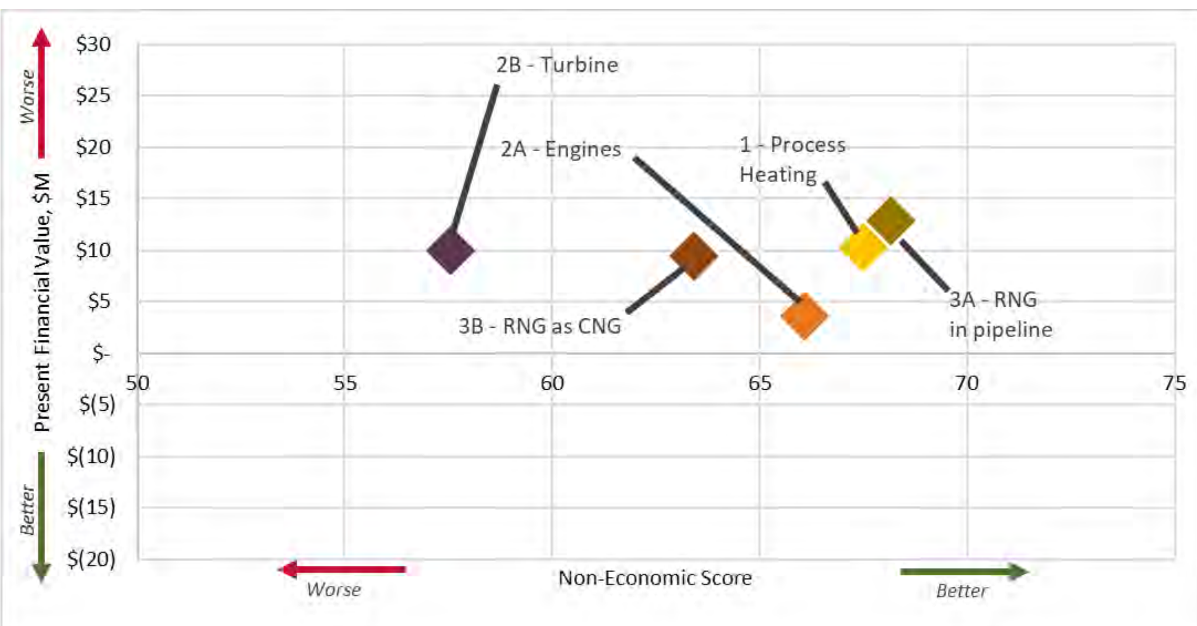


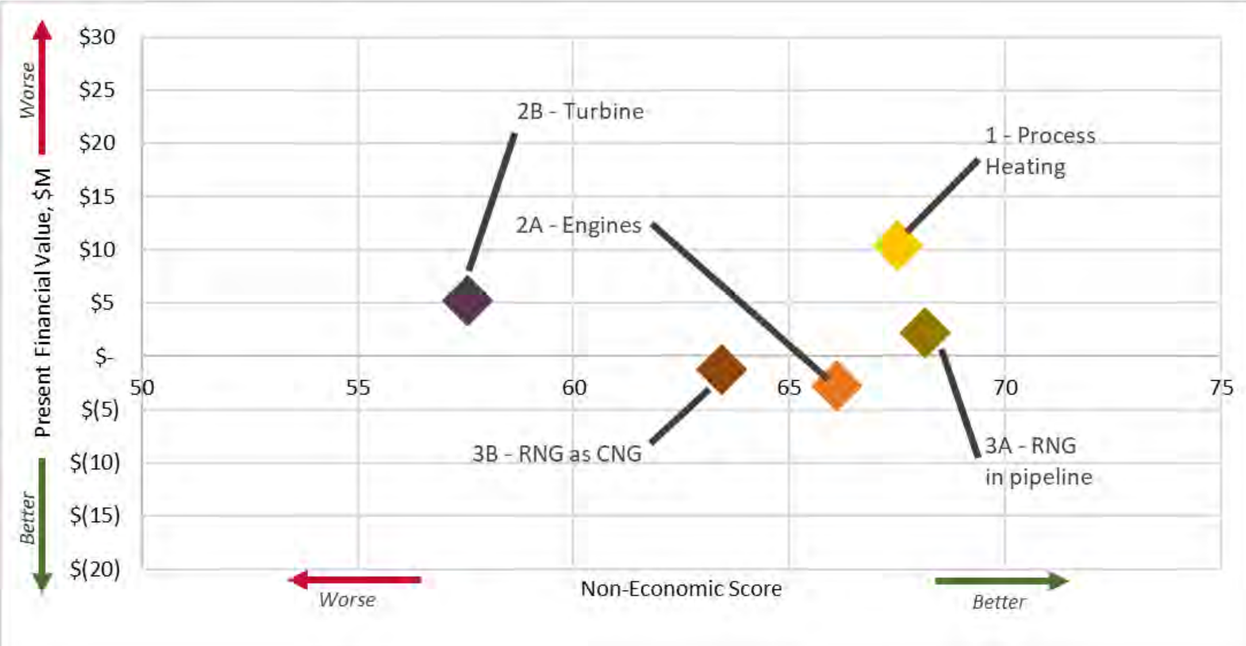
Figure 34 provides the same analysis including the social cost of GHG and the lowest weekly RIN value over the last 6 years of $6.38/MMBtu. In this scenario, Alternative 2A (CHP with engines) becomes more financially advantageous than Alternative 3A (RNG in pipeline). Note that this represents the RIN value averaging the minimum value for the entire 25-year analysis.

Figure 34: Scenario 3 ($0.078/kWh, Most-Likely GHG, RIN = $6.38/MMBtu)



Finally, when the electrical cost is increased to $0.117/kWh, the composite score of the CHP alternatives becomes more favorable than the RNG alternatives (see Figure 35).

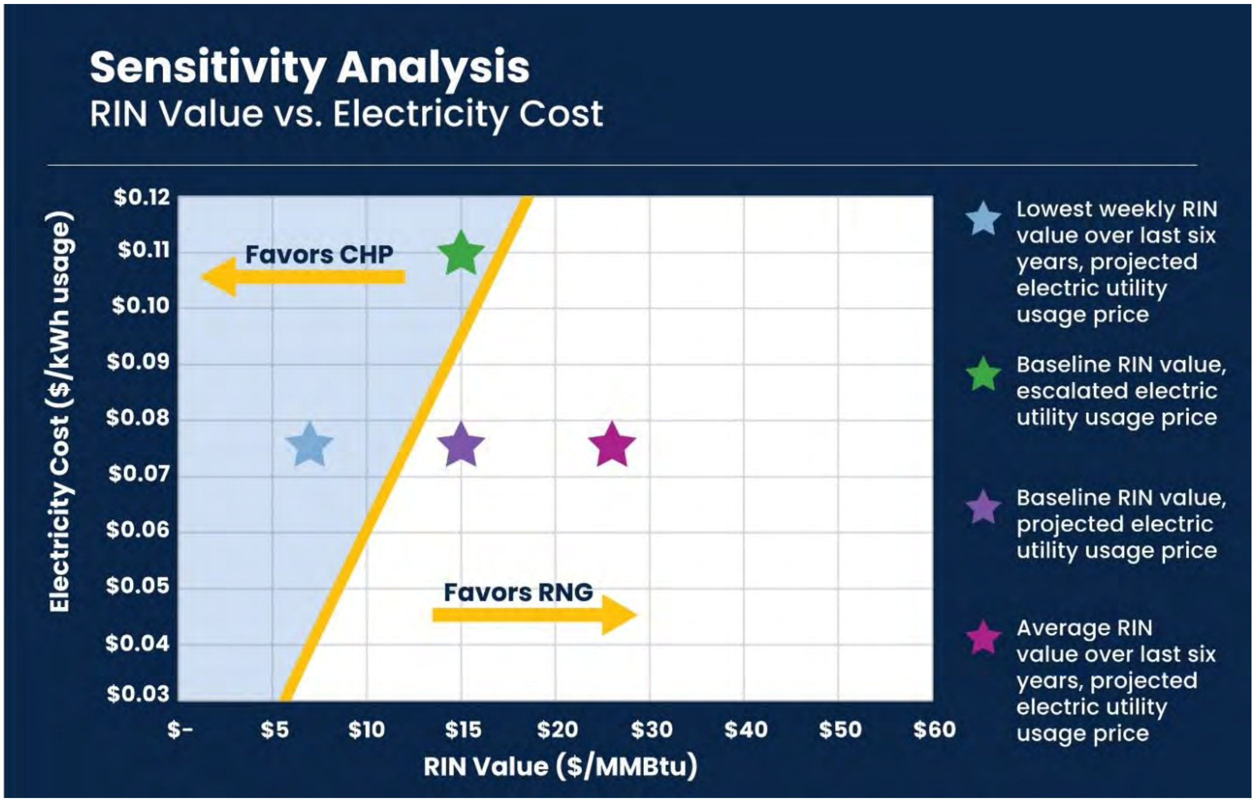
Figure 35: Scenario 4 ($0.117/kWh, Most-Likely GHG, RIN = $15/MMBtu)



5.4 Sensitivity Analysis

The financial analysis makes it clear that the main drivers in the comparison are the cost of electricity and the value of the RIN market. A break-even analysis was completed to identify the point at which Alternative 2A (CHP with engines) is financially equal to Alternative 3A (RNG into pipeline). This break-even analysis is shown on Figure 36, with the scenarios completed above identified.

Figure 36: Sensitivity Analysis of RIN Value vs. Electricity Cost



In addition to the sensitivity analysis described above, a more computationally rigorous approach, using Monte Carlo simulation methods, was completed to assess the combined impact of changing several factors at once.

5.4.1 Simulation Assumptions

Monte Carlo simulation involves defining input parameters as probability distributions of possible values, instead of one or several possible scenario values. For example, Figure 37 shows the probability distribution of annual growth rates (in percentage terms) for real electricity prices in the Mid-Atlantic region. This probability distribution was obtained by examining a variety of forecast scenarios produced by EIA (Figure 23) and identifying the lowest, baseline, and highest annual growth rates over a 30-year period.[4]

[4] The distribution was formed using a "Pert" distribution, a reasonable distributional form for engineering and economic analyses such as this.

Figure 37: Probability Distribution of Annual Growth Rates in Real Electricity Prices

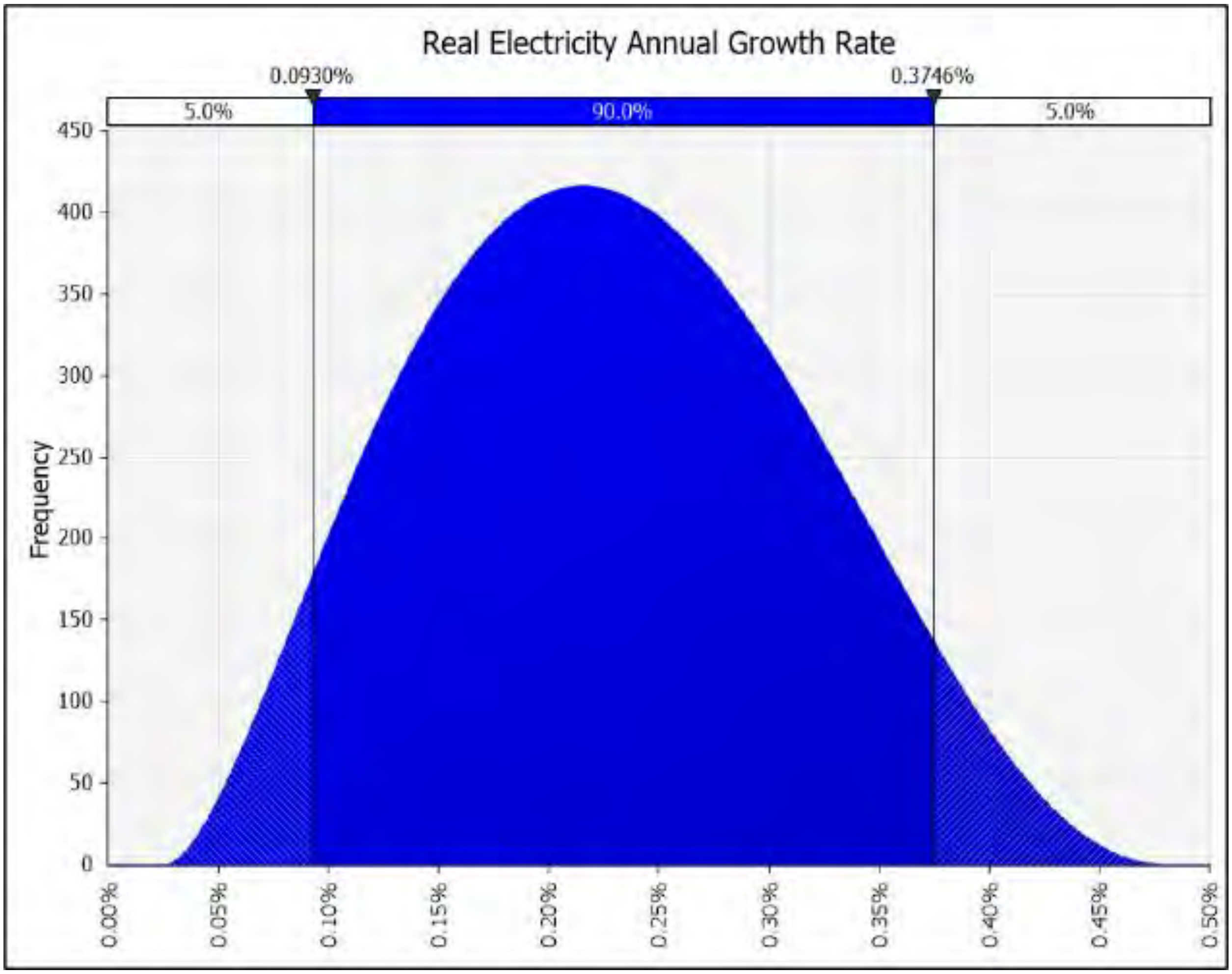


Table 40 presents the lower limit, estimated, and upper limit for the uncertain factors that are included in the model. Separate probability distributions are formed for each of these factors, using the same functional form as electricity price growth rates. The sources for these distributions include HDR assumptions and existing data.

Table 40: Monte Carlo Probability Distribution Parameter Values

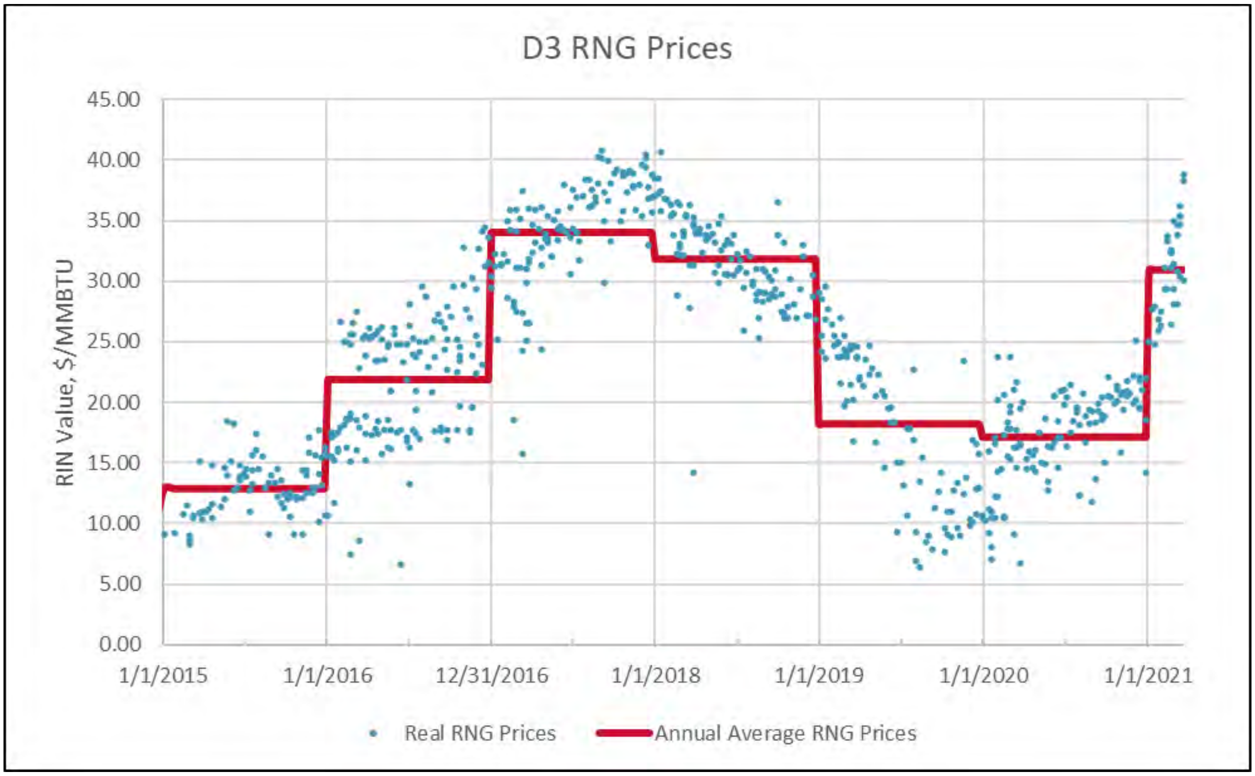
Uncertain Parameter	Lower Limit	Estimated Value	Upper Limit	Data Source
Energy Prices				
Electricity inflation (annual real rate)	0.03%	0.22%	0.48%	EIA
NG inflation (annual real rate)	-1.11%	-0.34%	0.88%	EIA
RIN price inflation (annual real rate)	0.00%	0.00%	2.18%	EPA
RIN market value (distribution for simulation)	$3	$22.36	$47	EPA
Capital Costs				
Contractor O&P (percentage of estimated cost)	12%	15%	18%	HDR
Contingency (percentage of estimated cost)	15%	20%	30%	HDR
Mobilization, bonds, and insurance (percentage of estimated cost)	6%	8%	10%	HDR
Building price, $/SF	$1,000	$1,150	$1,300	HDR
Slab-on-grade price, $/SF	$40	$50	$60	HDR
Performance				
Engine availability (annual probability)	90%	95%	97%	HDR
Turbine availability (annual probability)	85%	90%	95%	HDR
RNG treatment availability (annual probability)	85%	95%	95%	HDR

With a probability distribution of potential parameter values, such as the one shown in Figure 37 above, the model produces a full range of outcomes along with the likelihood that those values could occur.[5] When a model includes several uncertain parameters and each one is defined by its own independent probability distribution, the results will have fully accounted-for possible outcomes.

[5] A full range of model outcomes is achieved by the simulation process. Monte Carlo simulation methods involve performing thousands of iterations of model solutions whereby each iteration applies random draws of parameters from each probability distribution to solve the model.

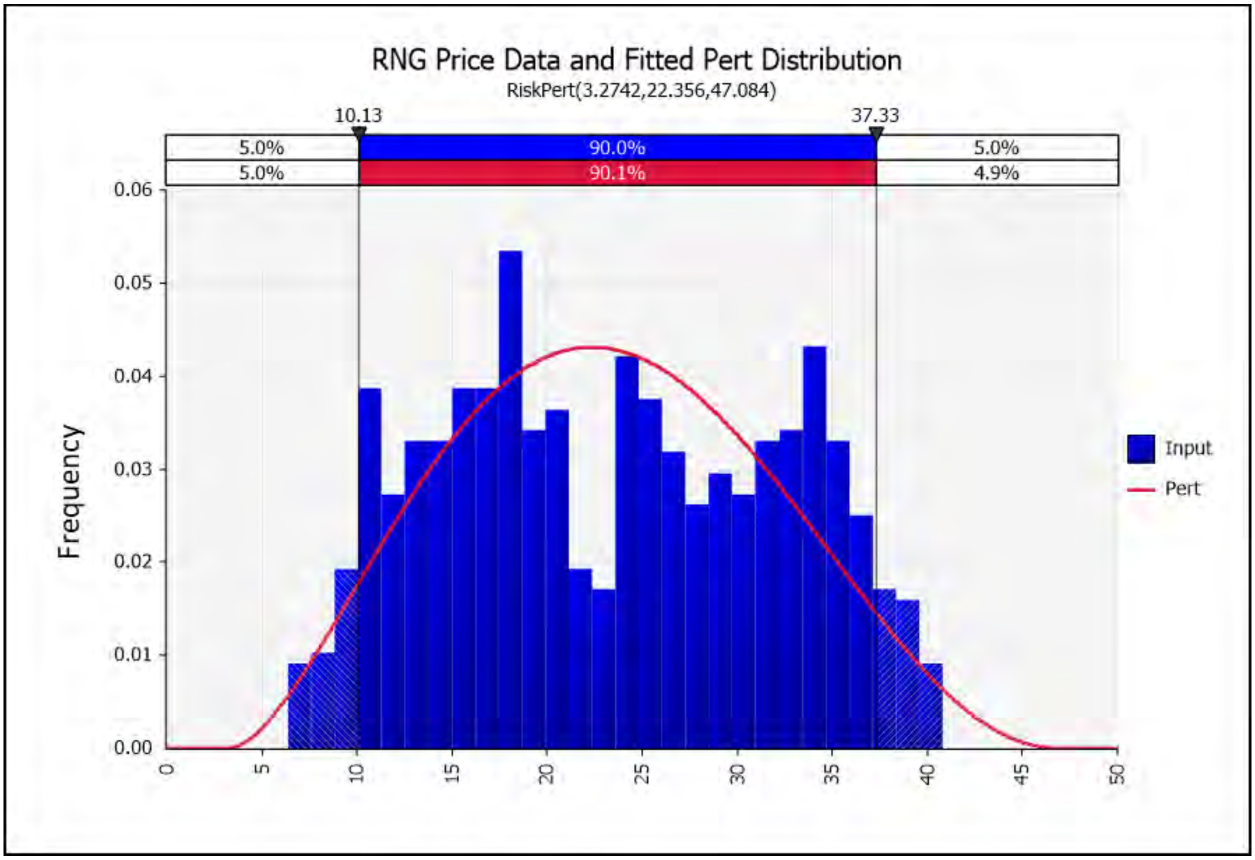
The parameter with the most significant influence on model results is RIN growth rates. The RIN distribution was estimated with a curve-fitting tool using the Palisade company's commercial @Risk software employed with Microsoft Excel. RIN prices for the past several years obtained from EPA records are shown in Figure 38. The curve-fitting approach assumes that all instances of RIN prices are independent of each other, as a group.[6] The resulting distribution is shown in Figure 39. The model uses the distribution to select a single annual price.

Figure 38: D3 RIN Prices (EPA)



[6] While trends may exist in the data, these were not evaluated at this stage. In fact, this approach is wider than the range of average annual values, which is how the data are used in the model.

Figure 39: Curve-fitted Probability Distribution of D3 RIN Prices



5.4.2 Simulation Results

Results from a Monte Carlo simulation are a probability distribution of possible outcomes, given the range of possible inputs of uncertain parameters. Figure 40 shows the distributions of possible present values of total financial and social outcomes for all five alternatives, in both probability density function (PDF) and cumulative density function (CDF).[7] The CDF has a useful interpretation for decision making because it can clearly indicate the probability that a condition holds, such as having a total present value of benefits exceeding costs.

[7] A PDF often appears to be bell-shaped; a CDF adds probabilities together for each value and appears as an S-curve.

Figure 40: Monte Carlo Simulation Results: Present Financial and Environmental Values of Alternatives

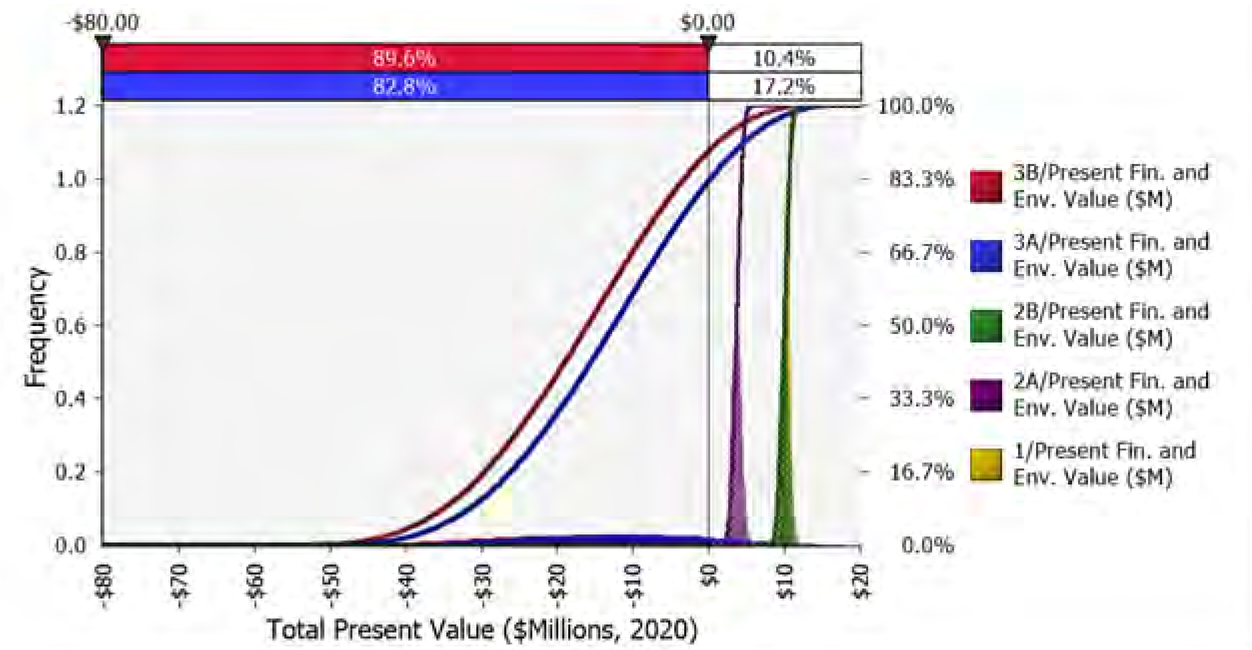
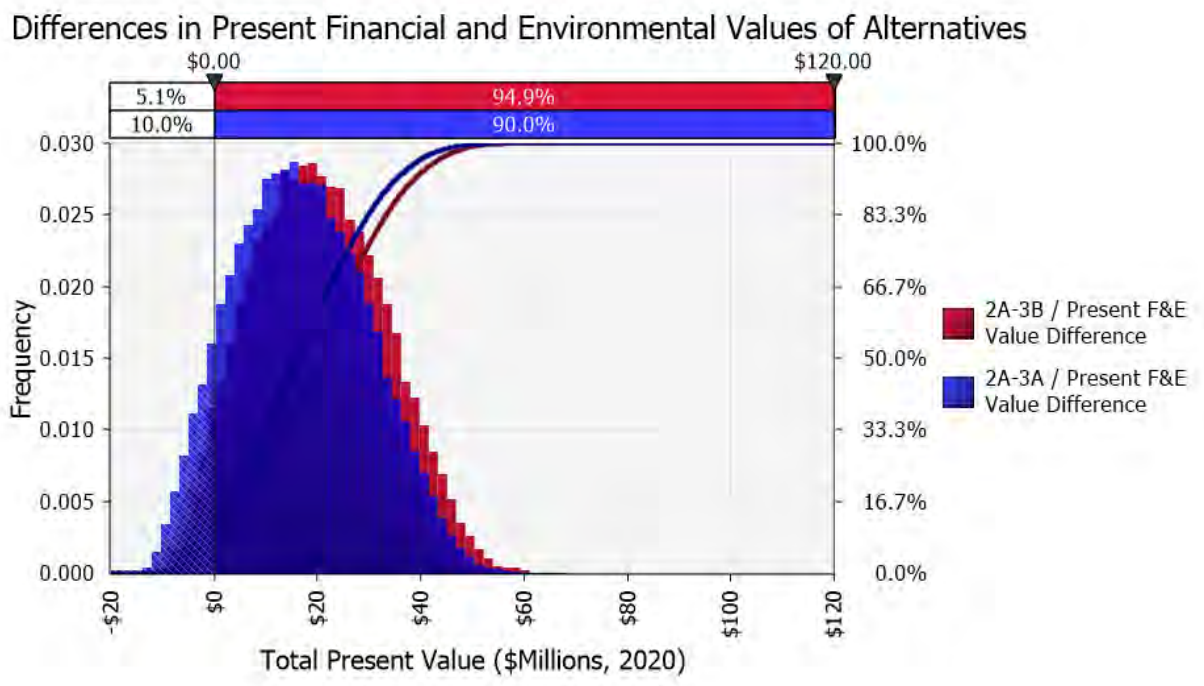


Figure 40 shows that Alternatives 1, 2A and 2B all have a very narrow range of potential financial values, and that these financial values are always positive (i.e., costs exceed benefits for the modeled parameters). Alternatives 3A and 3B have a wide range of potential financial values, which is a function of the uncertainty in the RNG market. However, even with the wide range, a majority of the model runs indicate a negative financial value (i.e., benefits exceed costs for the modeled parameters). Note, it is not a stated goal of the Program to be “cash positive” and many additional factors impact the overall Program cost. The analysis completed here is for the biogas utilization portion of the Program only.

A more direct comparison between alternatives can be performed by evaluating a distribution of the difference in present financial and social values. Figure 41 shows the results of the PDFs and CDFs of differences between Alternatives 2A and 3A, as well as Alternatives 2A and 3B. In both cases, there is a very low probability that the value of Alternative 2A would exceed that of Alternative 3A or 3B as shown on the top bar of Figure 41. For example, Alternative 2A has only a 5.1 percent chance of being a better value than Alternative 3B given the range of possible input values. Alternative 2A has a slightly better chance of being a better value than Alternative 3A, at 10 percent.

Figure 41: Monte Carlo Simulation Results: Differences in Present Financial and Environmental Values



6 Biogas Utilization Recommendation

Based on the analyses presented, the Water Pollution Control Bureau (WPCB) recommends proceeding with Alternative 3 (RNG) as the selected biogas utilization approach. The basis for this recommendation is as follows:

- The RNG alternatives have the lowest net present value (i.e., lowest total cost to the County) for the baseline conditions using conservative capital and operating costs.
- Alternative 3A (RNG into pipeline) scored the highest in the County's non-financial scoring. In particular, the County found that the RNG alternatives would be less complex and result in fewer localized impacts (noise and emissions) than the CHP alternatives.
- A sensitivity analysis concluded that when considering multiple variables, including RIN volatility and changes to electrical rates, Alternative 3A (RNG into pipeline) had a very high likelihood of being more financially advantageous than Alternative 2A.
- The County has the ability to retain GHG credits if the biogas is used within Arlington County for transportation purposes. Should the biogas be used outside of Arlington County, the revenue from the RINs could be used to purchase an equivalent amount of GHG credits on the open market.
- Biogas can be used on site for generation of steam in lieu of natural gas. This would slightly impact the financial analysis, as it would reduce the RNG being produced and the RINs generated. However, it would also eliminate the purchase of natural gas for the steam boilers and allow for effective use of the biogas if the RNG system is out of service.
- Benefits of on-site CHP are limited because the CHP size would not be sufficient to power the entire WPCP and the existing WPCP is already protected with two independent power feeds and backup generators.

Should the RFS program be terminated, CHP could be added at the WPCP in the future. In addition, the County is monitoring other programs - such as eRINs through the RFS and novel technologies that recover hydrogen and sequester carbon - that could be implemented in the future. The eRINs program could allow for the use of RNG off site for electrical generation to provide energy to electric vehicle fleets.

The County's current preference is for Alternative 3A (RNG into pipeline) over Alternative 3B (RNG as CNG) due to the uncertain future of ART and WMATA fueling stations and the lack of a match between fueling times and gas production times (resulting in the need for additional storage). However, the final decision to inject RNG into the NG utility pipeline or use CNG will be made in the future as more discussions with the stakeholders are conducted. Issues that need to be reviewed as the Program is further defined include the following:

- **Additional negotiations with the NG utility regarding offtake agreements, monitoring requirements, and cost of interconnection facilities:** The analysis made some assumptions regarding these items based on what is known today about the required gas specification and anticipated interconnection costs. These items need to be refined as the Program proceeds.

- **RNG market values:** While a sensitivity analysis was performed on the RNG market values based on historical values, these markets should be monitored closely in the future as they are impacted by political and regulatory pressures.
- **The long-term viability of ART and WMATA using RNG (as CNG) for fleet fueling:** Based on preliminary discussions, both transit systems have decarbonization goals, which adds risk to the CNG options. The NG utility has indicated that RNG can be part of its portfolio at the WPCP regardless of the ultimate decision for the CNG stations.

In addition to these items, a biogas conditioning technology needs to be selected for implementation. The financial analysis performed as part of Chapter 4 assumed the cost of membrane treatment, which is the most conservative capital cost. A detailed life-cycle cost, site visits, and discussions with equipment vendors are needed to make a final recommendation of the selected technology (refer to Appendix D for additional information on biogas conditioning).

APPENDICES

Appendix A

ART Fuel Specification

(/qs3/pubsys2/xml/en/manual/4021650/4021650-titlepage.html)

General Information

Cummins® natural gas engines provide a low emission alternative for various applications. In order for the engines to continually provide extremely low emission levels and provide the best durability and reliability, Cummins Inc. has developed several fuel standards. Operators of Cummins® natural gas engines should provide the standard or specification to the potential suppliers and request confirmation as to local availability.

For all Cummins® natural gas engines, the methane number based on Society of Automotive Engineers (SAE) 922359, and the higher or lower heating value (as appropriate) **must** equal or exceed those shown in the table below. As new ratings are developed and released, these values may change based on engine ratings.

These specifications apply to fuel as it is delivered to the engine, regardless of whether its origin was liquid or gaseous. Liquefied Natural Gas (LNG) is an acceptable fuel, provided the on-board fuel storage and supply system delivers proper pressure, temperature, and complete vaporization to the engine fuel system inlet. These specifications are **not** intended to cover certification requirements. The fuel **must not** contain water, dust, sand, dirt, oils, or any other substance or component in an amount that is detrimental to the operation of the engine. More specifications and test methods are detailed in these standards.

Cummins® natural gas engines are designed and adjusted to meet performance and emissions standards with fuel meeting these specifications. The engine may operate on fuels possessing a wide range of properties, but performance and emissions will be affected. In extreme cases, fuel with characteristics outside of these specifications can cause engine reliability or durability issues. Cummins Inc. assumes no responsibility for the use of fuels that do **not** meet these specifications. Engine damage caused by fuel **not** meeting these specifications is **not** covered by warranty.

Operators **must** be alert for sudden changes in engine operation, power levels, or the presence of knock. Each of these issues can be a sign of substandard fuel. If an issue related to fuel quality is suspected, ask the fuel supplier to sample and analyze the fuel in the vehicle. Contact a Cummins® Authorized Repair Location for information regarding calculating methane numbers, higher heating values, and lower heating values.

Fuel Standards for Cummins® Natural Gas Engines			
Standard	**Engine Family**		
	B5.9 G, C8.3 G	**ISB5.9 G B Gas International, B Gas Plus, C Gas Plus, L Gas Plus**	**ISL G ISX12 G**
Cummins® Engineering Standards (CES) 14604 Minimum Methane Number: 80 Minimum Higher Heating Value: 975 British Thermal Unit (BTU)/Standard Cubic Feet	Yes		
CES 14624 Minimum Methane Number: 75 Minimum Lower Heating Value: 37448.6 kJ/kg (16100 BTU/lbm)			Units 5054-5257 and 5281-5299 Yes
CES 14608 Minimum Methane Number: 65 Minimum Lower Heating Value: 37448.6 kJ/kg (16100 BTU/lbm)		Units 5258 - 5279 Yes	

The table below shows the basic chemical composition for CES 14604, CES14624, and CES 14608. More information for each standard will follow the chart.

Table 9: CES 14604, CES 14624, and CES 14608 Chemical Composition	
Constituents	**Test Method**
Methane (CH_4)	American Society of Testing and Materials (ASTM) D1945
Ethane (C_2H_6)	ASTM D1945

Table 9: CES 14604, CES 14624, and CES 14608 Chemical Composition	
Constituents	**Test Method**
Propane (C_3H_8)	ASTM D1945
Butane and Heavier (C_4H_{10}+)	ASTM D1945
Carbon Dioxide and Nitrogen (CO_2 + N_2)	ASTM D1945
Hydrogen (H_2)	ASTM D2650
Carbon Monoxide (CO)	ASTM D2650
Oxygen (O_2)	ASTM D1945
Sulfur (S)	Title 17 CCR Section 94112 Method 16

CES 14604 applies to B5.9 G and C8.3 G. For CES 14604, the methane number shall **not** be below 80 and the higher heating value shall **not** be below 975 BTU/Standard Cubic Foot. The methane number and higher heating value are calculated values. For more detail on CES 14604, contact an approved Cummins® authorized repair location.

CES 14624 applies to ISL G and ISX12 G. For CES 14624, the methane number shall **not** be below 75 and the lower heating value should **not** be below 16,100 BTU/lbm. The methane number and lower heating value are calculated values. For more detail on CES 14624, contact an approved Cummins® authorized repair location. The table below specifies the four constitutes in the natural gas mixture that **must** meet certain requirements to be used in the ISL G and ISX12 G engines.

CES 14608 applies to ISB5.9 G, B Gas International, B Gas Plus, C Gas Plus, and L Gas Plus engines. For CES 14608, the methane number shall **not** be below 65 and the lower heating value should **not** be below 16,100 BTU/lbm. The methane number and lower heating value are calculated values. For more detail on CES 14608, contact an approved Cummins® authorized repair location. The table below specifies the four constitutes in the natural gas mixture that **must** meet certain requirements to be used in ISB5.9 G, B Gas International, B Gas Plus, C Gas Plus, and L Gas Plus engines.

CES 14608 and CES 14624 Maximum Allowable Hydrogen, Hydrogen Sulfide, Sulfur, and Siloxanes		
Constituents	**Requirements**	**Test Method**
Hydrogen (H_2)	0.03 percent volume maximum	ASTM D2650
Hydrogen Sulfide (H_2S)	0.0006 percent volume maximum	ASTM D4084
Siloxanes	0.0003 percent volume maximum	Environmental Protection Agency (EPA) TO-14, 15 GC/ELCD,GC/AED, GC/MS

CES 14608 and CES 14624 Maximum Allowable Hydrogen, Hydrogen Sulfide, Sulfur, and Siloxanes		
Constituents	**Requirements**	**Test Method**
Sulfur (S)	0.001 percent weight maximum	Title 17 CCR Section 94112 Method 16

This table is an example using CES 14604 to determine if the fuel meets the fuel standards.

Test Fuel Data Input (See Notes at Right)			
Location (Description)		**Certified Fuel**	**Notes**
Methane	CH_4	90.20 percent	Fuel requirements for automotive spark-ignited gas engines **only**.
Ethane	C_2H_6	4.03 percent	Fuel as delivered to engine, regardless if liquid or gaseous.
Propane	C_3H_8	1.76 percent	The maximum allowable sulfur content is equal to 0.001 percent of the weight.
Butane	C_4H_{10}	0.01 percent	Fuel **must not** contain water, dust, sand, dirt, oils, or any substance that can harm the engine.
Pentane	C_5H_{12}	0.01 percent	
Hexane	C_6H_{14}	0.00 percent	
Heptane	C_7H_{16}	0.00 percent	
Octane	C_8H_{18}	0.00 percent	
Carbon Dioxide	CO_2	0.00 percent	
Nitrogen	N_2	3.99 percent	
Oxygen	O_2	0.00 percent	
Sum of Components		100 percent	
Methane Number:		89.76	**PASS** (Minimum Methane Number: 80)

Test Fuel Data Input (See Notes at Right)		
Location (Description)	**Certified Fuel**	**Notes**
Higher Heating Value (BTU/Standard Cubic Feet)	1024.50	**PASS** (Minimum Higher Heating Value is equal to 975 BTU/Standard Cubic Feet)

Note : Both the methane number and higher heating value criteria **must** be met to pass a given fuel.

L10 G		
CES 20067 Chemical Composition of Fuel		
Constituents	**Requirements**	**Test Method**
Methane (CH_4)	90.0 percent volume minimum	ASTM D1945
Ethane (C_2H_6)	4.0 percent volume maximum	ASTM D1945
Propane (C_3H_8)	1.7 percent volume maximum	ASTM D1945
Butane and Heavier (C_4H_{10}+)	0.7 percent volume maximum	ASTM D1945
Carbon Dioxide (CO_2)	3.0 percent volume maximum	ASTM D1945
Nitrogen (N_2)	3.0 percent volume maximum	ASTM D1945
Hydrogen (H_2)	0.1 percent volume maximum	ASTM D2650
Carbon Monoxide (CO)	0.1 percent volume maximum	ASTM D2650
Oxygen (O_2)	0.5 percent volume maximum	ASTM D1945
Sulfur (S)	0.001 percent weight maximum	Title 17 CCR, Section 94112, Method 16
Wobbe Index	1300 to 1377	ASTM D3588

For further details and discussion of fuels for Cummins® engines, refer to Fuels for Cummins® Engines, Bulletin 3379001 (/qs3/pubsys2/xml/en/bulletin/3379001.html).

This section presents the specifications for liquefied petroleum gas (LPG) engines.

CES 14612 and 14613 have been developed as a specification for LPG fueled engines. Operators of Cummins® LPG engines **must** refer the standard/specification to the potential fuel suppliers and request confirmation as to the local availability.

The requirements apply to fuel as it is delivered to the engine. This specification is **not** intended to cover certification requirements. The fuel **must not** contain water, dust, sand, dirt, oils, or any other substance or component in an amount that is detrimental to the operation of the engine. More specifications and testing methods are detailed in the standard.

- B5.9 LPG engines require fuels which conform to CES 14612.
- B LPG Plus engines include knock sensing and control. Fuels conforming to CES 14612 or CES 14613 can be used with these engines.

CES 14612 Chemical Composition		
Constituents	**Requirements**	**Test Method**
Propane (C_3H_8)	90.0 percent volume minimum	ASTM D 2163
Propylene (C_3H_6)	5.0 percent volume maximum	ASTM D 2163
Butane and Heavier (C_4H_{10}+)	2.5 percent volume maximum	ASTM D 2163
Hydrogen Sulfide (H_2S)	Pass	ASTM D 2420
Sulfur (S)	123 parts per million weight (ppmw)	ASTM D 2784
Oxygen (O_2)	0.5 percent weight maximum	ASTM D 1945
Carbon Dioxide and Nitrogen (CO_2 + N_2)	3.0 percent volume maximum	ASTM D 1945
Vapor Pressure with a gas temperature of 38°C [100°F]	1430 kPa [208 psig] maximum	ASTM D1267
Volatile residue temperature at 95% evaporation	-38.3°C [-37°F] maximum	ASTM D1837
Moisture Content	Pass	ASTM D2713
Copper corrosion strip test	Number 1 maximum	ASTM D1838

CES 14613 Chemical Composition		
Constituents	**Requirements**	**Test Method**
Propane (C_3H_8)	85.0 percent volume minimum	ASTM D 2163
Propylene (C_3H_6)	10.0 percent volume maximum	ASTM D 2163
Butane and Heavier (C_4H_{10}+)	5.0 percent volume maximum	ASTM D 2163
Hydrogen Sulfide (H_2S)	Pass	ASTM D 2420
Sulfur (S)	80 parts per million weight (ppmw)	ASTM D 2784

CES 14613 Chemical Composition		
Constituents	**Requirements**	**Test Method**
Vapor Pressure with a gas temperature of 38°C [100°F]	1430 kPa [208 psig] maximum	ASTM D1267
Volatile residue temperature at 95% evaporation	-38.3°C [-37°F] maximum	ASTM D1837
Moisture Content	Pass	ASTM D2713
Copper corrosion strip test	Number 1 maximum	ASTM D1838

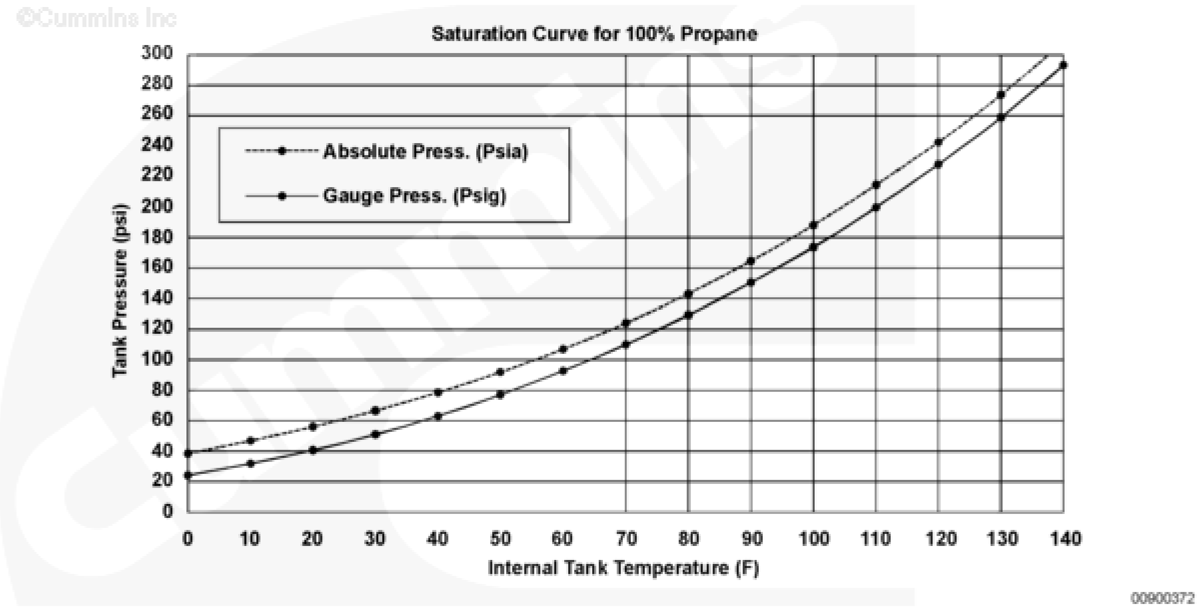
Cummins® LPG engines are designed and adjusted to meet performance and emissions standards with fuel meeting these specifications. The engine may be able to operate on fuels possessing a wide range of properties, but performance and emissions will be affected, and in extreme cases, fuel with characteristics outside of these specifications can cause engine reliability or durability issues. Cummins Inc. assumes no responsibility for the use of fuels that do **not** meet this specification. Engine damage caused by fuel **not** meeting this specification is **not** covered under warranty.

The vehicle supply hose to the engine **must** be approved for use with liquid phase propane (CGA Type III Approved). Engine damage, service issues, or performance issues that occur due to the use of other products are **not** considered a defect in workmanship or material as supplied by Cummins Inc. and can **not** be compensated under the Cummins Inc. warranty.

Operators **must** be alert for sudden changes in engine operation, power levels, or pre-ignition. Each of these can be a sign of substandard fuel. If you suspect an issue related to fuel quality, ask your fuel supplier to sample and analyze the fuel in the vehicle, or contact a Cummins® Authorized Repair Location for assistance.

Fuel pressure control is vital to proper engine operation. Liquid phase propane **must** be supplied to the engine at a steady pressure (+/- 5 psi) under all conditions (temperature and fuel flow rates). Fuel pressure will vary as a function of temperature. Fluctuations can **not** occur rapidly. Reference the engine data sheet for pressure and flow requirements.

For cold weather operation (less than 2°C [35°F]), a pressure assist fuel system may be needed to meet the fuel pressure requirements. The figure: Vehicle LPG Tank - Cold Ambient Effects, shows the pressure/temperature correlation for 100 percent propane.



Vehicle LPG Tank - Cold Ambient Effects

Last Modified: 18-Feb-2016

Appendix B

Detailed Energy Balance

Alternative		1	2A	2B	3A/3B	4A	4B
Description		Process and building heating	CHP with engines	CHP with gas turbine	RNG	RNG with engines	RNG with gas turbine
Thermal Efficiency							
Boilers		80%	80%	80%	80%	80%	80%
CHP							
Steam		0%	18%	50%	0%	18%	50%
Hot Water		0%	24%	0%	0%	24%	0%
Electrical Efficiency		0%	35%	25%	0%	35%	25%
Downtime							
CHP		0%	5%	10%	0%	5%	10%
RNG		0%	0%	0%	5%	5%	5%
RNG % Methane Use		0%	0%	0%	5%	5%	5%
Energy source/use	Unit						
Heat required total	MBH	3,560	3,560	3,560	3,560	3,560	3,560
Steam (hot)	MBH	3,060	3,060	3,060	3,060	3,060	3,060
Hot water							
Building	MBH	70	70	70	70	70	70
Boiler preheat	MBH	430	430	430	430	430	430
Steam total	MBH	3,490	3,490	3,490	3,490	3,490	3,490
Biogas production	MBH	14,870	14,870	14,870	14,870	14,870	14,870
Biogas used							
Boiler total	MBH	4,450	800	450	220	0	0
CHP	MBH	0	13,550	13,410	0	740	320
RNG	MBH	0	0	0	13,420	13,420	13,420
Waste gas flare	MBH	10,420	520	1,010	520	0	420
Tail gas combusted	MBH	0	0	0	710	710	710
Heat production	MBH	3,560	6,330	7,070	3,560	6,990	3,560
Boiler total	MBH	3,560	640	360	3,560	150	360
CHP							
Steam	MBH	0	2,440	6,710	0	2,930	3,200
Hot water	MBH	0	3,250	0	0	3,910	0
Capacity CHP	MBH	0	13,580	13,410	0	16,280	6,410
NG purchased, total	MBH	0	0	0	4,230	15,730	6,540
Boiler	MBH	0	0	0	4,230	340	450
CHP	MBH	0	0	0	0	15,390	6,090
Heating losses, total	MBH	890	3,280	3,440	44	3,745	1,602
Boiler	MBH	890	160	90	44	0	0
CHP	MBH	0	3,120	3,350	0	3,745	1,602
Unused heat	MBH	0	2,750	3,510	0	3,430	0
WPCP Electricity required	MBH	13,600	13,600	13,600	13,600	13,600	13,600
Electricity produced	MBH	0	4,740	3,350	0	5,699	1,602
Equivalent cap. CHP	MW	0	1.39	0.98	0	1.67	0.47
Electricity purchased	MBH	13,600	8,860	10,250	13,600	7,901	11,998

Appendix C

Dominion Energy Sustainability Report

Our Company

Metrics

Our story in numbers.

Environmental

Dominion Energy Portfolio

YEAR Baseline	2000 Baseline	2005	2015	2016	2017	2018	2019
Dominion Energy Virginia and Contracted Generation Owned Nameplate Generation Capacity at end of year (MW)	15,147	25,910	22,774	24,604	25,101	25,117	23,768
Coal	5,992	7,937	4,406	4,406	4,402	4,406	3,684
Natural Gas	1,800	7,107	7,836	9,256	9,297	9,187	8,413
Nuclear	3,253	5,726	5,349	5,349	5,349	5,349	5,349
Petroleum	2,476	3,219	2,171	2,171	2,168	2,155	2,143
Total Renewable Energy Resources	1,587	1,921	2,997	3,407	3,870	4,005	4,179
Biomass/Biogas		80	236	236	236	236	153
Geothermal							
Hydroelectric	1,587	1,841	2,120	2,126	2,126	2,124	2,124
Solar			359	763	1,226	1,363	1,752
Wind			282	282	282	282	150
Other	39		15	15	15	15	

Our Company

Metrics

YEAR Baseline	2000 Baseline	2005	2015	2016	2017	2018	2019
Dominion Energy South Carolina Owned Nameplate Generation Capacity at end of year (MW)	4,483	5,776	5,240	5,239	5,239	5,708	5,651
Coal	2,720	2,590	1,789	1,789	1,789	1,789	1,704
Natural Gas	372	1,719	2,004	2,003	2,003	2,507	2,513
Nuclear	635	644	647	647	647	647	650
Petroleum							
Total Renewable Energy Resources	756	823	800	800	800	765	784
Biomass/Biogas							
Geothermal							
Hydroelectric	756	823	800	800	800	765	784
Solar							
Wind							
Other							
Combined Owned Nameplate Generation Capacity at end of year (MW)	19,630	31,686	28,014	29,843	30,340	30,825	29,419
Coal	8,712	10,527	6,195	6,195	6,191	6,195	5,388
Natural Gas	2,172	8,826	9,840	11,259	11,300	11,694	10,926
Nuclear	3,888	6,370	5,996	5,996	5,996	5,996	5,999
Petroleum	2,476	3,219	2,171	2,171	2,168	2,155	2,143
Total Renewable Energy Resources	2,343	2,744	3,797	4,207	4,670	4,770	4,963
Biomass/Biogas		80	236	236	236	236	153
Geothermal							
Hydroelectric	2,343	2,664	2,920	2,926	2,926	2,889	2,908
Solar			359	763	1,226	1,363	1,752
Wind			282	282	282	282	150
Other	39		15	15	15	15	

Dominion Energy

Our Company

Metrics

YEAR	2000 Baseline	2005 Baseline	2015	2016	2017	2018	2019
Dominion Energy Virginia and Contracted Net Generation Production for the data year (MWH)	71,536,133	109,328,723	98,455,046	108,368,094	102,060,029	100,659,937	94,855,233
Coal	37,772,810	51,607,246	22,613,052	21,947,757	15,376,307	12,302,427	7,177,447
Natural Gas	3,698,671	7,728,873	28,858,084	38,370,996	37,654,007	38,838,261	38,386,925
Nuclear	26,552,901	44,164,092	42,888,281	43,951,909	44,548,239	43,541,335	43,833,345
Petroleum	3,021,949	4,710,344	847,768	459,162	271,644	626,111	123,323
Total Renewable Energy Resources	489,802	1,118,168	3,247,861	3,638,270	4,209,832	5,351,803	5,334,193
Biomass/Biogas		540,007	1,193,180	1,266,746	1,163,454	1,196,101	1,007,679
Geothermal							
Hydroelectric	489,802	578,161	613,069	771,100	488,627	850,529	690,754
Solar			747,748	934,322	1,983,498	2,686,996	3,037,885
Wind			693,864	666,103	574,253	618,177	597,876
Other							
Dominion Energy South Carolina Net Generation Production for the data year (MWH)	22,459,240	25,493,722	23,282,862	22,793,374	22,016,656	23,523,302	23,223,220
Coal	17,501,201	17,867,835	10,352,062	8,565,143	8,760,962	8,580,257	6,481,671
Natural Gas	90,882	2,063,550	7,477,292	7,892,092	8,178,640	9,519,949	10,970,384
Nuclear	4,240,198	4,979,600	4,743,582	5,772,294	4,610,254	4,910,880	5,483,003
Petroleum							
Total Renewable Energy Resources	626,959	582,737	709,926	563,845	466,800	512,217	288,162
Biomass/Biogas	382,880	154,836	321,718	312,548	305,081	150,181	
Geothermal							
Hydroelectric	244,079	427,901	388,208	251,297	161,719	362,036	288,162
Solar							
Wind							
Other							

Metrics

YEAR	2000 Baseline	2005 Baseline	2015	2016	2017	2018	2019
Combined Net Generation Production for the data year (MWH)	93,995,373	134,822,445	121,737,908	131,161,469	124,076,685	124,183,240	118,078,453
Coal	55,274,011	69,475,081	32,965,114	30,512,900	24,137,269	20,882,684	13,659,118
Natural Gas	3,789,553	9,792,423	36,335,376	46,263,088	45,832,647	48,358,209	49,357,309
Nuclear	30,793,099	49,143,692	47,631,863	49,724,203	49,158,493	48,452,215	49,316,348
Petroleum	3,021,949	4,710,344	847,768	459,162	271,644	626,111	123,323
Total Renewable Energy Resources	1,116,761	1,700,905	3,957,788	4,202,116	4,676,632	5,864,020	5,622,355
Biomass/Biogas	382,880	694,843	1,514,898	1,579,294	1,468,535	1,346,282	1,007,679
Geothermal							
Hydroelectric	733,881	1,006,062	1,001,277	1,022,397	650,346	1,212,565	978,916
Solar			747,748	934,322	1,983,498	2,686,996	3,037,885
Wind			693,864	666,103	574,253	618,177	597,876
Other							

YEAR	2017	2018	2019
Miles Distribution Lines-Electric (regulated utility)	58,277	58,300	85,000
Miles Transmission Lines-Electric (regulated utility) Includes circuit miles, including overhead and underground lines	6,600	6,700	10,400

Air[1]

YEAR	2000 Baseline	2005 Baseline	2015	2016	2017[2]	2018[3]	2019
Carbon Emissions Dominion Energy Virginia & Contracted Generation							
Total generation (net MWh) (by ownership)	71,536,133	109,328,723	98,455,046	108,368,094	102,060,029	100,659,937	94,855,233
Total CO_2 emissions (MT) (by ownership)	41,989,458	57,262,200	33,761,475	36,659,419	29,945,097	27,659,008	21,854,373
CO_2 intensity rate (MT/net MWh) (by ownership)	0.587	0.524	0.343	0.338	0.293	0.275	0.230
Total CO_2e emissions (MT) (by ownership)	42,298,827	58,025,709	34,253,305	37,186,655	30,155,246	27,763,387	21,982,856
CO_2e intensity rate (MT/net MWh) (by ownership)	0.591	0.531	0.348	0.343	0.295	0.276	0.232

[1] Reported carbon emissions (CO_2) includes emissions from electric generating units (EGUs). Carbon equivalent emissions (CO_2e) includes emissions from EGUs and other minor combustion sources, such as ancillary and auxiliary equipment, associated with electric generation operations. Note: This excludes sulfur hexafluoride reported as CO_2e, which includes emissions from power delivery transmission and delivery operations.

[2] By way of clarification and transparency, the company is restating its 2017 emissions as a result of a calculation update.

[3] By way of clarification and transparency, the company is restating its 2018 intensity rate as a result of updated MWhs.

Air[1] (continued)

YEAR	2000 Baseline	2005 Baseline	2015	2016	2017[2]	2018[3]	2019
Carbon Emissions Dominion Energy South Carolina							
Total generation (net MWh) (by ownership)	22,459,240	25,493,722	23,282,862	22,793,374	22,016,656	23,523,302	23,223,220
Total CO_2 emissions (MT) (by ownership)	16,115,664	17,035,669	12,008,478	11,081,704	11,426,554	11,522,827	9,820,746
CO_2 intensity rate (MT/net MWh) (by ownership)	0.718	0.668	0.516	0.486	0.519	0.490	0.423
Total CO_2e emissions (MT) (by ownership)	17,727,230	18,739,236	12,087,352	10,930,629	11,494,249	11,644,685	9,907,987
CO_2e intensity rate (MT/net MWh) (by ownership)	0.789	0.735	0.519	0.480	0.522	0.495	0.427
Carbon Emissions Combined							
Total generation (net MWh) (by ownership)	93,995,373	134,822,445	121,737,908	131,161,469	124,076,685	124,183,240	118,078,453
Total CO_2 emissions (MT) (by ownership)	58,105,122	74,297,869	45,769,953	47,741,123	41,371,652	39,181,835	31,675,119
CO_2 intensity rate (MT/net MWh) (by ownership)	0.618	0.551	0.376	0.364	0.333	0.316	0.268
Total CO_2e emissions (MT) (by ownership)	60,026,057	76,764,945	46,340,656	48,117,284	41,649,495	39,408,072	31,890,844
CO_2e intensity rate (MT/net MWh) (by ownership)	0.639	0.569	0.381	0.367	0.336	0.317	0.270

Air[1] (continued)

YEAR	2000 Baseline	2005 Baseline	2015	2016	2017[2]	2018[3]	2019
Purchased Power[4] Emissions (Net MWH) Dominion Energy Virginia	16,753,741	18,987,726	14,656,975	7,486,404	13,419,239	18,600,961	15,607,678
Total Purchased Generation CO_2 Emissions (MT)	12,159,115	13,780,442	10,637,376	5,443,297	8,399,959	10,968,543	8,637,107
Total Purchased Generation CO_2 Emissions Intensity (MT/Net MWH)	0.73	0.73	0.73	0.73	0.63	0.59	0.55
Carbon Dioxide Equivalent (CO_2e)							
Total Purchased Generation CO_2e Emissions (MT)	13,604,038	15,418,034	11,901,464	6,078,960	9,239,955	12,065,397	9,500,818
Total Purchased Generation CO_2e Emissions Intensity (MT/Net MWH)	0.812	0.812	0.812	0.812	0.69	0.65	0.61
Purchased Power[5] Emissions (Net MWH) Dominion Energy South Carolina	2,338,904	831,683	1,219,892	1,986,931	2,195,328	1,332,503	1,144,067
Total Purchased Generation CO_2 Emissions (MT)	1,547,978	478,330	535,759	942,564	971,451	161,986	114,343
Total Purchased Generation CO_2 Emissions Intensity (MT/Net MWH)	0.662	0.575	0.439	0.474	0.443	0.122	0.100
Carbon Dioxide Equivalent (CO_2e)							
Total Purchased Generation CO_2e Emissions (MT)	1,702,776	526,163	589,335	1,036,821	1,068,596	178,185	114,974
Total Purchased Generation CO_2e Emissions Intensity (MT/Net MWH)	0.73	0.63	0.48	0.52	0.49	0.13	0.10
Purchased Power Emissions (Net MWH) Combined	19,092,645	19,819,409	15,876,867	9,473,335	15,614,567	19,933,464	16,751,745
Total Purchased Generation CO_2 Emissions (MT)	13,707,093	14,258,772	11,173,135	6,385,861	9,371,410	11,130,529	8,751,450
Total Purchased Generation CO_2 Emissions Intensity (MT/Net MWH)	0.72	0.72	0.70	0.67	0.60	0.56	0.52
Carbon Dioxide Equivalent (CO_2e)							
Total Purchased Generation CO_2e Emissions (MT)	15,306,814	15,944,197	12,490,799	7,115,781	10,308,551	12,243,582	9,615,792
Total Purchased Generation CO_2e Emissions Intensity (MT/Net MWH)	0.80	0.80	0.79	0.75	0.66	0.61	0.57

[4]DEVA Purchased power and non-utility generators (NUGs) emissions are calculated based on PJM's CO_2 Emissions Intensity Factor published annually. CO_2e calculated using a conversion factor.

[5]DESC Purchased power emissions are calculated using EPA's eGRID (https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid) factors for the North American Electric Reliability Corporation (NERC) subregion. CO_2e calculated using a conversion factor.

Air[1] (continued)

YEAR	2000 Baseline	2005 Baseline	2015	2016	2017[2]	2018[3]	2019
Owned Generation + Purchased Power[4] Emissions (Net MWH) Dominion Energy Virginia & Contracted Generation	88,289,874	128,316,449	113,112,021	115,854,498	115,479,268	119,260,898	110,462,911
Total Owned + Purchased Generation CO_2 Emissions (MT)	54,148,573	71,042,641	44,398,851	42,102,716	38,345,056	38,627,551	30,491,480
Total Owned + Purchased Generation CO_2 Emissions Intensity (MT/Net MWH)	0.613	0.554	0.393	0.363	0.332	0.324	0.276
Carbon Dioxide Equivalent (CO_2e)							
Total Owned + Purchased Generation CO_2e Emissions (MT)	56,223,338	73,443,743	46,154,769	43,265,615	39,395,201	39,828,784	31,483,674
Total Owned + Purchased Generation CO_2e Emissions Intensity (MT/Net MWH)	0.637	0.572	0.408	0.373	0.341	0.334	0.285
Owned Generation + Purchased Power[5] Emissions (Net MWH) Dominion Energy South Carolina	24,798,144	26,325,405	24,502,754	24,780,305	24,211,984	24,855,805	24,367,287
Total Owned + Purchased Generation CO_2 Emissions (MT)	17,663,642	17,513,999	12,544,237	12,024,268	12,398,005	11,684,813	9,935,089
Total Owned + Purchased Generation CO_2 Emissions Intensity (MT/Net MWH)	0.712	0.665	0.512	0.485	0.512	0.470	0.408
Carbon Dioxide Equivalent (CO_2e)							
Total Owned + Purchased Generation CO_2e Emissions (MT)	31,331,268	19,265,399	12,676,687	11,967,450	12,562,845	11,822,870	10,022,961
Total Owned + Purchased Generation CO_2e Emissions Intensity (MT/Net MWH)	1.263	0.732	0.517	0.483	0.519	0.476	0.411
Owned Generation + Purchased Power[2] Emissions (Net MWH) Combined	113,088,018	154,641,854	137,614,775	140,634,804	139,691,252	144,116,704	134,830,198
Total Owned + Purchased Generation CO_2 Emissions (MT)	71,812,215	88,556,641	56,943,089	54,126,984	50,743,062	50,312,364	40,426,569
Total Owned + Purchased Generation CO_2 Emissions Intensity (MT/Net MWH)	0.635	0.573	0.414	0.385	0.363	0.349	0.300
Carbon Dioxide Equivalent (CO_2e)							
Total Owned + Purchased Generation CO_2e Emissions (MT)	87,554,606	92,709,142	58,831,455	55,233,064	51,958,046	51,651,654	41,506,635
Total Owned + Purchased Generation CO_2e Emissions Intensity (MT/Net MWH)	0.774	0.600	0.428	0.393	0.372	0.358	0.308

[4]DEVA Purchased power and non-utility generators (NUGs) emissions are calculated based on PJM's CO_2 Emissions Intensity Factor published annually. CO_2e calculated using a conversion factor.

[5]DESC Purchased power emissions are calculated using EPA's eGRID (https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid) factors for the North American Electric Reliability Corporation (NERC) subregion. CO_2e calculated using a conversion factor.

Metrics

Air[1] (continued)

YEAR	2015	2016	2017[2]	2018[3]	2019
Methane Emissions Dominion Energy					
Methane Emissions from Gas Operations* (MT)	53,328	60,838	62,625	63,543	59,996
Methane Emissions Dominion Energy South Carolina					
Methane Emissions from Gas Operations* (MT)	3,621	3,771	3,958	3,905	3,910
Methane Emissions Combined					
Methane Emissions from Gas Operations* (MT)	56,949	64,609	66,583	67,448	63,906

*As reported in EPA's GHG reporting program. In 2016, Dominion Energy began reporting additional emissions from pipeline blowdowns, gathering and boosting as part of EPA's reporting program.

YEAR	2000 Basline	2005 Baseline	2015	2016	2017[2]	2018[3]	2019
Other Air Emissions Dominion Energy Virginia & Contracted Generation							
Nitrogen oxide, sulfur dioxide and mercury generation basis for calculation (MWH)	71,421,615	108,511,203	97,958,771	108,050,001	101,775,887	100,374,893	94,710,520
Nitrogen oxide emissions (MT) (by ownership)	132,895	101,106	15,361	13,883	10,559	10,621	7,121
Nitogen oxide emissions intensity (MT/net MWH) (by ownership)	0.001861	0.000932	0.000157	0.000128	0.000104	0.000106	0.000075
Sulfur dioxide emissions (MT) (by ownership)	372,732	283,213	12,921	9,665	5,490	7,439	2,956
Sulfur dioxide emissions intensity (MT/net MWH) (by ownership)	0.005219	0.002610	0.000132	0.000089	0.000054	0.000074	0.000031
Mercury emissions (kg) (by ownership)	2,194	931	54	52	32	31	33
Mercury emissions intensity (kg/net MWH) (by ownership)	0.0000307	0.0000086	0.0000006	0.0000005	0.0000003	0.0000003	0.0000004
Sulfur hexafluoride (MT)			2.36	1.9	1.66	1.75	1.68
CO_2e of sulfur hexafluoride (MT)			53,819	42,847	37,841	39,900	38,338

Air[1] (continued)

YEAR	2000 Baseline	2005 Baseline	2015	2016	2017[2]	2018[3]	2019
Other Air Emissions Dominion Energy South Carolina							
Nitrogen oxide, sulfur dioxide and mercury generation basis for calculation (MWH)	22,459,240	25,493,722	23,282,862	22,793,374	22,016,656	23,523,302	23,223,220
Nitrogen oxide emissions (MT) (by ownership)	165,190	125,517	20,582	18,795	15,743	15,749	12,094
Nitogen oxide emissions intensity (MT/net MWH) (by ownership)	0.007355	0.004923	0.000884	0.000825	0.000715	0.000670	0.000521
Sulfur dioxide emissions (MT) (by ownership)	432,702	354,976	16,309	11,181	7,449	9,031	4,326
Sulfur dioxide emissions intensity (MT/net MWH) (by ownership)	0.019266	0.013924	0.000700	0.000491	0.000338	0.000384	0.000186
Mercury emissions (kg) (by ownership)	1,253	1,034	63	59	40	42	42
Mercury emissions intensity (kg/net MWH) (by ownership)	0.0000558	0.0000406	0.0000027	0.0000026	0.0000018	0.0000018	0.0000018
Sulfur hexafluoride (MT)			0.521	0.457	0.167	0.542	0.467
CO_2e of sulfur hexafluoride (MT)			11,455	10,049	3,678	11,914	10,265
Other Air Emissions Combined							
Nitrogen oxide, sulfur dioxide and mercury generation basis for calculation (MWH)	93,880,855	134,004,925	121,241,633	130,843,375	123,792,543	123,898,196	117,933,740
Nitrogen oxide emissions (MT) (by ownership)	298,085	226,623	35,943	32,678	26,302	26,370	19,214
Nitogen oxide emissions intensity (MT/net MWH) (by ownership)	0.003175	0.001691	0.000296	0.000250	0.000212	0.000213	0.000163
Sulfur dioxide emissions (MT) (by ownership)	805,434	638,189	29,230	20,846	12,939	16,470	7,282
Sulfur dioxide emissions intensity (MT/net MWH) (by ownership)	0.008579	0.004762	0.000241	0.000159	0.000105	0.000133	0.000062
Mercury emissions (kg) (by ownership)	3,447	1,965	117	111	72	73	76
Mercury emissions intensity (kg/net MWH) (by ownership)	0.0000367	0.0000147	0.0000010	0.0000008	0.0000006	0.0000006	0.0000006
Sulfur hexafluoride (MT)			2.881	2.357	1.827	2.292	2.148
CO_2e of sulfur hexafluoride (MT)			65,274	52,896	41,519	51,814	48,604

Water

YEAR	2000 Baseline	2005 Baseline	2015	2016	2017	2018	2019
Dominion Energy Virginia							
Water reused/recycled (million liters) (by ownership)			2,097	5,598	5,066	4,194,700	3,139,995
Water reused/recycled (million liters/net MWH) (by ownership)			0.00002	0.00005	0.00005	0.041	0.033
Fresh water withdrawn (billion liters)			7,984	7,760	7,625	6,885	6,815
Fresh water consumed (billion liters)			33.2	38	29	16.7	20
Water withdrawals - consumptive (billion liters/net MWH)	0.0000006	0.00000007	0.00000026	0.0000004	0.00000003	0.00000017	0.00000021
Water withdrawals - non-consumptive (billion liters/net MWH)	0.000142	0.000133	0.000082	0.0000703	0.000074	0.000068	0.000072
Dominion Energy South Carolina							
Water reused/recycled (million liters) (by ownership)			3,186,805	6,193,075	4,997,274	5,457,708	5,804,755
Water reused/recycled (million liters/net MWH) (by ownership)			0.27	0.62	0.48	0.47	0.59
Fresh water withdrawn (billion liters)			1,896	1,770	1,435	1,777	1,807
Fresh water consumed (billion liters)			18.1	17.7	18.9	16.2	5.3
Water withdrawals - consumptive (billion liters/net MWH)			0.00000074	0.00000071	0.00000078	0.00000069	0.00000023
Water withdrawals - non-consumptive (billion liters/net MWH)			0.000077	0.000071	0.000059	0.000071	0.000078
Combined							
Water reused/recycled (million liters) (by ownership)			3,188,902	6,198,673	5,002,340	9,652,408	8,944,750
Water reused/recycled (million liters/net MWH) (by ownership)			0.27	0.62	0.48	0.51	0.62
Fresh water withdrawn (billion liters)			9,880	9,530	9,060	8,662	8,622
Fresh water consumed (billion liters)			51.3	55.7	47.9	32.9	25.3
Water withdrawals - consumptive (billion liters/net MWH)			0.00000042	0.00000042	0.00000039	0.00000026	0.00000021
Water withdrawals - non-consumptive (billion liters/net MWH)			0.000081	0.000073	0.000073	0.000069	0.000073

*The significant increase is due to the inclusion of Bath County Pumped Storage and the Nuclear facilities that withdrawal/discharge water from the same source as reused/recycled water, in addition to improved accounting.

Dominion Energy

Recycled and Reused Materials

YEAR	2015	2016	2017	2018	2019
Dominion Energy					
Coal combustion byproducts (tons)*	776,765	718,257	433,927	340,695	399,901
Gypsum (tons)	193,747	191,071	110,503	97,157	319,516
Biomass combustion products (tons)	13,896	7,473	7,110	6,564	13,066
Oils, fluids for reclamation/recovery (tons)	10,241	12,335	11,151	10,481	832
Scrap metals (tons)	8,145	20,553	17,661	18,973	15,431
Paper, cardboard, plastic, glass (tons)	721	495	528	724	4,543
E-waste (tons)	14	34	50	54	4.41
Dominion Energy South Carolina					
Coal combustion byproducts (tons)*	474,139	538,330	507,294	377,973	387,769
Gypsum (tons)	135,481	129,626	129,835	48,851	159,401
Biomass combustion products (tons)	0	0	0	0	0
Oils, fluids for reclamation/recovery (tons)	1,071	916	787	861	564
Scrap metals (tons)	11,694	17,273	5,273	3,415	4,911
Paper, cardboard, plastic, glass (tons)	499	544	540	493	614
E-waste (tons)	22.26	17.06	12.14	16.25	41.90
Combined					
Coal combustion byproducts (tons)*	1,250,904	1,256,587	941,221	718,668	787,670
Gypsum (tons)	329,228	320,697	240,338	146,008	478,917
Biomass combustion products (tons)	13,896	7,473	7,110	6,564	13,066
Oils, fluids for reclamation/recovery (tons)	11,312	13,251	11,938	11,342	1,397
Scrap metals (tons)	19,839	37,826	22,934	22,388	20,342
Paper, cardboard, plastic, glass (tons)	1,220	1,039	1,068	1,217	5,157
E-waste (tons)	36.26	51.06	62.14	70.25	46.31

*The amount of CCB material recycled includes material from newly generated CCB, reuse of deposited material, and material from storage unit closures.

Other

YEAR	2015	2016	2017	2018	2019
Dominion Energy					
Coal ash produced / reused (million tons) (by ownership)	3.3/0.6	3.2/0.5	2.53/0.5	2.21/0.34	1.2/0.08
Coal combustion byproducts produced / reused (million tons) (by ownership)	3.4/0.8	3.4/0.7	2.53/0.5	2.31/0.44	1.62/0.4
Percent of coal combustion byproducts reused / recycled (by ownership)	24%	21%	20%	19%	25%
Hazardous waste produced (million lbs) (by ownership)	2.39	3.67	3.56	3.72	11.1
Notices of violation (NOVs)	12	11	15	18	19
Environmental penalties paid	$447,732	$404,415	$175,124	$485,111	$168,200
Dominion Energy South Carolina					
Coal ash produced / reused (million tons) (by ownership)	0.42/0.34	0.38/0.4	0.44/0.37	0.43/0.33	0.29/0.23
Coal combustion byproducts produced / reused (million tons) (by ownership)	0.59/0.47	0.53/0.54	0.59/0.51	0.61/0.38	0.4/0.39
Percent of coal combustion byproducts reused / recycled (by ownership)	81%	101%*	86%	62%	98%
Hazardous waste produced (million lbs) (by ownership)	< 0.05	0.015	0.044	0.016	0.005
Notices of violation (NOVs)	2	1	2	0	1
Environmental penalties paid	$0	$0	$3,200	$0	$10,000
Combined					
Coal ash produced / reused (million tons) (by ownership)	3.7/0.9	3.5/0.9	2.9/0.8	2.6/0.6	1.5/0.3
Coal combustion byproducts produced / reused (million tons) (by ownership)	3.99/1.27	3.9/1.2	3.1/1.0	2.9/0.78	2.01/0.79
Percent of coal combustion byproducts reused / recycled (by ownership)	32%	31%	32%	27%	39%
Hazardous waste produced (million lbs) (by ownership)	2.39	3.69	3.60	3.74	11.10
Notices of violation (NOVs)	14	12	17	18	20
Environmental penalties paid	$447,732	$404,415	$178,324	$485,111	$178,200

*The amount of CCB material recycled includes material from newly generated CCB, reuse of deposited material, and material from storage unit closures.

Appendix D

Biogas Conditioning Technical Memo

Technical Memorandum No. 16

Date:	November 30, 2022
Project:	Arlington County Biosolids Program Management Services
To:	Mary Strawn Lisa Racey
From:	HDR
Subject:	Biogas Conditioning Evaluation

Contents

Tables

Figures

1.0 Introduction

This introductory section presents the background and purpose of this project and the biogas conditioning evaluation, followed by a description of the evaluation approach.

1.1 Background and Purpose

Arlington County (County) is implementing a program of biosolids management improvements at the Arlington Water Pollution Control Plant (WPCP). Currently, solids handling includes primary sludge (PS) and waste activated sludge (WAS) thickening, dewatering, and Class B lime stabilization of undigested solids. Planned improvements will replace the existing lime stabilization process with a Class A THP and anaerobic digestion, as recommended in the 2018 Solids Master Plan report (Master Plan) for the WPCP.

The purpose of this biogas conditioning evaluation is to further assess requirements and technologies for biogas conditioning. The results of this evaluation will inform a final decision on which technology will be chosen for biogas conditioning.

1.2 Evaluation Approach

A suite of alternatives using various biogas conditioning technologies was developed. Conceptual process conditions, configurations, cooling technology sizing, and conceptual operation costs were prepared and then presented and reviewed at the July 22, 2021 and August 30, 2021 project workshops with the County. In this evaluation, the technologies are evaluated and compared based on budgetary capital equipment costs, conceptual operating cost estimates, and non-cost considerations including space requirements and noise. A 20-year life-cycle cost analysis was also completed.

2.0 Biogas Conditioning

The level of biogas conditioning required is directly related to the end use of the biogas. With the recommended alternative of upgrading the biogas to renewable natural gas, the required biogas conditioning will include H_2S, moisture, siloxane, carbon dioxide, and volatile organic compound (VOC) removal with compression and tail gas disposal. Emergency biogas disposal will be through a waste gas flare.

2.1 Hydrogen Sulfide Removal

Hydrogen sulfide removal would be required for any of the gas utilization alternatives considered. When hydrogen sulfide (H_2S) is combusted (either onsite in boilers or engines or offsite as RNG), sulfur dioxide forms. This can condense into sulfuric acid with the presence of water vapor and cause significant corrosion issues. Removing H_2S prior to combustion reduces the likelihood of corrosion. Hydrogen sulfide is typically removed by precipitating the dissolved sulfide in the anaerobic digesters (thus preventing its formation in the biogas) or by directly removing the hydrogen sulfide from the biogas in a biogas scrubber. Removal with biogas scrubbers requires the gas to be fully saturated with moisture to reduce safety concerns (fires) associated with the exothermic nature of the treatment process. Therefore, hydrogen sulfide is normally the first constituent removed from raw biogas in traditional biogas uses as the raw biogas is fully saturated,

The Arlington WPCP currently uses iron salt addition, in the form of ferric chloride ($FeCl_3$), to provide chemical phosphorus removal in the liquid stream process. $FeCl_3$ is added at multiple locations in the process including the primary clarifiers and secondary clarifiers to precipitate dissolved orthophosphate, which ends up in the solids treatment train. At the current high dosage levels, it is anticipated that a significant amount of dissolved hydrogen sulfide in the digesters will also be precipitated along with the phosphate, which will significantly lower the H_2S concentrations in the biogas. If this practice continues, the H_2S concentrations in the biogas may be below 200 ppm, in which case no further removal would be required for any of the alternatives. However, if the facility were to move away from chemical phosphorus removal to an enhanced biological phosphorus removal (EBPR) approach, hydrogen sulfide concentrations would increase and additional treatment would be required. For the purposes of this alternative, H_2S removal is retained in all alternatives. Pilot testing currently being conducted by Virginia Tech will provide data on potential H_2S concentrations in the biogas and ultimately inform the final design.

2.1.1 Precipitation with Iron Salt Addition

Iron salts combine chemically with dissolved sulfide to form relatively insoluble metal sulfides that precipitate from the wastewater, thus preventing the release of H_2S gas. Iron sulfide precipitates exist as soft, black, or reddish-brown flocs that usually do not settle well in the collection system but are easily removed at treatment plants. Sulfur precipitation with iron salts has the following advantages and disadvantages:

- Advantages:
  - Long residuals can be maintained to precipitate sulfides as they are generated.
  - Iron salts Iron salts can be used to treat sludge or full wastewater flows.
  - Reaction by-products are harmless.
  - The precipitates are beneficial to downstream treatment processes because they help increase settling and remove phosphorus.
- Disadvantages:
  - Precipitates can dissociate at lower pH levels (less than 6.5), allowing sulfides to release back into the wastewater.
  - Dissolved sulfide cannot be decreased to much lower than 0.2 to 0.5 milligram per liter (mg/L) using iron salts.
  - Iron salts can form a film on pipe walls, instrument sensors, and ultraviolet treatment equipment.
  - Precipitates increase sludge production.

As stated previously, the Arlington WPCP currently uses iron salt addition, in the form of FeCl3, to provide chemical phosphorus removal in the liquid stream process. A stoichiometric dose of 3.3 to 4.9 pounds of FeCl3 is required per pound of sulfide. However, field and laboratory experiments indicate that the typical required dose to remove sulfide in domestic wastewater is between 3 and 7 pounds of FeCl3 per pound of sulfide removed. In the near term, it is anticipated that the WPCP will continue to utilize FeCl3 optimized for phosphorus (not sulfide removal). Impacts of this $FeCl_3$ dosing strategy on biogas H_2S removal will be evaluated in on-going pilot tests with Virginia Tech.

2.1.2 Adsorptive Media

Adsorptive media is commonly used to remove hydrogen sulfide from biogas ahead of downstream unit processes. Hydrogen sulfide is removed by chemical adsorption in the fixed-media vessel using metal oxides. Common media types include iron sponge, Sulfatreat™, and other proprietary products.

Iron sponge media is typically wood chips impregnated with iron oxide. The iron oxide reacts with the hydrogen sulfide and binds to the media as iron sulfide and water. The metal sulfides are contained within the media. Once the media is spent, it must be replaced. Engineered iron oxide media, such as Sulfatreat™, is also available for H_2S removal. This media is typically more expensive than iron sponge but is easier to remove once the media is exhausted. The primary advantages of the solid media technology are the passive operation, simple use, and reliability. If the $FeCl_3$ addition continues, the County's low H_2S concentrations will likely require infrequent media replacement.

Several companies manufacture the adsorptive media treatment systems for installation in the United States. Common iron sponge providers for installation at wastewater treatment plants include Unison Solutions, Marcab, Varec Biogas, and DMT Clear Gas Solutions. Figure 1 shows a photo of an adsorptive media system installation.

Figure 1. Adsorptive Media Installation Example

Table 1 below presents the advantages and disadvantages of the H_2S removal technologies.

Table 1. Advantages and Disadvantages of H_2S Removal Technologies

Alternative	Advantages	Disadvantages
Iron salt addition	• Already used at WPCP • Improves phosphorus removals and odor control • Can achieve good H_2S removal with high doses	• Safety considerations with storage and feed facilities • May not be used in the future if WPCP switches to biological phosphorus removal • High costs of chemicals
Adsorptive media (iron sponge)	• Proven technology with many installations • Simple configuration with no moving parts • Removes sulfur from the system • Lower media replacement costs at concentrations anticipated with iron salt addition	• Higher media replacement costs at anticipated H_2S levels without iron salt addition • Media can combust

2.2 Moisture Removal

Biogas is saturated with moisture as it leaves the digester and nearly all end uses require at least some level of moisture removal. For RNG, moisture must be nearly completely removed to meet injection specifications. It is recommended that a two-step process be used for moisture removal, where the first step is mechanical refrigeration for the bulk of the moisture, followed by an adsorption technology for final biogas drying. Figure 2 presents an example of a moisture removal installation.

Figure 2. Moisture Removal Installation Example

2.3 Siloxane and VOC Removal

Siloxanes and VOCs are typically removed following moisture removal and initial compression, as the vessels have higher head loss and require a dry gas environment to work properly. Siloxanes and VOCs at normal levels within biogas (between 1 and 5 parts per million by volume [ppmv]) are removed using similar solid sorptive media as with hydrogen sulfide, described above. The most common media choice is activated carbon. In addition to siloxane removal, the media also serves as polishing to remove residual hydrogen sulfide and VOCs that may be in the biogas. Because of this polishing, the media is exhausted as much by residual hydrogen sulfide and VOCs as it is by siloxanes. Figure 3 presents an example of siloxane removal equipment and media.

Figure 3. Siloxane Removal Equipment and Media

Caution should be used with media selection because gas flow is very important for effective removal. If the media size is too large, at lower gas flow rates the flow will channelize, resulting in breakthrough occurring because media is exhausted in a concentrated area, while the overall bed is in good condition. Small media size will distribute flow better. However, if flows are higher, small media size will result in high pressure drops and potentially fluidizing the bed, leading to carry-over of media out of the treatment vessel. Careful coordination between the engineers and vendors on the range of gas flows is important for selection of media size.

2.4 Carbon Dioxide Removal

Biogas treatment to natural gas quality requires the removal of carbon dioxide from the biogas stream. Several technologies are available to condition the biogas to RNG quality, including water wash, pressure swing adsorption (PSA), and membranes. These technologies are described in more detail later in this Chapter, but Table 2 provides a summary of the advantages and disadvantages of each.

Table 2. Biogas Storage Scenarios

Alternative	Advantages	Disadvantages
Water wash	• Proven technology with many installations • No media to be replaced • High CH_4 recovery (98%) at design efficiency point	• More appropriate for larger installations (>750 scfm) • Requires high-pressure water (~150 psig) and water cooling • Requires post-scrubbing drying • Reduction in CH_4 recovery efficiency at turndown • Moderate energy use
PSA	• Proven technology with many installations • Regenerative adsorbent has long media life	• Lowest CH_4 recovery (95%) • Continuous actuation of vessel valves during operation is loud and causes mechanical wear of equipment • Moderate energy use
Membrane	• Proven technology with many installations • Highest CH_4 recovery (99%) with three-pass system • Fewer moving parts • Modular design • Good for smaller installations (<600 scfm)	• Requires separate upstream treatment of H_2S, VOCs, and siloxanes • Requires multiple passes to get higher CH_4 recovery • Higher energy use

2.5 Waste Gas Management

In addition to biogas treatment options, there are alternatives for how to properly dispose of waste gas generated at the WPCP. Below are the viable options for waste gas management at Arlington County WPCP.

2.5.1 Enclosed Waste Gas Flares

The most common method of waste gas disposal is with a waste gas flare. Waste gas flares are mostly used to combust raw biogas or off-spec RNG that is higher in heating value, or Btu content, and can provide self-sustaining direct combustion. Waste gas flares are always provided at anaerobic digestion facilities as a safety provision to be able to dispose of the flammable biogas during system downtime regardless of the biogas utilization method. Because of the visibility of the WPCP and footprint constraints an enclosed waste gas flare is recommended for the Arlington WPCP. An example of an enclosed flare is shown in Figure 4.

Figure 4. Enclosed Waste Gas Flare

2.5.2 Regenerative Thermal Oxidizers

For lower-Btu waste gases, or tail gas, produced as a by-product from the processing of RNG, RTOs are often used. RTOs provide higher efficiencies than regular thermal oxidizers when the waste gas does not have the Btu content to provide self-sustaining combustion. They provide this efficiency with a common combustion chamber and two sets of ceramic media with switching valves to capture and reuse the heat provided by the combustion to preheat the incoming waste gas. Once the heat is recovered from one combustion cycle the waste gas flow is reversed with the valves to recover heat from the recently combusted gas. An RTO is shown in Figure 5 and Figure 6.

Like any other form of thermal oxidation, a startup burner (fueled by natural gas) is employed to raise the temperature of the unit to proper destruction conditions. Once at the proper temperature, the process gas can be introduced and blended with the correct amount of dilution/combustion air, and the RTO cycles through the combustion sequence. The burner provides supplemental fuel to maintain the combustion chamber temperature should the heat content fall below that required for self-sustaining operation. Using a hot-gas bypass can expand the range of possible operating conditions by diverting some of the combusted air directly to atmosphere, rather than sending it through the heat-recovery media.

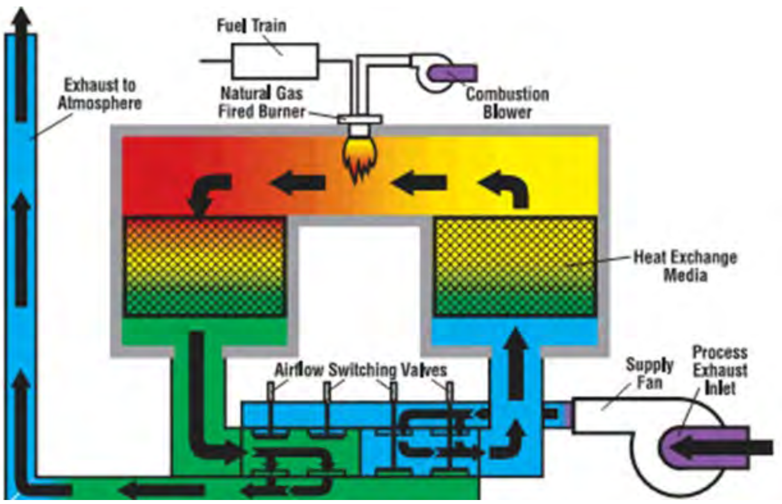


Figure 5. Regenerative Thermal Oxidizer

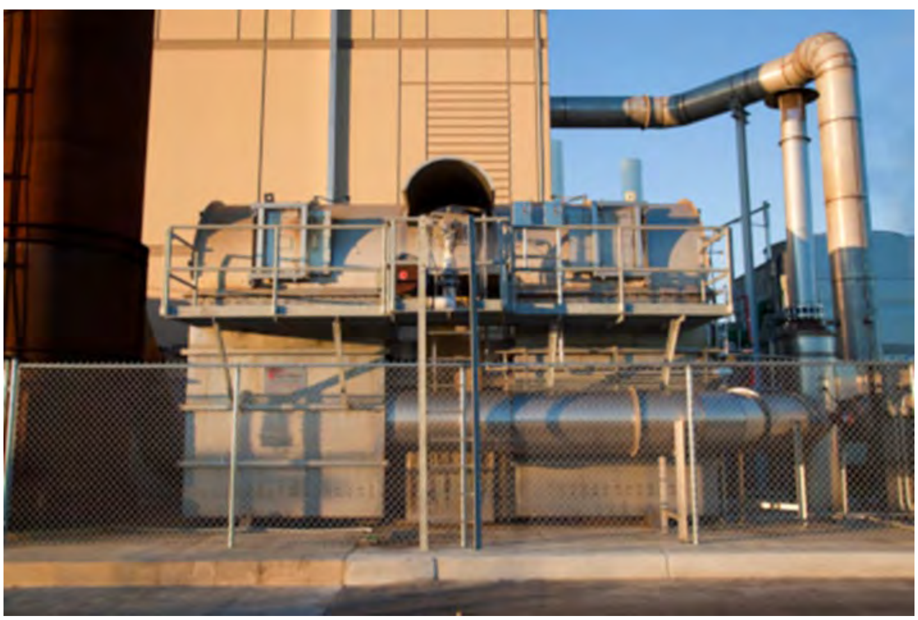


Figure 6. Regenerative Thermal Oxidizer

2.6 Pressure Boosting

Digester pressure is typically around 6 to as much as 20 inches of water column (in WC) or 0.2 to 0.7 psig. There are a wide range of pressure requirements for end use and for the associated treatment requirements described above that must be considered as part of a project. Depending on the technology used for biogas upgrading, a large range of pressure requirements are necessary to account for pressure losses through pipelines and the treatment system and achieve the required delivery pressure of the biogas equipment. Different RNG upgrading equipment technologies require a range between 100 and 250 psig for CO_2 removal. Typically, the upgrading equipment includes a compressor that can increase pressure necessary to the full requirement of that system. If there is pipeline injection, then it is also possible that an additional compressor would be needed to meet the requirement of the natural gas pipeline pressure for injection. Figure 7 shows an example of a biogas compression skid.

Figure 7. Biogas Compression Equipment Example

3.0 Biogas Upgrading Alternatives

With the recommended alternative of conditioning the biogas to be used as RNG off site, an additional analysis is needed to select the most appropriate carbon dioxide removal conditioning technology. There are three main types of biogas conditioning to produce RNG: membrane separation, pressure swing adsorption, and water wash scrubbing. The following sections provide additional descriptions of each technology followed by a life-cycle cost analysis to compare the three types and make a recommended selection for the Arlington WPCP.

3.1 Membrane Treatment

Membrane treatment systems consist of bundles of hollow membrane fibers fashioned together in canisters to remove carbon dioxide and other contaminants from the methane. The pores in the membrane fibers are sized to allow CO_2 molecules to pass through, while retaining the CH_4 molecules, as shown in Figure 8. Biogas is pressurized to 150 to 200 psig and conveyed through a series of canisters in a multi-pass configuration to improve CH_4 recovery and maintain a high CH_4 content in the product gas.

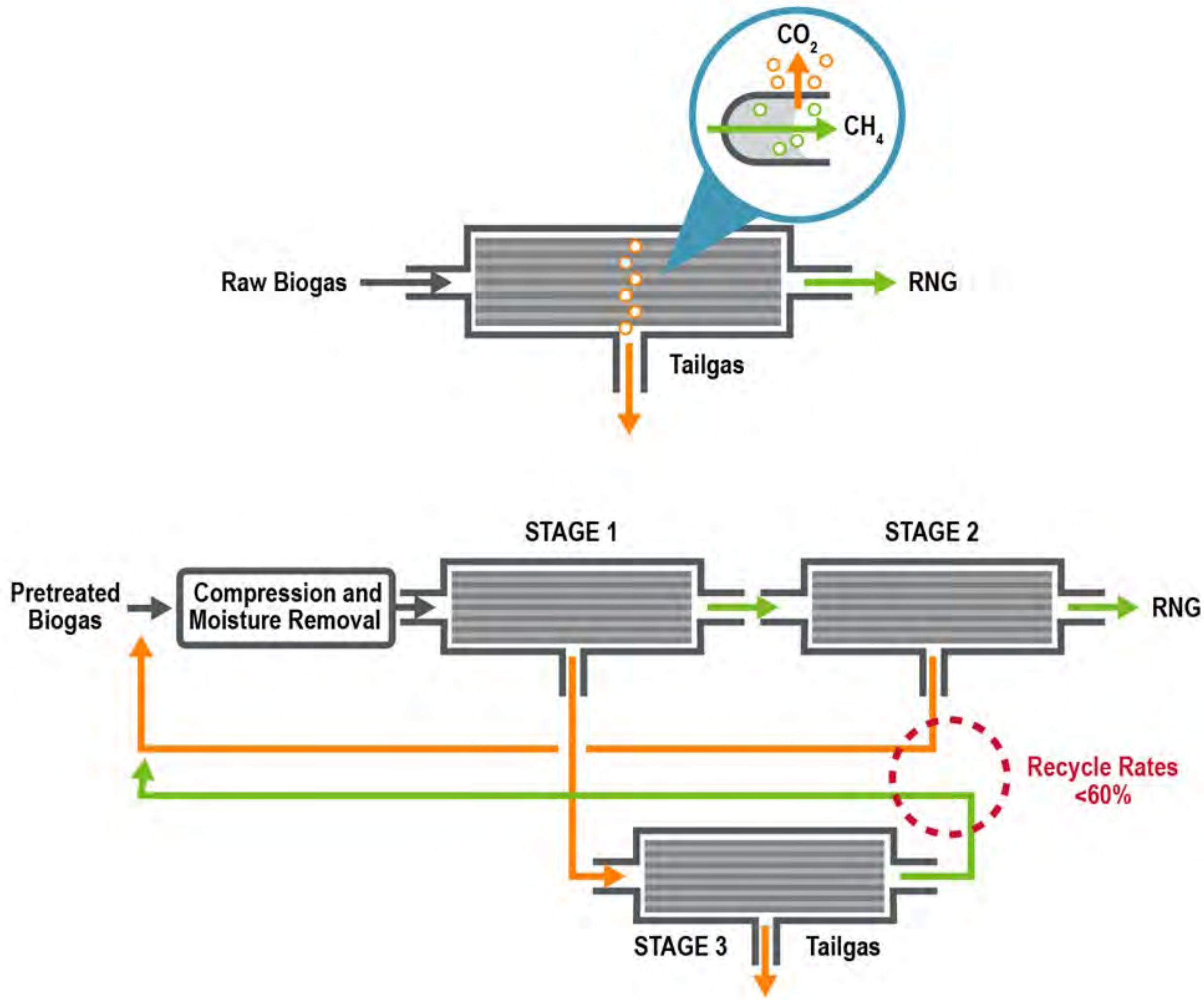


Figure 8. Membrane Treatment Schematic

Membrane systems must be used in combination with other technologies to remove hydrogen sulfide, siloxanes, moisture, and VOCs ahead of the membranes to protect the integrity of the fibers. The number of membrane filtration steps, or passes, determines the quality of the RNG and the methane recovery of the system. With additional membrane steps, higher finished gas quality is produced and/or more methane is captured from the waste tail gas stream. Gas typically passes through the membranes two to three times.

Currently, several companies manufacture membrane systems for installation in the United States: Unison Solutions, DMT Clear Gas Solutions, Greenlane Biogas, Air Liquide, and Pentair. A simplified schematic of a typical membrane system with mass balance is shown Figure 9. Figure 10 shows a photo of a typical membrane system installation.

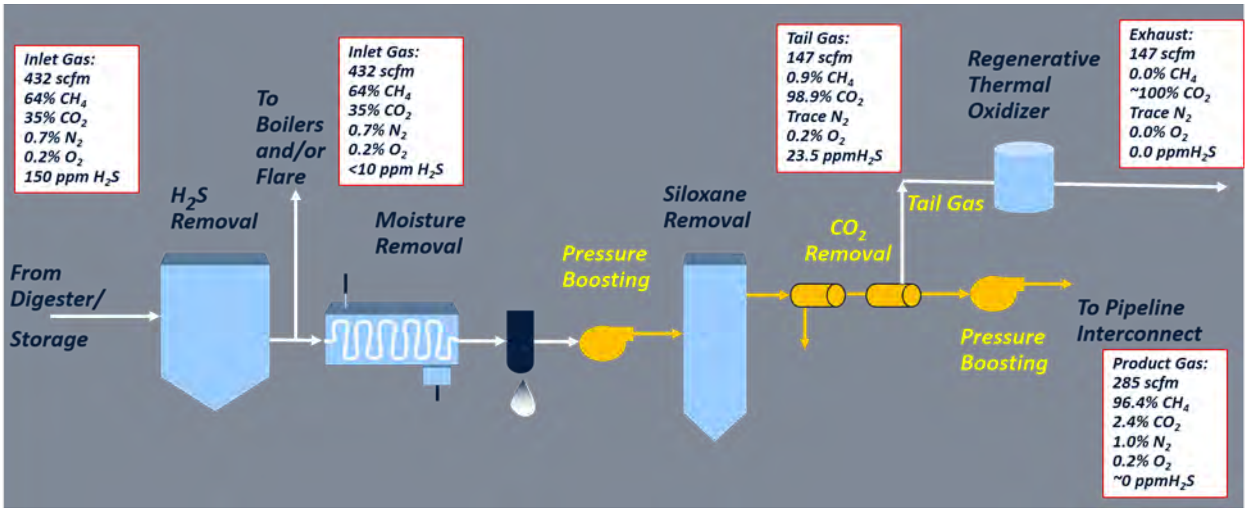


Figure 9. Membrane Treatment Process Flow Diagram

Figure 10. Typical Membrane Treatment Installation

3.2 Pressure Swing Adsorption

PSA systems remove hydrogen sulfide, carbon dioxide, and siloxanes in a single vessel by the adsorption of contaminants onto media under pressure (approximately 100 psig) and then regenerating the media under a vacuum. The systems operate with multiple pressure vessels so that the batch process of pressurizing the vessel, treating, and vacuum regeneration can be done while allowing for continuous operation. Figure 11 shows a schematic of the PSA treatment process. The systems are cost-effective; however, they typically have lower methane recovery rates (95 percent) compared to other gas upgrading systems being considered.

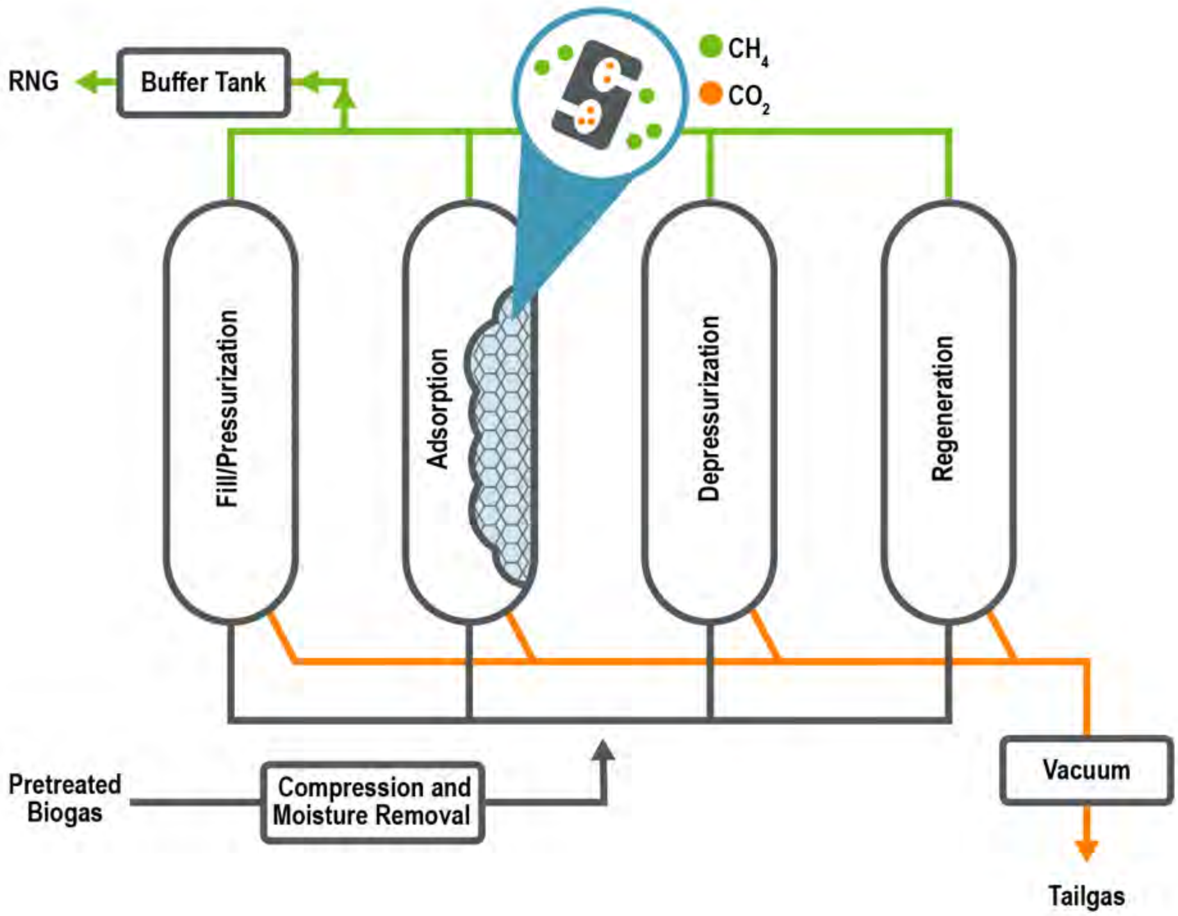


Figure 11. PSA Treatment Schematic

H_2S removal could occur upstream of the PSA or on the waste tail gas stream. The level of treatment provided will determine if an RTO or flare on the tail gas stream is needed to convert remaining hydrogen sulfide to sulfur oxides or if the stream can be vented to the atmosphere.

Currently, four companies manufacture PSAs for installation in the United States: Greenlane Biogas, Guild Associates, Xebec, and BioFERM. A simplified process flow diagram of a typical PSA system with mass balance is shown in Figure 12. Figure 13 shows a photo of a PSA system installation.

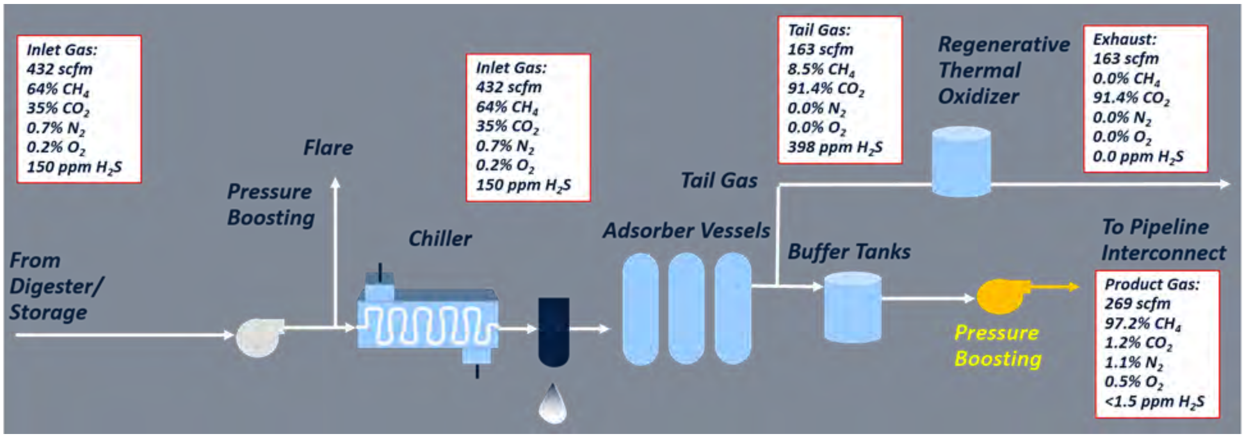


Figure 12. PSA Treatment Schematic

Figure 13. Typical PSA Installation

3.3 Water Wash Scrubber

The water wash, or water scrubber, treatment system dissolves carbon dioxide and other impurities in water to separate the CH_4 gas stream. Biogas compressed to approximately 150 psig enters the bottom of the scrubber vessel and flows upward through packing media as chilled water sprays downward. The carbon dioxide and other gas impurities (hydrogen sulfide, siloxanes, and VOCs) are dissolved in the water, the methane exits through the top of the scrubbing tower, and moisture is removed with a drier. The water, now saturated with carbon dioxide, is then depressurized in the flash tank, which operates as an intermediate step to release and recycle any methane that may have been absorbed in the water. The flash tank water is sent to the stripper vessel where pressure is lowest within the system. Lowering the pressure releases the carbon dioxide and contaminants into the tail gas waste stream. A schematic of the water wash treatment process is shown in Figure 14. A defoaming, antimicrobial, and pH adjustment solution may be fed to the water wash system to improve performance.

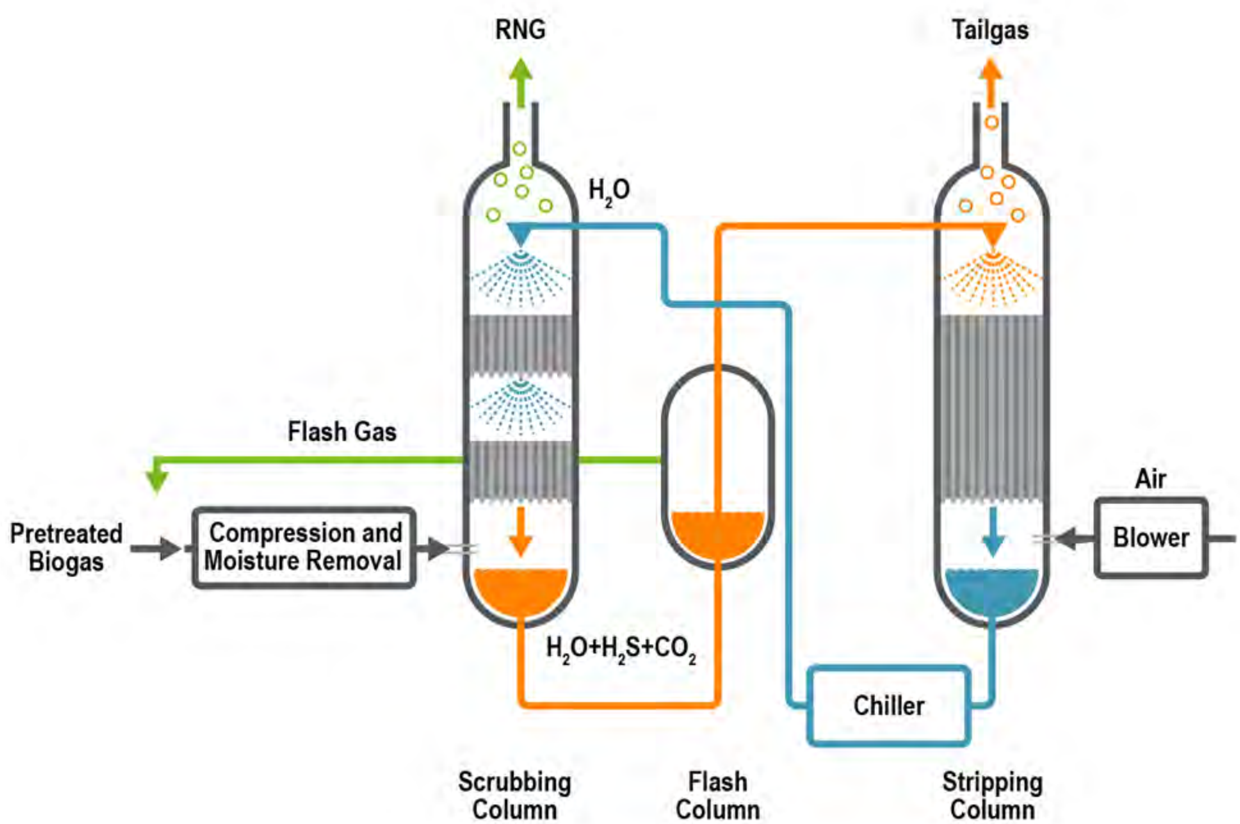


Figure 14. Water Wash Treatment

It should be noted that while the water wash systems remove hydrogen sulfide from the methane stream, the process does not actually treat it to a final product. The H_2S removal could occur upstream of the water wash process or on the waste tail gas stream. The level of treatment provided will determine if an RTO on the tail gas stream is needed to convert remaining hydrogen sulfide to sulfur oxides or if the stream can be vented to the atmosphere.

Water wash systems can achieve CH_4 recovery rates of up to 98 percent. However, this recovery rate drops when the system is operating below the designed best efficiency point.

Currently, two companies manufacture water wash systems for installation in the United States: Greenlane Biogas and Dürr Megtec. A simplified schematic of a typical water wash system with mass balance is shown in Figure 15. Figure 16 shows a photo of a water wash system installation.

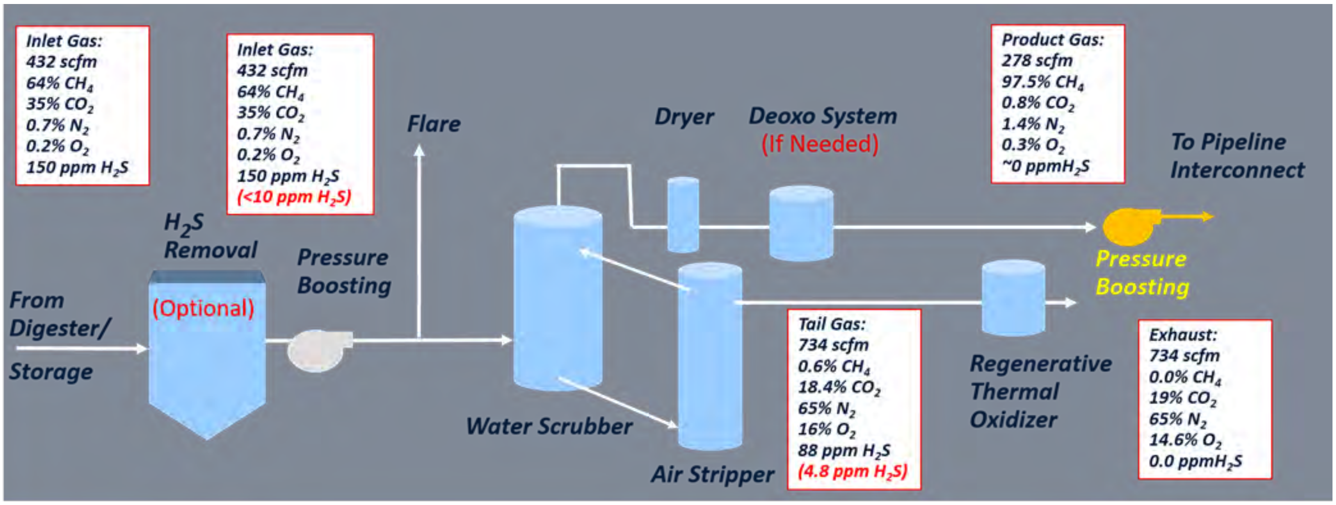


Figure 15. Water Wash System Process Flow Diagram

Figure 16. Typical Water Wash systems Installation
Source: HDR, Portland, Oregon.

4.0 Life-Cycle Cost Comparison

Similar to the gas utilization alternatives analysis, a life-cycle cost comparison was developed to evaluate and compare the three technologies from a capital and O&M cost basis.

4.1.1 Conceptual Capital Costs

Conceptual capital costs have been developed for each biogas conditioning alternative. Manufacturers for each equipment type were contacted for budgetary equipment pricing. The following multiplier percentages were used in the capital cost development:

- Electrical and instrumentation/controls: 28 percent
- Sitework/general civil: 15 percent
- Specialty piping: 5 percent
- Contractor general requirements (O&P, mobilization, etc.): 23 percent
- Contingency: 20 percent

No salvage or deep foundation costs or engineering, legal, and administrative costs are included in the cost estimates.

Capital costs are associated with the interconnection to the natural gas utility pipeline injection. These costs typically include the custody transfer station and the pipeline to the tie-in location. An estimated cost of $5 million is applied to all RNG injection alternatives and is based on preliminary feedback from the gas utility. This cost will be confirmed as additional discussions with the natural gas utility are conducted.

It is assumed that the natural gas pipeline will require post-treatment compression to 600 psig to inject RNG into the pipeline. Each pipeline injection alternative includes capital cost for this pressure increase. Each CO_2 removal technology discharges RNG at a different pressure, between 80 and 190 psig, so the compression needs vary for each alternative.

Capital costs for the conditioning alternatives are summarized in Table 3. The vendor quotes for each alternative are included in Appendix D.

Table 3. Biogas Conditioning Conceptual Capital Costs

Item		Membrane	PSA	Water Wash
Boilers		$0.60M	$0.60M	$0.60M
Building requirements		$2.45M	$2.45M	$2.45M
Pretreatment H_2S and siloxane removal		$0.50M	$0.00M	$0.00M
Inlet conditioning		$0.27M	$0.27M	$0.27M
CO_2 removal		$3.53M	$3.39M	$3.86M
Tail gas handling		$0.15M	$0.15M	$0.25M
Compression to delivery		$0.49M	$0.49M	$0.49M
Custody transfer station and pipeline		$5.00M	$5.00M	$5.00M
Total direct costs		$7.98M	$7.34M	$7.92M
Markups				
Electrical, instrumentation/controls	28%	$2.24M	$2.06M	$2.22M
Sitework	15%	$1.20M	$1.10M	$1.19M
Specialty piping	5%	$0.40M	$0.37M	$0.40M
Contingency	20%	$2.36M	$2.17M	$2.34M
Contractor general requirements	23%	$3.26M	$3.00M	$3.23M
Conceptual Capital costs		**$22.44M**	**$21.04M**	**$22.30M**
Compared to minimum		107%	100%	106%

4.2 O&M Costs

Similar to the capital costs, O&M costs have been estimated from vendor proposals, reference project experience, and the County's historical cost information. Anticipated O&M costs were developed and are presented in Table 4. Assumptions include costs related to operations labor, maintenance labor, labor parts, power requirements, water use, media replacement, and chemical costs. The common values used across all alternatives include the following:

- Power cost: $0.06/kWh
- Natural gas cost: $0.85/therm
- Operations labor: $80/hr
- Maintenance labor: $60/hr

Annual O&M cost summaries for the conditioning alternatives are provided in Table 4.

Table 4. Annual Biogas Conditioning O&M Costs at Start-up

Item	Membrane	PSA	Water Wash
Pretreatment H_2S and siloxane removal	\$29,700	\$0	\$0
Inlet conditioning	\$25,900	\$25,900	\$25,900
CO_2 removal	\$237,500	\$197,000	\$252,600
Tail gas H_2S treatment	\$0	\$0	\$0
Tail gas handling	\$12,000	\$12,000	\$12,900
Compression to delivery	\$17,900	\$17,900	\$17,900
Total O&M	**\$323,000**	**\$252,800**	**\$309,300**
Total O&M \$/MMBtu	**\$2.45**	**\$1.91**	**\$2.34**

The membrane system has the highest annual O&M cost of the three options because of the higher power requirements and also media costs associated with H_2S and siloxane removal systems.

4.3 Present Values

The net present financial values for each technology option were calculated using the same heating requirements, biogas production quantities, annual costs, and financial assumptions as Alternatives 3A and 3B presented in Chapters 04 and 05 of the Arlington Re-Gen Biogas Utilization Report. These included the same WPCP energy costs for electricity and natural gas, O&M inflation, discount rate, and planning period.

Table 5 presents the present financial values for Alternatives 1, 3A, and 3B for each of the biogas conditioning technologies. The present financial values are presented for a range of RIN market values from \$5/RIN to \$35/RIN. The main differences between the options are the specific capital and O&M costs presented above as well as the methane capture for each of the technologies.

This analysis shows that the PSA technology has the lowest net present financial value as compared to the membrane and water wash system. This is mostly due to the difference in capital costs and slightly lower O&M costs for the PSA system. Even with the higher percentage methane capture for membranes and water wash, the difference in capital and O&M cannot be overcome through RNG revenue.

Table 5. Net Financial Values, \$M

Item	Membrane	PSA	Water Wash
Conceptual Capital Cost	\$22.4M	\$21.0M	\$22,3M
Annual Operating and Maintenance Costs	(\$0.32M)	(\$0.25M)	(\$0.31M)
Annual RIN Revenue at \$15/MMBtu	\$1.85M	\$1.78M	\$1.84M
Total Net Present Value	\$3.46M	\$1.92M	\$3.32M

4.4 Summary

Overall, the three biogas conditioning technologies are very comparable in present value and performance; however, some differences should be discussed before the final decision is made.

Table 6 presents these differences graphically. The membrane system has the highest capital and O&M costs, but also the highest methane capture while the PSA has the lowest capital and O&M costs and the lowest methane capture. From an uptime perspective, all the technologies are similar. The PSA equipment will likely by louder and will not have the flexibility to simply add CHP in the future (additional pre-treatment would be required). The noise production of the PSA will be evaluated as part of the future site visits. Water wash has similar challenges and also will be less aesthetically pleasing because of its height, and tail gas management would be more costly because of higher gas flows. Membranes will be similar to or better than PSA and water wash in all of these categories.

Table 6. Technology Comparison

Criterion	Membranes	PSA	Water Wash
Capital cost	↑	↓	↑
O&M cost	↑	↓	↓
Methane capture	↑	↓	↑
Uptime	↔	↔	↔
Noise	↓	↑	↓
Aesthetics	↑	↑	↓
Flexibility for future CHP	↑	↓	↓
Tail gas management	↑	↑	↓

5.0 Recommended Alternative

Based on the analysis presented, it was recommended that the Program continue to pursue all three biogas treatment technologies until more understanding of the day-to-day operations and maintenance can be obtained. This was accomplished with additional discussions with the equipment vendors and site visits to existing installations to see the equipment in person and talk to O&M staff who have experience with the equipment options. Recommended next steps for the biogas utilization equipment selection included:

- Schedule technical brown bag sessions with equipment suppliers for the membrane, water wash, and PSA conditioning systems. This next step is currently in progress and potential dates and times are being discussed. *These technical brown bag sessions were conducted over three lunch and learn sessions in October 2021.*
- Identify potential facilities to perform in-person site visits. The equipment suppliers have provided lists of relevant installations, but additional facilities are currently being identified. A preliminary list of facilities that are being considered is shown in Table 7. The site visits should have relevance to the Arlington WPCP

where biogas from domestic wastewater digestion is conditioned to natural gas quality. Facilities of similar size and biogas conditioning capacity will be preferred.

- Schedule and perform site visits. It is anticipated that this will occur sometime in late 2021 or early 2022 depending on COVID-19 protocols. *Site visits to representative installations were conducted in October 2022.*
- Select a technology for implementation based on the results of the vendor discussions, site visits, and further refinement of the WPCP requirements as part of the Program.

Based on the results of this analysis, lessons learned from vendor presentations and discussions with operations and maintenance staff during site visits at representative installations, the preferred biogas treatment technology for implementation at the WPCP is membrane separation. The final technology and manufacturer selection will be determined during the detailed design phase of the Program.

Table 7. Technology Installation Lists

Water Wash (Greenlane)	PSA (Guild)	Membrane (Unison/Air Liquide)
Fair Oaks, Indiana (manure)	San Antonio, Texas (muni)	Atlanta, Georgia (LFG)
Perris, California	Dayton, Ohio (muni)	Pittsburgh, Pennsylvania (LFG)
Canton, Michigan	Newark, Ohio (muni)	Waste Management (LFG: multiple locations)
Weld County, Colorado (manure, food waste)	Des Moines, Iowa (muni)	Avondale, Louisiana (LFG)
Portland, Oregon (muni) startup end of 2021		Lincoln, Nebraska (muni)

Appendix C

Draft Sustainability Management Plan Outline

ARLINGTON RE-GEN

DRAFT SUSTAINABILITY MANAGEMENT PLAN

HDR

April 25, 2022

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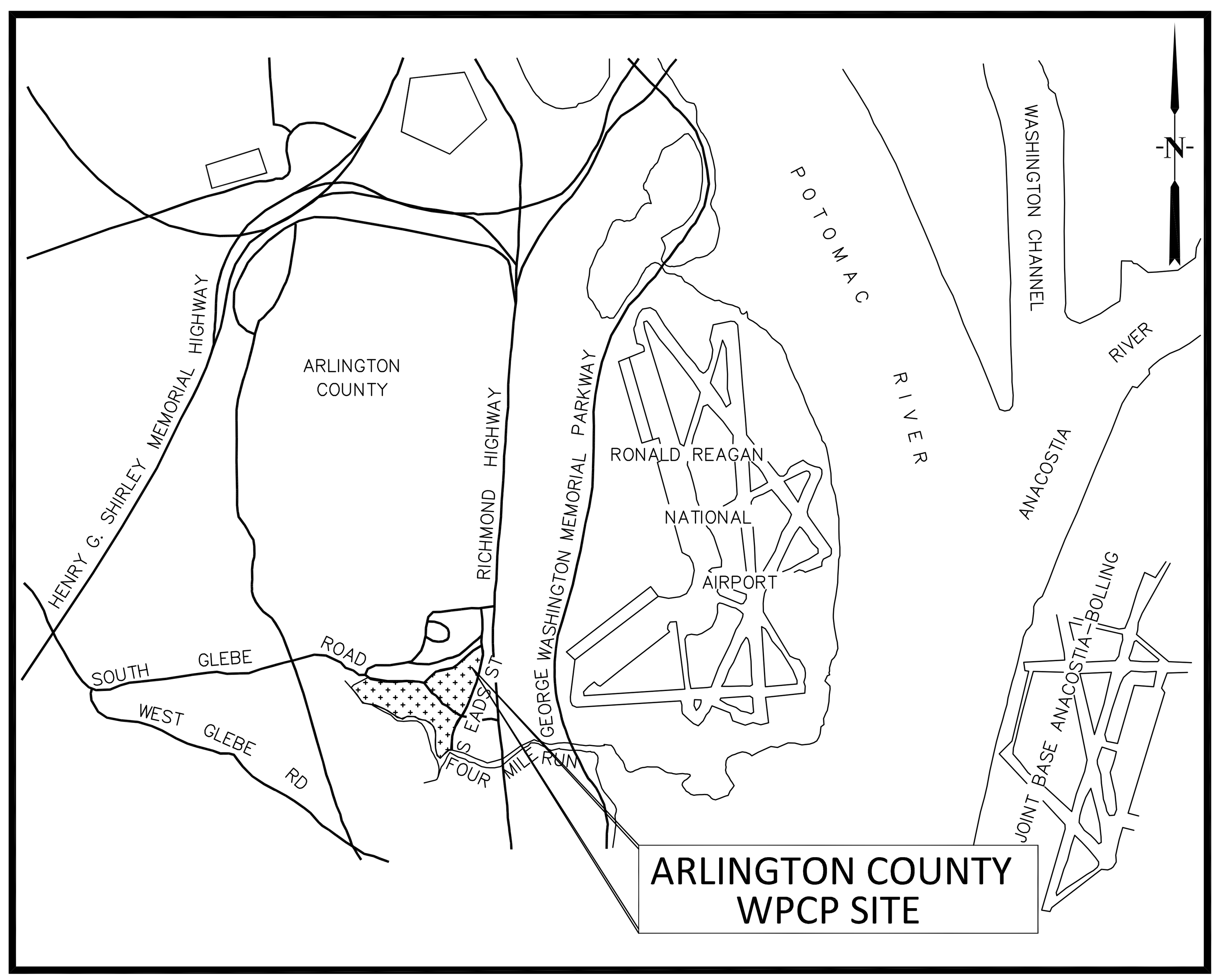
ARLINGTON
VIRGINIA

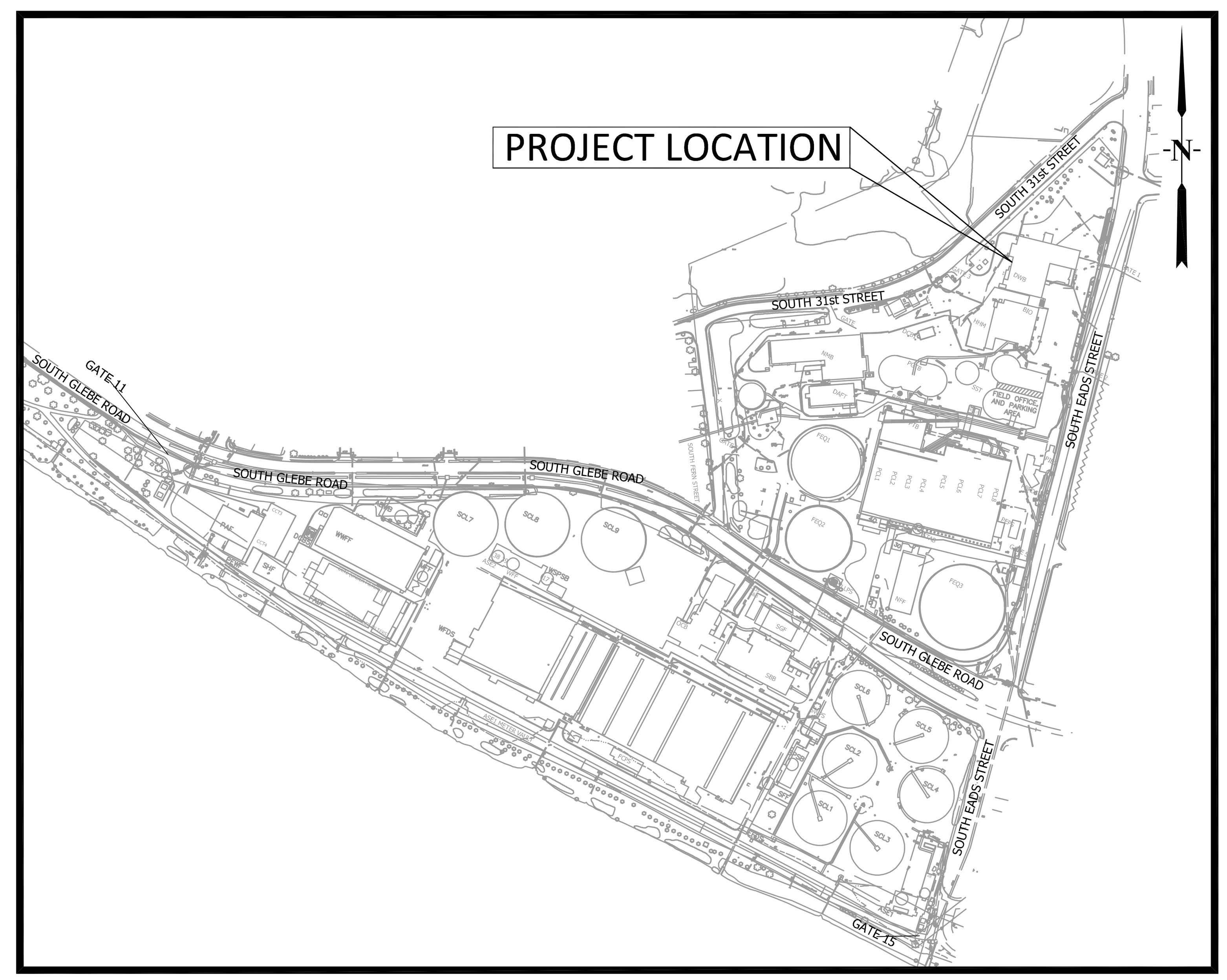
ARLINGTON WATER POLLUTION CONTROL PLANT PHASE 10C

BIOSOLIDS UPGRADES - EARLY WORK RFP PLANS

JULY 2022



VICINITY MAP



LOCATION PLAN

OWNER:
ARLINGTON COUNTY WPCP
3402 S. GLEBE ROAD
ARLINGTON, VA 22202

HDR

1 2 3 4 5 6 7 8

DRAWING INDEX

GENERAL

G-001 COVER SHEET
G-002 DRAWING INDEX AND ABBREVIATIONS, GENERAL NOTES
G-003 GENERAL LEGEND AND SYMBOLS
G-004 PROCESS FLOW DIAGRAM - SLUDGE TRANSFER
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ABBREVIATIONS

AS	AIR SUPPLY
ALP	AIR LOW PRESSURE
APPROX	APPROXIMATELY
AUX	AUXILIARY
BBD	BOILER BLOWDOWN
BCT	BOILER CHEMICAL TREATMENT
BF	BUTTERFLY VALVE
BFP	BELT FILTER PRESS
BFW	BOILER FEED WATER
BM	BENCHMARK, BEAM
BMP	BEST MANAGEMENT PRACTICES
BYP	BYPASS
CA	COMPRESSED AIR
℄	CENTERLINE
CCK	CAKE
CCT	CENTRATE
CDR	CHEMICAL DRAIN
CHEX	COOLING HEAT EXCHANGER
CHD	CHORD
CHH	COMMUNICATION OR CONTROL HANDHOLE
CHP	COMBINED HEAT AND POWER
CI	CURB INLET
CIP	CAST-IN-PLACE
CIRC	CIRCULATION, CIRCULAR
CKT	CIRCUIT
CL	CENTERLINE, CLASS, CLOSE
CLKG	CAULKING
CONC	CONCENTRATION, CONCENTRATED, CONCRETE
COND	CONDENSATE
COW	COUNTY WATER
CUW	CHLORINATED UTILITY WATER
CUYD	CUBIC YARD
CWR	COOLING WATER RETURN
CWS	COOLING WATER SUPPLY
DBR	DIRTY BACKWASH RETURN
DCR	DISTRIBUTED CONTROL SYSTEM
DEG	DEGREE
DEG C	DEGREE CENTIGRADE
DEG F	DEGREE FAHRENHEIT
Ø	DIAMETER
DG	DIGESTER GAS
DN	DOWN
DR	DRAIN
DS	DIGESTED SLUDGE
DSR	DIGESTED SLUDGE RECYCLE
DSRF	DIGESTED SLUDGE RECYCLE PLUS FEED
DTON	DRY TON
DW	DILUTION WATER
DWB	DEWATERING BUILDING
EH	ENGINE EXHAUST
EL	ELEVATION
EX, EXIST	EXISTING
EXH	EXHAUST
F	DEGREES FAHRENHEIT
FA	FOUL AIR
FAD	FOUL AIR DUCT
FE	FLOW SENSOR
FFE	FINISHED FLOOR ELEVATION
FG	FINISHED GRADE
FH	FIRE HYDRANT
FIT	FLOW INDICATING TRANSMITTER
FL	FLOOR
FLA	FULL LOAD AMPERES
FLT	FILTRATE
FM	FLOW METER, FORCE MAIN
FOG	FATS OIL AND GREASE
FPW	FIRE PROTECTION WATER
FS	FLASH STEAM
FVNR	FULL VOLTAGE NON-REVERSING
GEN	GENERAL, GENERATOR
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GTI	GRAVITY THICKENER INFLUENT
GTO	GRAVITY THICKENER OVERFLOW
HB	HOSE BIB
HDG	HIGH PRESSURE DIGESTER GAS
HEX	HEXAGONAL, HEAT EXCHANGER
HOA	HAND/OFF/AUTO
HOR	HAND/OFF/REMOTE
HT - LOOP	HIGH TEMPERATURE LOOP (JACKET WATER)
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
H2S	HYDROGEN SULFIDE
IN	INCH
INF	INFLUENT
IN WC	INCHES WATER COLUMN
LB/D	POUNDS PER DAY
LBVS	POUND OF VOLATILE SOLIDS
LCS	LOCAL CONTROL STATION
LE	LEVEL ELEMENT
LI	LEVEL INDICATOR
LIT	LEVEL INDICATING TRANSMITTER
LO	LOADOUT
LOD	LIMITS OF DISTURBANCE
LPOL	LIQUID POLYMER
LS	LEVEL SWITCH, LIMIT SWITCH
LSH	LEVEL SWITCH
L-STOP	LOCAL STOP
LSL	LEVEL SWITCH LOW
LT - LOOP	LOW TEMPERATURE LOOP (AFTER COOLER)
MCC	MOTOR CONTROL CENTER
MFR	MANUFACTURER
MG	MILLION GALLONS
mg/L	MILLIGRAMS PER LITER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE, METAL HALIDE, MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MOV	MOTOR OPERATED VALVE
MPC	MEDIUM PRESSURE CONDENSATE
MPS	MEDIUM PRESSURE STEAM
MTR	MOTOR
MW	MAKE UP WATER
N/A	NOT APPLICABLE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NG	NATURAL GAS (NG)
NGM	NATURAL GAS METER
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN, NUMBER
NOS	NUMBERS
NTS	NOT TO SCALE
NaOH	SODIUM HYDROXIDE
OA	ODOROUS AIR
OCS	ODOR CONTROL STATION
OFLW	OVERFLOW
ORP	OXIDATION REDUCTION POTENTIAL
OVRF	OVERFLOW
PD	PLANT DRAIN
PDS	DIFFERENTIAL PRESSURE SWITCH
PDSH	DIFFERENTIAL PRESSURE SWITCH HIGH
PDSL	DIFFERENTIAL PRESSURE SWITCH LOW
PEW	PLANT EFFLUENT WATER
PG	PROCESS GAS
PGCON	PROCESS GAS CONDENSATE
PGU	PROCESS GAS UNIT
PIT	PRESSURE INDICATING TRANSMITTER
PL	PROPERTY LINE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PMP	PUMP
PNL	PANEL
POLY	POLYMER
POLYS	POLYMER SOLUTION
PS	PIPE SUPPORT, PRESSURE SWITCH, PUMP STATION, PRIMARY SLUDGE
PSH	PRESSURE SWITCH HIGH
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAGE
PSL	PRESSURE SWITCH LOW
PW	POTABLE WATER
Q	RATE OF FLOW
QTY	QUANTITY
RAS	RETURN ACTIVATED SLUDGE
RDB	RENOVATE DEWATERING BUILDING
RG	RAW GAS
RNG	RENEWABLE NATURAL GAS
RSL	RECIRCULATED SLUDGE
SA	SERVICE AIR
SCE	SECONDARY CLARIFIER EFFLUENT
SC	SCUM
SCFM	STANDARD CUBIC FEET PER MINUTE
SDB	SOLIDS DISTRIBUTION BOX
SDS	STORED DIGESTED SOLIDS
SEPT	SEPTAGE
SHC	SODIUM HYPOCHLORITE
SL	SLUDGE
SNT	SUPERNATANT
SR	SCRUBBER RECIRCULATION
SST	STAINLESS STEEL
STD	STANDARD
STL	STEEL
STS	SCREENED THICKENED SLUDGE
SUL	SULFURIC ACID
SWM	STORMWATER MANAGEMENT
TBD	TO BE DETERMINED
TD	TIME DELAY
T/GRADE	TOP OF GRADE
THP	THERMAL HYDROLYSIS PROCESS
THPF	THERMAL HYDROLYSIS FEED (SOLIDS CAKE)
THS	THERMALLY HYDROLYZED SLUDGE
THSR	THERMALLY HYDROLYZED SOLIDS RECYCLE
TIT	TEMPERATURE INDICATING TRANSMITTER
TPS	THICKENED PRIMARY SLUDGE
TSH	TEMPERATURE SWITCH HIGH
TSL	TEMPERATURE SWITCH LOW
TS	THICKENED SLUDGE THICKENED SOLIDS, TEMPERATURE SWITCH
TSS	TOTAL SUSPENDED SOLIDS
TWAS	THICKENED WASTE ACTIVATED SLUDGE
TYP	TYPICAL
UG	UNDERGROUND
UGE	UNDERGROUND ELECTRIC
UGT	UNDERGROUND TELEPHONE
UNO	UNLESS NOTED OTHERWISE
UON	UNLESS OTHERWISE NOTED
UV	UTILITY VAULT, ULTRAVIOLET
W/O	WITHOUT
WAS	WASTE ACTIVATED SLUDGE
WSE	WATER SURFACE ELEVATION
YH	YARD HYDRANT

GENERAL NOTES:

1. THE BACKGROUNDS FOR ALL DRAWINGS, WITH THE EXCEPTION OF THE CIVIL DRAWINGS, IS FROM THE ARLINGTON COUNTY WATER POLLUTION CONTROL PLANT UPGRADE AND EXPANSION-PHASE IIIA SOLIDS PROCESSING FACILITIES CONTRACT, PREPARED BY HAZEN AND SAWYER.
2. THE DESIGN BUILDER SHALL CONFIRM THE EXISTENCE AND LOCATION OF UTILITIES SHOWN.

ABBREVIATION NOTES:

1. THESE ABBREVIATIONS APPLY TO THE ENTIRE SET OF DRAWINGS.
2. LISTING OF ABBREVIATIONS DOES NOT IMPLY THAT ALL ABBREVIATIONS ARE USED IN THE DRAWINGS.

D C B A

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

DRAWING INDEX, ABBREVIATIONS AND GENERAL NOTES

0 1" 2"

FILENAME G-002.dwg
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SHEET **G-002**

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1 | 2 | 3 | 4 | 5 | 6 | 7 | 8

GENERAL SYMBOLOGY

ARROW INDICATES DIRECTION OF TRUE/PLAN NORTH

N

PLAN
1/4" = 1'-0"
PLAN TITLE

SECTION LETTER
FLAG INDICATES DIRECTION OF SECTION CUT
X
XXX
SHEET WHERE SECTION IS LOCATED
SECTION CUT MARKER

SECTION LETTER
X
XXX
SECTION
3" = 1'-0"
SHEET WHERE DETAIL WAS CALLED OUT *
SECTION TITLE

DETAIL NUMBER
#
XXX
SHEET WHERE DETAIL IS LOCATED *
DETAIL MARKER
FOR REFERENCING DETAILS INCLUDED IN DRAWING SET.

XXXXXXXXX
DETAIL MARKER
FOR REFERENCING DETAILS BOUND IN SPECIFICATIONS OR SEPARATE VOLUME.

DETAIL NUMBER
X
XXX
DETAIL
3" = 1'-0"
SHEET WHERE DETAIL WAS CALLED OUT *
DETAIL TITLE

ELEVATION NUMBER
ARROW INDICATES POINT OF VIEW
X
XXX
SHEET WHERE ELEVATION IS LOCATED *
SINGLE ELEVATION OR PHOTO MARKER

A
B
C
D
X
XXX
ELEVATION NUMBER
ARROW INDICATES POINT OF VIEW ELEVATION
INDICATES SHEET WHERE ELEVATION IS LOCATED *
MULTIPLE ELEVATION OR PHOTO MARKER

ELEVATION IDENTIFICATION NUMBER
X
XXX
ELEVATION
3" = 1'-0"
SHEET WHERE POINT OF VIEW MARKER CAN BE FOUND *
ELEVATION TITLE

* EXCEPTIONS WHERE THE SHEET NUMBER IS REPLACED BY A DASH (-).
1) FOR COMMON DETAILS, SECTIONS, ELEVATIONS OR DETAILS THAT ARE CUT OR CALLED OUT ON MULTIPLE SHEETS.
2) SECTIONS, ELEVATIONS OR DETAILS THAT ARE LOCATED ON THE SAME SHEET THEY ARE CUT OR CALLED OUT ON.

GENERAL LEGEND AND SYMBOLS NOTES:

1. THIS SHEET IS A STANDARD SHEET SHOWING COMMON SYMBOLOGY. NOT ALL SYMBOLS ARE NECESSARILY USED ON THIS PROJECT.
2. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FOR USAGE.

TARGET ELEVATION

ARCHITECTURAL

ROOM NAME
XX-XX — ROOM NUMBER
XXX — DOOR NUMBER
A — COLUMN GRID LINE
X — WALL TYPE

KEY NOTE DESIGNATION
— KEY NOTE NUMBER

IDENTIFICATION SYMBOLOGY

PIPING

FIGURE | 36-NPW | EXAMPLE
LINE SIZE — 36"
SERVICE — NON POTABLE WATER

CIVIL SYMBOLOGY

- CO — CLEAN OUT
- MANHOLE
- FIRE HYDRANT
- YH — YARD HYDRANT
- TRUCK, WB-67
- TRUCK, WB-40
- TRUCK, SU-30
- BENCHMARK
- TEST PITS
- BR-1 — BORING
- VALVE (GENERIC)
- LIGHT POLE
- POWER POLE
- 10 — CONTOUR

CIVIL SYMBOLOGY CONTINUED

- VEGETATION
- 10.3 — SPOT ELEVATION
- T — TRANSFORMER
- CB — CATCH BASIN
- PD — PROCESS DRAIN MANHOLE
- SD — STORM DRAIN MANHOLE
- SS — SANITARY SEWER MANHOLE
- PIPE SUPPORT (FOR PIPE LARGER THAN 12" DIA.)
- CONCRETE WASHOUT

EXISTING CIVIL CONDITIONS

- EXISTING VALVE
- EXISTING PIPELINE
- EXISTING LARGE PIPELINE
- EXISTING LIGHT POLE
- EXISTING POWER POLE
- 10 — EXISTING CONTOUR
- EXISTING VEGETATION
- 10.3 — EXISTING SPOT ELEVATION
- X — EXISTING FENCE

LINE SYMBOLOGY

- T — TELEPHONE LINE
- E — ELECTRIC LINE
- F — FIBER OPTIC
- C — COMMUNICATION
- HANDRAIL AND GUARDRAIL
- PIPELINE
- LARGE PIPELINE
- DRAINAGE FLOW
- NATURAL WATERWAY
- X — BARBED WIRE CHAIN LINK FENCE
- CHAIN LINK FENCE
- XX — TEMPORARY BARRIER
- PROPERTY LINE
- CENTERLINE
- SF — SILT FENCE
- EASEMENT
- ALUMINUM COVER
- LIMITS OF CONSTRUCTION
- ROW
- LIMITS OF WETLANDS
- VEGETATED SWALE
- MATCH LINE
- DRAINAGE DITCH
- COLUMN GRID LINE/CENTERLINE

EQUIPMENT SYMBOLOGY

- ARCHIMEDES SCREW
- CENTRIFUGE
- CENTRIFUGAL PUMP
- CHEMICAL FEED PUMP
- COMPRESSOR
- DOUBLE DISC POSITIVE DISPLACEMENT PUMP
- GRINDER
- HEAT EXCHANGER
- RADIATOR
- U-TUBE HEAT EXCHANGER
- TUBE IN TUBE HEAT EXCHANGER
- MIXER - PROPELLER TYPE
- M OR M — MOTOR
- PLATE TYPE HEAT EXCHANGER
- PROGRESSING CAVITY PUMP
- ROTARY LOBE PUMP
- POSITIVE DISPLACEMENT PUMP
- INCLINED BELT CONVEYOR
- SCREW CONVEYOR
- SHELL AND TUBE TYPE HEAT EXCHANGER
- SLUDGE GATE / WEIR GATE
- VERTICAL TURBINE CAN PUMP
- EDUCTOR
- SOLIDS SCREEN
- POSITIVE DISPLACEMENT BLOWER

PIPING AND VALVE SYMBOLOGY

- BALL VALVE
- BUTTERFLY VALVE
- DIAPHRAGM VALVE
- GATE VALVE
- GLOBE VALVE
- KNIFE GATE VALVE
- NEEDLE VALVE
- PINCH VALVE
- PLUG VALVE
- THREE WAY BALL VALVE
- THREE WAY PLUG VALVE
- BALL CHECK VALVE
- CHECK VALVE
- DOUBLE DISK CHECK VALVE
- CONE VALVE
- OR — PRESSURE RELIEF VALVE
- PRESSURE REDUCING VALVE
- X — AIR RELEASE VACUUM VALVE
  A = AIR RELEASE
  V = VACUUM
- AIR RELEASE VALVE
- PRESSURE REGULATING VALVE
- BACK PRESSURE VALVE
- S — SOLENOID VALVE
- 36"-RWI — TYPICAL PIPE LINE CALLOUT
- OA DAMPER
- BACKFLOW PREVENTER
- M — FLOW METER
- NGM — NATURAL GAS METER
- UNION
- WYE-STRAINER
- FLEXIBLE HOSE OR TUBING
- FLEXIBLE PIPING CONNECTION
- LINE SIZE CHANGE
- LINE TURNING DOWN
- LINE TURNING UP
- BLIND FLANGE
- PIPE BREAK
- V-PORT BALL VALVE
- THREE-WAY CONTROL VALVE

NOTE:
1. VALVES SHOWN AS BLACK /SOLID ARE TO INDICATE NORMALLY CLOSED VALVES.

- 3-WAY VALVE
- 4-WAY VALVE
- CALIBRATION POT
- BASKET STRAINER
- QUICK CONNECT
- PNEUMATIC ACTUATOR
- SUCTION DIFFUSER-STRAINER
- PUMP DISCHARGE (TRIPLE DUTY) VALVE
- THERMOSTATIC MIXING VALVE
- INJECTION RING
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)
- COMPRESSION SLEEVE TYPE COUPLING
- FLANGED COUPLING ADAPTER (FCA)
- FLEXIBLE CONNECTION
- HARNESSED MECHANICAL COUPLING
- EXPANSION COUPLING/JOINT
- PRESSURE GAUGE (WITH COCK)
- TRAP
- QUICK DISCONNECT CAM & GROOVE COUPLING
- CAP OR PLUG
- CO — INTERIOR CLEANOUT
- HOSE BIBB -1
- HOSE BIBB -2
- HR — HOSE REEL
- FD-X — FLOOR DRAIN

X = TYPE DESIGNATED IN SPECIFICATIONS

- PIPE IN SECTION
- BU — BELL UP (PLAN)
- BU — BELL UP (SECTION OR SCHEMATIC)
- D — DRAIN (SECTION OR SCHEMATIC)

D | C | B | A

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

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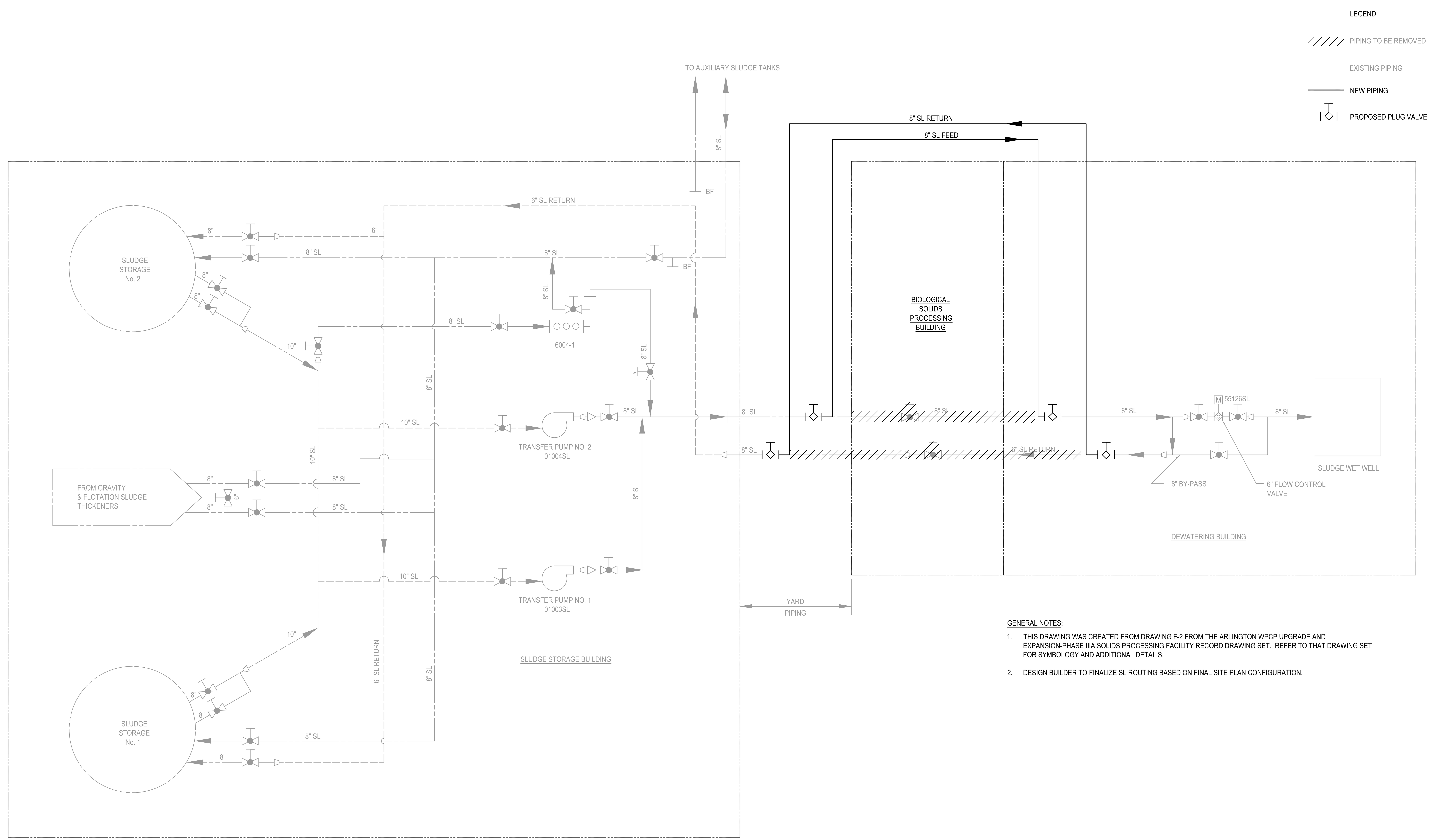
VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN
EARLY WORK

GENERAL LEGEND AND SYMBOLS

0 1" 2"

FILENAME G-003.dwg
SCALE NOT TO SCALE
SHEET G-003



GENERAL NOTES:

1. THIS DRAWING WAS CREATED FROM DRAWING F-2 FROM THE ARLINGTON WPCP UPGRADE AND EXPANSION-PHASE IIIA SOLIDS PROCESSING FACILITY RECORD DRAWING SET. REFER TO THAT DRAWING SET FOR SYMBOLOGY AND ADDITIONAL DETAILS.
2. DESIGN BUILDER TO FINALIZE SL ROUTING BASED ON FINAL SITE PLAN CONFIGURATION.

ISSUE	DATE	DESCRIPTION
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PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
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ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

PROCESS FLOW DIAGRAM
SLUDGE TRANSFER

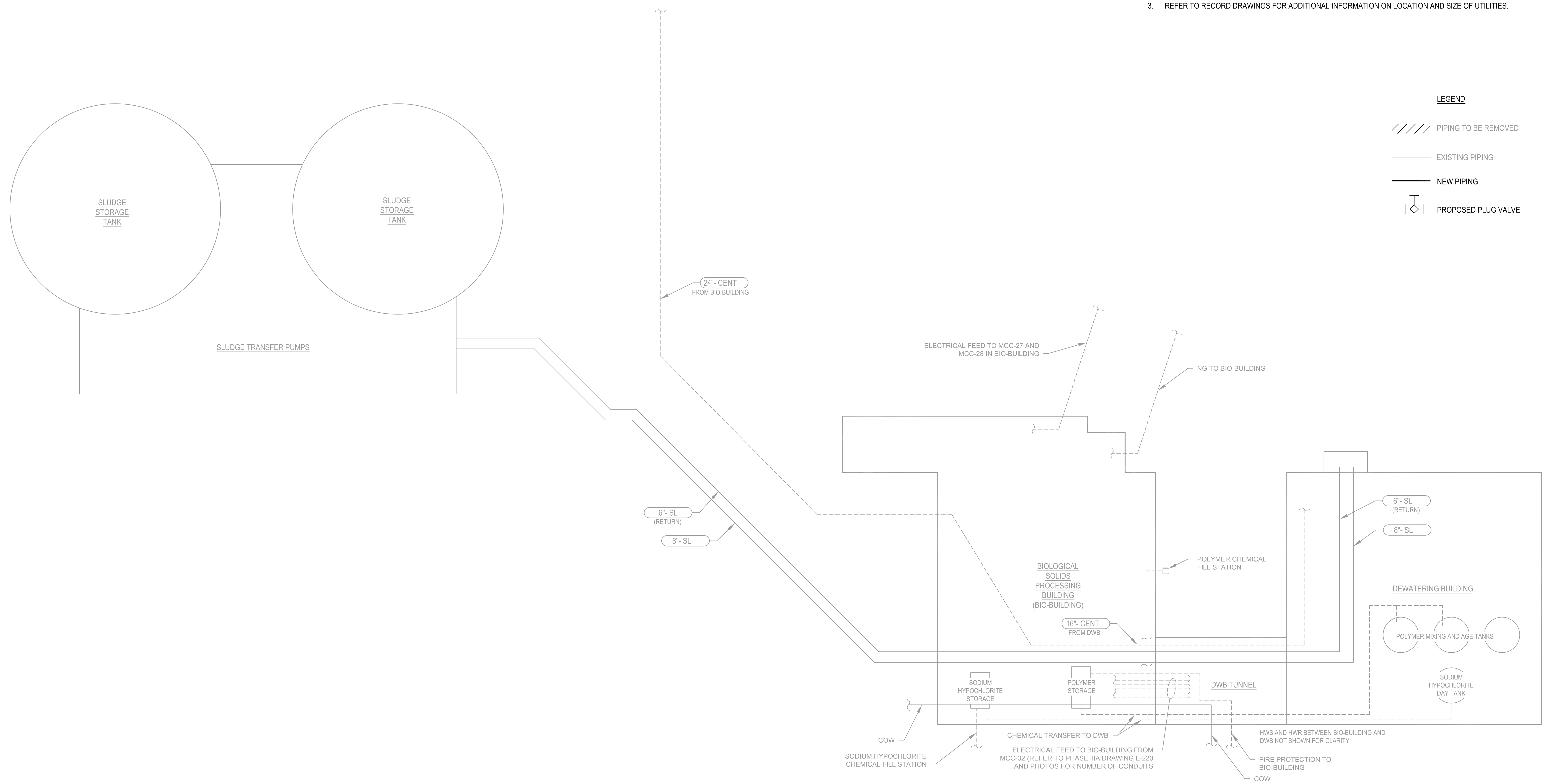
FILENAME G-004.dwg
SCALE NOT TO SCALE
SHEET G-004

GENERAL NOTES:

1. THIS DRAWING IS SCHEMATIC AND NOT TO SCALE.
2. INTENT OF SCHEMATIC IS TO SHOW UTILITIES IMPACTED BY DEMOLITION OF BIO-BUILDING ONLY. DESIGN BUILDER SHALL COORDINATE AS NECESSARY, INCLUDING IMPACTS TO OTHER UTILITIES NOT SHOWN.
3. REFER TO RECORD DRAWINGS FOR ADDITIONAL INFORMATION ON LOCATION AND SIZE OF UTILITIES.

LEGEND

- PIPING TO BE REMOVED
- EXISTING PIPING
- NEW PIPING
- PROPOSED PLUG VALVE



ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

EXISTING UTILITIES SCHEMATIC BIOLOGICAL SOLIDS PROCESSING BUILDING

0 1" 2"

FILENAME G-005.dwg

SCALE NOT TO SCALE

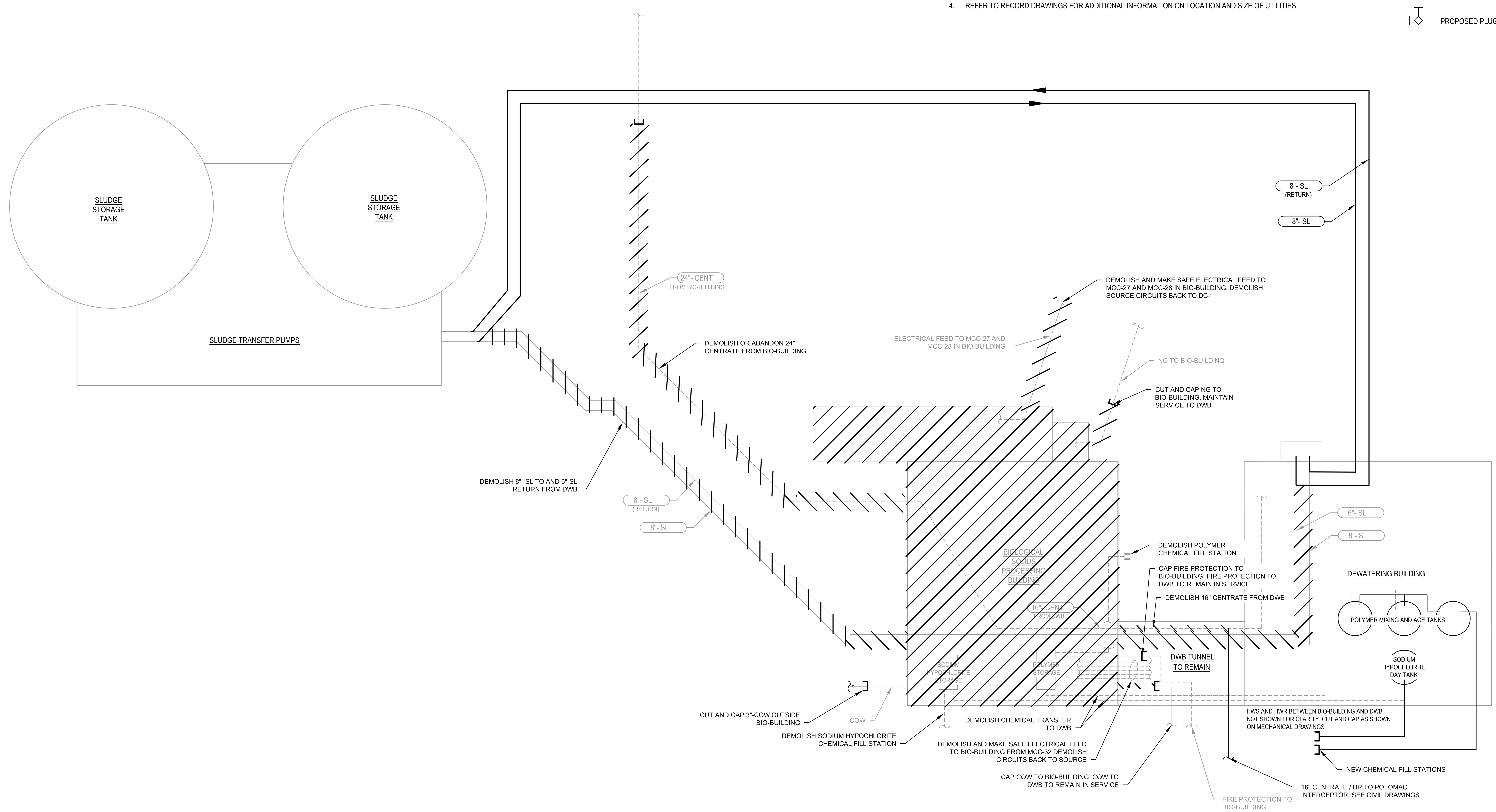
SHEET **G-005**

GENERAL NOTES:

1. THIS DRAWING IS SCHEMATIC AND NOT TO SCALE.
2. INTENT OF SCHEMATIC IS TO SHOW UTILITIES IMPACTED BY DEMOLITION OF BIO-BUILDING ONLY. DESIGN BUILDER SHALL COORDINATE AS NECESSARY, INCLUDING IMPACTS TO OTHER UTILITIES NOT SHOWN.
3. SCHEMATIC DOES NOT SHOW ABANDONED EQUIPMENT AND UTILITIES.
4. REFER TO RECORD DRAWINGS FOR ADDITIONAL INFORMATION ON LOCATION AND SIZE OF UTILITIES.

LEGEND

- PIPING TO BE REMOVED
- EXISTING PIPING
- NEW PIPING
- PROPOSED PLUG VALVE



PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

ISSUE	DATE	DESCRIPTION
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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

POST DEMOLITION UTILITIES SCHEMATIC

FILENAME G-006.dwg

SCALE NOT TO SCALE

SHEET **G-006**

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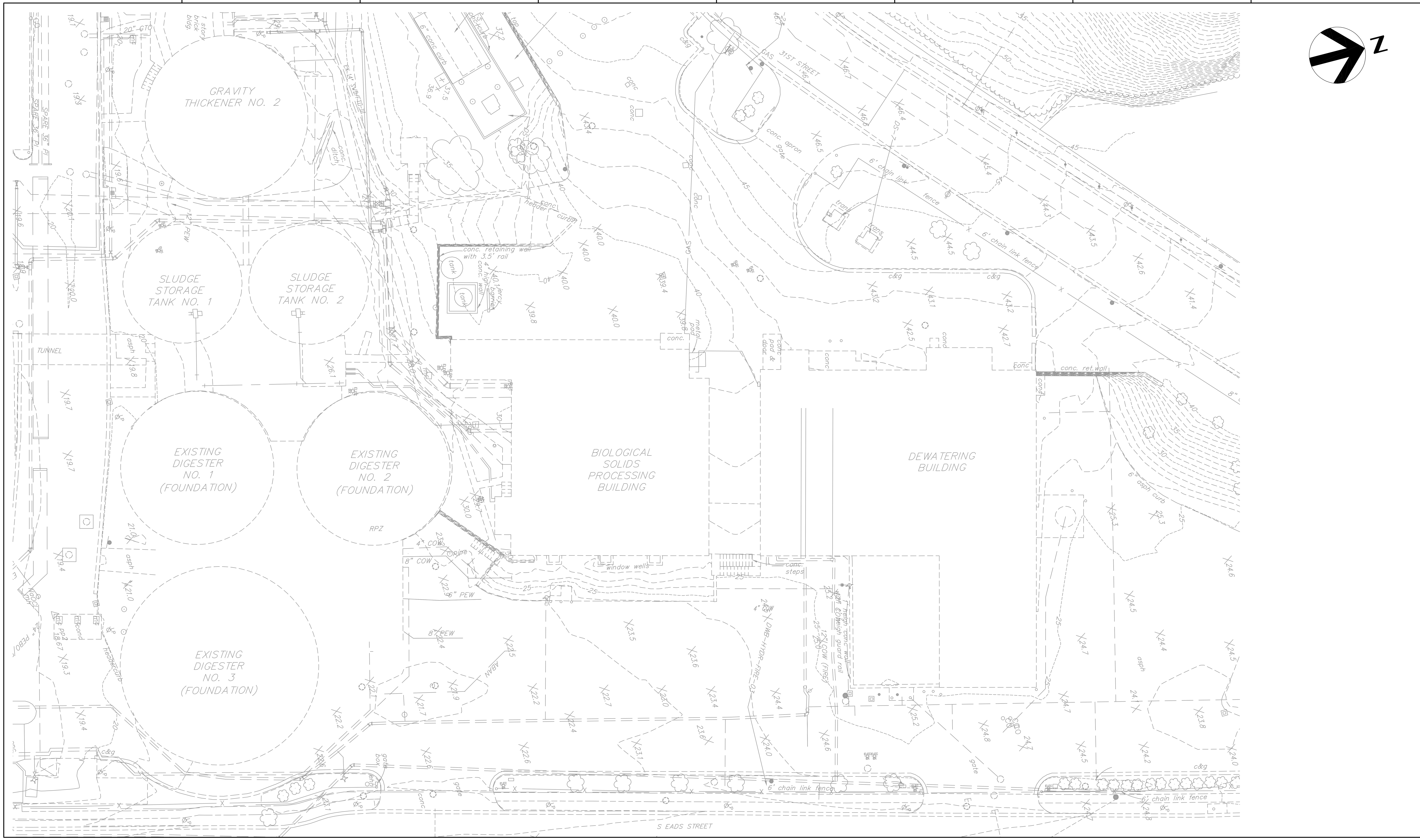


A	06/2022	35% SUBMITTAL
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

EXISTING SITE PLAN

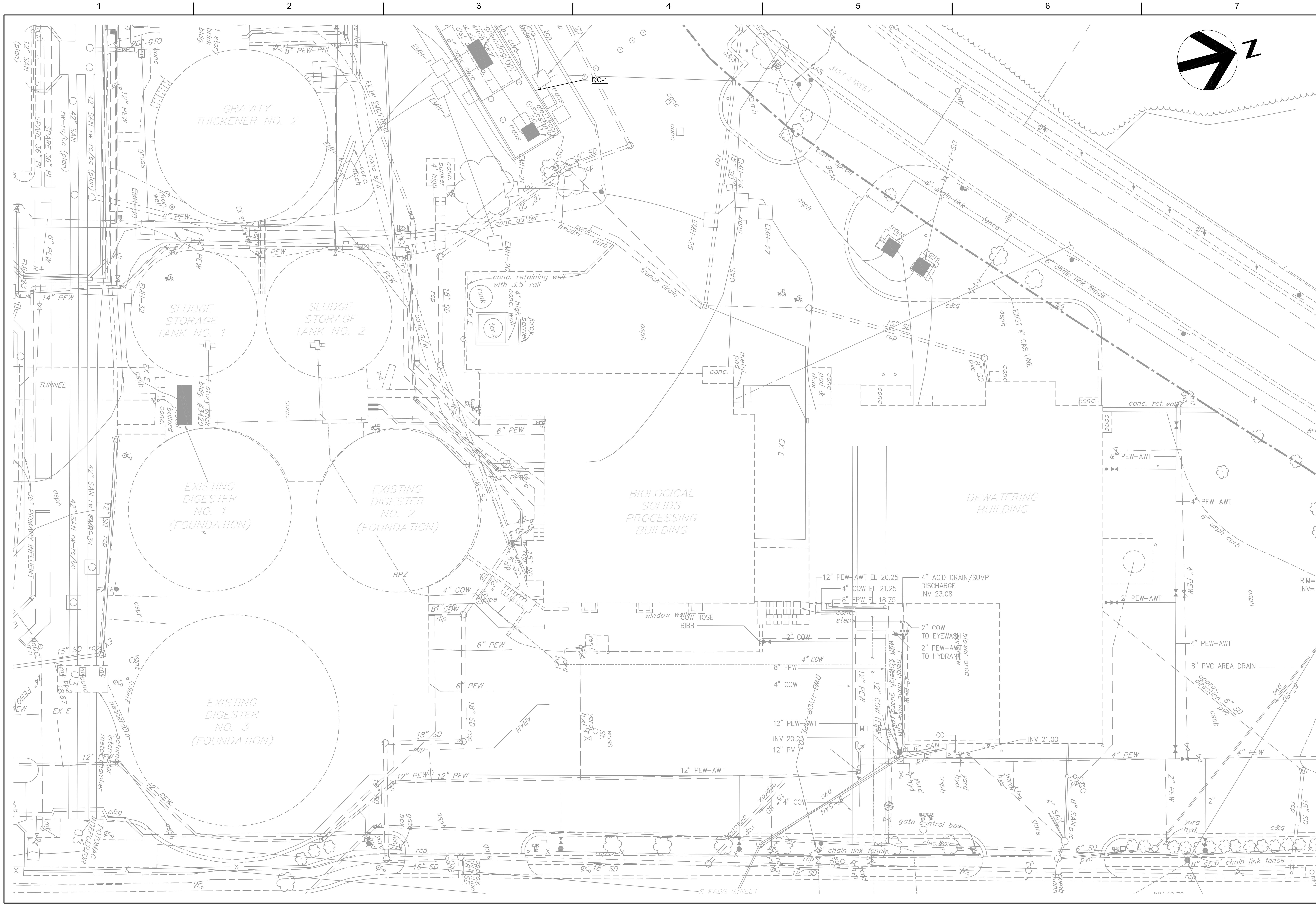
0 1" 2"

FILENAME C-001.dwg

SCALE 1"=20'

SHEET C-001

1 2 3 4 5 6 7 8



GENERAL NOTES:

1. DRAWING IS FOR REFERENCE ONLY. FIELD LOCATE ALL UTILITIES.
2. REFER TO G-004 AND G-005 FOR SCHEMATIC REPRESENTATION OF UTILITIES IMPACTED BY EARLY WORK.

D C B A

HDR

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

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CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
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PROJECT NUMBER	10263882

PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

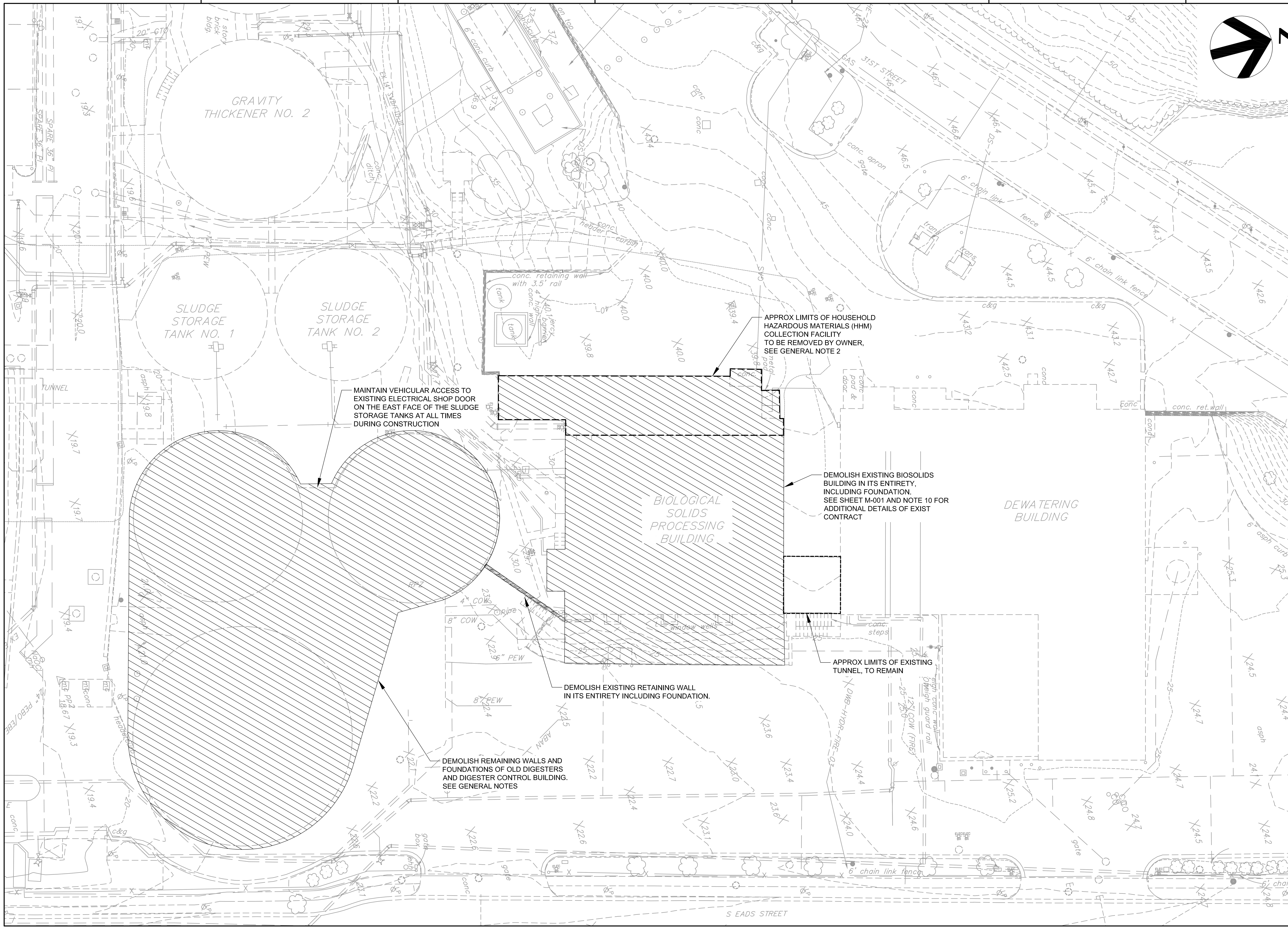
EXISTING SITE PLAN UNDERGROUND UTILITIES

0 1" 2"

FILENAME C-002.dwg

SCALE 1"=20'

SHEET C-002



GENERAL NOTES:

1. REFERENCE THE FOLLOWING DRAWING SETS FOR INFORMATION ABOUT EXISTING EQUIPMENT AND STRUCTURES IN BIOLOGICAL SLUDGE PROCESS BUILDING THAT WILL NEED TO BE DEMOLISHED:

   a. ARLINGTON WPCP UPGRADE AND EXPANSION PHASE 7E, HOUSEHOLD HAZARDOUS MATERIALS FACILITY.

   b. ARLINGTON WPCP UPGRADE AND EXPANSION-PHASE IIIA, SOLIDS PROCESSING FACILITIES.

   c. ARLINGTON WPCP ADVANCED WASTE TREATMENT BIOLOGICAL SLUDGE PROCESSING BUILDING, CONTRACT 72-47-S.

   d. ARLINGTON SEWAGE TREATMENT PLANT SECONDARY TREATMENT FACILITIES, CONTRACT I.

   e. ARLINGTON COUNTY SEWAGE TREATMENT PLANT (FIRST PLANT EXPANSION), 1946.

2. OWNER WILL RELOCATE ARLINGTON COUNTY HOUSEHOLD HAZARDOUS MATERIALS (HHM) COLLECTION FACILITIES PRIOR TO START OF CONSTRUCTION. ALL TEMPORARY EQUIPMENT AND FACILITIES ASSOCIATED WITH THE HHM FACILITY WILL BE REMOVED. PERMANENT FIXTURES, INCLUDING LIGHTING, WALLS, ELECTRICAL, AND HVAC WILL BE DEMOLISHED BY DESIGN BUILDER.

3. AN ALLOWANCE IS INCLUDED FOR ABATEMENT OF HAZARDOUS MATERIALS. REFER TO THE CONTRACT DOCUMENTS FOR ADDITIONAL INFORMATION.

4. DESIGN BUILDER IS RESPONSIBLE FOR DESIGN AND CONSTRUCTION OF EARTH RETENTION SYSTEMS AS NECESSARY TO SUPPORT THE DEMOLITION AND FUTURE WORK.

5. DESIGN BUILDER IS RESPONSIBLE FOR PROTECTION OF EXISTING DWB TUNNEL AND DWB DURING DEMOLITION. SEE M-001, GENERAL REQUIREMENTS, AND DIVISION 2 SPECIFICATIONS. THE DEWATERING BUILDING TO REMAIN FULLY OPERATIONAL DURING DEMOLITION.

6. EXISTING SLUDGE TRANSFER PUMPING STATION BETWEEN SLUDGE STORAGE TANKS AND OLD DIGESTERS TO REMAIN IN TACT AND OPERATIONAL. DEMOLISH ABANDONED DIGESTERS AS FAR AS POSSIBLE TO KEEP FACILITY IN OPERATION.

7. DEMOLITION AND RELOCATION OF UTILITIES NOT SHOWN THIS PLAN. REFER TO G-005, G-006 AND MECHANICAL DRAWINGS.

8. FINAL SITE LAYOUT AT END OF EARLY WORK TO BE DETERMINED BY DESIGN BUILDER. ALL FOUNDATIONS TO BE COMPLETELY DEMOLISHED AND AREAS BACK FILLED TO APPROPRIATE GRADE TO FACILITATE FUTURE MAIN PROJECT CONSTRUCTION.

9. EXISTING DIGESTERS WERE CONSTRUCTED IN MULTIPLE PHASES (FIRST PLANT EXPANSION, 1946; SECONDARY TREATMENT FACILITIES, CONTRACT I). DIGESTERS WERE PARTIALLY DEMOLISHED UNDER CONTRACT 7C. NO RECORD DRAWINGS EXIST OF DEMOLITION. ASSUME WALLS TO GRADE AND FOUNDATIONS REMAIN. APPROXIMATE FOUNDATION ELEVATIONS ARE 10.0 AT PERIMETER AND 0.0 AT CONE.

10. THE BIOLOGICAL SLUDGE PROCESSING BUILDING (BIO-BUILDING) WAS CONSTRUCTED IN 1977 AS PART OF CONTRACT 72-47-S. THE BIO-BUILDING IS APPROXIMATELY 72.5 FEET TALL AND WAS CONSTRUCTED BY A COMBINATION OF CONCRETE, BLOCK, BRICK AND METAL FRAMING ON AN APPROXIMATELY 4 FEET THICK MAT FOUNDATION. THE BIO-BUILDING INCLUDES ABANDONED EQUIPMENT FOR DEWATERING AND TREATING SLUDGE, INCLUDING BUT NOT LIMITED TO FILTER PRESSES, CAKE PUMPS, MULTIPLE HEARTH INCINERATORS, ASH HANDLING EQUIPMENT, AIR POLLUTION CONTROL EQUIPMENT, AND OTHER ANCILLARY COMPONENTS.

20 0 20 40
HORIZONTAL SCALE 1" = 20'

HDR

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY
NOT FOR
CONSTRUCTION

ARLINGTON
VIRGINIA

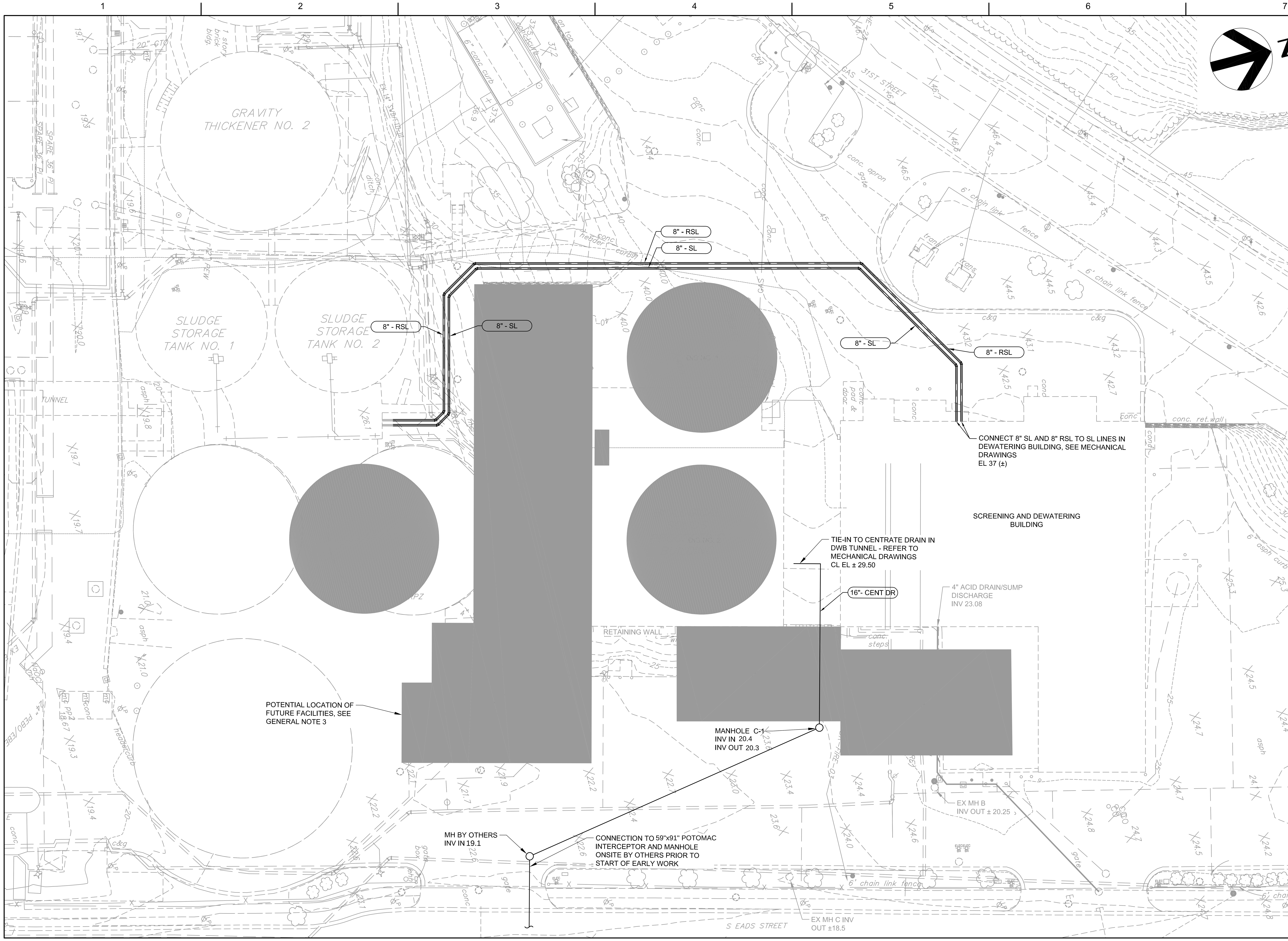
ARLINGTON COUNTY
WPCP
RE-GEN
EARLY WORK

SITE DEMOLITION PLAN

0 1" 2"

FILENAME C-003.dwg
SCALE 1"=20'

SHEET
C-003



GENERAL NOTES:

1. DRAWING IS FOR REFERENCE ONLY. FIELD LOCATE ALL UTILITIES.
2. REFER TO G-004 AND G-005 FOR SCHEMATIC REPRESENTATION OF UTILITIES IMPACTED BY EARLY WORK.
3. SITE LAYOUT FOR RENOVATE DEWATERING BUILDING SHOWN. SITE LAYOUT IS SCHEMATIC AND TO BE FINALIZED BY DESIGN BUILDER. COORDINATE UTILITY RELOCATION WITH FINAL SITE LAYOUT.
4. PROVIDE PROVISIONS FOR TWICE ANNUAL PUMP AROUND OF CENTRATE / DR TO PRIMARY CLARIFIER EFFLUENT CHANNEL. REFER TO SPECIFICATIONS.

20 0 20 40
HORIZONTAL SCALE 1" = 20'

HDR

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INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY
NOT FOR
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ARLINGTON
VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN
EARLY WORK

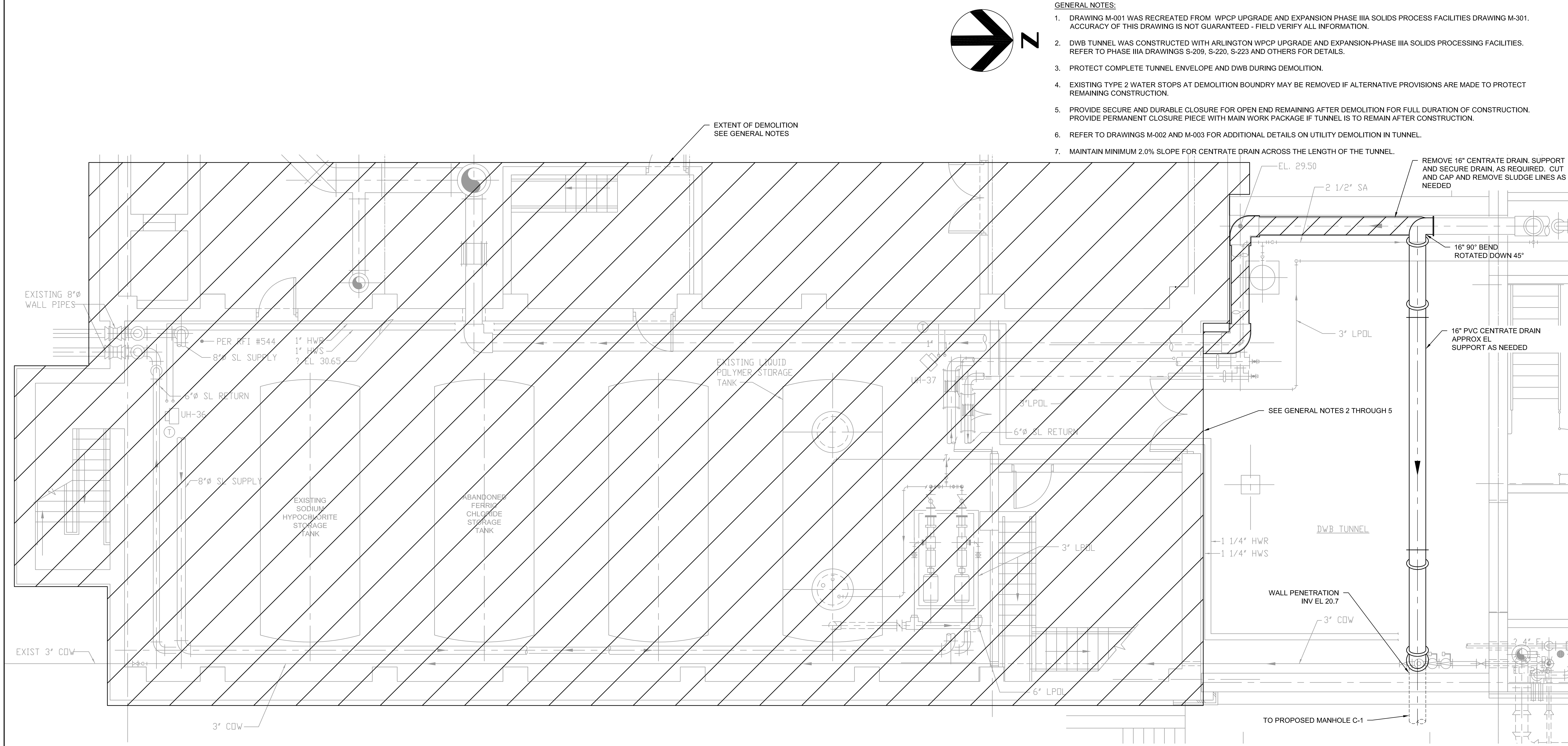
SITE LAYOUT
UTILITY RELOCATION CONCEPT

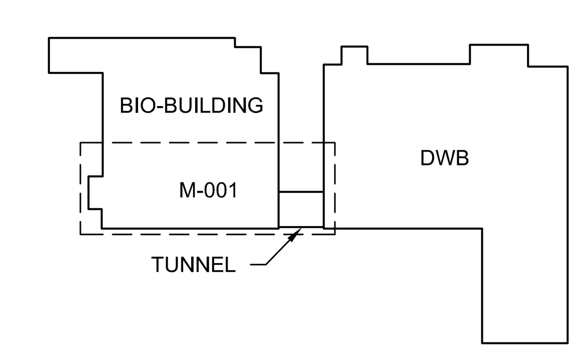
0 1" 2"

FILENAME C-004.dwg
SCALE 1"=20'
SHEET C-004

GENERAL NOTES:

1. DRAWING M-001 WAS RECREATED FROM WPCP UPGRADE AND EXPANSION PHASE IIIA SOLIDS PROCESS FACILITIES DRAWING M-301. ACCURACY OF THIS DRAWING IS NOT GUARANTEED - FIELD VERIFY ALL INFORMATION.
2. DWB TUNNEL WAS CONSTRUCTED WITH ARLINGTON WPCP UPGRADE AND EXPANSION-PHASE IIIA SOLIDS PROCESSING FACILITIES. REFER TO PHASE IIIA DRAWINGS S-209, S-220, S-223 AND OTHERS FOR DETAILS.
3. PROTECT COMPLETE TUNNEL ENVELOPE AND DWB DURING DEMOLITION.
4. EXISTING TYPE 2 WATER STOPS AT DEMOLITION BOUNDRY MAY BE REMOVED IF ALTERNATIVE PROVISIONS ARE MADE TO PROTECT REMAINING CONSTRUCTION.
5. PROVIDE SECURE AND DURABLE CLOSURE FOR OPEN END REMAINING AFTER DEMOLITION FOR FULL DURATION OF CONSTRUCTION. PROVIDE PERMANENT CLOSURE PIECE WITH MAIN WORK PACKAGE IF TUNNEL IS TO REMAIN AFTER CONSTRUCTION.
6. REFER TO DRAWINGS M-002 AND M-003 FOR ADDITIONAL DETAILS ON UTILITY DEMOLITION IN TUNNEL.
7. MAINTAIN MINIMUM 2.0% SLOPE FOR CENTRATE DRAIN ACROSS THE LENGTH OF THE TUNNEL.





BIO-BUILDING AND DWB KEY PLAN

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY
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CONSTRUCTION

ARLINGTON VIRGINIA

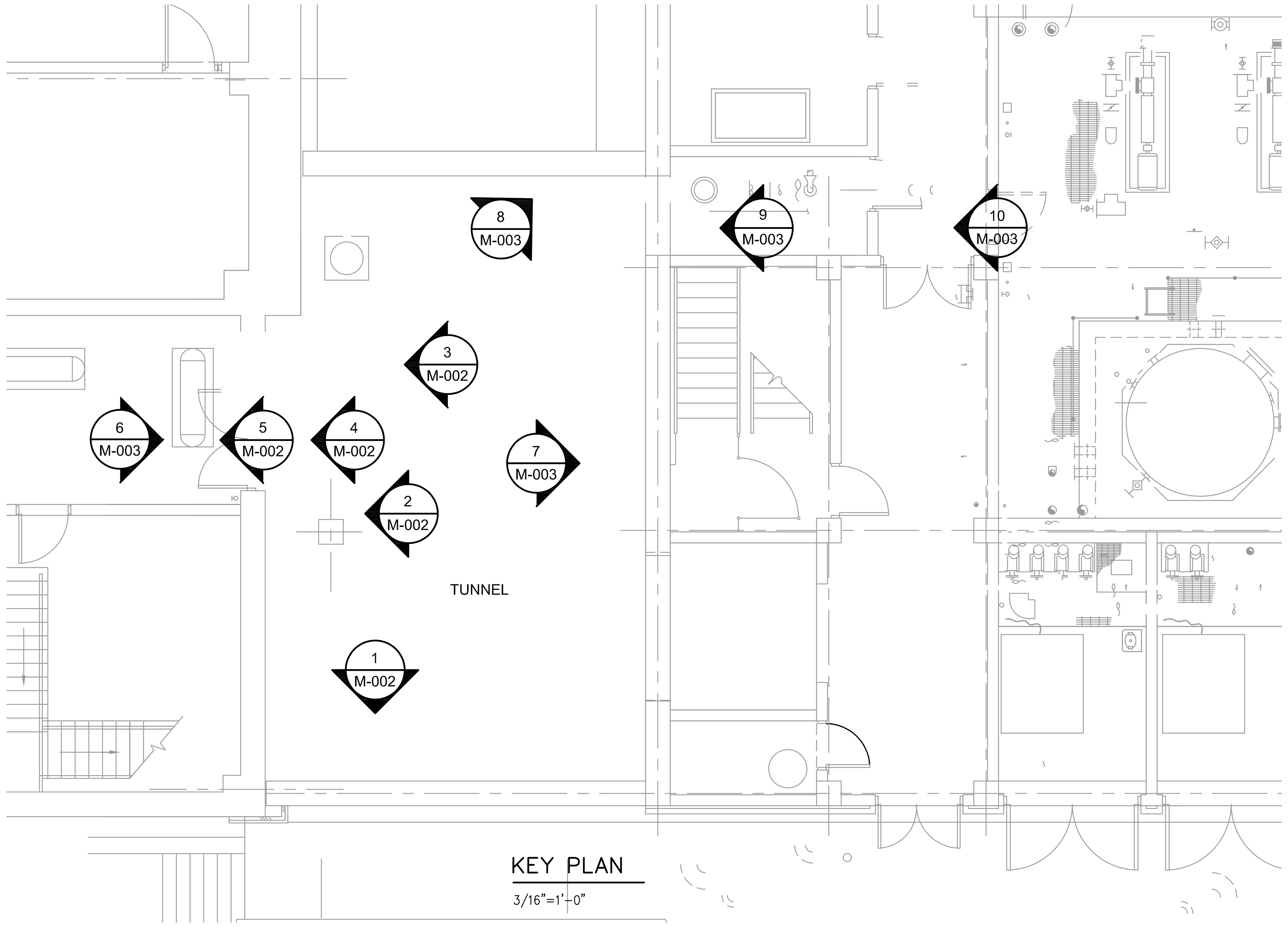
ARLINGTON COUNTY
WPCP
RE-GEN
EARLY WORK

BIO-BUILDING BASEMENT AND DWB TUNNEL PLAN

FILENAME M-001.dwg
SCALE 3/16" = 1'-0"

SHEET
M-001

1 2 3 4 5 6 7 8



KEY PLAN
3/16"=1'-0"

1 M-002 DWB TUNNEL–SE CORNER

2 M-002 DWB TUNNEL–UPPER SOUTH WALL

REMOVE EXISTING FIRE PROTECTION WATER TO BIO-BUILDING AND INSTALL VICTAULIC CAP. FIRE PROTECTION WATER TO DWB TO REMAIN

3 M-002 DWB TUNNEL–LOWER SOUTH WALL

4 M-002 DWB TUNNEL–SOUTH WALL

DEMOLISH AND MAKE SAFE ELECTRICAL FEED TO BIO-BUILDING FROM MCC-32, DEMOLISH CIRCUITS BACK TO SOURCE

5 M-002 DWB TUNNEL–CEILING

D C B A

HDR

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

TUNNEL PHOTO PLAN 1

0 1" 2"

FILENAME M-002.dwg
SCALE NOT TO SCALE

SHEET M-002

GENERAL NOTES:

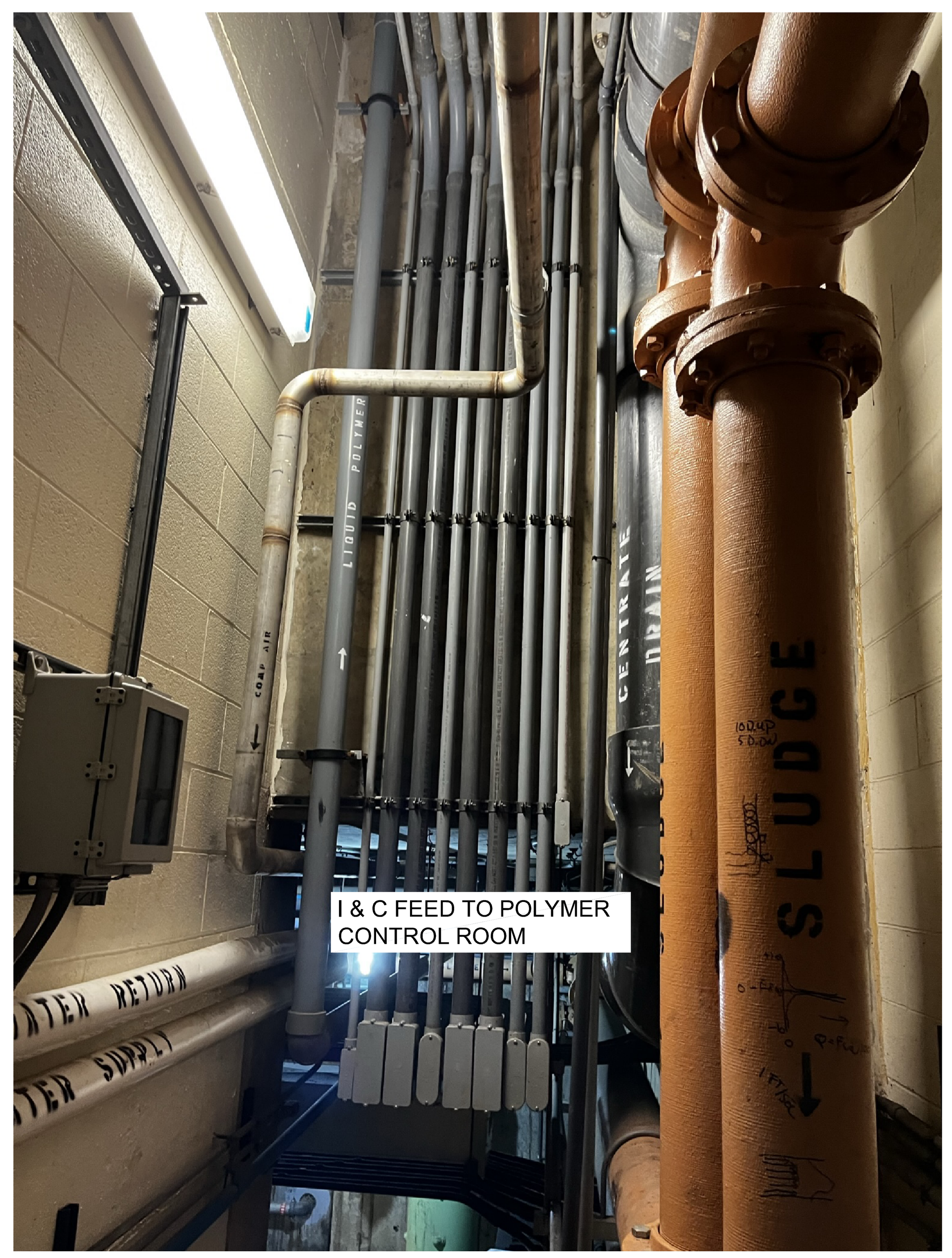
1. PHOTOGRAPHS PROVIDED ON THIS DRAWING ARE FOR INFORMATION ONLY. REFER TO OTHER DRAWINGS FOR UTILITY RELOCATION AND DEMOLITION AND ABANDONMENT.

6 / M-002 BIO–BUILDING LOOKING TOWARD DWB TUNNEL

7 / M-002 DWB TUNNEL–NORTH WALL AND CEILING

8 / M-002 DWB TUNNEL–NORTHWEST CORNER

9 / M-002 PIPE CLOSET LOOKING SOUTH TOWARD DWB TUNNEL



10 / M-002 PIPE CLOSET LOOKING SOUTH TOWARD DWB TUNNEL

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY
NOT FOR
CONSTRUCTION

ARLINGTON
VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN
EARLY WORK

TUNNEL PHOTO PLAN 2

0 1" 2"

FILENAME M-003.DWG

SCALE NOT TO SCALE

SHEET M-003

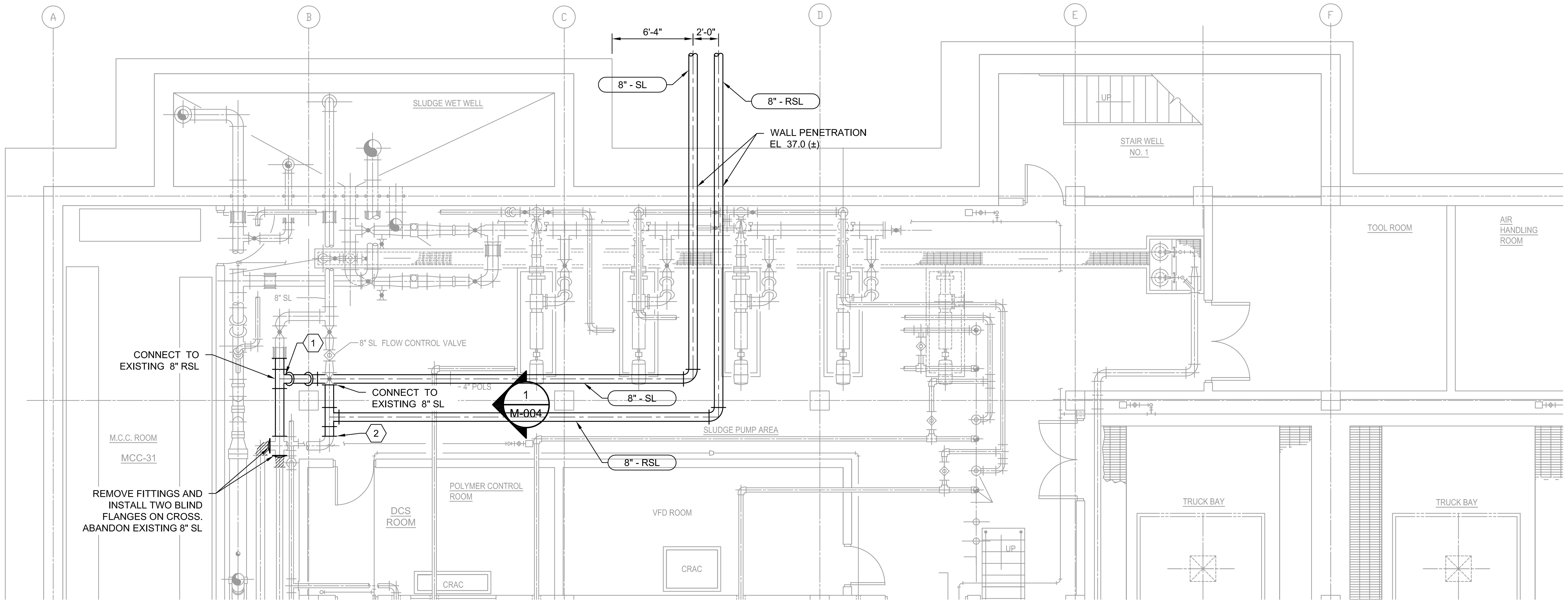
1 2 3 4 5 6 7 8

GENERAL NOTES:

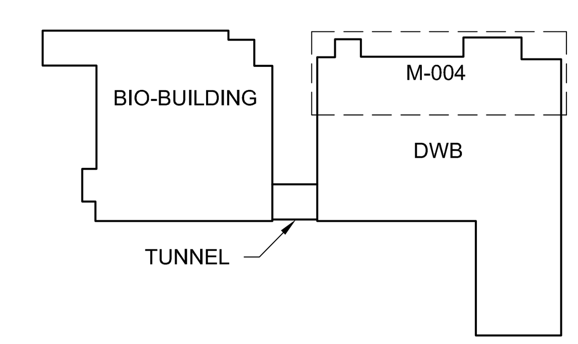
1. DRAWING M-004 WAS RECREATED FROM WPCP UPGRADE AND EXPANSION PHASE IIIA SOLIDS PROCESS FACILITIES DRAWING M-201. ACCURACY OF THIS DRAWING IS NOT GUARANTEED - FIELD VERIFY ALL INFORMATION.
2. PROVIDE PIPE SUPPORT AS NEEDED TO SAFELY CONSTRUCT BOTH LINES.
3. DESIGN BUILDER TO INSTALL NECESSARY BENDS TO AVOID EXISTING PIPING.

KEY NOTES: #

1. INSTALL NEW 8" PIPE FROM EXISTING PLUG VALVE TO EXISTING 8"x8" CROSS TO INCLUDE 8" TEE, ROTATED DOWN, AND REQUIRED BENDS, TO ALLOW SLUDGE RETURN TO RUN BELOW 8" SL. SEE PHOTO BELOW.
2. INSTALL NEW 8" PIPE FROM EXISTING PLUG VALVE TO EXISTING 90° ELBOW TO INCLUDE 8" TEE.



1 M-004 DWB LOOKING SOUTH EL 25.0



BIO-BUILDING AND DWB KEY PLAN

HDR

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

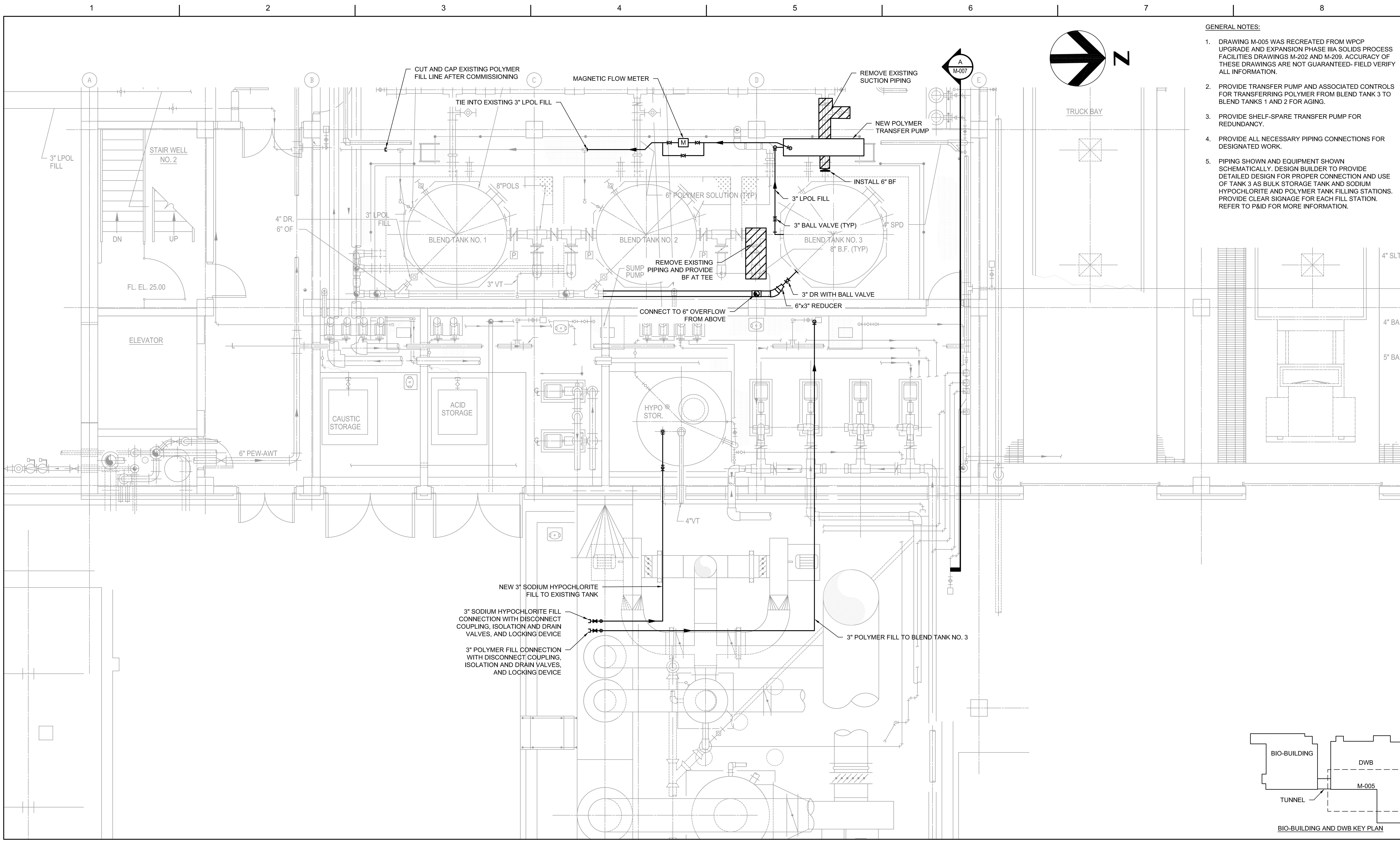
DWB SLUDGE FEED PIPING RELOCATION PLAN

0 1" 2"

FILENAME M-004.dwg

SCALE 3/16" = 1'-0"

SHEET M-004



GENERAL NOTES:

1. DRAWING M-005 WAS RECREATED FROM WPCP UPGRADE AND EXPANSION PHASE IIIA SOLIDS PROCESS FACILITIES DRAWINGS M-202 AND M-209. ACCURACY OF THESE DRAWINGS ARE NOT GUARANTEED- FIELD VERIFY ALL INFORMATION.
2. PROVIDE TRANSFER PUMP AND ASSOCIATED CONTROLS FOR TRANSFERRING POLYMER FROM BLEND TANK 3 TO BLEND TANKS 1 AND 2 FOR AGING.
3. PROVIDE SHELF-SPARE TRANSFER PUMP FOR REDUNDANCY.
4. PROVIDE ALL NECESSARY PIPING CONNECTIONS FOR DESIGNATED WORK.
5. PIPING SHOWN AND EQUIPMENT SHOWN SCHEMATICALLY. DESIGN BUILDER TO PROVIDE DETAILED DESIGN FOR PROPER CONNECTION AND USE OF TANK 3 AS BULK STORAGE TANK AND SODIUM HYPOCHLORITE AND POLYMER TANK FILLING STATIONS. PROVIDE CLEAR SIGNAGE FOR EACH FILL STATION. REFER TO P&ID FOR MORE INFORMATION.

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

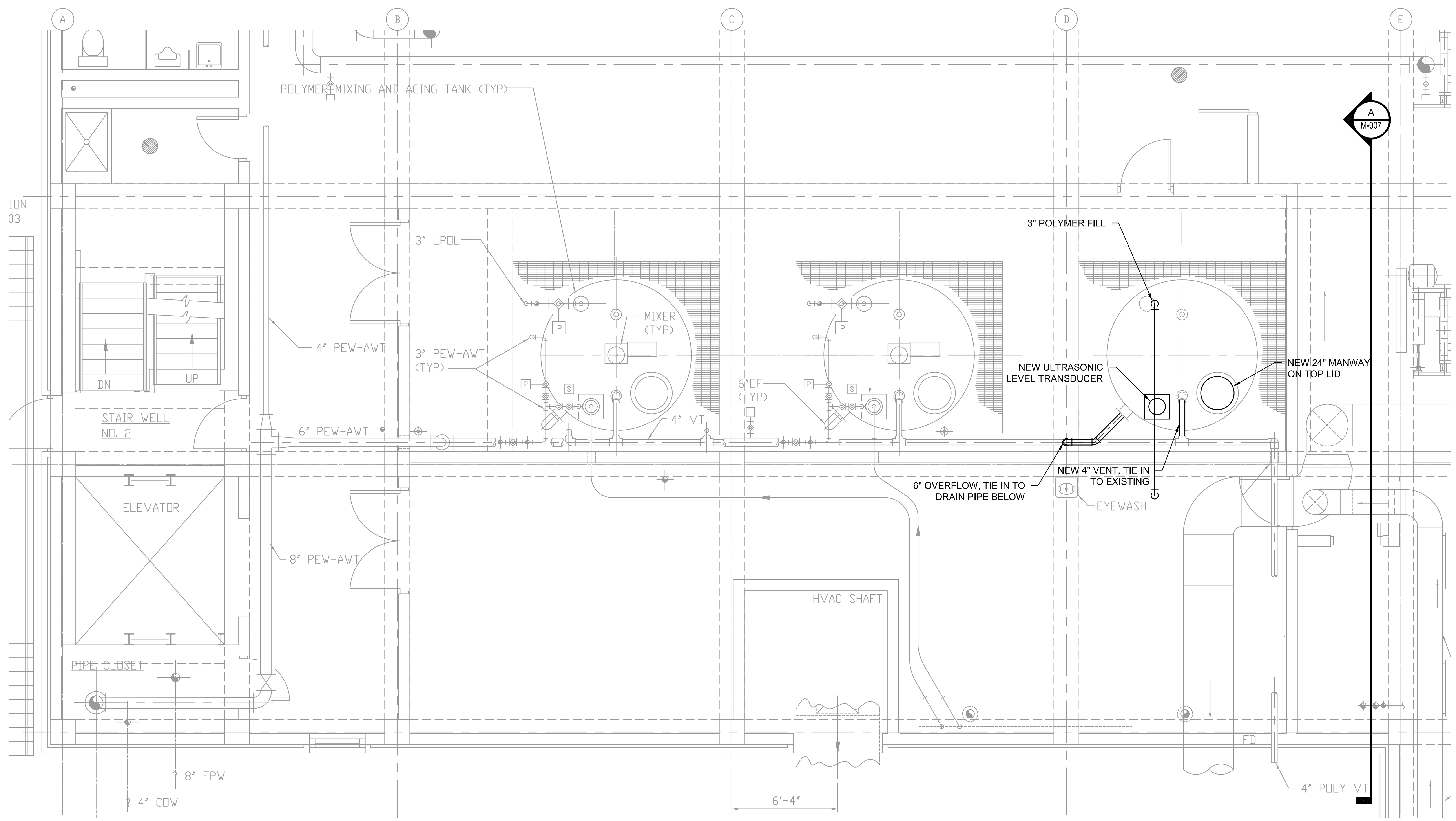
ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

DWB CHEMICAL SYSTEM MODIFICATIONS
FIRST FLOOR PLAN - EL 25.0

0 1" 2"

FILENAME M-005.dwg
SCALE 3/16" = 1'-0"
SHEET M-005

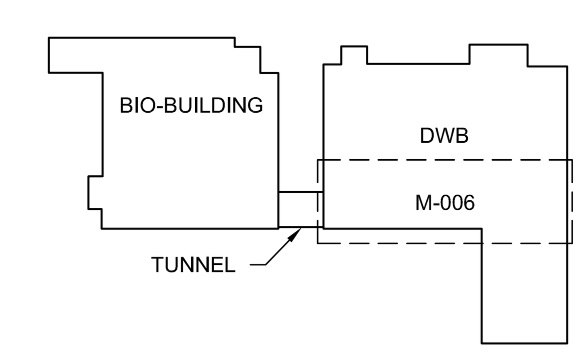
1 2 3 4 5 6 7 8



GENERAL NOTES:

1. DRAWING M-006 WAS RECREATED FROM WPCP UPGRADE AND EXPANSION PHASE IIIA SOLIDS PROCESS FACILITIES DRAWING M-204. ACCURACY OF THIS DRAWING IS NOT GUARANTEED- FIELD VERIFY ALL INFORMATION.
2. PROVIDE TRANSFER PUMP AND ASSOCIATED CONTROLS FOR TRANSFERRING POLYMER FROM BLEND TANK 3 TO BLEND TANKS 1 AND 2 FOR AGING.
3. PROVIDE SHELF-SPARE TRANSFER PUMP FOR REDUNDANCY.
4. PROVIDE ALL NECESSARY PIPING CONNECTIONS FOR DESIGNATED WORK.
5. PIPING SHOWN AND EQUIPMENT SHOWN SCHEMATICALLY. DESIGN BUILDER TO PROVIDE DETAILED DESIGN FOR PROPER CONNECTION AND USE OF TANK 3 AS BULK STORAGE TANK.
6. EXISTING 6,200 GALLON FRP BLEND TANK NO. 3 TO BE CONVERTED TO BULK POLYMER STORAGE. FABRICATE PENETRATIONS AS NECESSARY FOR POLYMER FILL, MANWAY, AND ULTRASONIC LEVEL DETECTOR CONNECTIONS TO TANK LID.

D C B A



BIO-BUILDING AND DWB KEY PLAN

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

DWB CHEMICAL SYSTEM MODIFICATIONS
SECOND FLOOR PLAN - EL 43.0

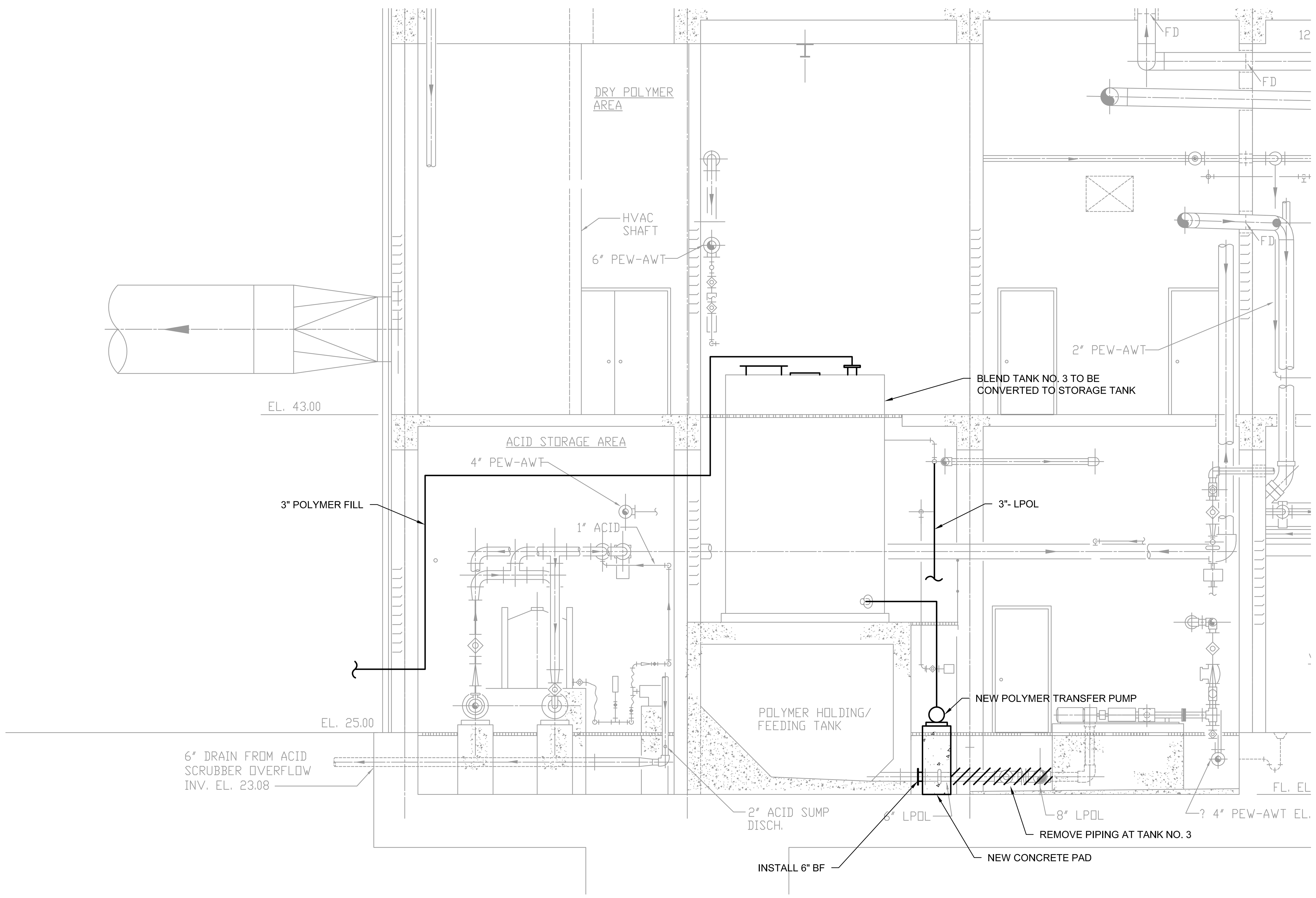
0 1" 2"

FILENAME M-006.dwg
SCALE 1/4" = 1'-0"

SHEET M-006

GENERAL NOTES:

1. DRAWING M-007 WAS RECREATED FROM WPCP UPGRADE AND EXPANSION PHASE IIIA SOLIDS PROCESS FACILITIES DRAWING M-214. ACCURACY OF THIS DRAWING IS NOT GUARANTEED- FIELD VERIFY ALL INFORMATION.
2. PROVIDE TRANSFER PUMP AND ASSOCIATED CONTROLS FOR TRANSFERRING POLYMER FROM BLEND TANK 3 TO BLEND TANKS 1 AND 2 FOR AGING.
3. PROVIDE SHELF-SPARE TRANSFER PUMP FOR REDUNDANCY.
4. PROVIDE ALL NECESSARY PIPING CONNECTIONS FOR DESIGNATED WORK.
5. PIPING SHOWN AND EQUIPMENT SHOWN SCHEMATICALLY. DESIGN BUILDER TO PROVIDE DETAILED DESIGN FOR PROPER CONNECTION AND USE OF TANK 3 AS BULK STORAGE TANK.
6. FABRICATE PENETRATIONS AS NECESSARY FOR POLYMER FILL, MANWAY, AND ULTRASONIC LEVEL DETECTOR CONNECTIONS TO TANK LID.



A SECTION M-005
SCALE: 1/4" = 1'-0"

A	06/2022	35% SUBMITTAL
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

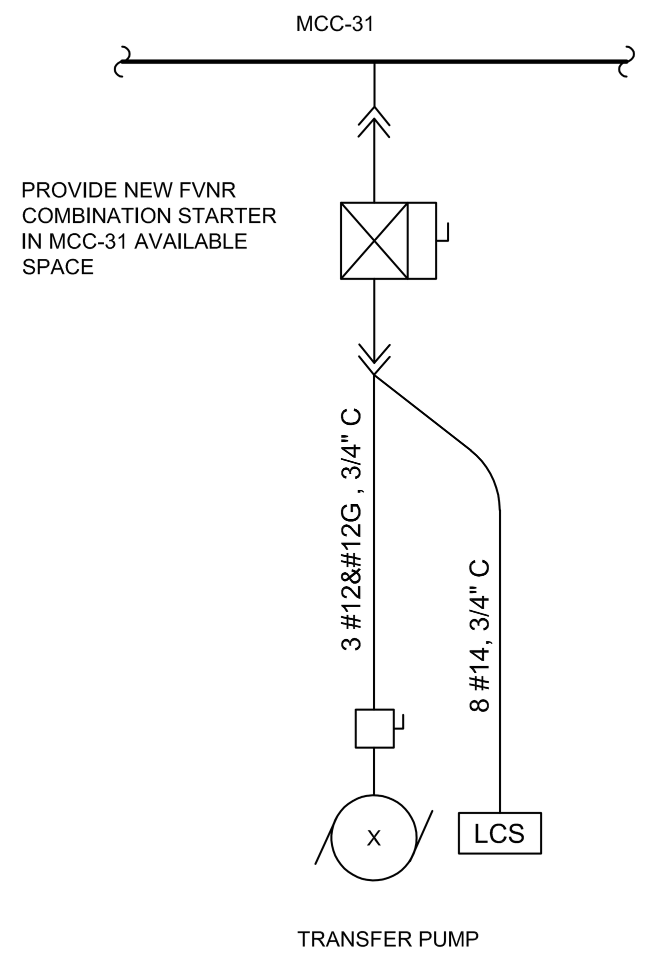
PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

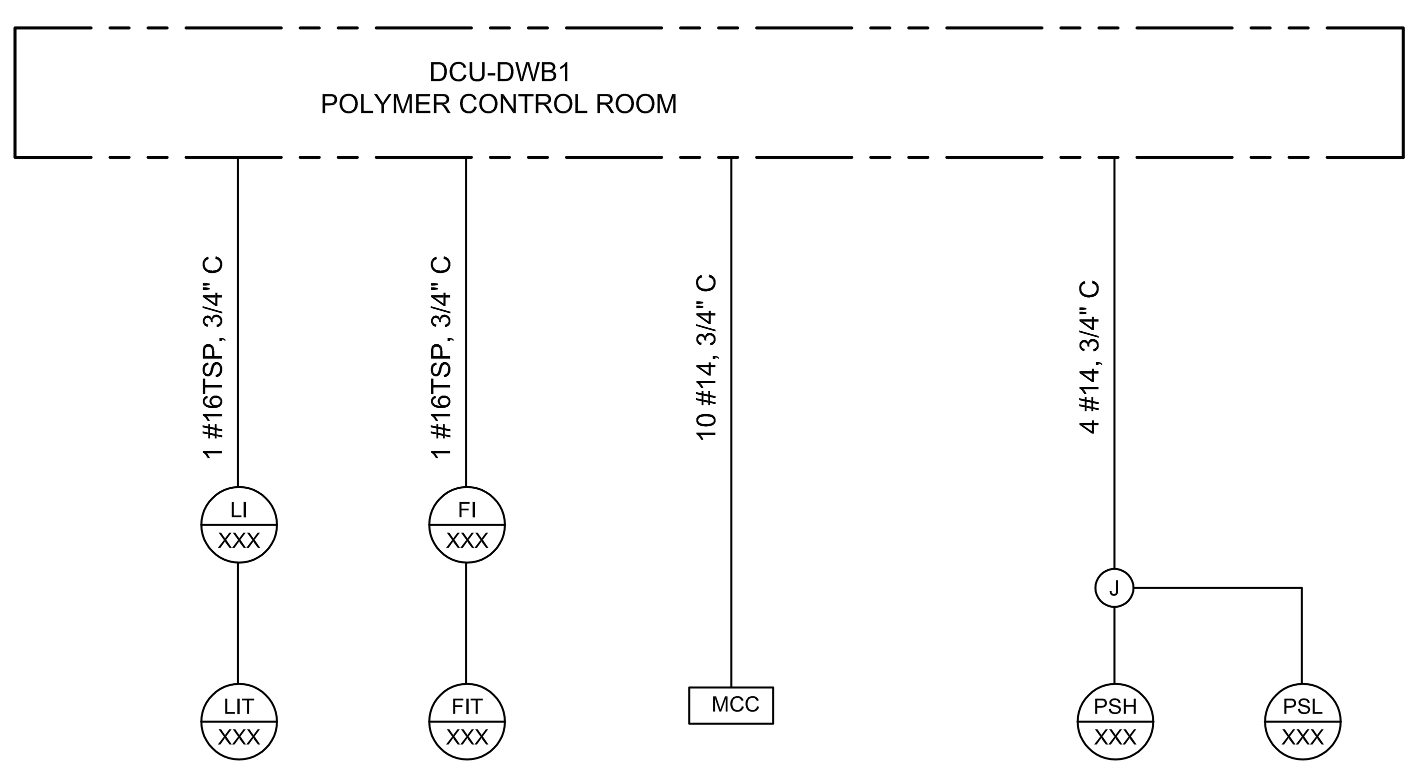
ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

DWB CHEMICAL SYSTEM MODIFICATIONS SECTION

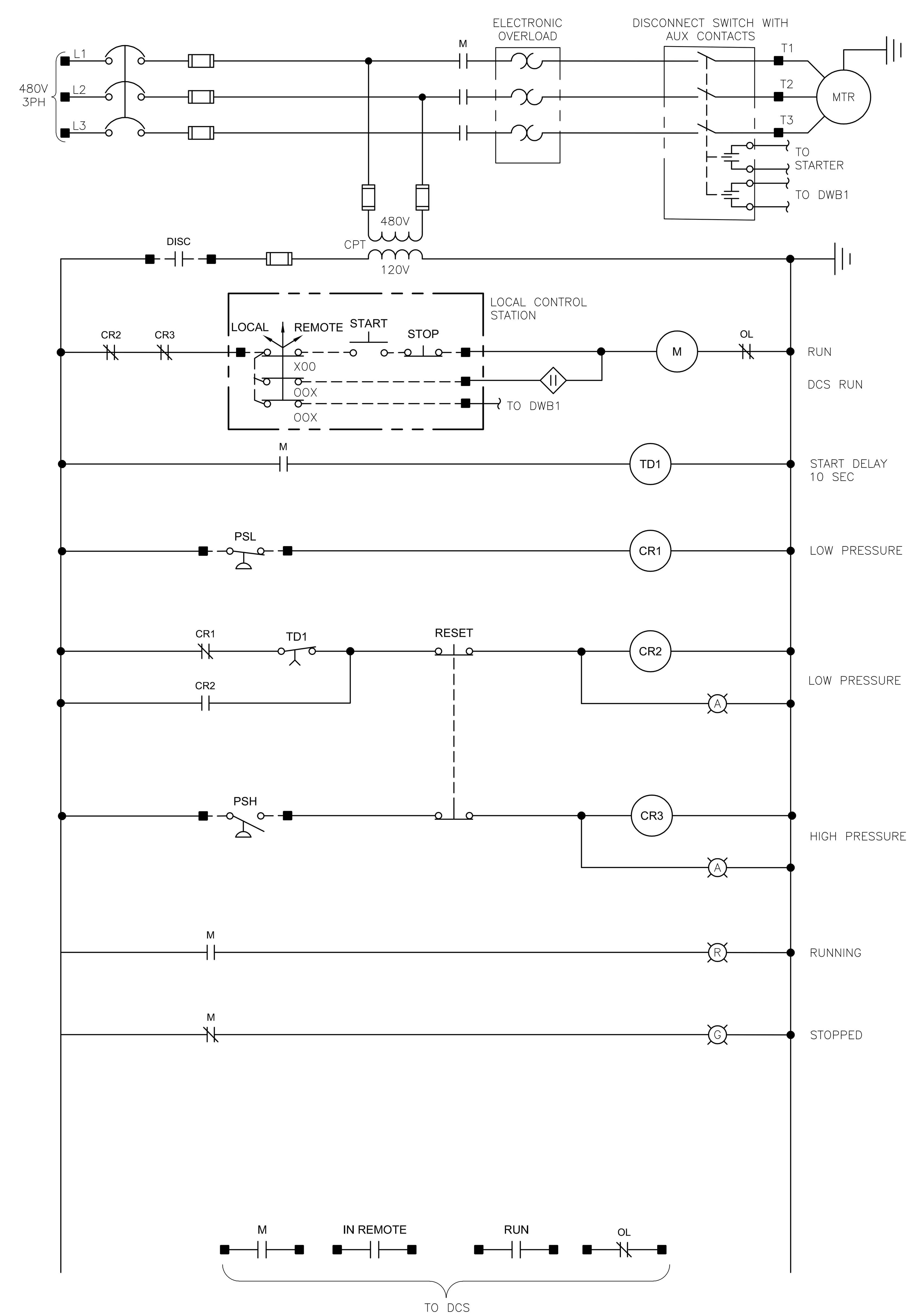
FILENAME M-007.dwg
SCALE 1/4" = 1'-0"
SHEET M-007



POWER ONE-LINE DIAGRAM



INSTRUMENT ONE-LINE DIAGRAM



TRANSFER PUMP SCHEMATIC

GENERAL NOTES:

1. ALL WORK SHALL COMPLY WITH THE 2018 VIRGINIA UNIFORM STATEWIDE BUILDING CODE.
2. ALL EQUIPMENT SHALL BE UL LISTED FOR THE INTENDED APPLICATION.
3. CONDUIT SHALL BE PVC COATED RGS. WIRE SHALL BE THHN-2.
4. MOTOR STARTERS SHALL MATCH EXISTING MANUFACTURER AND COMPLYWITH NEMA ICS-2. PILOT AND CONTROL DEVICES SHALL MEET NEMA ICS-5

HDR

ISSUE	DATE	DESCRIPTION
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INSTRUMENTATION	
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PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

ELECTRICAL WIRING DIAGRAMS

0 1" 2"

FILENAME E-001.dwg

SCALE NONE

SHEET **E-001**

PRIMARY ELEMENT SYMBOLOGY

- ORIFICE PLATE
- PITOT TUBE OR ANNUBAR
- FI — ROTAMETER
- SONIC OR ULTRASONIC FLOWMETER
- M — MAGNETIC FLOWMETER
- FT — MASS DISPERSION FLOWMETER
- FLUME
- WEIR
- PROPELLER OR TURBINE METER
- VENTURI TUBE
- FLOAT SWITCH
- TE — TEMPERATURE ELEMENT WITH THERMOWELL
- FG — SIGHT FLOW GLASS
- TD — THERMAL DISPERSION METER
- ULTRASONIC LEVEL TRANSMITTER
- RADAR TYPE LEVEL TRANSMITTER
- DIFFERENTIAL PRESSURE FLOW METER

LINE TYPES

- MAIN PROCESS LINE
- SECONDARY PROCESS LINE
- AUXILIARY PROCESS LINE
- DIRECTION OF FLOW
- PNEUMATIC SIGNAL
- ELECTRICAL SIGNAL
- HYDRAULIC SIGNAL
- SOFTWARE OR DATA LINK
- SIGNAL CONNECTION
- CROSSOVER - NO CONNECTION
- CAPILLARY

CROSS REFERENCE SYMBOLOGY

- Y-3 — CONTINUATION ON SHEET Y-3
- Y-3 — CONTINUATION ON SHEET Y-3

INSTRUMENT SYMBOLOGY

- LOCALLY MOUNTED FIELD INSTRUMENTATION
- MOUNTED ON PANEL FRONT
- MOUNTED INSIDE PANEL
- XXX — FRONT PANEL MOUNTED ON AUXILIARY PANEL (SUBSCRIPT INDICATES PANEL)
- MOUNTED INSIDE AUXILIARY PANEL
- PILOT LIGHT
- INSTRUMENT FUNCTIONS SHARING COMMON HOUSING
- I — COMPLEX INTERLOCK AS DEFINED IN CONTROL DIAGRAM OR IN SPECIFICATIONS
- SHARED DISPLAY, SHARED CONTROL, FIELD MOUNTED
- SHARED DISPLAY, SHARED CONTROL, PRIMARY LOCATION - NORMALLY ACCESSIBLE TO OPERATOR
- PROGRAMMABLE LOGIC CONTROL, PRIMARY LOCATION - NORMALLY ACCESSIBLE TO OPERATOR
- PROGRAMMABLE LOGIC CONTROL, FIELD MOUNTED

ACTUATOR SYMBOLOGY

- X — OPERATOR ABBREVIATIONS:
  - M = MOTOR
  - P = PNEUMATIC
  - S = SOLENOID
- FLOAT OPERATOR
- SPRING-OPPOSED SINGLE-ACTING PNEUMATIC CYLINDER
- DOUBLE-ACTING PNEUMATIC CYLINDER
- PNEUMATIC DIAPHRAGM
- PNEUMATIC DIAPHRAGM WITH POSITIONER

TYPES OF POWER SUPPLY

A	PLANT COMPRESSED AIR
IA	INSTRUMENTATION AIR
ES	ELECTRIC SUPPLY
NG	NATURAL GAS
HYD	HYDRAULIC

INSTRUMENT IDENTIFICATION LETTERS

	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USERS CHOICE			CONTROL	CLOSED
D	USERS CHOICE	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME; RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USER'S CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECH. ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

MISCELLANEOUS INSTRUMENTATION ABBREVIATIONS

AI	ANALOG INPUT
AO	ANALOG OUTPUT
CL2	CHLORINE (ANALYZER MODIFIER)
CO	CARBON MONOXIDE (ANALYZER MODIFIER)
CO2	CARBON DIOXIDE (ANALYZER MODIFIER)
COMB	COMBUSTIBLES (ANALYZER MODIFIER)
COND	CONDUCTIVITY (ANALYZER MODIFIER)
DEN	DENSITY (ANALYZER MODIFIER)
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
DO	DISSOLVED OXYGEN (ANALYZER MODIFIER)
E/P	VOLTAGE TO PNEUMATIC
H2S	HYDROGEN SULFIDE (ANALYZER MODIFIER)
HCL	HYDROGEN CHLORIDE (ANALYZER MODIFIER)
I/O	INPUT/OUTPUT
I/P	CURRENT TO PNEUMATIC
NOX	NITROGEN OXIDE (ANALYZER MODIFIER)
OI	OPERATOR INTERFACE
OIT	OPERATOR INTERFACE TERMINAL
O2	OXYGEN (ANALYZER MODIFIER)
P&ID	PROCESS AND INSTRUMENTATION DIAGRAM
SS	SUSPENDED SOLIDS (ANALYZER MODIFIER)
TURB	TURBIDITY (ANALYZER MODIFIER)
WAN	WIDE AREA NETWORK

CONTROL SWITCH NOTATION ABBREVIATIONS

XXX / XXXX — XXX

ACK	ACKNOWLEDGE
E-STOP	EMERGENCY STOP
FAIL	FAILURE
FOR	FORWARD-OFF-REVERSE
FR	FORWARD-REVERSE
FS	FAST-SLOW
HA	HAND-AUTO
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
LL	LEAD-LAG
LLS	LEAD-LAG-STANDBY
LOR	LOCAL-OFF-REMOTE
LR	LOCAL-REMOTE
LS	LEAD-STANDBY
MA	MANUAL-AUTO
OAC	OPEN-AUTO-CLOSE
OC	OPEN-CLOSE
OO	ON-OFF
OSC	OPEN-STOP-CLOSE
RJ	RUN-JOG
RJR	RUN-JOG-REVERSE
SIL	SILENCE
SS	START-STOP

VALVES

- BALL VALVE
- BUTTERFLY VALVE
- CONE VALVE
- CHECK VALVE
- DOUBLE-DISK CHECK VALVE
- BALL CHECK VALVE
- DIAPHRAGM VALVE
- GATE VALVE
- GLOBE VALVE
- KNIFE GATE VALVE
- NEEDLE VALVE
- PINCH VALVE
- PLUG VALVE
- THREE-WAY BALL VALVE
- THREE-WAY PLUG VALVE
- PRESSURE-REDUCING VALVE
- PRESSURE-REGULATING VALVE
- THREE-WAY CONTROL VALVE
- OR — PRESSURE-RELIEF VALVE
- X — AIR-RELEASE VACUUM VALVE
  - A = AIR RELEASE
  - VAC = VACUUM
- LUBRICATED PLUG VALVE
- NORMALLY CLOSED VALVE (FILLED IN)

MISCELLANEOUS SYMBOLOGY

- PROGRESSIVE CAVITY PUMP
- PROGRESSIVE CAVITY CAKE PUMP
- M — MIXER - PROPELLER TYPE
- SUMP PUMP
- CHEMICAL FEED PUMP
- CENTRIFUGAL PUMP
- M — MOTOR
- BAG FILTER
- FLEXIBLE CHUTE
- CALIBRATION COLUMN
- SIGHT GLASS
- FLEXIBLE CONNECTION
- R — ROTAMETER
- QUICK DISCONNECT COUPLING WITH BALL VALVE (CAMBI'S INTERPRETATION)
- GRINDER
- 3W, C — 3W=NPW, THE "C" STANDS FOR A SEAL WATER CONTROL UNIT
- D — DRAIN
- DT, D — DRIP TRAP
- DRAIN WITH CONCRETE CONTAINMENT
- SLIDE GATE
- REDUCER
- PULSATION DAMPENER
- FLAME ARRESTER

GENERAL NOTES:

1. THIS IS A STANDARD INSTRUMENTATION SYMBOLOGY AND ABBREVIATIONS SHEET. LISTING OF SYMBOLS AND ABBREVIATIONS DOES NOT IMPLY ALL SYMBOLS AND ABBREVIATIONS HAVE BEEN USED ON THIS PROJECT.
2. SEE PROCESS, MECHANICAL AND PLUMBING LEGEND SHEET FOR MISCELLANEOUS PIPING SYMBOLS.
3. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK, REFER TO CONTEXT OF EACH SHEET FOR USAGE.
4. VALVE SYMBOLS SHOWN HERE ARE APPLICABLE ONLY TO INSTRUMENTATION DIAGRAMS. SEE PROCESS, MECHANICAL AND PLUMBING LEGEND SHEET FOR VALVE SYMBOLS USED ELSEWHERE ON THE SHEETS.

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

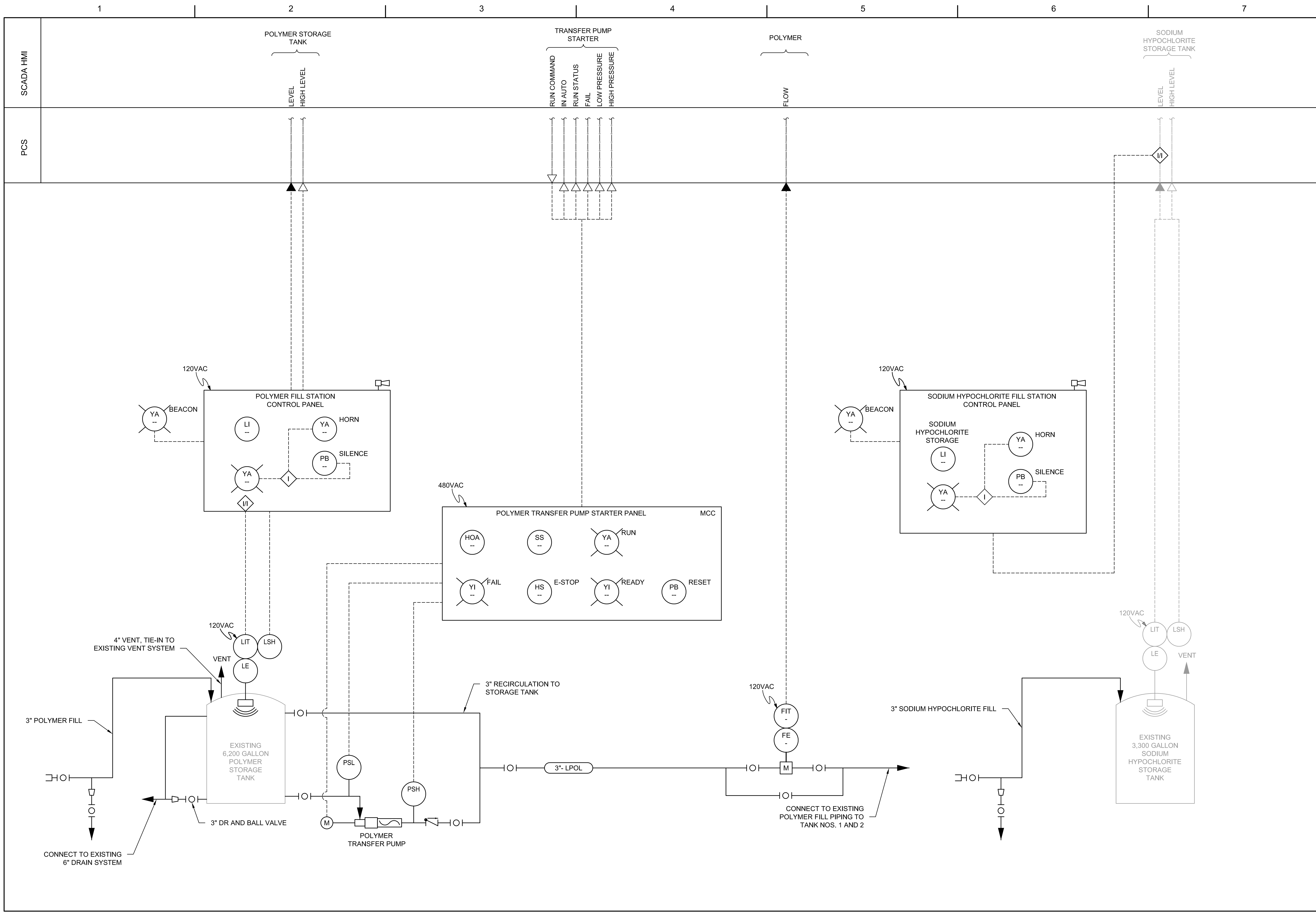
INSTRUMENTATION LEGEND AND SYMBOLS

0 1" 2"

FILENAME: I-001.dwg

SCALE: NOT TO SCALE

SHEET: **I-001**



GENERAL NOTES:

1. PRELIMINARY CONCEPT SHOWN. DESIGN BUILDER IS RESPONSIBLE FOR FINAL CONFIGURATION, INCLUDING CONNECTION TO EXISTING ELECTRICAL AND CONTROL SYSTEMS.
2. PROVIDE ALL COMPONENTS, INCLUDING PROGRAMMING, FOR A FULLY FUNCTIONAL SYSTEM.
3. CONFIRM RIO AND PANELBOARD CONNECTION LOCATIONS THROUGH FIELD INVESTIGATIONS.
4. CONNECT PROCESS CONTROL SIGNALS TO EXISTING I/O CARDS IN POLYMER / SLUDGE FEED CONTROL ROOM (ROOM 105). ASSUME SPACE IS AVAILABLE IN EXISTING RIO PANEL.
5. MODIFY POLYMER TRANSFER CONTROLS TO UTILIZE NEW POLYMER TRANSFER PUMP AND FLOW METER.
6. UTILIZE EXISTING POLYMER TRANSFER CONTROLS FOR FEEDING DAY / AGING TANKS AND PEW DILUTION.
7. CONNECT 120 VAC POWER AS NECESSARY TO EXISTING PANELBOARDS IN EXISTING VFD ROOM (ROOM 106). ASSUME EXISTING CIRCUITS ARE AVAILABLE.
8. REFER TO WPCP UPGRADE AND EXPANSION-PHASE IIIA SOLIDS PROCESSING FACILITIES DRAWINGS I-3 AND I-4 FOR EXISTING POLYMER SYSTEM P&ID'S.
9. REFER TO WPCP UPGRADE AND EXPANSION-PHASE IIIA SOLIDS PROCESSING FACILITIES DRAWING I-11 FOR EXISTING SODIUM HYPOCHLORITE SYSTEM P&ID.

ISSUE	DATE	DESCRIPTION
A	06/2022	35% SUBMITTAL

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	L. PEELE
STRUCTURAL	H. ANTSHEL
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

PRELIMINARY NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN EARLY WORK

POLYMER FILL, STORAGE, AND TRANSFER AND SODIUM HYPOCHLORITE FILL PROCESS AND INSTRUMENTATION DIAGRAM

0 1" 2"

FILENAME I-002.dwg

SCALE NOT TO SCALE

SHEET **I-002**

Arlington County Water Pollution Control Bureau

Early Work Package, Preliminary Specifications

December 2022

HDR Project No. 10263882

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TABLE OF CONTENTS

Arlington County Water Pollution Control Bureau
Early Work Package, Preliminary Specifications

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SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General provisions applicable to all demolition and removals.
   2. Civil/site demolition and removals.
   3. Architectural and structural demolition and removals.
   4. Mechanical demolition and removals
   5. Electrical demolition and removals.
   6. Disposal of demolition debris, materials, and equipment.
   7. Protection of construction and improvements to remain.
   8. Salvaged items for Owner retention.

B. Scope:
   1. Design Builder shall provide all labor, materials, equipment, tools, and incidentals as shown, specified and required for demolition, removals, disposal and protective Work for the Early Work Implementation. Requirements for the remainder of the Work shall be specified by the Design Professional.
   2. The Work under this Specification section includes, but is not necessarily limited to:
      a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of hazardous materials, structural concrete, foundations, foundation piles, walls, doors, windows, structural steel, metal systems and equipment, pavement and similar existing materials, equipment, and items.
      b. Demolition and removal of all above-grade facilities and Underground Facilities and structures shown or indicated for demolition, unless the Underground Facilities or above-grade facilities are specifically shown or indicated as to remain.
      c. Remove from slabs, foundations, walls, and footings that are to be demolished all utilities and appurtenances embedded in such construction.
   3. Demolitions and removals indicated in other Specifications sections shall comply with requirements of this Specifications section.
   4. Perform demolition Work within areas shown or indicated.
   5. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition and removals Work.
   6. Carefully protect all work not scheduled for demolition or removal.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Fire Protection Association (NFPA):
      a. 241, Safeguarding Construction, Alteration, and Demolition Operations.

B. Regulatory Requirements:
   1. Demolition, removals, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T – Demolition), and all other Laws and Regulations.
   2. Comply with requirements of the EPA and authorities having jurisdiction.

C. Qualifications:
   1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician(s) legally qualified to perform electrical construction and electrical work in Arlington County, Virginia.

2. Plumbing Removals: Entity and personnel performing plumbing removals shall be plumber(s) legally qualified to perform plumbing construction and plumbing work in Arlington County, Virginia.
3. Design Builder shall employ a registered professional engineer to design and oversee construction of shoring, bracing and other required supports, whether temporary or permanent.
   a. Details of permanent new features shall be submitted for information to the Program Manager and Owner.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Comply with Section 01 14 16 - Coordination with Owner's Operations.
   2. Review procedures under this and other Specifications sections and coordinate the Work that will be performed with or before demolition and removals.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Procedure Submittals:
      a. Demolition and Removal Plan: Not less than thirty (30) days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:
         1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.
         2) Other proposed procedures as applicable.
         3) Equipment proposed for use in demolition operations.
         4) Recycling/disposal facility(ies) proposed, including facility owner, facility name, location, and processes. Include copy of appropriate permits and licenses, and compliance status.
         5) Planned demolition operating sequences.
         6) Detailed schedule of demolition Work in accordance with the Schedule accepted by Program Manager.
   2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Specifications Section.
   3. Field Quality Control Test Results:
      a. Results of megger-testing of existing motors to remain Owner's property.
   4. Qualifications Statements:
      a. Name and qualifications of entity performing electrical removals, including copy of licenses required by authorities having jurisdiction.
      b. Name and qualifications of entity performing plumbing removals,

1.5 JOB CONDITIONS

A. Owner makes no representation of condition, hazards or structural integrity of area(s) to be demolished or where removals are required by the Contract Documents.

B. Obtain and pay for permits required by authorities.

C. Notify affected utilities of work to be executed.

D. Owner will make provisions for inspection of facilities prior to bidding. Conditions not readily apparent shall not be cause for extra work cost claims.

E. Separate, store and dispose of any hazardous or toxic materials in accordance with local and EPA regulations.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Notification:
1. Not less than 7 days prior to commencing demolition or removal, advise Owner in writing of planned start of demolition Work. Do not start removals without permission of Owner.
2. Where demolition or removals has potential to affect adjacent properties, occupants, streets, or other public thoroughfare, transportation facilities, and utilities, furnish required notices to owners and occupants of properties, buildings, and structures that may be affected by the demolition of removal.
3. In accordance with Laws and Regulations, furnish to authorities having jurisdiction, including emergency services as necessary, appropriate notices of planned demolition and removals.
4. Submit to Owner copies of notices furnished to adjacent property owners, occupants, and authorities having jurisdiction.

B. Protection of Adjacent Areas and Facilities:
1. Perform demolition and removal Work in manner that prevents damage and injury to unscheduled property, structures, facilities, occupants, and the public. Do not interfere with use of, and free and safe access to and from, structures and properties unless allowed by the Contract Documents or otherwise allowed in writing by Owner.
2. Closing or obstructing of roads, drives, sidewalks, and passageways adjacent to the Work is not allowed unless indicated otherwise in the Contract Documents. Conduct the Work with minimum interference to vehicular and pedestrian traffic.
3. Provide temporary partitions between demolition work areas and (a) areas that will be occupied during demolition and removals, and (b) areas accessible to the public or visitors. Temporary partitions shall be sturdy, braced plywood in good condition, of dimensions sufficient to adequately screen demolition work from view of occupants, public, and visitors. Maintain temporary partitions in place until demolition and removals work in the subject area is complete or until other Work requires removal of temporary partitions after deemed not necessary.
4. Provide appropriate temporary barriers, lighting, sidewalk enclosures, and other necessary protection.
5. Repair damage as a result of Design Builder's operations to facilities that are to remain.

C. Existing Utilities
1. Sanitary Sewerage: Before proceeding with demolition, locate and cap all sewer lines and service laterals discharging from the building or structure being demolished.
2. Water Piping and Related Facilities: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished. Ensure compliance with Laws and Regulations regarding water quality.
3. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as plant process lines, fuel and gas; compressed air; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.
4. Shutdown of utility services shall be coordinated by Design Builder, assisted by Owner as required relative to contacting utility owners.

D. Remediation:
1. Prior to performing demolition Work that disturbs asbestos, remove and dispose of asbestos in accordance with all Laws and Regulations.
2. Prior to performing demolition Work involving lead-based paint, remediate lead in accordance with all Laws and Regulations.
3. Prior to performing demolition Work involving Polychlorinate Biphenyls (PCBs), remediate PCBs in accordance with all Laws and Regulations.

4. If unanticipated Hazardous Environmental Condition is believed to be encountered during demolition and removals, comply with requirements of this Specification and the General Conditions.

3.2 DEMOLITION - GENERAL

A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.

B. Pollution Controls:
   1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level. Comply with Section 01 57 05 - Temporary Controls, and Laws and Regulations.
   2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.
   3. Clean adjacent structures, facilities, properties, and improvements of dust, dirt, and debris caused by demolition Work.

C. Explosives:
   1. Explosives are not allowed at the Site. Do not use explosives for demolition and removal Work.

D. Building or Structure Demolition and Removals:
   1. Remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.
   2. Break up and remove foundations, mats, and slabs-on-grade unless otherwise shown or indicated as remaining in place.
   3. Temporary Bracing and Supports:
      a. Provide temporary and permanent bracing and supports sufficient to maintain safety, stability, and resist all loads to which the structure may be subject during demolition and removals, until entirety is permanently removed or permanently stabilized.
      b. Temporary and permanent bracing and supports shall be sufficient for associated dead load, live load, transient loading, and dynamic loads such as wind, seismic, and other loads to which the bracing or support may be subject.
      c. Retain a professional engineer, duly licensed and registered in the same jurisdiction as the Site, to design all bracing and supports.

E. Salvage and Ownership:
   1. Materials and equipment to remain Owner’s property shall be:
      a. Carefully removed and appropriately handled by Design Builder to avoid damage. Brace motors attached to flexible mountings until reinstallation or delivery to Owner’s storage location. Fully remedy to pre-construction condition or replace items damaged during removal or handling by Design Builder.
      b. Removed as functional units, together with all appurtenances required for operation.
      c. Cleaned, listed, and tagged for storage.
      d. Protected from damage.
      e. Delivered to Owner designated storage location indicated in the Contract Documents, or to a place designated by Program Manager or Owner.
   2. Items to be and delivered to Owner are as indicated in Table 02 41 00-A.

Table 02 41 00-A – Items to be Salvaged

EQUIPMENT NAME/ DESIGNATION	EQUIPMENT LOCATION	DELIVER TO OWNER'S LOCATION
Diaphragm Sump Pump	Bio-Building Basement	Warehouse
Polymer Transfer Pumps (2)	Bio-Building Basement	Warehouse
Polymer Transfer Instrumentation (complete)	Bio-Building Basement	Warehouse

3. Preparation of Owner’s existing equipment for storage:
   a. Where appropriate, identify each component with markings or tags to indicate its position in the assembly and the assembly of which it is part.
   b. Place small parts in appropriate, durable boxes and clearly mark contents on the outside of box or container.
   c. Remove oil from oil-lubricated bearings and gear boxes and replace with storage oil.
   d. Grease grease-lubricated bearings.
   e. Replace breather plugs with solid plugs.
   f. Megger-test motor windings: Attach report of the test results to the associated motor and submit copy to Program Manager.
   g. Attach unit to suitable crate bottom.
   h. Enclose unit in polyethylene film and seal all seams and the film to the base of the unit with tape.
   i. Construct crate of wood slats around top and sides of unit.
   j. Attach permanent instruction tag to outside of crate stating “This unit has been prepared for storage. Replace oil, vent plugs, and lubricant in accordance with manufacturer's instructions before start-up.”

F. Finishing of Surfaces Exposed by Removals: Unless otherwise shown or indicated in the Contract Documents, surfaces of walls, floors, ceilings, and other areas exposed by removals, and that will remain as finished surfaces, shall be repaired and re-finished with materials that match existing adjacent surface, or as otherwise approved by Program Manager.

3.3 STRUCTURAL REMOVALS

A. Remove structures to lines and grades indicated or necessary, Removals beyond these limits shall be at Design Builder’s risk and expense and such excess removals shall be reconstructed to satisfaction of Program Manager without additional cost to Owner.

B. Recycling and Reuse of Demolition Materials:
1. With or as part of the construction management plan, the Contractor shall submit a construction waste management (CWM) plan in accordance with Specification Section 01 81 13 prior to mobilization that:
   a. Identifies waste materials that will be removed from the site, the process for collecting and storing materials, and locations for disposal
   b. Outlines a plan for materials that will be taken off-site to be recycled. The plan should include what can be recycled, where reclamation facilities are located and how implementation will be documented.
2. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, in accordance with the CWM plan, unless otherwise approved by Program Manager.
3. Contractor shall document quantities of non-recycled waste material and recycled materials removed from the site by:
   a. Document waste diversion efforts following the instructions in the provided RA1.4 Reduce Construction Waste Diversion Summary Forms as Attachment D to Specification Section 01 81 13, including, but not limited to:
      1) Waste brought to recycling facilities and landfill with waste tickets for each delivery.

2) Demolition materials housed and prepped for reuse on-site.
3) Waste reduction measures and quantify impact (example – reuse of existing structures that were planned to be demolished and rebuilt).
4) Include manifests, weight tickets, receipts, and invoices, as applicable for recycled and landfilled materials with submittal of forms.

b. Submitting reclamation facility lift tickets
c. Submitting landfill lift tickets
d. Documenting any other off-site material disposal
e. Documentation will be submitted monthly or as coordinated with the Engineer and Envision lead.

4. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.

C. After removing concrete and masonry walls or portions thereof, mats, slabs, and similar construction that ties in to the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.

D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.

1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.
2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.
3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 IN below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.
4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.

E. Removal of Anchorages and Protruding Metals:

1. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, and where existing metals (and to be removed) protrude from concrete, remove the anchors and other metal to not less than 1.5 IN beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface.
2. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by Program Manager.

F. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.

G. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials as specified in the Contract Documents.

3.4 MECHANICAL REMOVALS

A. Mechanical demolition and removal Work includes dismantling and removing existing:

1. Piping systems and ductwork systems.
2. Mechanical equipment and appurtenances.
3. Mechanical elements of instrumentation and control systems, such as sensors and transmitters and similar items.
4. Mechanical removals include cutting and capping as required.

5. Mechanical removals as required herein apply to systems exposed to view, hidden from view, and Underground Facilities. Mechanical removals may require work in spaces that may be classified confined spaces.

B. Life-Safety Systems:
   1. Retain existing life-safety systems, including but not limited to fire suppression systems, in place for as long as possible prior to performing associated demolition and removals.
   2. Where demolishing buildings or structures equipped with life-safety systems, remove or deactivate life-safety systems only in the area where active demolition operations are in progress.
   3. Coordinate removal of Life-Safety Systems with Owner and authorities having jurisdiction.

C. Demolition and Removals of Piping, Ductwork, and Similar Items:
   1. Scope:
      a. Safety purge piping and tanks (as applicable) of chemicals, fuel, solids, liquids, and gases (as applicable) and make safe for removal and capping. Discharge contents of existing piping appropriately while avoiding damaging property; restricting access to or use of property; and cresting unsafe, unsanitary, nuisances, and noisome conditions.
      b. To the extent shown or indicated, remove existing piping conveying water (potable and non-potable), waste and vent, fuel (liquids and gases), heating fluids (such as water-glycol solutions), chemicals, solids and slurries, sludge, wastewater, other fluids, and processes gases, and other piping.
      c. Remove piping to the nearest structurally sound (or "solid") piping support, and provide caps on ends of remaining piping.
      d. Where piping to be demolished passes through existing walls to remain, cut off and cap pipe on each side of the wall.
   2. Caps, Closures, Blind Flanges, and Plugs – General (All Piping and Ducts):
      a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.
      b. Where used in this Specifications section, the term "cap" means the appropriate type closure for the piping or ductwork being closed, including caps, blind flanges, and other closures.
      c. Caps shall be compatible with the piping or ductwork on which the cap is installed, fluid-tight and gastight, and appropriate for the fluid or gas conveyed in the pipe or duct.
      d. Unless otherwise shown or indicated, caps shall be mechanically fastened, fused, or welded to pipe or duct. Plug piping with means other than specified in this Specifications section only when expressly so shown or indicated in the Design Builder Documents or when allowed by Program Manager.
   3. Underground Facilities:
      a. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.
   4. Waste and Vent Piping; Ductwork:
      a. Remove waste and vent piping, and ductwork to extent shown and cap as required.
      b. Where demolished vent piping, stacks, and ductwork passes through existing roofing, patch the roof with the same or similar materials as existing, and fully compatible with ensign materials. Completed patch shall be watertight and comply with roofing manufacturer's recommendations.
   5. Potable Water Piping; Plumbing; Fire Suppression Piping and Systems; Heating Piping:
      a. Modifications to potable water piping, fire suppression systems, other plumbing piping, and heating system piping shall comply with Laws and Regulations.
      b. All portions of potable water systems that have been modified or opened shall be hydrostatically tested and disinfected in accordance with AWWA Requirements, and Laws and Regulations. Hydrostatically test other, normally-pressurized, plumbing and fire suppression piping and heating piping systems.

D. Equipment Demolition and Removals:
   1. To the extent shown or indicated and as required for the Work, remove existing mechanical equipment, including (but not limited to):
      a. Facility equipment
      b. Conveying equipment such as elevators, and similar general-use conveying systems.
      c. Fire suppression and plumbing equipment.
      d. Heating, ventilating, and air conditioning equipment.
      e. Security systems equipment.
      f. Flow control gates and valves.
      g. Hoisting equipment.
      h. Bulk materials conveying equipment.
      i. Process heating and cooling equipment.
      j. Blowers, compressors, air filters, air dryers, and similar equipment.
      k. Pumps.
      l. Tanks.
      m. Process equipment, including purification equipment, incineration equipment, pollution control and solid waste equipment, and treatment process equipment.
      n. Appurtenances (including motors, drive systems, controls, cooling water and seal water systems) as shown, indicated, and required for completion of the Work.
   2. Where required, disassemble equipment to avoid imposing excessive loading on supporting walls, floors, framing, facilities, and Underground Facilities. Disassemble equipment as required for access through and egress from building or structure. Disassembly and removal shall comply with Laws and Regulations. Provide required means to remove equipment from building or structure.
   3. Remove control panels, operator stations, and instruments associated with equipment being removed, unless shown or indicated otherwise.
   4. Tanks and Equipment Containing Process Material:
      a. Purge contents in accordance with Paragraph 3.5.A of this Specifications Section and other requirements of the Contract Documents, as applicable.
      b. Where contents of tank or equipment item may pose a potential hazard, properly dispose of contents in accordance with Laws and Regulations and the Contract Documents.
      c. Where tank or equipment contains wastewater or liquid sludge, and the Site is a wastewater treatment facility, transport and dispose of stored contents on-site at location acceptable to Owner.
      d. Where tank or equipment contains solid or slurry-type material, remove, handle, and transport the contents and appropriately dispose of the materials off-site in accordance with Laws and Regulations, unless otherwise indicated in the Contract Documents.
   5. Remove equipment supports as applicable, anchorages, base, grout, and piping. Remove anchorage systems in accordance with the "Structural Removals" Article in this Specifications section.
   6. Remove small-diameter piping back to header unless otherwise indicated.
   7. Remove access platforms, ladders, and stairs related to equipment being removed, unless otherwise shown or indicated.
   8. Instrumentation and Control Systems Removal:
      a. Remove instrumentation and controls equipment in accordance with this Specifications section's requirements for mechanical removals and electrical removals.

3.5 ELECTRICAL REMOVALS

A. Electrical demolition Work includes removing existing:
   1. Disconnecting cabling from motors, electrical sources, control panels, control stations, instrumentation and control items, and similar devices and equipment.
   2. Conduits, raceways, cable trays, hangers and supports, cabling, and related items.
   3. Switches, panelboards, control stations, and similar items.

4. Transformers, distribution switchboards, control panels, motors, starters, variable speed controllers, and similar items.
5. Lighting fixtures and related items.
6. Appurtenances and miscellaneous electrical equipment, as shown, specified, or required.

B. Electrical Removals – General:
1. Comply with Laws and Regulations, including the National Electric Code.
2. Lock Out and Tagging:
   a. Design Builder shall lock out and tag circuit breakers and switches operated by Owner and shall verify that affected cabling are de-energized to ground potential before commencing electrical removals Work.
   b. Upon completion of electrical removals Work, remove the locks and tags and promptly advise Program Manager and Owner that existing facilities are available for use.
3. Remove existing electrical equipment, fixtures, and systems to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
4. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated.
5. Store removed motors, microprocessors and electronics, and other electrical gear to be reused in accordance with its manufacturer's recommendations and requirements of the Contract Documents.

C. Motor Control Centers and Switchgear:
1. Remove or modify motor control centers and switchgear within the demolition areas.
2. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.

D. Removal of Cabling, Conduits, Raceways and Similar Items:
1. Verify the function of each cable before disconnecting and removing.
2. Remove cabling, conduits, hangers and supports, and similar items back to the power source or control panel, unless otherwise shown or indicated.
3. Remove cabling, conduits, and similar items where shown or indicated for removal. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to Program Manager.
4. Disassemble and remove exposed conduits, junction boxes, other electrical appurtenances, and their supports.
5. Repair all areas of the Work to prevent rusting on exposed surfaces.
6. Underground Electric:
   a. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.
   b. Where shown or indicated, remove direct-burial cabling. Openings in buildings for entrance of direct-burial cabling shall be patched with repair mortar or other material approved by Program Manager for such purpose, and made watertight.

E. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as Owner's property, shall be removed and properly disposed off-site as required in accordance with Laws and Regulations.

3.6 DEMOLITION OF SITE IMPROVEMENTS

A. Pavement, Sidewalks, Curbs, and Gutters:
1. Demolition of asphalt or concrete pavement, sidewalks, curbs, and gutters, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.
2. To cut pavement, sidewalks, curbs, and gutters, use machinery or tools that provides a smooth-cut edge, appropriate for the required. Where cut edges are not smooth, repair the cut edge to remain to provide a smooth, even appearance.

B. Fencing, Guardrails, and Bollards:
   1. Remove to the limits shown or indicated on the Drawings.
   2. Completely remove below-grade posts and concrete.

C. Manholes, Vaults, Chambers, and Handholes:
   1. Remove to the limits shown or indicated on the Drawings.
   2. If not shown or indicated on the Drawings, remove to not less than 3 FT below finished grade indicated on the Drawings.

D. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes:
   1. Remove to the extent shown or indicated on the Drawings.
   2. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Specifications section.

E. Other Site Improvements: When the Contract Documents require removal of other site improvements not addressed above, copy with Contract requirements for removal of buildings or structures.

3.7 DISPOSAL OF DEMOLITION DEBRIS

A. Disposal – General:
   1. Promptly remove from the Site all debris, waste, rubbish, material, and equipment resulting from demolition and removal operations. Promptly upon completion of demolition and removal operations, remove from the Site construction equipment used in demolition Work.
   2. Do not sell at the Site demolition materials or removed equipment. If materials, equipment or debris will be sold by Design Builder, remove the items from the Site and perform the sale or transaction elsewhere, in accordance with Laws and Regulations.
   3. Cleaning and Removal of Debris: Comply with the General Conditions and General Requirements.

B. Transportation and Disposal:
   1. Non-Hazardous Materials, Equipment, and Debris: Properly transport and dispose of non-hazardous demolition materials, equipment, and debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Constituents of Concern such as (but not limited to) asbestos, PCBs, petroleum, hazardous waste, radioactive material, or other material designated as hazardous in Laws or Regulations.
   2. Hazardous Materials, Equipment, and Debris: When handling and disposal of items containing Constituents of Concern is included in the Work, properly transport and dispose of such items in accordance with the Contract Documents and Laws and Regulations.

C. In accordance with Specification Section 01 81 13, submit to Program Manager information required in this Specification Section on proposed facility(ies) where demolition materials, equipment, and debris will be recycled. Upon request, Program Manager or Owner, shall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist Program Manager and Owner.

END OF SECTION

SECTION 03 15 19
ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for all cast-in-place anchor bolts, anchor rods, reinforcing adhesive anchorage, and post-installed concrete anchors required for the Early Work Implementation but not specified elsewhere in the Contract Documents. Requirements for the remainder of the Work shall be specified by the Design Professional.
   2. Design of all concrete anchors not indicated on the Drawings including, but not limited to, installation of anchors into concrete for the following structural and nonstructural components:
      a. Structural members and accessories.
      b. Metal, wood, and plastic fabrications.
      c. Architectural components.
      d. Mechanical and electrical equipment and components.
      e. Plumbing, piping, and HVAC work.
      f. All other components requiring attachment to concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 05 07 - Pipe Support Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete and Commentary.
      b. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
      a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
   3. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
   4. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      d. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      e. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      f. A563, Standard Specification for Carbon and Alloy Steel Nuts.
      g. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      h. F436, Standard Specification for Hardened Steel Washers.
      i. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
      j. F594, Standard Specification for Stainless Steel Nuts.
      k. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
      l. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

5. ICC Evaluation Service (ICC-ES):
    a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
    b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

B. Qualifications:
   1. Anchor designer for Design Builder-designed post-installed anchors and cast in place anchorage shall be a professional engineer licensed in the Commonwealth of Virginia.
   2. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Program Manager.
   3. Installer for adhesive anchors installed in horizontal, upward incline, or overhead applications shall be certified by ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Post-installed anchors and related materials shall be listed by the following agencies:
   1. ICC-ES.
   2. Program Manager approved equivalent.

1.3 DEFINITIONS

A. Adhesive Anchors:
   1. Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
   2. Includes anchors using acrylics, epoxy and other similar adhesives.

B. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e., bolt) material.

C. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.

D. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.

E. Galvanizing: Hot-dip galvanizing per ASTM A123, ASTM F2329 with minimum coating of 2.0 OZ of zinc per SQFT of metal (average of specimens) unless noted otherwise or dictated by standard.

F. Hardware: As defined in ASTM F2329.

G. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

H. MPII: Manufacturer’s printed installation instructions.

I. Mechanical Anchors:
   1. Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.
   2. Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
   3. Drop-in anchors and other similar anchors are not allowed.

J. Post-Installed Anchor: Any adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that submitted products meet requirements of referenced standards.

b. Manufacturer material data sheet for each anchor.
    1) Clearly indicate which products on the data sheet are proposed for use on the Project.
c. Manufacturer's printed installation instructions.
d. Current ICC-ES report for each post-installed anchor system indicating the following:
    1) Certification that anchors meet all requirements indicated in this Specification.
    2) Performance data showing that anchor is approved for use in cracked concrete.
    3) Seismic design categories for which anchor system has been approved.
    4) Required installation procedures.
    5) Special inspection requirements for installation.
e. Anchorage layout drawings and details:
    1) Indicate anchor diameter, embedment, length, anchor type, material and finish.
    2) Drawings showing location, configuration, spacing and edge distance.
f. Design Builder Designed Post-Installed Anchors:
    1) Show diameter and embedment depth of each anchor.
    2) Indicate compliance with ACI 318, Chapter 17 or ACI 350 Appendix D.
    3) Design tension and shear loads used for anchor design.
    4) Engineering design calculations:
        a) Indicate design load to each anchor.
        b) When the design load is not indicated on Drawings, include calculations to develop anchor forces based on Design Criteria listed herein.
        c) Sealed and signed by Design Builder's professional engineer.
        d) Calculations will be submitted for information purposes only.
    5) Type of post-installed anchor system used.
        a) Provide manufacturer's ICC-ES report for the following:
            (1) Mechanical anchorage per ICC-ES AC193.
            (2) Adhesive anchorage per ICC-ES AC308.

B. Samples:
    1. Representative samples of concrete anchors may be requested by Program Manager. Review will be for type and finish only. Compliance with all other requirements is exclusively the responsibility of the Design Builder.

C. Informational Submittals:
    1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
    2. Certification of qualifications for each installer of post-installed anchors.
        a. Indicate successful completion or certification for each type of approved post-installed anchor as required by the Contract Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer's or distributor's packaging undamaged and complete with installation instructions.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

C. Protect and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast-in-place Concrete Anchors:
   1. Building, nonbuilding structures, and equipment, located in dry environment:
      a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized threaded rods.
      b. ASTM A307, Grade A for galvanized headed bolts.
   2. All other cast-in-place concrete anchors:
      a. Stainless steel with matching nut and washer.
      b. Submerged application: ASTM F593, Type 316.
      c. Non-submerged application: ASTM F593, Type 304 or Type 316.

B. Post-Installed Mechanical and Adhesive Concrete Anchors:
   1. Stainless steel with matching nut and washer.
   2. Submerged application: ASTM F593, Type 316.
   3. Non-submerged application: ASTM F593, Type 304 or Type 316.
   4. Zinc coated carbon steel anchors with matching nut and washer where anchoring zinc coated carbon steel members, painted carbon steel members, or specifically noted on the contract drawings.

C. Reinforcement: See Owner Standard Specifications.

D. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 PSI and a minimum tensile strength of 60,000 PSI.

E. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 PSI and a minimum tensile strength of 80,000 PSI.

F. Washers:
   1. ASTM F436 unless noted otherwise.
   2. If stainless steel anchorage is being used for cast-in-place anchorage, furnish washers of the same material and alloy as in the accompanying anchorage.
   3. Plate washers: Minimum 1/2 IN thick fabricated ASTM A36 (or equal) of matching finish as accompanying bolt, square plates as required.
   4. Follow manufacturer's requirements for all post-installed anchorage.

G. Nuts:
   1. ASTM A563 of matching finish as accompanying bolt, for all cast-in-place anchorage.
   2. If stainless steel anchorage is being used for cast-in-place anchorage, nuts shall meet ASTM F594 and be the matching material and alloy as in the accompanying anchorage.
   3. Follow manufacturer's requirements if using post-installed anchorage.

H. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. ASTM A780.
   3. Zinc content: Minimum 92 PCT in dry film.
   4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

I. Dissimilar Materials Protection: Protect systems from dissimilar materials corrosion as necessary.

2.2 DESIGN BUILDER DESIGNED ANCHORAGE

A. Manufacturers:
   1. Post-installed anchor systems for the listed manufacturers will be considered only if a current ICC-ES evaluation report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section and if the anchor system is approved by the Program Manager.
      a. Hilti.
      b. Dewalt.
      c. Simpson Strong-Tie.

B. Design the anchorage when any of the following occur:
   1. Design load for concrete anchorage is shown on the Drawings.
   2. When specifically required by the Contract Documents.
   3. When an anchorage is required but not specified in the Drawings.
   4. When anchorage is shown on Drawings other than Structural Drawings.

C. Anchorage Design Loads:
   1. Determine all of the design loads, including wind and seismic loads, per the building code.
      a. Anchorage of equipment and non-structural components: Use the actual dead and operating loads provided by the manufacturer.
      b. Additional support requirements for utilities: See appropriate Specification Section.
      c. Pipe hangers and pipe support steel: See additional requirements listed in Specification Section 40 05 07.

D. When Contract Drawings, other than the Structural Drawings, indicate an anchor diameter or length, the Design Builder design shall incorporate these as “minimums.”

E. Cast-in-Place Concrete Anchors:
   1. Provide the material, nominal diameter, embedment length, spacing, edge distance and design capacity to resist the calculated load based on the requirements given in the building code including ACI 318or ACI 350, Appendix D.
   2. Design assuming cracked concrete.

F. Post-installed Concrete Anchors:
   1. Provide the manufacturer’s system name/type, nominal diameter, embedment depth, spacing, minimum edge distance, cover, and design capacity to resist the specified or calculated load based on requirements given in the building code, ACI 318, Chapter 17 ACI 350, Appendix D and current ICC-ES report, for the anchor to be used.
   2. Design assuming cracked concrete.

PART 3 - EXECUTION

3.1 GENERAL

A. Cast-in-Place Anchorage:
   1. Use where anchor rods or bolts are indicated on the Drawings, unless another anchor type is approved by the Program Manager.
   2. Provide concrete anchorage as shown on the Drawings or as required to secure components to concrete.

B. Adhesive Anchorage:
   1. Use only where specifically indicated on the Drawings or when approved for use by the Program Manager.
   2. May be used where subjected to vibration or where buried or submerged.
   3. Do not use in overhead applications or sustained tension loading conditions such as utility hangers.

4. Contact Program Manager for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.

C. Mechanical Anchorage:
   1. Use only where specifically indicated on the Drawings or when approved for use by the Program Manager.
   2. Do not use where subjected to vibration.
   3. May be used in overhead applications.
   4. Contact Program Manager for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.

D. Do not use powder actuated fasteners and other types of bolts and fasteners not specified herein for structural applications unless approved by the Program Manager or specified in Contract Documents.

3.2 PREPARATION

A. Provide adequate time to allow for proper installation and inspection prior to placing concrete for cast-in-place concrete anchorage.

B. Prior to installation, inspect and verify areas and conditions under which concrete anchorage is to be installed.
   1. Notify Program Manager of conditions detrimental to proper and timely completion of work.
   2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Program Manager.

C. Special Inspection is required in accordance with the building code for all concrete anchorage.
   1. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
   2. See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section for additional requirements.

D. Post-installed anchor manufacturer's representative shall demonstrate and observe the proper installation procedures for the post-installed anchors at no additional expense to the Owner.
   1. Follow such procedures to assure acceptable installation.
   2. Adhesive anchors must be installed in concrete aged a minimum of 21 days.

3.3 INSTALLATION

A. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
   1. Tack welding of anchorage is prohibited.
   2. Coat the projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
   3. Anchorage location tolerance shall be in accordance with AISC 303.
   4. Provide steel or durable wood templates for all column and equipment anchorage.
      a. Templates to be placed above top of concrete and not impede proper concrete placement and consolidation.

B. Unless noted or specified otherwise:
   1. Connect aluminum and steel members to concrete and masonry using stainless steel cast-in-place anchorage unless shown otherwise.
      a. Provide dissimilar materials protection.
   2. Provide washers for all anchorage.
   3. Where exposed, extend threaded anchorage a maximum of 3/4 IN and a minimum of 1/2 IN above the top of the fully engaged nut.
      a. If anchorage is cut off to the required maximum height, threads must be dressed to allow nuts to be removed without damage to the nuts.

C. Do the following after nuts are snug-tightened down:
   1. If using post-installed anchorage, follow MPII.
   2. Upset threads of anchorage to prevent nuts from backing off.
      a. Provide double nut or lock nut in lieu of upset threads for items that may require removal in the future.
   3. For all other cast-in-place anchorage material, tighten nuts down an additional 1/8 turn to prevent nuts from backing off.
   4. If two nuts are used per concrete anchor above the base plate, tighten the top nut an additional 1/8 turn to "lock" the two nuts together.
   5. If using post-installed anchorage, follow manufacturer's installation procedures.

D. Assure that embedded items are protected from damage and are not filled in with concrete.

E. Secure architectural components such that it will not be aesthetically distorted nor fasteners overstressed from expansion, contraction or installation.

F. Coat aluminum surfaces in contact with dissimilar materials as needed to protect from dissimilar metal corrosion.

G. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Prepare damaged surfaces by abrasive blasting or power sanding.
   2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions and ASTM A780.

H. For post-installed anchors, comply with the MPII on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar.
   1. Use hammer drills to create holes.
   2. Properly clean out the hole per the ICC-ES reports utilizing a non-metallic fiber bristle brush and compressed air or as otherwise required to remove all loose material from the hole prior to installing the anchor in the presence of the Special Inspector.

3.4 FIELD QUALITY CONTROL

A. Special Inspection:
   1. See Section 01 45 33 and requirements of the VUSBC.

3.5 CLEANING

A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings as necessary.

END OF SECTION

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SECTION 40 05 07
PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe support and anchor systems.
   2. Design of Pipe Support Systems as specified.
   1. Section 03 15 19 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.1, Power Piping.
      b. B31.2 Fuel Gas Piping.
      c. B31.3, Process Piping.
   2. ANVIL International (ANVIL).
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A276, Standard Specification for Stainless Steel Bars and Shapes.
      c. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
      d. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
      e. A917, Standard Specification for Steel Sheet, Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface (General Requirements).
      f. A918, Standard Specification for Steel Sheet, Zinc-Nickel Alloy Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
      g. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   4. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
      b. D1.6, Structural Welding Code - Stainless Steel.
   5. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
      b. SP-69, Pipe Hangers and Supports - Selection and Application.

B. Responsibility:
   1. Design complete support systems for all piping, as required, and as noted on the Drawings.
   2. Provide all labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.
   3. Incorporate those details with requirements of this Specification Section to provide the piping support system.

C. Each type of pipe hanger or support shall be the product of one manufacturer.

D. Qualifications:
   1. Pipe support designer:
      a. Licensed Professional Engineer registered in the Commonwealth of Virginia.
      b. Minimum of 5 years’ experience designing pipe supports for projects of similar size and complexity.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
      d. Scaled drawings showing location, installation, material, loads and forces, and deflection of all hangers and supports.
      e. Analyze each pipe system for all loads and forces on hangers and supports and their reaction forces to the structure to which they are fastened.
      f. Where Contract Documents indicate Design Builder is to design pipe support systems, submit detail design calculations and scaled drawings signed by pipe support designer.
   2. Certifications.
      a. Pipe support designer qualifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 MANUFACTURED UNITS

A. General:
   1. Galvanized components:
      a. Hot-dipped galvanized components.
   2. Dissimilar metals protection:
      a. Galvanized-to-galvanized and galvanized-to-aluminum: No protection required.
      b. All other galvanized-to-dissimilar metal connections: Neoprene or nylon pads, shims, grommets, etc.

B. Hanger Rods:
   1. Material:
      a. ASTM A36.
      b. ASTM A575, Grade M1020.
      c. ASTM A576, Grade 1020.
      d. Minimum allowable tensile stress of 12,000 PSI at 650 DEGF per MSS SP-58.
      e. Corrosion resistant: 304 or 316 stainless steel per ASTM A276.
      f. to match material of support attached thereto
   2. Continuously threaded.
   3. Electro-galvanized or cadmium plated after threads are cut.
   4. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, (LBS)
3/8 IN DIA (min)	610
1/2 IN DIA	1,130
5/8 IN DIA	1,810
3/4 IN DIA	2,710
7/8 IN DIA	3,770
1 IN DIA	4,960

C. Hangers:
   1. Materials for corrosive areas: 304 or 316 stainless steel.
   2. Hangers for use other than directly on copper pipe: Cadmium plated or galvanized.
   3. Hanger type schedule:

APPLICATION	PIPE SIZE	HANGER TYPE
All except noted	4 IN and less	ANVIL Figure 108 with Figure 114
All except noted	Over 4 IN	ANVIL Figure 590
Steam, condensate and hot water	All	ANVIL Figure 181, Figure 82
Service in chemical storage areas and as indicated on drawings for corrosion resistance	All	CorPro CP - Hanger or equal

D. Concrete Inserts for Hanger Rods:
   1. Continuous slots: Unistrut #P1000.
   2. Individual inserts: ANVIL Figure 281.
   3. See Specification Section 03 15 19, Anchorage to Concrete.

E. Beam Clamps for Hanger Rods:
   1. Standard duty.
   2. ANVIL Figure 133.

F. Trapeze Hangers for Suspended Piping:
   1. General:
      a. Material: Steel.
      b. Galvanized.
      c. Angles, channels, or other structural shapes.
      d. Curved roller surfaces at support point corresponding with type of hanger required.
   2. In chemical storage and feed areas and as indicated on the drawings:
      a. Materials: FRP.
      b. Unistrut fiberglass channel or equal.
   3. Corrosive areas:
      a. Material: 304 or 316 stainless steel.
      b. Angles, channels or other structural shapes.

G. Vertical Pipe Supports:
   1. At base of riser.

H. Expanding Pipe Supports:
   1. Spring hanger type.
   2. MSS SP-58.

I. Pipe Support Saddle:
   1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
   2. ANVIL Figure 264.

J. Pipe Support Risers:
   1. Schedule 40 pipe.
   2. Galvanized.
   3. Size: As recommended by saddle manufacturer.

K. Pipe Support Base Plate:
   1. 4 IN larger than support.
   2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.

3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
4. Collar welded to floor plate.
5. Edges ground smooth.
6. Assembly hot-dipped galvanized after fabrication.

L. Pipe Covering Protection Saddle:
1. For insulated pipe at point of support.
2. ANVIL Figure 167, Type B.

M. Wall Brackets:
1. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
2. ANVIL Figure 199.

N. Pipe Anchors:
1. For locations shown on the Drawings.
2. 1/4 IN steel plate construction.
3. Hot-dipped galvanized after fabrication.
4. Designed to prevent movement of pipe at point of attachment.

O. Pipe Guides:
1. For locations on both sides on each expansion joint or loop.
2. To ensure proper alignment of expanding or contracting pipe.
3. ANVIL Figure 256.

2.3 DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions.
1. Provide 5 to 1 safety factor, against failure.

B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
1. ASME B31.3.
2. MSS SP-58 and MSS SP-69.
3. Except where modified by this Specification.

E. For steam and hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
1. ASME B31.1.
2. MSS SP-58 and MSS SP-69.

F. Check all physical clearances between piping, support system and structure.
1. Provide for vertical adjustment after erection.

G. Support vertical pipe runs in pipe chases at base of riser.
1. Support pipes for lateral movement with clamps or brackets.

H. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.

I. Pipe Support Spacing:
1. General:
   a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
   b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.

c. Provide at least one support for each length of pipe at each change of direction and at each valve.

2. PVC pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5

3. Support each length and every fitting:
   a. Bell and spigot piping:
      1) At least one hanger.
      2) Applied at bell.
   b. Mechanical coupling joints:
      1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.
4. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.
5. For PVC, FRP and copper piping:
   a. Provide Unistrut Unicushion wrap of pipe at each support.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
   1. Included in this requirement are movements from:
      a. Trap discharge.
      b. Water hammer.
      c. Similar internal forces.

B. Weld Supports:
   1. AWS D1.1.
   2. Weld anchors to pipe in accordance with ASME B31.3.
   3. AWS D1.6 for stainless steel supports.

C. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.

D. Inspect hangers for:
   1. Design offset.
   2. Adequacy of clearance for piping and supports in the hot and cold positions.
   3. Guides to permit movement without binding.
   4. Adequacy of anchors.

E. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

F. Anchorage to Concrete- reference Section 03 15 19.

G. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
   1. Install concrete inserts as concrete forms are installed.

H. Welding:
   1. Welding rods: ASTM and AWS standards.

2. Integral attachments:
    a. Include welded-on ears, shoes, plates and angle clips.
    b. Ensure material for integral attachments is of good weldable quality.
3. Preheating, welding and postheat treating: ASME B31.3, Chapter V.

I. Field Painting:
    1. Per manufacturer's recommendation and approved by Program Manager.

END OF SECTION

SECTION 40 05 51

VALVES - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Valving, actuators, and valving appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Section 40 05 62 - Plug Valves.
   2. Section 40 05 64 - Butterfly Valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.20.1, Pipe Threads, General Purpose.
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      c. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
      c. D638, Standard Test Method for Tensile Properties of Plastics.
      d. D648, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
      e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
      f. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   3. American Water Works Association (AWWA):
      a. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
      b. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      c. C504, Standard for Rubber-Seated Butterfly Valves.
      d. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
      e. C550, Standard for Protective Coatings for Valves and Hydrants.
      f. C606, Standard for Grooved and Shouldered Joints.
   4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Valve pressure and temperature rating.

d. Valve material of construction.
e. Special linings.
f. Valve dimensions and weight.
g. Valve flow coefficient.
h. Wiring and control diagrams for electric or cylinder actuators.
i. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70.
2. Test reports.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
1. Verification from valve actuator manufacturer that actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted, and that the valve actuator responds correctly to the valve position command.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to individual valve Specification Sections for acceptable manufacturers.

2.2 MATERIALS

A. Refer to individual valve Specification Sections.

2.3 VALVE ACTUATORS

A. Valve Actuators - General:
1. Provide actuators as shown on Drawings or specified.
2. Counter clockwise opening as viewed from the top.
3. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
4. Size actuator to produce required torque with a maximum pull of 80 LB at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 LB on handwheel or chainwheel or 300 FT-LBS torque on the operating nut.
5. Unless otherwise specified, actuators for valves to be buried, submerged or installed in vaults or manholes shall be sealed to withstand at least 20 FT of submergence.
6. Extension stem:
a. Install where shown or specified.
b. Solid steel with actuator key and nut, diameter not less than stem of valve actuator shaft.
c. Pin all stem connections.
d. Center in valve box or grating opening band with guide bushing.

B. Buried Manual Valve Actuators:
1. Provide screw or slide type adjustable cast iron valve box, 5 IN minimum DIA, 3/16 IN minimum thickness, and identifying cast iron cover rated for traffic load.
2. Box base to enclose buried valve gear box or bonnet.
3. Provide 2 IN standard actuator nuts complying with AWWA C500, Section 3.16.
4. Provide at least two tee handle keys with 5 FT extension between key and handle.
5. Extension stem:
a. Provide for buried valves greater than 4 FT below finish grade.
b. Extend to within 6 IN of finish grade.
6. Provide concrete pad encasement of valve box as shown for all buried valves unless shown otherwise.

C. Exposed Valve Manual Actuators:
  1. Provide for all exposed valves not having electric or cylinder actuators.
  2. Provide handwheels for gate and globe valves.
     a. Size handwheels for valves in accordance with AWWA C500.
  3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 IN DIA and smaller.
     a. Lever actuators for butterfly valves shall have a minimum of five intermediate lock positions between full open and full close.
     b. Provide at least two levers for each type and size of valve furnished.
  4. Gear actuators required for plug valves, butterfly valves, and ball valves 4 IN DIA and larger.
  5. Provide gearing for gate valves 20 IN and larger in accordance with AWWA C500.
  6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
  7. Provide chain actuators for valves 6 FT or higher from finish floor to valve centerline.
     a. Cadmium-plated chain looped to within 3 FT of finish floor.
     b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without "gagging" the wheel.
     c. For smaller valves with lever or handle operators, provide offset tee handles with attached chain for operation from the operating floor.
  8. Provide cast iron floor stands where shown on Drawings.
     a. Stands to be furnished by valve manufacturer with actuator.
     b. Stands or actuator to include thrust bearings for valve operation and weight of accessories.

D. Valve Lockout Devices:
  1. Device manufactured from same material as valve operator, preventing access to valve operator, to accept lock shackle.

2.4 FABRICATION

A. End Connections:
  1. Provide the type of end connections for valves as required as shown on the Drawings.
  2. Comply with the following standards:
     a. Threaded: ASME B1.20.1.
     b. Flanged: ASME B16.1, Class 125 unless otherwise noted or AWWA C207.
     c. Bell and spigot or mechanical (gland) type: AWWA/ANSI C111/A21.11.

B. Refer to individual valve Specification Sections for specifications of each type of valve used on Project.

C. Nuts, Bolts, and Washers:
  1. Wetted or internal to be bronze or stainless steel.
     a. Exposed to be zinc or cadmium plated.

D. Epoxy Interior Coating: Provide epoxy interior coating for all ferrous surfaces in accordance with AWWA C550.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Painting Requirements: Comply with manufacturer’s instructions and approved by the Program Manager

C. Setting Buried Valves:
  1. Locate valves installed in pipe trenches where buried pipe indicated on Drawings.
  2. Set valves and valve boxes plumb.

3. Place valve boxes directly over valves with top of box being brought to surface of finished grade.
4. Install in closed position.
5. Place valve on firm footing in trench to prevent settling and excessive strain on connection to pipe.
6. After installation, backfill up to top of box for a minimum distance of 4 FT on each side of box.

D. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.

E. Install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.

F. For threaded valves, provide union on one side within 2 FT of valve to allow valve removal.

G. Install valves accessible for operation, inspection, and maintenance.

3.2 ADJUSTMENT

A. Adjust valves, actuators and appurtenant equipment to comply with Section 01 75 00.
   1. Operate valve, open and close at system pressures.

END OF SECTION

SECTION 40 05 62
PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plug valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 05 51 - Valves - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
   2. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
      b. A536, Standard Specification for Ductile Iron Castings.
      c. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   3. American Water Works Association (AWWA):
      a. C517 Resilient-Seated Cast-Iron Eccentric Plug Valves.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 40 05 51.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. See Specification Section 40 05 51.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed under the specific valve types are acceptable.

2.2 NON-LUBRICATED ECCENTRIC PLUG VALVES

A. Manufacturers:
   1. DeZurik.
   2. Henry Pratt.
   3. Millikin.
   4. ValMatic.

B. Materials:
   1. Body: Cast-iron ASTM A126, Class B.
   2. Plug: One or two-piece construction ductile iron, ASTM A536 65-45-12 or cast iron, ASTM A126 Class B.
   3. Plug facing: Grease and/or petroleum-resistant resilient Neoprene or Buna-N compound, 70 Type A durometer hardness per ASTM D2240.

4. Shaft bearing bushings: Permanently lubricated TFE or Delrin sleeve type stainless steel or bronze.
5. Valve seats: Welded-in overlay of 90 percent nickel, (minimum 1/8 IN thick).
6. Stem seal: per AWWA C517, Section 4.4.7.

2.3 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuator.
    1. Furnish actuator integral with valve.

B. Refer to Specification Section 40 05 51 for actuator requirements.

2.4 DESIGN REQUIREMENTS

A. Non-Lubricated Eccentric Plug Valves (Wastewater, Sludge):
    1. Port area:
        a. Valves 4 IN through 20 IN: Equal to or exceed 80 percent of full pipe area.
    2. Valve body: Fitted with bolted bonnet.
    3. End connections: See Specification Section 40 05 51.
    4. Stem seal: Adjustable and replaceable without disassembling valve or bonnet.
    5. Designed for seating drip tight in any flow direction.
    6. Rating:
        a. 1/2 through 12 IN, 175 PSI working pressure.
        b. 14 through 36 IN, 150 PSI working pressure.
        c. Three-way valves, 125 PSI working pressure.
    7. Actuator:
        a. Actuator gearing in enclosure suitable for running in oil with seals on shaft to prevent entry of dirt or water.
        b. Positive identification on actuator indicating valve position.
        c. Adjustable stop to set closing torque.

2.5 FABRICATION

A. See Specification Section 40 05 51.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 40 05 51.

B. Install valves with valve stem horizontal, plug seat on inlet side and with plug rotating up into the open position for valves in horizontal lines.

C. Install valve with actuator above pipe or plug centerline.

END OF SECTION

SECTION 40 05 64
BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Butterfly valves.

B. Related Sections include but are not necessarily limited to:
   1. Section 40 05 51 – Valves – Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings - NPS 1/2 Through NPS 24.
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
      e. A436, Standard Specification for Austenitic Gray Iron Castings.
      f. A536, Standard Specification for Ductile Iron Castings.
   3. American Water Works Association (AWWA):
      a. C504, Standard for Rubber-Seated Butterfly Valves.
   4. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-67, Butterfly Valves.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 40 05 51.
   2. For valves 8 IN and larger, furnish "Affidavit of Compliance" with Owner in accordance with AWWA C504.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. DeZurik.
   2. Clow.
   3. Mueller/Lineseal.
   4. Pratt a Mueller Water Company.
   5. Bray.
   6. Pentair/Keystone.

2.2 GENERAL USE BUTTERFLY VALVES

A. For use in all location, except where high performance butterfly valves are required.

B. Comply only with AWWA C504, as noted in this Specification Section.

C. Materials:
   1. Valve bodies:
      a. ASTM A126, Class B or ASTM A536 Grade 65-45-12 ductile iron.
      b. Wafer valves may be constructed of ASTM A48, Class 40 cast iron.
   2. Valve shafts:
      a. One-piece stainless steel, Type 304.
      b. Pins: 304 stainless steel.
      c. Bushings/Packing/O-rings: EPDM, RTFE or TFE.
      d. Bearings: Reinforced TFE or equal.
   3. Valve discs:
      a. Cast iron with welded nickel edge or 304 Stainless Steel disk.
   4. Valve seats:
      a. Water: EPDM or Hycar.
      b. Compressed air: Teflon, PTFE.
      c. Process air: Viton, RTFE, rate for 300 DegF minimum or higher if required by service.
   5. Shaft bearing: Bronze, TFE-coated stainless steel or reinforced TFE.
   6. Shaft seal in addition to any sealing provided by seat: Suitable synthetic rubber rings or PTFE V-ring suitable for operating conditions.

D. Design Requirements:
   1. Seat type: Resilient.
   2. Body type:
      a. Wafer Lug (laying length may vary from AWWA C504).
      b. Equip wafer type with fully tapped anchor lugs drilled per ASME B16.5.
   3. Direct buried valves:
      a. All valves: Working pressure rated for 150 PSI (Class 150B per AWWA C504).
   4. Shaft diameter: One-piece constant diameter.

2.3 ACCESSORIES

A. Refer to Drawings and/or valve schedule for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Section 40 05 51 for actuator requirements.

C. Valve Flange Seal Rings:
   1. If Steel Slip-on flanges are being used on the process piping, flange seals will be required for proper installation of valves.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 40 05 51.

END OF SECTION

SECTION 40 71 00
FLOW INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Flow Transmitters:
      a. Magnetic Flow Meters (Inline).

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. PTC 19.5, Application of Fluid Meters, Part 2.
   2. ASTM International (ASTM):
   3. American Water Works Association (AWWA).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 78 23 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

2.2 FLOW TRANSMITTERS

A. Magnetic Flow Meters (Inline):
   1. Acceptable manufacturers:
      a. Endress + Hauser (ProMag).
      b. Rosemount (8700 Series).
   2. Design and fabrication:
      a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
      b. High input impedance pre-amplifiers.
         1) Minimum impedance: 10^{10} ohms.
      c. Provide wafer body design rated for piping system operating and test conditions. Meter body shall be rated to same pressure as the flanges.
      d. Grounding requirements:
         1) Nonmetallic or lined pipe:
            a) Inlet and outlet grounding rings of same material as electrode or as recommended by manufacturer to meet process requirements.
         2) Conductive piping:
            a) Conductive path between the meter and the piping flanges.
      e. Provide cable between magnetic flow meter and transmitter.
         1) Cable shall be potted and fitted by manufacturer at the factory.

f. Pulsed DC magnetic field excitation.
g. Automatic zero.
h. Adjustable low flow cutoff.
i. Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
j. Inaccuracy: ±0.5 percent of rate.
k. 4-20 mA DC isolated output into maximum 800 ohms.
l. Power supply: 120 V ±10 percent, 60 Hz.
m. Indication of flow rate and totalized flow at transmitter.
n. Meter operable as specified in liquids with 5.0 micro mho/cm or more conductivity.
o. Transmitter electronics shall use microprocessor based architecture and be configured using parameters.

3. Schedule:

TAG NUMBER	SERVICE	FLOW RANGE (GPM)	METER SIZE (IN)	NEMA (IP) RATING
TBD	Polymer Transfer	0-10	3	NA

TAG NUMBER	LINER MATERIAL	ELECTRODE MATERIAL	INTEGRAL, FIELD OR PANEL-MOUNTED TRANSMITTER
TBD	Per Design Builder	Per Design Builder	Field

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

SECTION 40 72 00
LEVEL INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Level Transmitters:
      a. Ultrasonic Level Sensor and Transmitter.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings.
   2. ASTM International (ASTM):
      a. A106, Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
      b. A743, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 78 23 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

2.2 LEVEL TRANSMITTERS

A. Ultrasonic Level Sensor and Transmitter:
   1. Manufacturers:
      a. Endress + Hauser (*Prosonic* FMU40).
      b. Magnetrol (*Echotel* Model 335).
   2. Specifications:
      a. General:
         1) Measurement Principle: Ultrasonic, time-of-flight.
            a) Automatic temperature compensation with internal temperature sensor.
            b) Able to ignore false targets.
            c) Maximum Beam Angle: 10 DEG (±5.0 DEG).
         2) Measurement Range: See Schedule.
         3) Level Resolution: 0.10 IN.
         4) Accuracy: ±0.25 percent of measured distance or 0.25 IN.
         5) Blanking Distance: 12 IN.
         6) Update: 200 msec.

b. Process Connection:
    1) Mounting Thread Size: 2 IN NPT, coordinate installation on existing tank.
    2) Optional: Flange connection.
c. Display and Configuration:
    1) Integral Display for live measurement and configuration.
    2) Adjustable zero and span.
    3) Output variables: Level; optional: Volume, Flow (Open Channel Flow).
    4) Output Units: Feet, inches, meters, or millimeters (mm).
d. Electrical:
    1) Signal Power: Either Loop-powered, 2-wire, 24 VDC or Isolated 4-wire, 120 VAC/60Hz.
    2) Current Output: Analog 4-20 Ma into a 400 ohm loop.
    3) High/Low signal alarms: < 4.0 mA and > 20.0 mA.
    4) Optional Communication: HART=.
    5) Configuration: With remote hand-held configurator.
    6) Required Relays: Two SPDT rated at 1A @ 30 VDC or 5A @ 120 VAC.
    7) Cable entry: 1/2 IN NPT connection.
e. Materials of Construction.
    1) Wet-side material: PVDF, PVC, polypropylene, or Kynar.
    2) Body: Polyurethane-covered aluminum or cast aluminum.
f. Environment:
    1) Ambient Temperature: -40 to 158 DegF (-40 to 70 DegC).
    2) Humidity: Up to 95 percent, non-condensing.
    3) Process Temperature: -4 to 158 DegF (-20 to 70 DegC).
    4) Process Pressure: 0 to 35 PSIG.
    5) Protection: NEMA-4X.

3. Schedule (or Instrument List):

TAG NUMBER	SERVICE	RANGE	MAXIMUM DEPTH TO LIQUID SURFACE	MOUNT
TBD	Polymer Tank Level	0-15 ft	14 ft	To be determined by Design Builder

2.3 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
    1. Materials, unless otherwise specified, shall be as follows:
        a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
        b. Mounting brackets:
            1) 316 stainless steel.
        c. Mounting plates, angles:
            1) 316 stainless steel.

B. Provide handheld communicator compatible for all intelligent transmitters furnished.
    1. Handheld communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
    2. If these features are provided with the intelligent transmitter that is accessible, the handheld communicator is not required.

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as determined by Design Builder.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

D. Keep foreign matter out of the system.

E. Remove all oil on piping and tubing with solvent before piping and tubing installation.

F. Plug all open ends and connections to keep out contaminants.

G. Threaded Connection Seals:
   1. Use Tite-Seal or acceptable alternate.
   2. Use of lead base pipe dope or Teflon tape is not acceptable.
   3. Do not apply Tite-Seal to tubing threads of compression fittings.

H. Instrument Mounting:
   1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
   2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
   3. Mount instruments level, plumb, and support rigidly.
   4. Mount to provide:
      a. Protect from heat, shock, and vibrations.
      b. Provide accessibility for maintenance.
      c. Free from interference with piping, conduit and equipment.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

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SECTION 43 23 57
PUMPING EQUIPMENT - PROGRESSIVE CAVITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material, design, fabrication and installation requirements for progressive cavity pumps for polymer transfer.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American National Standards Institute (ANSI).
   3. Hydraulic Institute (HI).

1.3 SUBMITTALS

A. Shop Drawings:
   1. Requirements in Specification Section 01 33 00.
   2. Source quality control test reports.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 78 23 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Progressive cavity pumps:
      a. Moyno.
      b. Netzsch.
      c. Seepex.

2.2 MATERIALS

A. Polymer Transfer Pump
   1. Pump body: stainless steel, AISI 316.
   2. RotorAISI 316 stainless steel.
   3. Stator:
      a. Buna-N or nitrile rubber.
   4. Base plate: Fabricated steel.
   5. Stuffing box gland: Ductile iron.
   6. Lantern ring: 316 stainless steel.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
   1. Polymer Transfer Pump
      a. Design condition: 10 GPM at less than 500 RPM.
      b. Nameplate driver horsepower: per Design Builder.

c. Drive type: Constant speed
d. Suction 3 IN DIA minimum, discharge 3 IN DIA minimum.

2.4 ACCESSORIES

A. Provide run-dry protection for each pump consisting of a temperature probe installed in the pump stator for switching off the pump upon high temperature.

B. Provide protection against run dry or overpressurization by furnishing and installing an adjustable pressure switch at the pump discharge for switching off the pump upon low or overpressurization.

2.5 FABRICATION

A. Pump Body:
   1. Provide body containing two inspection ports 180 DEG apart.
   2. Cradle mount pump to permit suction port to be rotated at 90 degree increments perpendicular to pump centerline.

B. Rotor:
   1. Harden to minimum Rockwell C-57.

C. Stator:
   1. Construct by bonding rubber-type material to inside of a steel tube.
   2. Minimum 65 durometer hardness (Shore A).

D. Drive Train:
   1. Include crown gear-type or pin-type universal joints, seals, connecting rod, driveshaft, and shaft bearings.
   2. Connect rotor drive shaft by a connecting rod equipped with two crowned gear-type or pin-type factory grease lubricated and positively sealed universal joints.
      a. Joint unconditionally guaranteed by manufacturer to meet 10,000 HR operation at the required performance conditions.
   3. Use universal joints to transmit thrust and torque while allowing the rotor to move through an eccentric path.
   4. Joint shall be positively sealed and encased in a series 300 stainless steel cover to protect it from tramp metal and glass.
   5. Mount drive shaft in two ball or tapered roller bearings.
   6. Bearing ABMA L-10 life: 50,000 HRS at design operating conditions specified.
   7. Provide fittings for grease or oil lubrication of bearings.
   8. Stuffing box:
      a. Design for either grease lubrication or water seal.
      b. Permit gland adjustment and repacking without dismantling pump.

E. Suction and Discharge:
   1. Provide ANSI, Class 150, 125 LB rated flanged.

F. Base Plate: Provide common base plate for pump, drive and motor.

2.6 SOURCE QUALITY CONTROL

A. Testing:
   1. Perform Level I test for each pump as defined by HI standards to assure conformance to manufacturer's commercial performance criteria.
   2. Perform hydrostatic test for each pump in compliance with HI standards.

2.7 MAINTENANCE MATERIALS

A. Furnish Owner the following extra parts for each pump category:
   1. One complete spare pump
   2. One rotor.

3. One stator.
4. One connecting rod with bushings.
5. One set of connecting rod joint assemblies.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor or Pad-Mounted Units (Non-Submersible):
   1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
   2. Assure no unnecessary stresses are transmitted to equipment flanges.
   3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.
   4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
   5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
   6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
   7. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
      a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
      b. Realign as necessary, install flange bolts and make equipment connection.
   8. Field paint units per manufacturer’s requirements.
   9. Provide pressure gage, visible from grade or operating floor, on discharge of all pumps and on suction and discharge of all non-submersible units.

3.2 FIELD QUALITY CONTROL

1. Inspect equipment covered by this Specification Section.
2. Supervise pre-start adjustments and installation checks.
3. Conduct initial start-up of equipment and perform operational checks.
4. Instruct Owner's personnel.

END OF SECTION

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Storm Sewer As-Built

EX. 67
Ex. Grate Inlet
Ex. Top=18.43
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 86
Ex. Grate Inlet
Ex. Top=19.44
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 87
Ex. Grate Inlet
Ex. Top=19.39
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 88
Ex. Grate Inlet
Ex. Top=18.98
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 89
Ex. Grate Inlet
Ex. Top=18.74
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 104
Ex. Storm Manhole
Ex. Top=22.70
Ex. Inv. @ C/L of Structure=13.70
*Unable to obtain inverts of pipe from above ground. Confined space required.

EX. 104A
Ex. Storm Manhole
Ex. Top=21.95
Ex. Inv. In=13.93 (18" RCP from 105)
Ex. Inv. In=13.93 (18" RCP from South)
Ex. Inv. Out=13.86 (18" RCP to 104)

EX. 105
Ex. Storm Manhole
Ex. Top=21.64
Ex. Inv. In=14.30 (18" RCP from 106)
Ex. Inv. Out=14.24 (18" RCP to 104A)

EX. 106
Ex. Grate Inlet
Ex. Top=21.36
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 107
Ex. Storm Manhole
Ex. Top=22.46
Ex. Inv. In=17.36 (18" RCP from 107)
Ex. Inv. Out=17.28 (18" RCP to 106)

EX. 108
Ex. Grate Inlet
Ex. Top=29.10
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 109
Ex. Storm Manhole
Ex. Top=27.56
Ex. Inv. In=20.24 (18" RCP from 117)
Ex. Inv. Out=20.22 (18" RCP to 109)

EX. 110
Ex. Storm Manhole
Ex. Top=22.60
Ex. Inv. @ C/L of Structure=12.91
*Unable to obtain inverts of pipe from above ground. Confined space required.

EX. 111
Ex. Storm Manhole
Ex. Top=23.21
Ex. Inv. @ C/L of Structure=14.73
*Unable to obtain inverts of pipe from above ground. Confined space required.

EX. 112
Ex. Storm Manhole
Ex. Top=23.93
Ex. Inv. In=16.93 (18" RCP from 113)
Ex. Inv. Out=16.84 (18" RCP to 111)

EX. 113
Ex. Storm Manhole
Ex. Top=24.62
Ex. Inv. In=20.38 (15" RCP from 114)
Ex. Inv. Out=18.94 (18" RCP to 112)

EX. 114
Ex. Grate Inlet
Ex. Top=23.44
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 115
Ex. Grate Inlet
Ex. Top=23.89
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 116
Ex. Storm Manhole
Ex. Top=25.57
Ex. Inv. In=19.90 (6" PVC from West)
Ex. Inv. Out=19.88 (6" PVC to MM)
*Appears to be a combined Storm and Sanitary line.

EX. 117
Ex. Storm Manhole
Ex. Top=29.23
Ex. Inv. In=23.02 (18" RCP from Northwest)
Ex. Inv. Out=21.23 (18" RCP to 109)
*Appears to be a combined Storm and Sanitary line.

EX. 118
Ex. Storm Manhole
Ex. Top=40.22
Ex. Inv. In=31.12 (15" RCP from 119)
Ex. Inv. In=30.72 (15" RCP from 122)
Ex. Inv. Out=27.30 (18" RCP to South)

EX. 119
Ex. Storm Manhole
Ex. Top=42.78
Ex. Inv. In=38.23 (15" RCP from 120)
Ex. Inv. Out=38.11 (15" RCP to 118)

EX. 120
Ex. Grate Inlet
Ex. Top=45.31
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

EX. 121
Ex. Grate Inlet
Ex. Top=46.34
Ex. Inv. In=
Ex. Inv. Out=
*Unable to get lid open.

EX. 122
Ex. Grate Inlet
Ex. Top=39.11
Ex. Inv. In=36.21 (15" RCP from 123)
Ex. Inv. In=31.86 (15" RCP from 124)
Ex. Inv. In=34.76 (6" PVC from Northeast)
Ex. Inv. Out=31.66 (15" RCP to 118)

EX. 123
Ex. Curb Inlet
Ex. Top=46.37
Ex. Inv. In=40.69 (15" RPC from West)
Ex. Inv. Out=40.34 (15" RCP to 122)

EX. 124
Ex. Curb Inlet
Ex. Top=42.49
Ex. Inv. In=32.59 (15" RPC from 125)
Ex. Inv. Out=32.21 (15" RCP to 122)

EX. 125
Ex. Grate Inlet
Ex. Top=42.03
Ex. Inv. In=
Ex. Inv. Out=
*Grate inlet has a liner in it prohibiting any access to structure. We were instructed by Brian with HDR, not to disturb the liner.

Sanitary Sewer As-Built

EX. JJ
Ex. Sanitary Manhole
Ex. Top=Buried
Ex. Inv. In=
Ex. Inv. Out=
*Could not find. No evidence on the ground of a structure. approximate location shown on plan.

EX. KK
Ex. Sanitary Manhole
Ex. Top=24.80
Ex. Inv. In=20.95 (6" PVC from North)
Ex. Inv. In=21.05 (4" PVC from Southwest)
Ex. Inv. Out=20.02 (8" PVC to JJ)

EX. LL
Ex. Sanitary Manhole
Ex. Top=24.53
Ex. Inv. In=
Ex. Inv. Out=
*Structure full of sludge.

EX. MM
Ex. Sanitary Manhole
Ex. Top=24.53
Ex. Inv. @ C/L structure=19.31 (6" PVC from 116)

*Not all sanitary manholes located and shown hereon are part of the gravity sewer network. Only the ones labeled as such were opened and as-built.

LEGEND

- Ex. Sanitary Sewer
- Ex. Overhead Electric
- W Ex. Water Line
- G Ex. Underground Gas Line
- UGE Ex. Underground Electric
- UGT Ex. Underground Telephone
- Ex. Guard Rail
- C&G Ex. Curb and Gutter
- EP Ex. Edge Of Pavement
- Ex. Geotechnical Boring
- Ex. Water Meter
- Ex. Water Valve
- Ex. Fire Hydrant
- Ex. Storm Sewer
- Ex. Sanitary Sewer
- Ex. Telephone Manhole
- Ex. Electric Manhole
- Ex. Hand Hole
- Ex. Sanitary Clean Out
- Ex. Gas Vent Pipe
- Ex. Unknown Utility
- Ex. Power Pole
- Ex. Guy Wire
- Ex. Light Post
- Ex. Sign
- Ex. Bollard

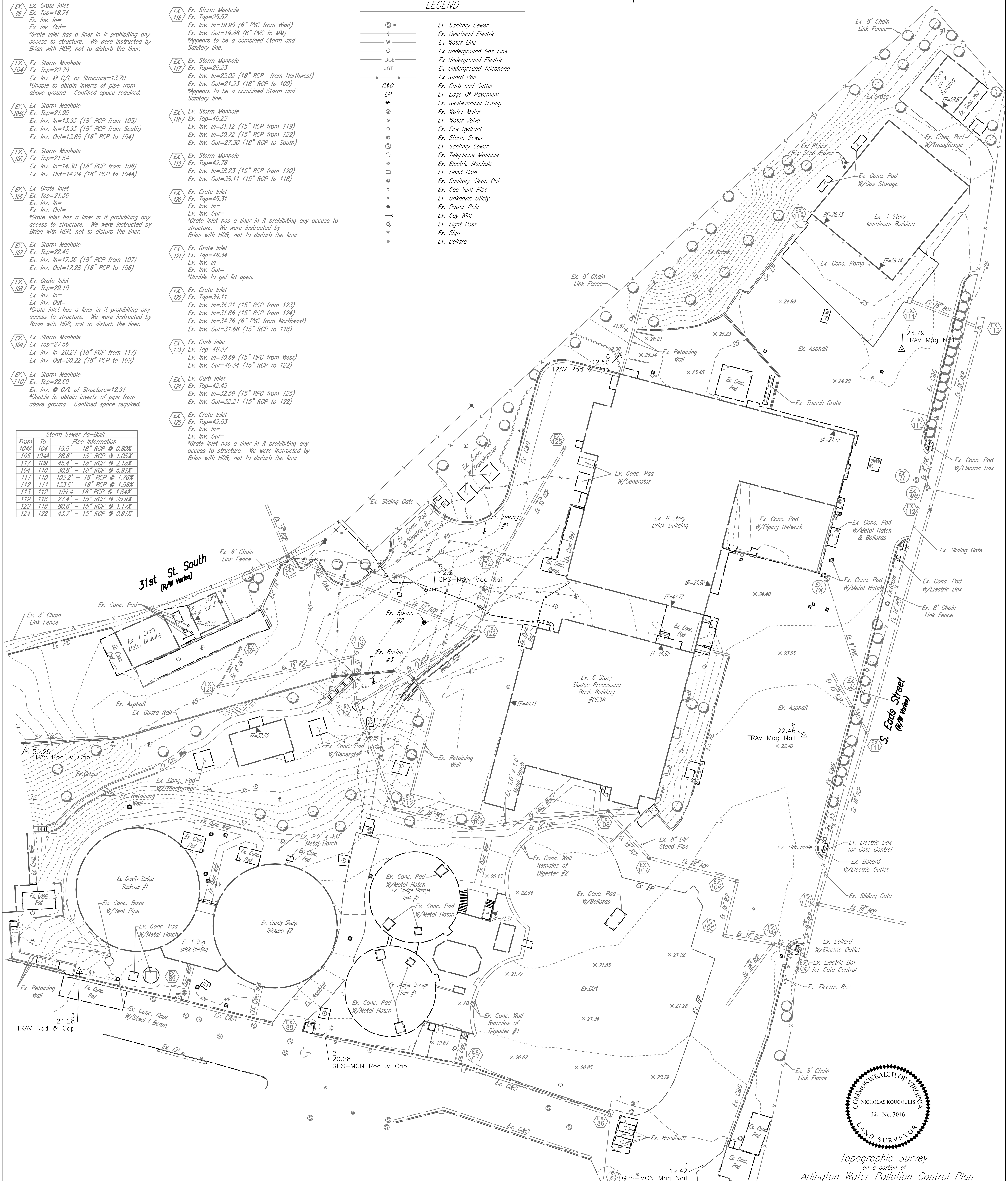
VCS83

Notes:

1. No boundary information was compiled for this survey. Not all easements may be shown.
2. This site survey was completed under the direct and responsible charge of Rinker Design Associates, P.C. from an actual ground survey made under my supervision; that the imagery and other data was obtained on December 28, 2022, and that this digital geospatial data, including metadata, meets minimum accuracy standards unless otherwise noted.
3. Subsurface utility data depicted in this survey was designated by an unknown source at an unknown time. At the request of the client, RDA located the utility paint designation on December 28, 2022. RDA is not responsible for the accuracy or completeness of the utility designation paint depicted in this survey.
4. Horizontal datum: VCS 1983 – North Zone
Vertical Datum: NGVD29
Contour Interval: 1 foot
5. Storm and Sanitary manholes were located and shown to the center of the structure, not to the center of the manhole.

Survey Control

Point	Northing	Easting	Elevation	Description
1	6993808.289	11894644.460	19.42	GPSM–Mag Nail
2	6993884.459	11894425.987	20.28	GPSM–Rod & Cap
3	6993920.491	11894284.161	21.28	TRV–Rod & Cap
4	6994047.536	11894253.162	51.29	TRV–Rod & Cap
5	6994141.374	11894489.092	42.21	GPSM–Mag Nail
6	6994276.337	11894595.993	42.50	TRV–Rod & Cap
7	6994280.168	11894759.838	23.79	TRV–Mag Nail
8	6994056.904	11894703.281	22.46	TRV–Mag Nail



Storm Sewer As-Built

From	To	Pipe Information
104A	104	19.9' – 18" RCP @ 0.80%
105	104A	28.6' – 18" RCP @ 1.08%
117	109	45.4' – 18" RCP @ 2.18%
104	110	30.8' – 18" RCP @ 5.91%
111	110	103.2' – 18" RCP @ 1.76%
112	111	133.6' – 18" RCP @ 1.58%
113	112	109.4' 18" RCP @ 1.84%
119	118	27.4' – 15" RCP @ 25.9%
122	118	80.6' – 15" RCP @ 1.17%
124	122	43.7' – 15" RCP @ 0.81%

COMMONWEALTH OF VIRGINIA
NICHOLAS KOUGOULIS
Lic. No. 3046
LAND SURVEYOR

Topographic Survey
on a portion of
Arlington Water Pollution Control Plan
Arlington County, Virginia
Date: December 28, 2022
Scale: 1" = 25'
Path: M:\work\18019\001\Survey\dwg files\18019-001 TOPO HC-Update.dwg

Geotechnical Boring Table

Boring #	Northing	Easting	Elevation	Description
1	6994174.446	11894518.205	44.37	TEST-HOLE/ASPHALT PATCH
2	6994122.271	11894483.527	40.77	TEST-HOLE/ASPHALT PATCH
3	6994087.729	11894454.304	41.50	TEST-HOLE/CL OF 5'X8'DIST.AREA

0 25 50 75

GEOTECHNICAL DATA REPORT

SOE Geotechnical Exploration
Water Pollution Control Plant
Arlington County, Virginia

Schnabel Reference 22230023.000
January 18, 2023

Prepared For:

HDR

Schnabel ENGINEERING

Schnabel ENGINEERING

T 703.779.0773 / F 703.443.0510
46020 Manekin Plaza, Suite 150 / Sterling, VA 20166 schnabel-eng.com

January 18, 2023

Ms. LaTasha Peele, PE LEED Green Associate
Senior Water/Wastewater Project Manager
HDR, Inc.
8115 Maple Lawn Blvd, Suite 360
Fulton, Maryland 20759

Subject: **Geotechnical Data Report, SOE Geotechnical Exploration, Water Pollution Control Plant, Arlington County, Virginia (Schnabel Reference No. 22230023.000)**

Dear Ms. Peele:

SCHNABEL ENGINEERING, LLC (Schnabel) is pleased to submit our geotechnical data report (GDR) for this project. This study was performed in accordance with our proposal dated April 4, 2022 and in general accordance with our Professional Services Subcontract with HDR dated May 17, 2022.

1.0 SITE AND PROJECT DESCRIPTION

The project site is located at the existing Arlington County Water Pollution Control Plant (WPCP) located within the Crystal City area of Arlington, Virginia. The WPCP It is located between South Eads Street and 31st Street, immediately to the west of 32nd Street. Within the WPCP the specific area of the site being considered for temporary excavation support is located to the west of the existing biological solids processing building and to the north of Sludge Storage Tank No. 1 and No. 2. The project site is generally asphalt paved with a small grass area along the southern portion of the site, north of the sludge storage tanks. The on-site grade near the planned excavation is gently sloping south with elevation between EL 39 ft and EL 45 ft.

We understand the project is a part of the Arlington Re-Gen Biosolids Upgrade Program planned to construct the next generation of biosolids management facilities. As part of the proposed construction, the project will require the demolition of existing structures and retaining walls and construction of new planned structures. We also understand that temporary excavation support will be required to facilitate the proposed construction. Based on the provided site drawings, the proposed temporary excavation support system may extend approximately 150 ft immediately north of the existing biological solids processing building into the asphalt paved area. The plan drawing provided by your office, indicates a proposed site elevation of EL 24 ft, indicating an excavation depth approximately 18 ft based on the existing site grades.

A site vicinity map is included as Figure 1 at the end of this report. We obtained the site information through our subsurface exploration, site visits, and review of readily available aerial images of the project site. Project information was obtained from the provided site drawings and our conversation with your office.

2.0 SUBSURFACE EXPLORATION AND LABORATORY TESTING PROGRAM

We performed a subsurface exploration and field-testing program to identify the subsurface conditions underlying the site and to provide geotechnical data for the existing soils encountered. This program included test borings with Standard Penetration Testing (SPT). The exploration methods used are discussed below. The appendices contain the results of our exploration.

2.1 Subsurface Exploration Methods

2.1.1 Test Borings

Our subcontractor, Connelly & Associates, Inc., drilled three test borings under our observation from December 12, 2022 to December 14, 2022. The SPT test was performed at selected depths within the borings. Appendix A includes specific observations, remarks, and logs for the borings; classification criteria; drilling methods; and sampling protocols. Figure A1, included at the end of this report, indicates the approximate test boring locations. We will retain soil samples up to 45 days beyond the issuance of this report, unless you request other disposition.

The SPT samples were obtained using an automatic trip hammer (ATH) rather than the standard safety hammer. The energy applied to the split-spoon sampler using the ATH is about 33 percent greater than that applied using the standard safety hammer. The hammer blows shown on the boring logs are uncorrected for the higher energy. Additionally, the uncorrected N-values were also considered while describing the relative density/consistency of the soils in the generalized subsurface stratigraphy section of this report.

2.1.2 Temporary Water Observation Well

Groundwater level measurements were obtained in all the test borings during drilling and upon completion. One temporary water observation well (TOW) was installed in boring SB-01 to obtain 24 and 48-hr groundwater levels. The temporary well consisted of 1-1/4-inch PVC standpipe extending to a depth of 75 ft below the ground surface. The PVC standpipe was screened the entire length in the boring.

2.2 Soil Laboratory Testing

Our laboratory performed geotechnical laboratory tests on soil samples obtained during our subsurface exploration. This laboratory testing specifically included the following tests and methodologies:

- 9 Moisture Content, ASTM D2216
- 6 Grain Size Distribution, ASTM D422
- 6 Liquid Limit, Plastic Limit, and Plasticity Index of Soils, ASTM D4318

The testing aided in the classification of materials encountered in the subsurface exploration which are summarized on our boring logs. The results of the laboratory tests are included in Appendix B and are summarized in the Site Geology and Subsurface Conditions Sections of this report. Select test results are also shown on the boring logs in Appendix A.

3.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

3.1 Site Geology

Review of existing geologic data in our files and our subsurface exploration indicate that the site is located within the Atlantic Coastal Plain Physiographic Province of Virginia. The Coastal Plain generally consists of a seaward thickening wedge of semi- to unlithified sedimentary deposits of Cretaceous and younger Geologic Age. Coastal Plain sediments were deposited in the early Atlantic Ocean and its tributaries during several cycles of ocean advance and retreat. The Coastal Plain extends eastward to the Atlantic Ocean and is bounded to the west by the Piedmont Physiographic Province. The transition between the Coastal Plain and the Piedmont is referred to as “The Fall Line”, where waterfalls are present on rivers that cross this interface. The Fall Line in Virginia generally extends from Washington, DC to Emporia, Virginia, and includes the cities of Fredericksburg, Richmond, and Petersburg. A geologic Map is included as Figure 2 at the end of this report.

During our subsurface exploration, we encountered the existing fill soils of Stratum A, and the fine and coarse-grained Potomac Formation Soils of Strata B1 and B2, respectively. The existing fill soils are believed to related to the past development of the WPCP, while the Potomac Formation soils are Cretaceous Age deposits by the historic movements of the Potomac River. One subsurface profile depicting the encountered subsurface conditions of the project site is included as Figure A2 in Appendix A of this report.

3.2 Generalized Subsurface Stratigraphy

We characterized the following generalized subsurface stratigraphy based on the exploration and laboratory test data included in the appendices.

3.2.1 Ground Cover

Topsoil

Boring SB-01 was drilled within the grass area along the southern portion of the site, north of the sludge storage tanks. This boring encountered about 3 inches of topsoil below the ground surface.

Asphalt Concrete

Boring SB-02 and SB-03 were drilled in the existing parking west of the existing biological solids processing building. These borings encountered about 7 to 8 inches of asphalt concrete underlain by about 4 to 5 inches of dense graded aggregate. The thicknesses of the asphalt concrete and aggregate materials and the subgrade materials encountered below the pavement at these boring locations are summarized in the table below.

Table 3-1: Summary of Pavement Sections

Boring ID	Asphalt Thickness (inches)	Dense-Graded Aggregate Thickness (inches)	Stratum*	Subgrade Material
SB-02	7.0	5.0	A	GC
SB-03	8.0	4.0	A	CL

*Strata descriptions are provided below.

3.2.2 Stratum A: Existing Fill

Below the ground cover, existing fill soils of Stratum A were encountered in all borings. The existing fill soils of Stratum A extended to depths of up to 18.5 ft below the ground surface. The lowest elevation at which these soils were present was approximately EL 21.5 ft in boring SB-02. The soils of Stratum A consisted of SANDY FAT CLAY (CH), SANDY LEAN CLAY (CL), CLAYEY SAND (SC), CLAYEY GRAVEL (GC), and POORLY GRADED GRAVEL (GP) with varying amounts of gravel, sand, and asphalt fragments. Standard Penetration Test (SPT) N-values recorded in this stratum varied from 3 to 35 blows per foot (bpf), indicating firm to hard consistencies and very loose to dense relative densities.

One sample from this stratum was tested for index properties. The sample classified as SANDY FAT CLAY (CH) with a Liquid Limit of 56 and a Plasticity Index of 33. The amount of material passing a No. 200 sieve was measured to be 63.6 percent. This sample and an additional jar sample from this stratum were also tested for natural moisture content. The natural moisture contents varied from 6.5 to 29.2 percent.

3.2.3 Stratum B1: Fine-Grained Potomac Formation Soils

Underneath the existing fill soils of Stratum A or interlayered with the coarse-grained soils of Stratum B2, the fine-grained Potomac Formation soils of Stratum B1 were encountered in all boring locations. The soils of Stratum B1 extended to depths of up 75 ft below the ground surface, the maximum depth explored. These soils consisted of FAT CLAY WITH SAND (CH), SANDY FAT CLAY (CH), and SANDY LEAN CLAY (CL). The SPT N-values measured within this stratum ranged from 6 to 100+ bpf, indicating stiff to hard consistencies.

Laboratory tests performed on two samples collected from Stratum B1 measured Liquid Limits of 56 and 60 and Plasticity Indices of 30 and 35. The percentage passing a No. 200 sieve was measured as 98.3 and 98.5 percent. These samples and an additional jar sample from this stratum were also tested for natural moisture content. The natural moisture contents varied from 21.0 to 26.6 percent.

3.2.4 Stratum B2: Coarse -Grained Potomac Formation Soils

The coarse-grained Potomac Formation soils of Stratum B2 were encountered interlayered with the fine-grained soils of Stratum B1. The soils from this Stratum extended to depths of up to 53.5 ft below the ground surface. Stratum B2 soils classified as CLAYEY SAND (SC). SPT N-values recorded within this stratum varied from 27 to 50 bpf, indicating medium to dense relative densities.

Laboratory tests performed on three samples collected from Stratum B2 measured Liquid Limits ranging from 28 to 48 and Plasticity Indices ranging from 8 to 30. The percentage passing a No. 200 sieve was measured between 22.9 and 23.8 percent. The natural moisture content of the samples tested ranged from 13.7 to 21.8 percent.

3.3 Groundwater

Groundwater was encountered during drilling in all borings at depths ranging from 13.5 to 48.0 ft below the ground surface. This corresponds to approximate elevations of EL 26.7 ft and EL -3.0 ft, respectively. Upon completion of drilling, before pulling augers, groundwater was observed within the borings at depths ranging from 32.0 to 39.0 ft below the ground surface. This corresponds to approximate elevations of EL 13.0 ft and EL 1 ft, respectively.

A temporary, hand-slotted PVC pipe was also installed in boring SB-01 to obtain longer term groundwater readings. The groundwater elevation measured within the observation well varied between EL 10.0 ft and EL 12.0 ft. A summary of the water level readings is presented in the table below.

Table 3-2: Summary of Observed Groundwater Levels

Boring ID	Approximate Ground Surface Elevation (ft)	Approximate Groundwater Elevation (ft)			
		Encountered Day of Drilling	Completion of Drilling	24 hours After Completion	48 hours After Completion
SB-01	41.0	2.5	3.0	10.0	12.0
SB-02	40.0	26.5[1]	1.0	-	-
SB-03	45.0	-3.0	13.0	-	-

[1] Based on the groundwater measurements collected during our exploration we consider this reading to likely be perched groundwater.

The groundwater levels on the boring logs indicate our estimate of the hydrostatic water table at the time of our subsurface exploration. The final design should anticipate the fluctuation of the hydrostatic water table depending on variations in precipitation, surface runoff, pumping, tidal action, evaporation, leaking utilities, and similar factors.

4.0 LIMITATIONS

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or other instrument of service.

We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Sincerely,

SCHNABEL ENGINEERING, LLC

Lucas Hoyos, EIT
Senior Staff Engineer

Samer Hassan, PE
Senior Engineer

Bill Khouri, PE
Principal

LH:SH;BK;jdb

Figures
Appendix A: Subsurface Exploration Data
Appendix B: Soil Laboratory Test Data

\\FFAX-FS\SCHNABEL_PROJECTS\2021-2030\2022\22230023.000 - WPCP SOE EXPLORATION\03-SE PRODUCTS\03-REPORTS\02-FINAL\22230023.000 - WPCP SOE EXPLORATION GDR.DOCX

FIGURES

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Projection: WGS 1984 Web Mercator Auxiliary Sphere

NOT TO SCALE

Schnabel ENGINEERING	SOE GEOTECHNICAL EXPLORATION WATER POLLUTION CONTROL PLANT ARLINGTON COUNTY, VIRGINIA PROJECT NO. 22230023.000	SITE VICINITY MAP FIGURE 1

12/30/2022 This Map was Created In Schnabel Engineerings Site Vicinity Map Application arcgis af — **Artificial fill**—Sandy and gravelly materials in areas filled for construction of roads, highways, bridges, and dams

Qal — **Alluvium (Holocene and Pleistocene)**—Fine to coarse gravelly sand and sandy gravel, silt, and clay, light- to medium-gray and yellowish-gray; clasts consist mainly of vein quartz, quartzite, and other metamorphic rocks. Beds along the Potomac River and its tributaries south of the District of Columbia contain sparse brackish water clam shells as well as rare lenses of shells reworked from units as old as Paleocene.

Qbc — **Bacons Castle Formation (lower Pleistocene)**—Sandy gravel and feldspathic quartz sand. Basal beds are commonly cobble and gravel composed mainly of quartz, quartzite, and lesser amounts of chert and sandstone. The unit is extensive in northern Mason Neck State Park, lower Pohick Creek and Accotink Creek drainage basin, and the vicinity of Fort Belvoir Military Reservation in Virginia. Surface elevation of the top of the terrace deposits is commonly 44 to 50 m (144 to 164 ft) in elevation. The base of deposits ranges from 37 to 43 m (121 to 141 ft) in elevation

Qchow — **Chowan River Formation (lower Pleistocene)**—Sandy gravel and quartz to feldspathic sand; pebble- to cobble-size clasts are mainly quartz, quartzite, sandstone, and chert. Generally, the top of the unit is land surfaces from 58 to 65.5 m (190 to 215 ft) in elevation. It is interpreted to have been deposited about 2.4 million years ago (Blackwelder, 1981)

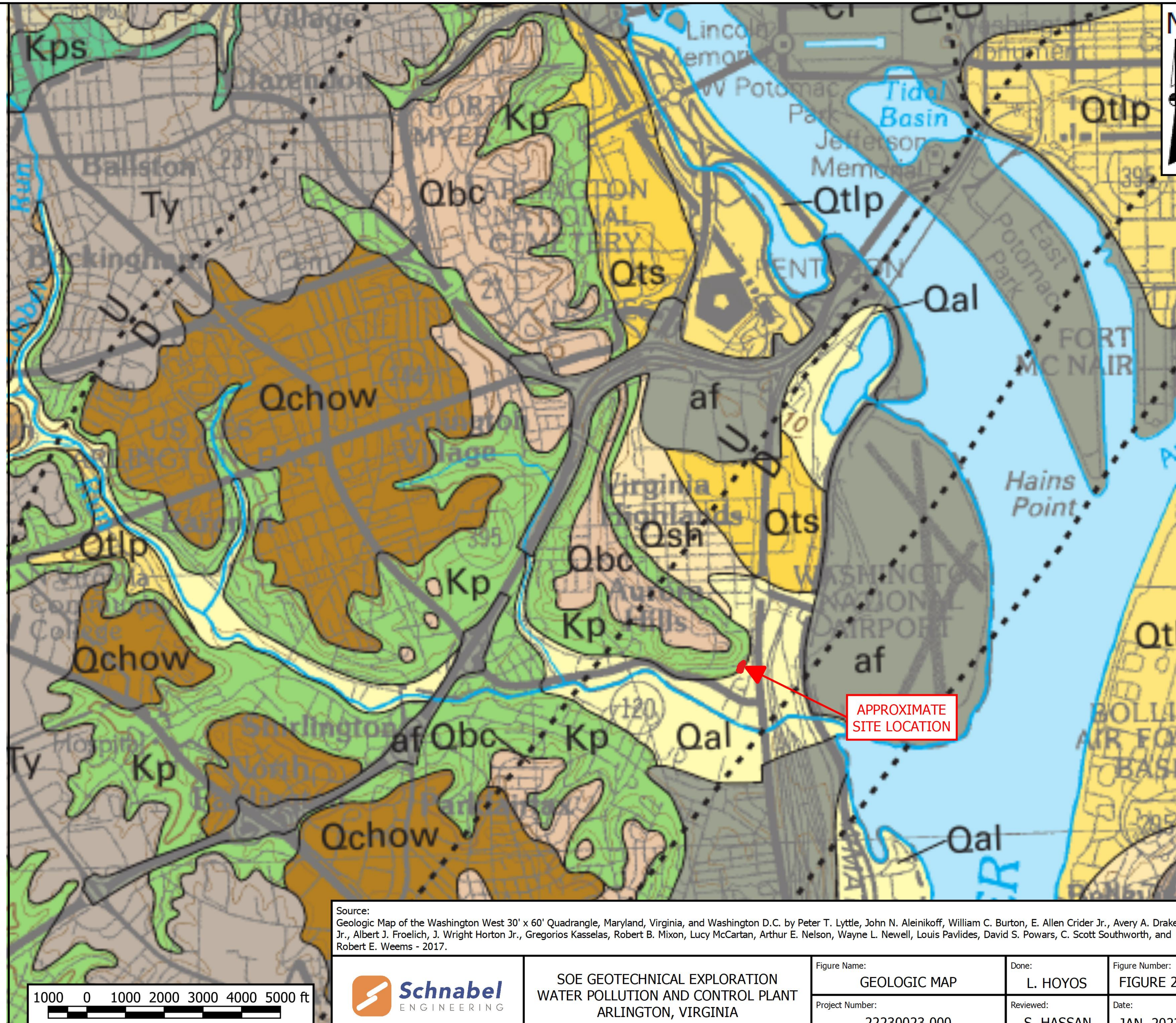
Qsh — **Shirley Formation (middle Pleistocene)**—The sequence generally includes, from bottom to top, at least three of the following sediment types: (1) medium to coarse, light-gray to white sand, thick-bedded and coarsely cross-stratified, commonly oxidized bright yellow or orange, in units as much as 3 m (10 ft) thick; (2) light- to medium-gray sand, thin-bedded, interbedded with thin silt and clay beds, which locally contain abundant wood fragments; the unit weathers yellowish brown to pale red, thin beds of limonite are common; (3) massive, light-gray or greenish-gray, sandy clay and silt in units 1.5 to 3 m (5 to 10 ft) thick; contains scattered pebbles, cobbles, and limonite-filled root tubes; weathers pale red and forms vertical faces in natural exposures; and (4) fine to coarse, massive, orange-brown sand as much as 2 m (6.5 ft) thick, which locally forms the uppermost part of the terrace.

Qtlp — Lynnhaven and Poquoson Members, undivided (upper Pleistocene)—Muddy, fine to coarse sand and sandy silt underlying low terraces ranging in elevation from sea level to about 6 m (20 ft) and paralleling tidal creeks and bays tributary to the Potomac River. Thickness varies from a feather edge to 14 m (40 ft) and as much as 30 m (100 ft) in paleochannels beneath the Potomac River

Qts — Sedgefield Member (upper Pleistocene)—Upward fining sequence of gravelly sand, silt, and clay; primarily fine to coarse sand, well to poorly sorted, tan to orange in the upper one-third; poorly sorted, gray to olive silty clay in most of the lower two-thirds; and olive-gray pebbly sand at the base. Underlies terraces at elevations of 6 to 11 m (20 to 36 ft) along the Potomac River and is typically 1.5 to 14 m (5 to 46 ft) thick and as much as 30 m (100 ft) thick in paleochannels beneath the Potomac River.

Ty — **Yorktown Formation (Pliocene)**—Sandy gravel and feldspathic sand; pebble- to cobble-size clasts are mainly quartz, quartzite, sandstone, and chert. The base of unit ranges from about 73 to 77 m (240 to 253 ft) in elevation. North of Occoquan River, remnants of relatively undissected flats (inferred to be depositional surfaces at top of the unit), slope gently southeastward from elevations of about 80 m (262 ft) at the toe of a highly eroded and poorly defined scarp that extends from Dale City northeastward.

Kpc / Kp / Kps — **Potomac Formation (Upper and Lower Cretaceous)**—Very light gray to pinkish-gray, medium to very coarse, feldspathic quartz sand; green montmorillonite-illite clay and clayey sand; and dark-yellowish-brown to olive-gray, lignitic sandy silt and clay containing abundant poorly preserved leaf and stem impressions of ferns, cycads, and gymnosperms and rare silicified tree trunks. The highest elevation of this unit is 100 m (328 ft), located in the District of Columbia. The unit reaches 245 m (804 ft) of thickness in the southeastern corner of the map area. Mostly north and east of Hybla Valley, Virginia, the Potomac Formation is divided into 2 units: **Kpc** (clay-dominated lithofacies) and **Kps** (sand-dominated lithofacies). **Kpc** is distinguished by cross fractures that give a blocky structure not generally found in younger units. Clay is found as lenses in the sand at all scales. **Kps** commonly contains medium-scale trough and planar crossbeds, with most dips to the south, southeast, and east. Sedimentary structures and a lack of marine fossils indicate a fluvial depositional environment for this unit. The Potomac Formation is unconformably overlain by units ranging in age from Late Cretaceous to Holocene. This contact is sharp and commonly marked by phosphate and quartz pebbles at the base of the overlying unit.



Source:
Geologic Map of the Washington West 30' x 60' Quadrangle, Maryland, Virginia, and Washington D.C. by Peter T. Lyttle, John N. Aleinikoff, William C. Burton, E. Allen Crider Jr., Avery A. Drake Jr., Albert J. Froelich, J. Wright Horton Jr., Gregorios Kasselas, Robert B. Mixon, Lucy McCartan, Arthur E. Nelson, Wayne L. Newell, Louis Pavlides, David S. Powars, C. Scott Southworth, and Robert E. Weems - 2017.

Schnabel ENGINEERING	SOE GEOTECHNICAL EXPLORATION WATER POLLUTION AND CONTROL PLANT ARLINGTON, VIRGINIA	Figure Name: GEOLOGIC MAP	Done: L. HOYOS	Figure Number: FIGURE 2
		Project Number: 22230023.000	Reviewed: S. HASSAN	Date: JAN. 2023

APPENDIX A
SUBSURFACE EXPLORATION DATA

Subsurface Exploration Procedures
General Notes for Subsurface Exploration Logs
Identification of Soil
Figure A1, Boring Location Plan
Figure A2, Subsurface Profile A-A
Boring Logs, SB-01 through SB-03

SUBSURFACE EXPLORATION PROCEDURES

Test Borings – Hollow Stem Augers

The borings are advanced by turning an auger with a center opening of 3¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger by standard methods after removal of the plug. No water is introduced into the boring using this procedure.

Standard Penetration Test Results

The Standard Penetration Test (SPT) is performed in the borings at regular depth intervals to collect soil samples. The numbers in the Sampling Data column of the boring logs represent SPT results. Each number represents the blows needed to drive a 2-inch O.D., 1⅜-inch I.D. split-spoon sampler 6 inches, using a 140-pound hammer falling 30 inches. The sampler is driven a total of 18 inches. The first 6 inches are considered a seating interval. The total of the number of blows for the second and third 6-inch intervals is the SPT "N-value." The Standard Penetration Test is performed according to ASTM D1586.

The SPT samples were obtained using a hydraulically driven automatic trip hammer (ATH). Most correlations with SPT data are based on N-values collected with a safety hammer. The energy applied to the split-spoon sampler using the ATH is about 33 percent greater than that applied using the safety hammer, resulting in lower N-values. The hammer blows shown on the boring logs are uncorrected for the higher energy.

Soil Classification Criteria

The group symbols on the logs represent the Unified Soil Classification System Group Symbols (ASTM D2487) based on visual observation and limited laboratory testing of the samples. Criteria for visual identification of soil samples are included in this appendix. Some variation can be expected between samples visually classified, and samples classified in the laboratory.

Pocket Penetrometer Results

The values following "PP=" in the sampling data column of the logs represent pocket penetrometer readings. Pocket penetrometer readings provide an estimate of the unconfined compressive strength of fine-grained soils.

Boring Locations and Elevations

The borings were located in the field by Schnabel Engineering personnel by measuring off the existing site features. Approximate boring locations are shown on Figure A1 at the end of this report. Ground surface elevations at the boring locations were obtained from publicly available imagery and are indicated on the boring logs. Locations and elevations should be considered no more accurate than the methods used to determine them.

GENERAL NOTES FOR SUBSURFACE EXPLORATION LOGS

1. Numbers in sampling data column next to Standard Penetration Test (SPT) symbols indicate blows required to drive a 2-inch O.D., 1⅜-inch I.D. sampling spoon 6 inches using a 140-pound hammer falling 30 inches. The Standard Penetration Test (SPT) N value is the number of blows required to drive the sampler 12 inches, after a 6-inch seating interval. The Standard Penetration Test is performed in general accordance with ASTM D1586.
2. Visual classification of soil is in accordance with terminology set forth in “Identification of Soil.” The ASTM D2487 group symbols (e.g., CL) shown in the classification column are based on visual observations.
3. Estimated water levels indicated on the logs are only estimates from available data and may vary with precipitation, porosity of the soil, site topography, and other factors.
4. Refusal at the surface of rock, boulder, or other obstruction is defined as an SPT resistance of 50 blows for 1 inch or less of penetration.
5. The logs and related information depict subsurface conditions only at the specific locations and at the particular time when drilled or excavated. Soil conditions at other locations may differ from conditions occurring at these locations. Also, the passage of time may result in a change in the subsurface soil and water level conditions at the subsurface exploration location.
6. The stratification lines represent the approximate boundary between soil and rock types as obtained from the subsurface exploration. Some variation may also be expected vertically between samples taken. The soil profile, water level observations and penetration resistances presented on these logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.
7. Key to symbols and abbreviations:

S-1, SPT	Sample No., Standard Penetration Test
5+10+1	Number of blows in each 6-inch increment

LL	Liquid Limit
MC	Moisture Content (percent)
PL	Plastic Limit
PP	Pocket Penetrometer Reading (tsf)
%Passing#200	Percent by weight passing a No. 200 Sieve

IDENTIFICATION OF SOIL

I. DEFINITION OF SOIL GROUP NAMES (ASTM D2487)

			SYMBOL	GROUP NAME
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels – More than 50% of coarse fraction retained on No. 4 sieve Coarse, ¾” to 3” Fine, No. 4 to ¾”	Clean Gravels Less than 5% fines	GW	WELL GRADED GRAVEL
			GP	POORLY GRADED GRAVEL
		Gravels with fines More than 12% fines	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	Sands – 50% or more of coarse Fraction passes No. 4 sieve Coarse, No. 10 to No. 4 Medium, No. 40 to No. 10 Fine, No. 200 to No. 40	Clean Sands Less than 5% fines	SW	WELL GRADED SAND
			SP	POORLY GRADED SAND
		Sands with fines More than 12% fines	SM	SILTY SAND
			SC	CLAYEY SAND
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays – Liquid Limit less than 50 Low to medium plasticity	Inorganic	CL	LEAN CLAY
			ML	SILT
		Organic	OL	ORGANIC CLAY
				ORGANIC SILT
	Silts and Clays – Liquid Limit 50 or more Medium to high plasticity	Inorganic	CH	FAT CLAY
			MH	ELASTIC SILT
		Organic	OH	ORGANIC CLAY
				ORGANIC SILT
Highly Organic Soils	Primarily organic matter, dark in color and organic odor		PT	PEAT

II. DEFINITION OF SOIL COMPONENT PROPORTIONS (ASTM D2487)

			Examples
Adjective Form	GRAVELLY SANDY	>30% to <50% coarse grained component in a fine-grained soil	GRAVELLY LEAN CLAY
	CLAYEY SILTY	>12% to <50% fine grained component in a coarse-grained soil	SILTY SAND
“With”	WITH GRAVEL WITH SAND	>15% to <30% coarse grained component in a fine-grained soil	FAT CLAY WITH GRAVEL
	WITH GRAVEL WITH SAND	>15% to <50% coarse grained component in a coarse-grained soil	POORLY GRADED GRAVEL WITH SAND
	WITH SILT WITH CLAY	>5% to <12% fine grained component in a coarse-grained soil	POORLY GRADED SAND WITH SILT

III. GLOSSARY OF MISCELLANEOUS TERMS

SYMBOLS .... Unified Soil Classification Symbols are shown above as group symbols. A dual symbol “-” indicates the soil belongs to two groups. A borderline symbol “/” indicates the soil belongs to two possible groups.

FILL .... Man-made deposit containing soil, rock and often foreign matter.

PROBABLE FILL .... Soils that contain no visually detected foreign matter, but which are suspect with regard to origin.

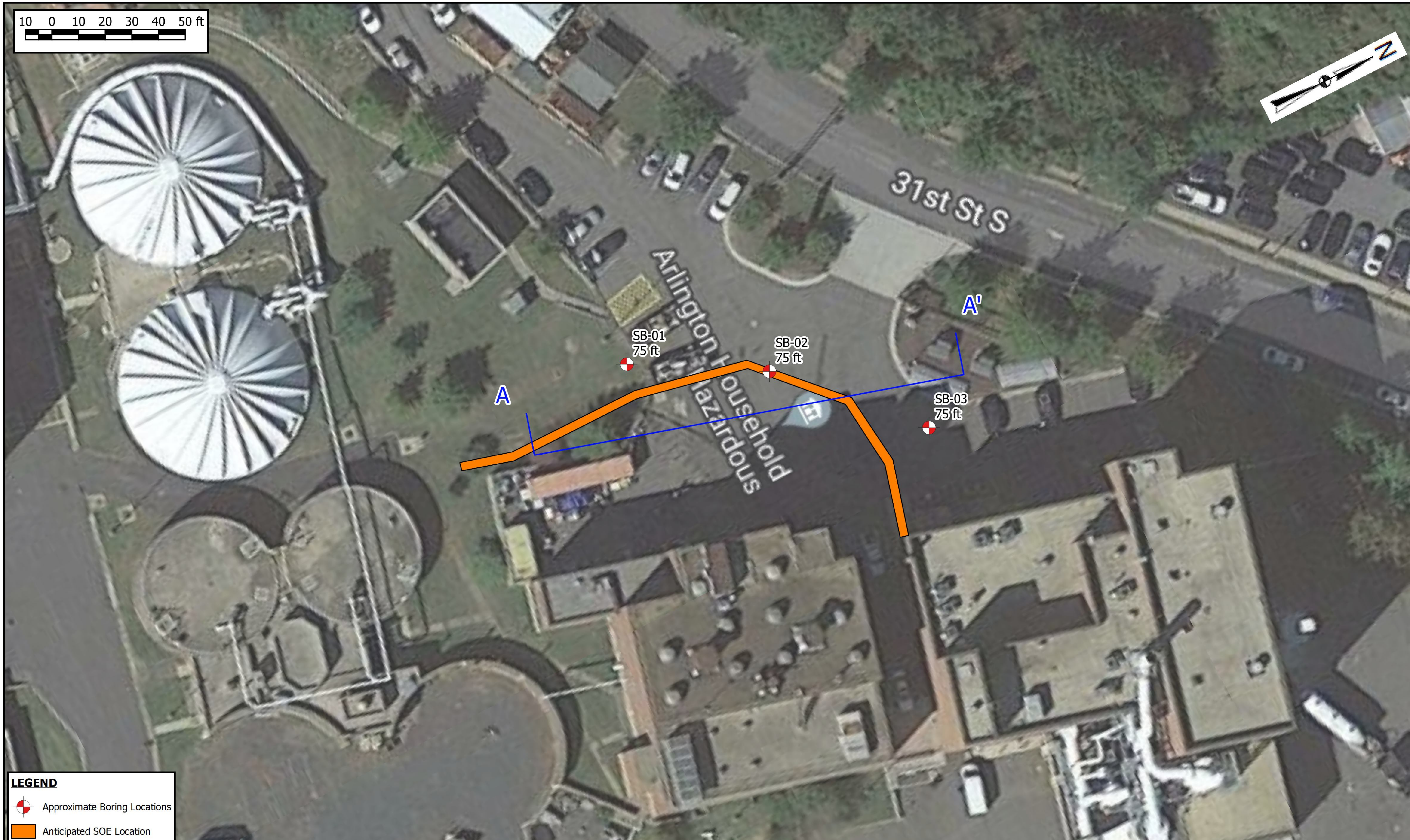
LENSES................................... 0 to ½-inch seam within a material in a test pit.

LAYERS .... ½ to 12-inch seam within a material in a test pit.

POCKET .... Discontinuous body within a material in a test pit.

MOISTURE CONDITIONS........ Saturated, moist or dry to indicate visual appearance of specimen.

COLOR .... Overall color, with modifiers such as light to dark or variation in coloration.

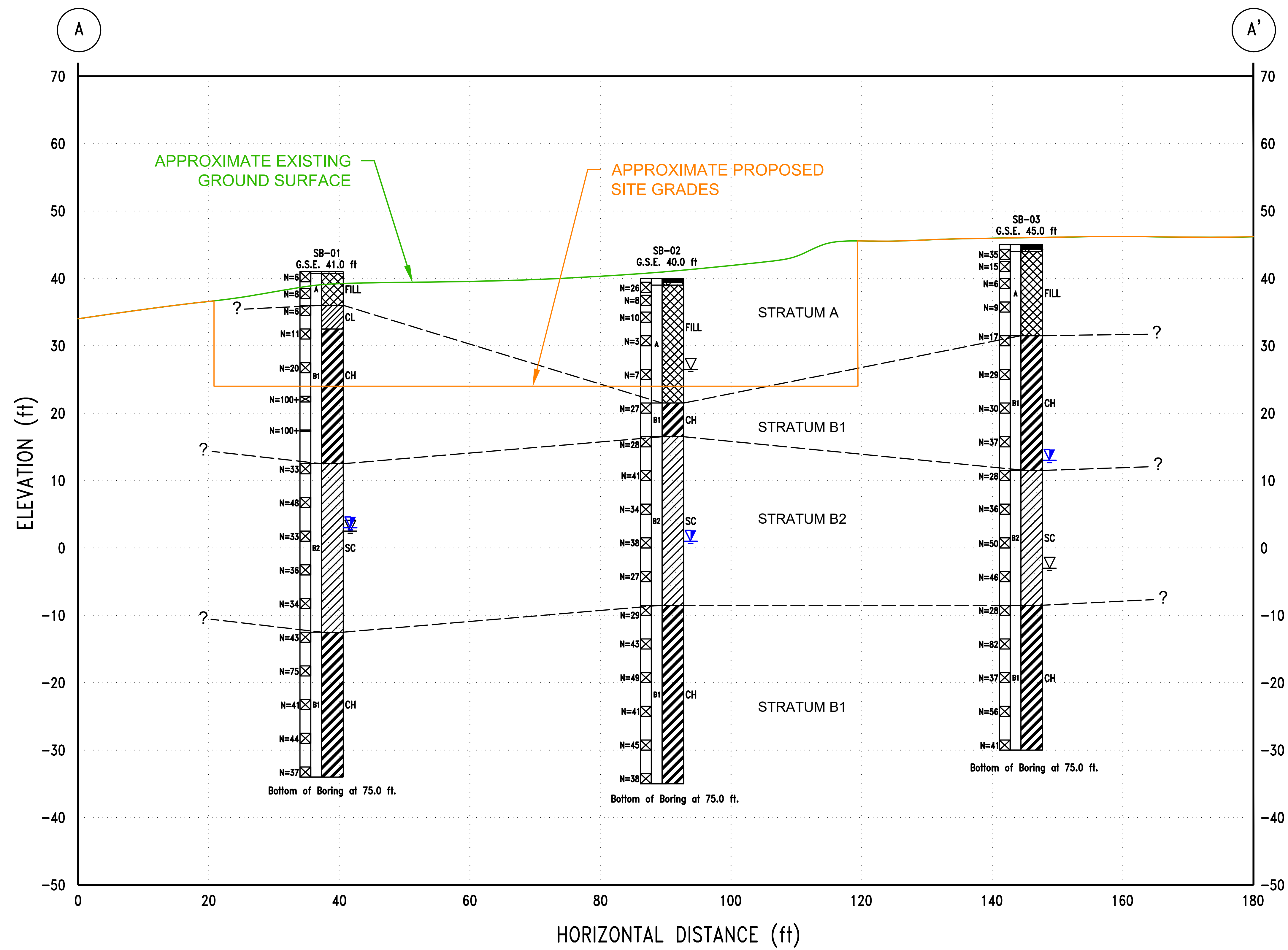


LEGEND

- Approximate Boring Locations
- Anticipated SOE Location
- Subsurface Profile

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Esri, HERE, Garmin, (c) OpenStreetMap contributors

Schnabel ENGINEERING	SOE GEOTECHNICAL EXPLORATION WATER POLLUTION AND CONTROL PLANT ARLINGTON, VIRGINIA	Figure Name: BORING LOCATION PLAN	Done: L. HOYOS	Figure Number: FIGURE A1
		Project Number: 22230023.000	Reviewed: S. HASSAN	Date: JAN 2023



GENERAL NOTES

1. THE NUMBER TO THE LEFT OF BORING COLUMNS INDICATES THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2 INCH O.D. 1-3/8 INCH I.D. SAMPLING SPOON ONE FOOT USING A 140 POUND HAMMER FALLING 30 INCHES PER ASTM D1586.

2. A DESCRIPTION OF THE STRATUM DESIGNATIONS IS PROVIDED IN THE BODY OF THE REPORT.

3. A PLAN INDITICATING THE LOCATION OF THE SUBSURFACE PROFILE IS INCLUDED AS FIGURE A1.

4. ESTIMATED GROUNDWATER LEVELS INDICATED, ▽, ARE ONLY ESTIMATES FROM AVAILABLE DATA AND MAY VARY WITH PRECIPITATION, POROSITY OF THE SOIL, SITE TOPOGRAPHY, ETC.

5. G.S.E. = GROUND SURFACE.

6. THIS DRAWING CONTAINS INTERPRETATIONS OF TEST BORING DATA AND SHOULD NOT BE USED AS A PART OF THE CONTRACT DOCUMENTS.

7. THIS PROFILE WAS DEVELOPED BY INTERPOLATION BETWEEN WIDELY SPACED BORINGS. ONLY AT THE BORING LOCATIONS SHOULD IT BE CONSIDERED AS AN APPROXIMATE REPRESENTATION AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS.

LEGEND

Fill, CH, SC, Asphalt, Approximate Existing Ground Surface, Subsurface Stratigraphy Break Line, Topsoil, CL, Crushed Stone, Approximate Proposed Grade, Groundwater Measurement, SPT N-Value

Schnabel ENGINEERING	SOE GEOTECHNICAL EXPLORATION WATER POLLUTION AND CONTROL PLANT ARLINGTON, VIRGINIA	Figure Name: SUBSURFACE PROFILE A-A'	Done: L. HOYOS	Figure Number: FIGURE A2
		Project Number: 22230023.000	Reviewed: S. HASSAN	Date: JAN 2023

Schnabel ENGINEERING TEST BORING LOG	**Project:** WPCP - SOE Exploration Arlington County, Virginia	**Boring Number:** **SB-01** **Contract Number:** 22230023.000 **Sheet:** 1 of 3

Contractor: Connelly and Associates, Inc.
Frederick, Maryland

Contractor Foreman: A. Moore

Schnabel Representative: L. Hoyos

Equipment: CME-55 (Track)

Method: 3-1/4" ID Hollow Stem Auger

Hammer Type: Auto Hammer (140 lb)

Dates Started: 12/12/22 **Finished:** 12/12/22

Location: See Location Plan

Ground Surface Elevation: 41.0 (ft) **Total Depth:** 75.0 ft

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	12/12	---	38.5'	---	---
Casing Pulled ▼	12/12	---	38.0'	---	---
24 hr Reading	12/13	---	31.0'	---	---
48 hr Reading	12/14	---	29.0'	---	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
0.3	0.0 - 0.3 ft: Topsoil; 3 inches		40.8			S-01, SPT 2+3+3 REC=8", 44%	PP = 3.00 tsf	
	0.3 - 5.0 ft: FILL, sampled as sandy lean clay; moist, dark bluish gray, estimated 5 - 10% gravel	FILL		A		S-02, SPT 3+5+3 REC=14", 78%	PP = 3.00 tsf	
5.0	5.0 - 8.5 ft: SANDY LEAN CLAY; moist, greenish gray with streaks of brown	CL	36.0		5	S-03, SPT 4+4+2 REC=15", 83%	PP = 3.25 tsf	
8.5	8.5 - 28.5 ft: FAT CLAY; moist, bluish gray		32.5		10	S-04, SPT 3+5+6 REC=16", 89%	PP = 4.00 tsf	
	13.5 ft: Change: bluish gray with reddish brown				15	S-05, SPT 4+8+12 REC=18", 100%	LL = 56 PI = 30 MC = 26.6% % Passing #200 = 98.3 PP = 4.25 tsf	
		CH		B1				
	18.5 ft: Change: reddish brown				20	S-06, SPT 47+50/4" REC=6", 60%	PP = 4.25 tsf	
					25	S-07, SPT 50/3" REC=3", 100%	PP = 4.25 tsf	
28.5	28.5 - 53.5 ft: CLAYEY SAND, fine to medium grained sand; light bluish gray	SC	12.5	B2		S-08, SPT 17+16+17 REC=18", 100%	MC = 14.2%	

(continued)

Schnabel ENGINEERING	TEST BORING LOG	Project: WPCP - SOE Exploration Arlington County, Virginia	Boring Number: SB-01 Contract Number: 22230023.000 Sheet: 2 of 3

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	28.5 - 53.5 ft: CLAYEY SAND, fine to medium grained sand; light bluish gray *(continued)*	SC		B2				
					35	S-09, SPT 45+26+22 REC=2", 11%		
	38.5 ft: Change: fine to coarse grained sand; light greenish gray				40	S-10, SPT 10+12+21 REC=18", 100%		
					45	S-11, SPT 12+15+21 REC=18", 100%		
	48.5 ft: Change: fine to medium grained sand; light greenish gray with streaks of yellowish brown				50	S-12, SPT 10+12+22 REC=18", 100%	LL = 28 PI = 8 MC = 21.8% % Passing #200 = 23.8	
53.5	53.5 - 75.0 ft: SANDY FAT CLAY; moist, greenish gray with streaks of orangish brown	CH	-12.5	B1	55	S-13, SPT 11+20+23 REC=18", 100%	PP >4.50 tsf	
					60	S-14, SPT 19+33+42 REC=18", 100%	PP >4.50 tsf	
	63.5 ft: Change: greenish gray with streaks of brown				65	S-15, SPT 10+18+23 REC=18", 100%	PP >4.50 tsf	
					70	S-16, SPT 12+19+25 REC=18", 100%	PP >4.50 tsf	

(continued)

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	53.5 - 75.0 ft: SANDY FAT CLAY; moist, greenish gray with streaks of orangish brown *(continued)*	CH		B1		S-17, SPT 9+14+23 REC=18", 100%	PP >4.50 tsf	
75.0			-34.0		75			

Bottom of Boring at 75.0 ft.
Boring terminated at selected depth.
Boring backfilled with cuttings after last groundwater measurement.
Installed 1-1/4 inch diameter temporary standpipe in borehole upon completion to a depth of 75.0 ft. Groundwater temporary Well was screened for 75 ft.

Schnabel ENGINEERING **TEST BORING LOG**	**Project:** WPCP - SOE Exploration Arlington County, Virginia	**Boring Number:** **SB-02** **Contract Number:** 22230023.000 **Sheet:** 1 of 3

Contractor: Connelly and Associates, Inc.
Frederick, Maryland

Contractor Foreman: A. Moore

Schnabel Representative: L. Hoyos

Equipment: CME-55 (Track)

Method: 3-1/4" ID Hollow Stem Auger

Hammer Type: Auto Hammer (140 lb)

Dates Started: 12/13/22 **Finished:** 12/13/22

Location: See Location Plan

Ground Surface Elevation: 40.0 (ft) **Total Depth:** 75.0 ft

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	12/13	---	13.5'	---	---
Completion ▼	12/13	---	39.0'	---	---
Casing Pulled ▼	12/13	---	Dry	---	9.0'

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
0.6	0.0 - 0.6 ft: Asphalt; 7 inches		39.4					
1.0	0.6 - 1.0 ft: DENSE GRADED AGGREGATE; 5 inches		39.0			S-01, SPT 5+14+12 REC=8", 44%		
	1.0 - 13.5 ft: FILL, sampled as clayey gravel, fine to medium grained sand; moist, yellowish brown, contains asphalt fragments	FILL		A		S-02, SPT 6+5+3 REC=10", 56%		
					5	S-03, SPT 5+5+5 REC=10", 56%	MC = 6.5%	
					10	S-04, SPT 2+2+1 REC=2", 11%		
13.5	13.5 - 18.5 ft: FILL, sampled as poorly graded gravel, fine to medium grained sand; wet, gray	FILL	26.5		15	S-05, SPT 5+4+3 REC=2", 11%		
18.5	18.5 - 23.5 ft: SANDY FAT CLAY; moist, reddish brown with streaks of greenish gray	CH	21.5	B1	20	S-06, SPT 9+12+15 REC=17", 94%	PP = 2.75 tsf	
23.5	23.5 - 48.5 ft: CLAYEY SAND, fine to medium grained sand; moist, greenish gray	SC	16.5	B2	25	S-07, SPT 6+12+16 REC=18", 100%		
	28.5 ft: Change: greenish gray with streaks of yellowish brown					S-08, SPT 8+19+22 REC=18", 100%		

(continued)

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	23.5 - 48.5 ft: CLAYEY SAND, fine to medium grained sand; moist, greenish gray *(continued)*	SC		B2				
					35	S-09, SPT 10+15+19 REC=18", 100%	LL = 48 PI = 30 MC = 14.0% % Passing #200 = 22.9	
					40	S-10, SPT 11+17+21 REC=18", 100%		
					45	S-11, SPT 6+12+15 REC=18", 100%		
48.5	48.5 - 75.0 ft: FAT CLAY; moist, greenish gray	CH	-8.5	B1	50	S-12, SPT 6+13+16 REC=18", 100%	PP = 3.75 tsf	
	53.5 ft: Change: bluish gray with streaks of orangish brown				55	S-13, SPT 12+17+26 REC=18", 100%	PP >4.50 tsf	
					60	S-14, SPT 13+20+29 REC=18", 100%	PP >4.50 tsf	
					65	S-15, SPT 12+18+23 REC=18", 100%	PP >4.50 tsf	
					70	S-16, SPT 14+17+28 REC=18", 100%	LL = 60 PI = 35 MC = 24.0%	

(continued)

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	48.5 - 75.0 ft: FAT CLAY; moist, greenish gray *(continued)*	CH		B1			% Passing #200 = 98.5 PP >4.50 tsf	
						S-17, SPT 16+15+23 REC=18", 100%	PP >4.50 tsf	
75.0			-35.0		75			

Bottom of Boring at 75.0 ft.
Boring terminated at selected depth.

TEST BORING LOG — Schnabel Engineering

Project: WPCP - SOE Exploration, Arlington County, Virginia

Boring Number: SB-03
Contract Number: 22230023.000

Contractor: Connelly and Associates, Inc., Frederick, Maryland
Contractor Foreman: A. Moore
Schnabel Representative: L. Hoyos
Equipment: CME-55 (Track)
Method: 3-1/4" ID Hollow Stem Auger
Hammer Type: Auto Hammer (140 lb)
Dates Started: 12/14/22 **Finished:** 12/14/22
Location: See Location Plan
Ground Surface Elevation: 45.0 (ft) **Total Depth:** 75.0 ft

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered	12/14	---	48.0'	---	---
Completion	12/14	---	32.0'	---	---
Casing Pulled	12/14	---	Dry	---	23.5'

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
0.7	0.0 - 0.7 ft: Asphalt; 8 inches		44.3					
1.0	0.7 - 1.0 ft: DENSE GRADED AGGREGATE; 4 inches		44.0			S-01, SPT 11+15+20 REC=8", 44%		
	1.0 - 8.5 ft: FILL, sampled as sandy fat clay; moist, yellowish brown with gray, est 15 -25% gravel	FILL		A		S-02, SPT 7+8+7 REC=10", 56%		
					5	S-03, SPT 5+3+3 REC=12", 67%	LL = 56 PI = 33 MC = 29.2% % Passing #200 = 63.6	
8.5	8.5 - 13.5 ft: FILL, sampled as clayey sand, fine to medium grained sand; moist, yellowish brown, estimated 5 - 10% gravel	FILL	36.5		10	S-04, SPT 5+4+5 REC=9", 50%		
13.5	13.5 - 33.5 ft: SANDY FAT CLAY; moist, bluish gray	CH	31.5	B1	15	S-05, SPT 6+8+9 REC=18", 100%	PP = 4.00 tsf	
	18.5 ft: Change: reddish brown				20	S-06, SPT 7+12+17 REC=18", 100%	PP = 4.00 tsf	
	23.5 ft: Change: reddish brown with streaks of bluish gray				25	S-07, SPT 8+11+19 REC=18", 100%	PP = 3.50 tsf	
						S-08, SPT 10+16+21 REC=18", 100%	PP = 4.25 tsf	

(continued)

Schnabel ENGINEERING — TEST BORING LOG	Project: WPCP - SOE Exploration Arlington County, Virginia	Boring Number: SB-03 Contract Number: 22230023.000 Sheet: 2 of 3

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	13.5 - 33.5 ft: SANDY FAT CLAY; moist, bluish gray *(continued)*	CH		B1				
33.5	33.5 - 53.5 ft: CLAYEY SAND, fine to medium grained sand; moist, greenish gray	SC	11.5	B2	35	S-09, SPT 4+11+17 REC=18", 100%		
	38.5 ft: Change: greenish gray with streaks of orangish brown				40	S-10, SPT 4+15+21 REC=18", 100%	LL = 33 PI = 11 MC = 13.7% % Passing #200 = 22.9	
					45	S-11, SPT 15+25+25 REC=18", 100%		
					50	S-12, SPT 13+20+26 REC=18", 100%		
53.5	53.5 - 58.5 ft: SANDY FAT CLAY; moist, greenish gray	CH	-8.5	B1	55	S-13, SPT 7+10+18 REC=18", 100%	MC = 21.0% PP = 4.25 tsf	
58.5	58.5 - 75.0 ft: FAT CLAY WITH SAND, fine; moist, bluish gray with purplish gray	CH	-13.5		60	S-14, SPT 10+32+50 REC=18", 100%	PP = 4.50 tsf	
					65	S-15, SPT 14+16+21 REC=18", 100%	PP >4.50 tsf	
	68.5 ft: Change: reddish brown with streaks of bluish gray				70	S-16, SPT 13+22+34 REC=18", 100%	PP >4.50 tsf	

(continued)

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	58.5 - 75.0 ft: FAT CLAY WITH SAND, fine; moist, bluish gray with purplish gray *(continued)*	CH		B1		S-17, SPT 11+17+24 REC=18", 100%	PP >4.50 tsf	
75.0			-30.0		75			

Bottom of Boring at 75.0 ft.
Boring terminated at selected depth.

APPENDIX B
SOIL LABORATORY TEST DATA

Summary of Laboratory Tests Results
Atterberg Limits
Gradation Curves

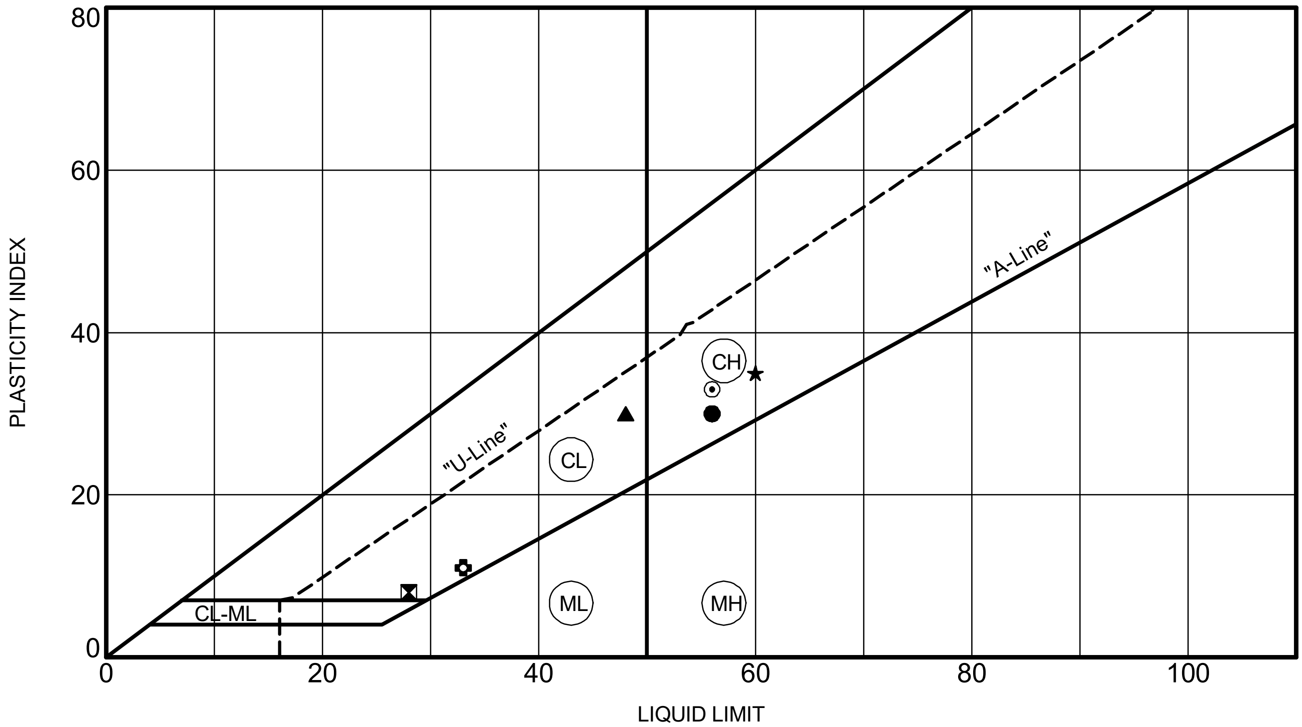
Summary of Laboratory Tests

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Gravel	Percent Sand	Percent Fines
SB-01	13.5 - 15.0 27.5 - 26.0	Jar	FAT CLAY (CH), trace sand, bluish gray with reddish brown.	B1	26.6	56	26	30	0.0	1.7	98.3
SB-01	48.5 - 50.0 -7.5 - -9.0	Jar	CLAYEY SAND (SC), fine to medium grained sand, light greenish with yellowish brown.	B2	21.8	28	20	8	0.0	76.2	23.8
SB-02	33.5 - 35.0 6.5 - 5.0	Jar	CLAYEY SAND (SC), fine to coarse grained sand, greenish gray.	B2	14.0	48	18	30	0.0	77.1	22.9
SB-02	68.5 - 70.0 -28.5 - -30.0	Jar	FAT CLAY (CH), trace sand, bluish gray with orangish brown.	B1	24.0	60	25	35	0.0	1.5	98.5
SB-03	5.0 - 6.5 40.0 - 38.5	Jar	FILL, sampled as, SANDY FAT CLAY (CH), yellowish brown with gray.	A	29.2	56	23	33	2.6	33.8	63.6
SB-03	38.5 - 40.0 6.5 - 5.0	Jar	CLAYEY SAND (SC), fine to coarse grained sand, greenish gray with orangish brown.	B2	13.7	33	22	11	0.0	77.1	22.9

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; ND=Not Detected; ; P=Present; T=Trace; -- indicates no test performed

Schnabel ENGINEERING

Project: WPCP - SOE Exploration
Arlington County, Virginia



PLOTTED DATA REPRESENTS SOIL PASSING NO. 40 SIEVE

	Specimen		LL	PL	PI	Fines	Description
●	**SB-01**	**13.5 ft**	**56**	**26**	**30**	**98**	**FAT CLAY (CH), trace sand, bluish gray with reddish brown.**
⧗	**SB-01**	**48.5 ft**	**28**	**20**	**8**	**24**	**CLAYEY SAND (SC), fine to medium grained sand, light greenish with yellowish brown.**
▲	**SB-02**	**33.5 ft**	**48**	**18**	**30**	**23**	**CLAYEY SAND (SC), fine to coarse grained sand, greenish gray.**
★	**SB-02**	**68.5 ft**	**60**	**25**	**35**	**99**	**FAT CLAY (CH), trace sand, bluish gray with orangish brown.**
⊙	**SB-03**	**5.0 ft**	**56**	**23**	**33**	**64**	**FILL, sampled as, SANDY FAT CLAY (CH), yellowish brown with gray.**
✿	**SB-03**	**38.5 ft**	**33**	**22**	**11**	**23**	**CLAYEY SAND (SC), fine to coarse grained sand, greenish gray with orangish brown.**

Schnabel ENGINEERING

ATTERBERG LIMITS

Project: WPCP - SOE Exploration
Arlington County, Virginia

Contract: 22230023.000

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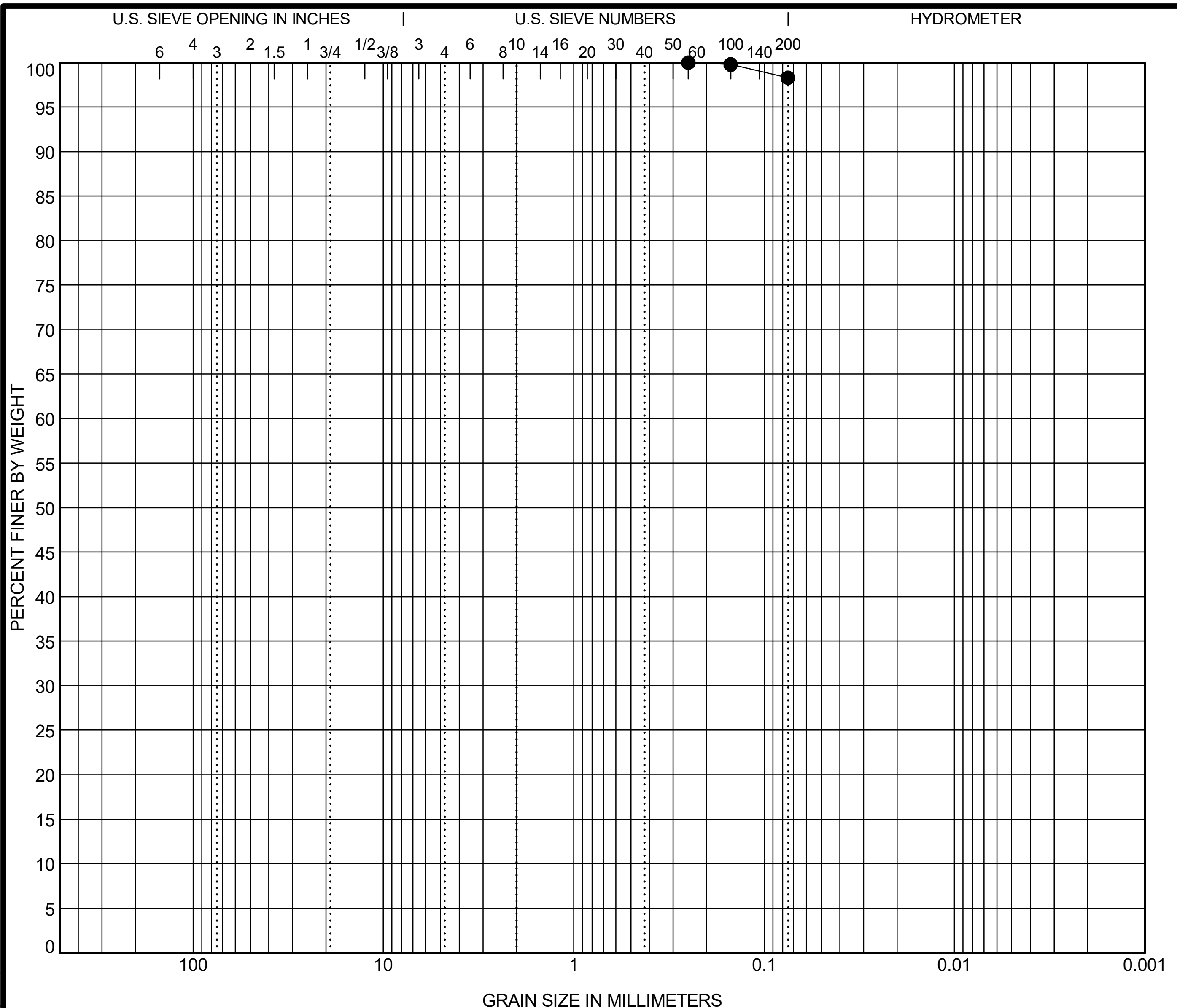


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI		
●	SB-01	13.5 ft	**FAT CLAY (CH), trace sand, bluish gray with reddish brown.**	**56**	**26**	**30**		

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D6913	**0.25**	**--**	**--**	**--**	**0.0**	**1.7**	**98.3**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60
% Finer	98.3	99.8	100.0

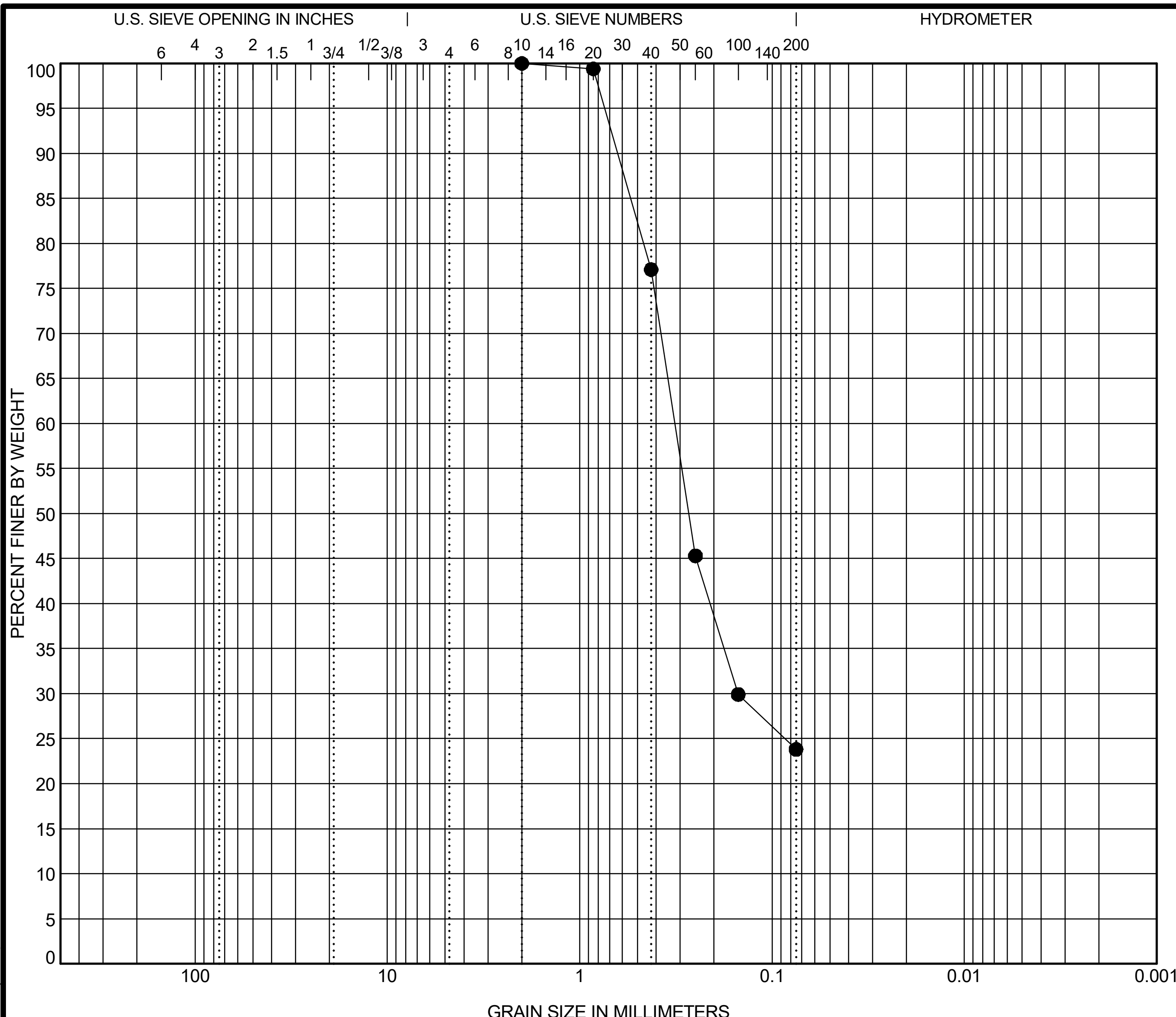
Tested By	Tested Date	Reviewed By	Calc By
MH	1/3/23		

Schnabel ENGINEERING

GRADATION CURVE

Project: WPCP - SOE Exploration
Arlington County, Virginia

Contract: 22230023.000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI		
●	SB-01	48.5 ft	**CLAYEY SAND (SC), fine to medium grained sand, light greenish with yellowish brown.**	**28**	**20**	**8**		

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D6913	**2**	**0.319**	**0.15**	**--**	**0.0**	**76.2**	**23.8**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10
% Finer	23.8	29.9	45.3	77.1	99.4	100.0

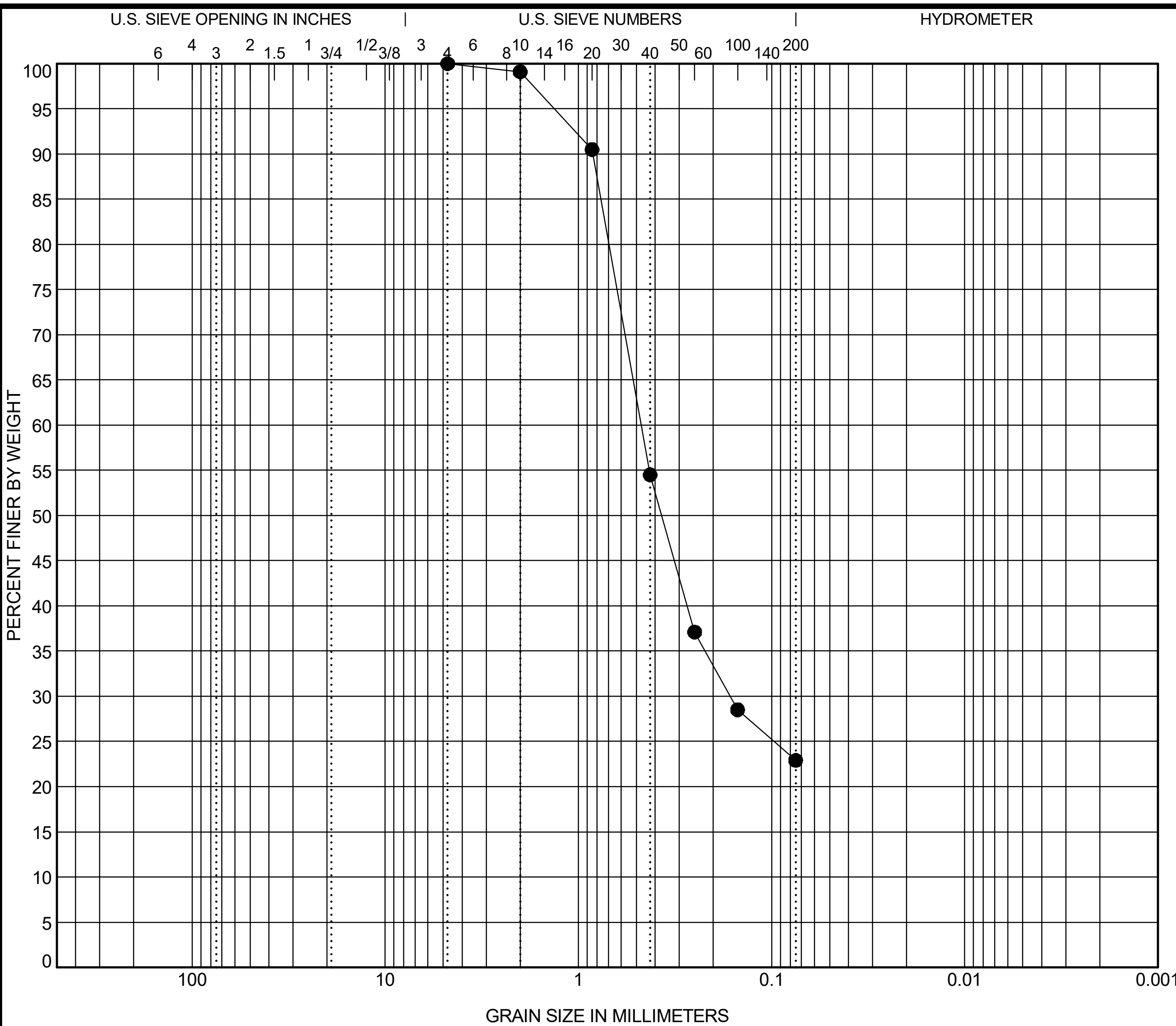
Tested By	Tested Date	Reviewed By	Calc By
MH	1/3/23		

Schnabel ENGINEERING

GRADATION CURVE

Project: WPCP - SOE Exploration
Arlington County, Virginia

Contract: 22230023.000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI		
●	SB-02	33.5 ft	**CLAYEY SAND (SC), fine to coarse grained sand, greenish gray.**	**48**	**18**	**30**		

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D6913	**4.75**	**0.472**	**0.164**	**--**	**0.0**	**77.1**	**22.9**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4
% Finer	22.9	28.5	37.1	54.5	90.5	99.1	100.0

Tested By	Tested Date	Reviewed By	Calc By
MH	1/3/23		

Schnabel ENGINEERING

GRADATION CURVE

Project: WPCP - SOE Exploration
Arlington County, Virginia

Contract: 22230023.000

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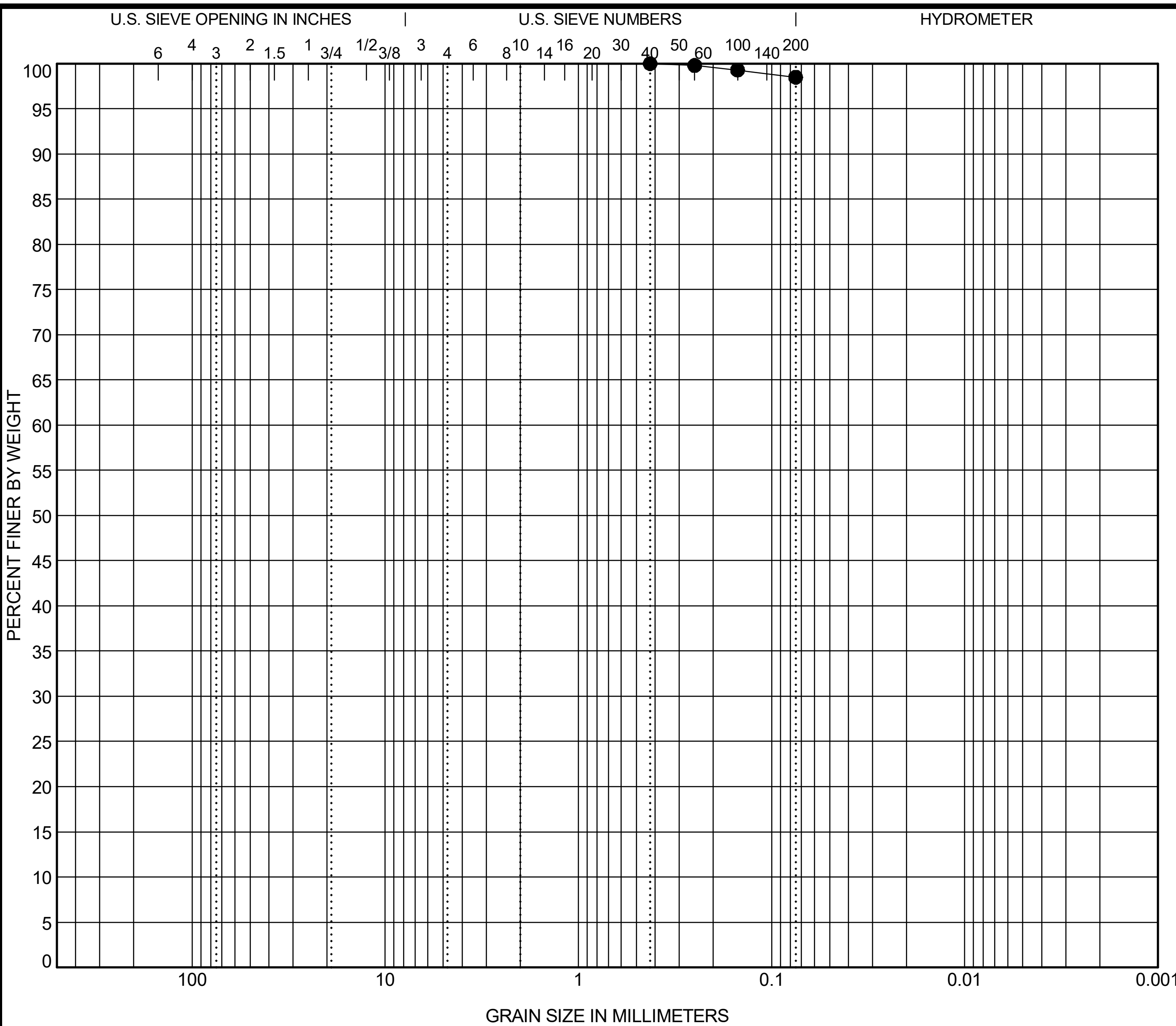

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI		
●	SB-02	68.5 ft	**FAT CLAY (CH), trace sand, bluish gray with orangish brown.**	**60**	**25**	**35**		

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D6913	**0.425**	**--**	**--**	**--**	**0.0**	**1.5**	**98.5**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40
% Finer	98.5	99.3	99.8	100.0

Tested By	Tested Date	Reviewed By	Calc By
MH	1/3/23		

Schnabel ENGINEERING

GRADATION CURVE

Project: WPCP - SOE Exploration
Arlington County, Virginia

Contract: 22230023.000

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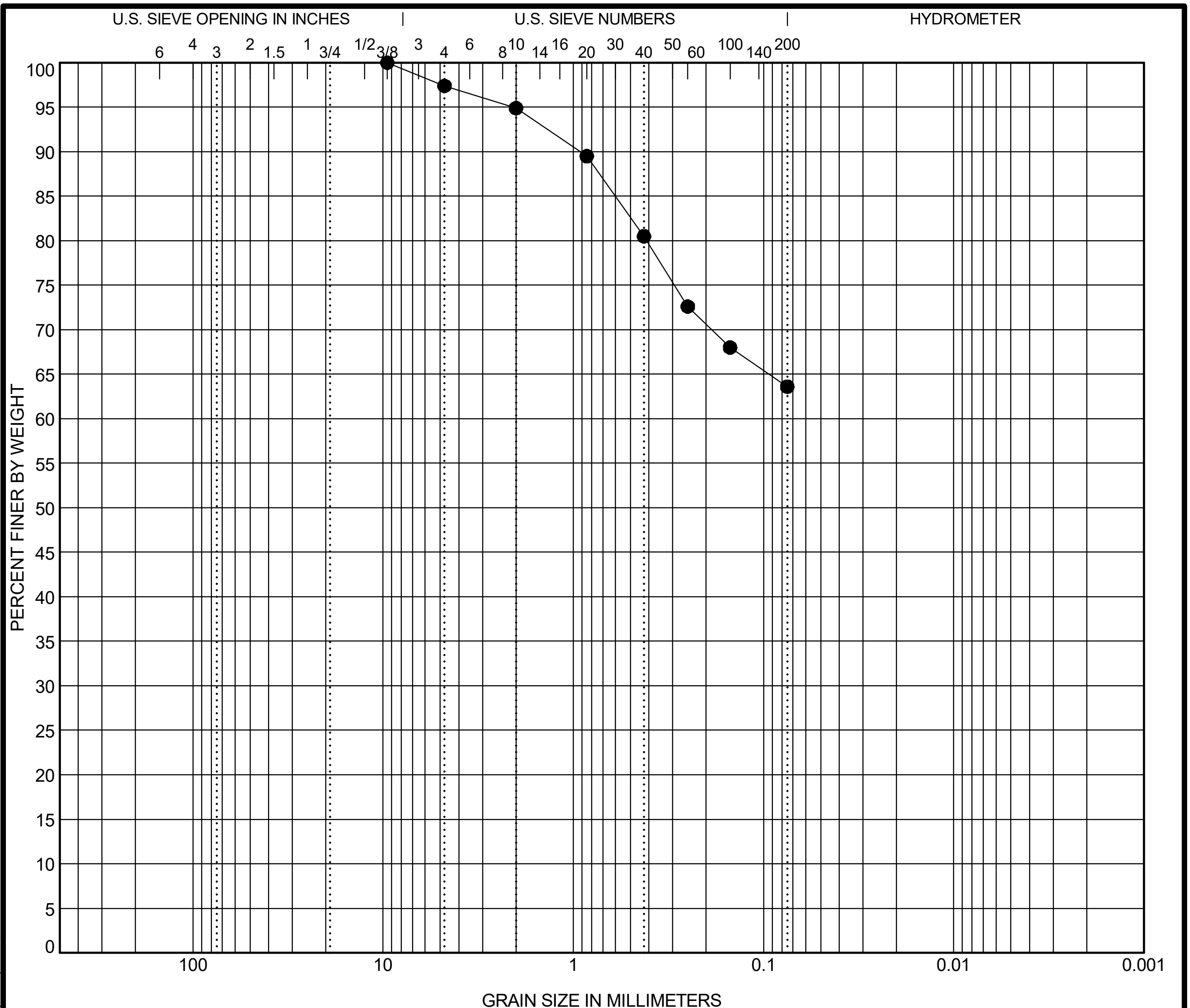


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI		
●	SB-03	5.0 ft	**FILL, sampled as, SANDY FAT CLAY (CH), yellowish brown with gray.**	**56**	**23**	**33**		

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D6913	**9.5**	**--**	**--**	**--**	**2.6**	**33.8**	**63.6**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4	3/8"
% Finer	63.6	68.0	72.6	80.5	89.5	94.9	97.4	100.0

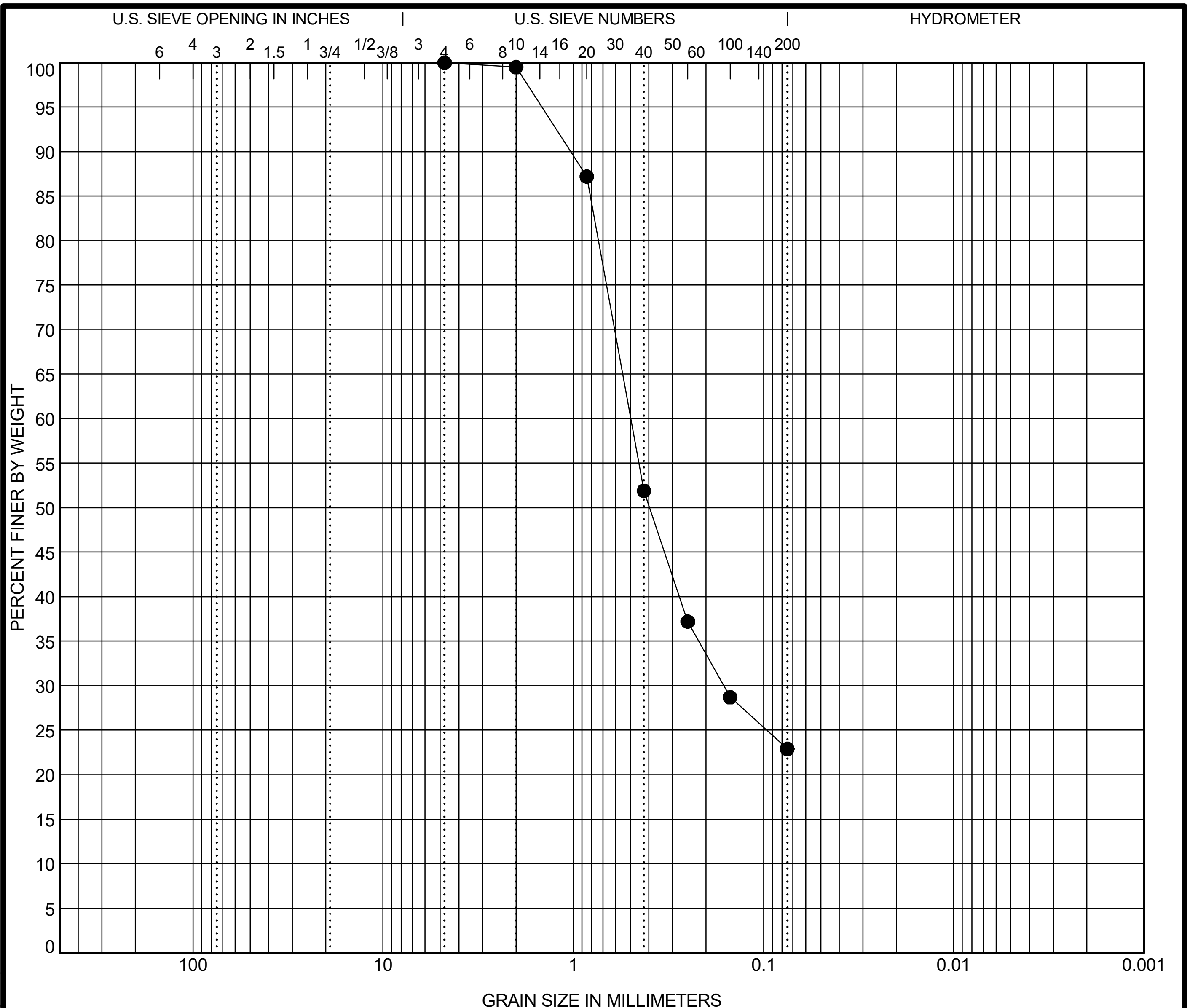
Tested By	Tested Date	Reviewed By	Calc By
MH	1/3/23		

Schnabel ENGINEERING

GRADATION CURVE

Project: WPCP - SOE Exploration
Arlington County, Virginia

Contract: 22230023.000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI		
●	SB-03	38.5 ft	**CLAYEY SAND (SC), fine to coarse grained sand, greenish gray with orangish brown.**	**33**	**22**	**11**		

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D6913	**4.75**	**0.498**	**0.162**	**--**	**0.0**	**77.1**	**22.9**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4
% Finer	22.9	28.7	37.2	51.9	87.2	99.5	100.0

Tested By	Tested Date	Reviewed By	Calc By
MH	1/3/23		

Schnabel ENGINEERING

GRADATION CURVE

Project: WPCP - SOE Exploration
Arlington County, Virginia

Contract: 22230023.000

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Arlington County Water Pollution Control Bureau

Biosolids Upgrades - General Requirements

Specifications

February 2023

HDR Project No. 10263882

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TABLE OF CONTENTS

DIVISION 01 — GENERAL REQUIREMENTS

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Location and description of Work and prior uses of the Site.
   2. Others retained by Owner for the Project.
   3. Work by others under Owner’s control on other projects.
   4. Work by others not under Owner’s control.
   5. Work by Owner.
   6. Sequence and progress of Work.
   7. Design Builder’s use of the Site.
   8. Easements and rights-of-way.
   9. Partial utilization by Owner.
   10. Utility owners.

B. Related Requirements:
   1. Include, but are not limited to, the following:
      a. Section 01 14 16 - Coordination with Owner’s Operations.
      b. Section 01 14 19 - Use of Site.
      c. Section 01 45 33 - Code-Required Special Inspections and Procedures
      d. Section 01 71 33 - Protection of the Work and Property.

1.2 LOCATION AND DESCRIPTION OF WORK

A. The Work is located at the Arlington Water Pollution Control Plant (WPCP), 3402 S. Glebe Road, Arlington, VA 22202.

B. The Project includes designing and constructing the Work described in and in accordance with the Contract Documents, with all related appurtenances. The Design Builder is required to provide the Owner with fully functional facilities to achieve the objectives of the project regardless of the information presented in the RFP Plans or elsewhere in the Contract Documents.

C. Contracting Method: The Project will be constructed under a Design Build Contract.

D. Hazardous Environmental Conditions:
   1. A Hazardous Environmental Condition, described in reports provided to the Design Builder, will (or has reasonable potential to) affect the Work. The Design Builder shall verify the presence of hazardous environmental conditions prior to start of construction and shall be responsible for remediating such conditions impacted by the Work.

1.3 OTHERS RETAINED BY OWNER FOR THE PROJECT

A. Program Manager:
   1. Program Manager is identified in the Agreement.
   2. Program Manager’s responsibilities for the Project, relative to Design Builder, are indicated throughout the Contract Documents.

B. Non-Professional Services Contracted by Owner: Design Builder shall coordinate and schedule the Work with, and cooperate with, the entities performing the following services for Owner.
   1. Code-Required Special Inspections and Testing:
      a. Owner has, or will, retain the services of a qualified testing laboratory to perform code-required testing and special inspections for the Work, in accordance with Section 01 45

33 - Code-Required Special Inspections and Procedures, and selected other provisions of the Contract Documents related to field testing.

1.4 WORK BY OTHERS UNDER OWNER'S CONTROL - OTHER PROJECTS

A. Other construction contracts have been or will be awarded by Owner that are in close proximity to or border on the Work of this Project. Work under these other contracts is briefly described in this Article.

B. Gravity Thickener Rehabilitation:
1. Principal Work Location: Gravity Thickeners and adjacent areas.
2. Scope:
a. Rehabilitation of the existing gravity thickeners and gravity thickener building, including equipment and cover replacement.
3. Contract times expected to start running in Fall 2023.
4. Approximate Substantial Completion: Spring 2025.
5. Approximate Final Completion: Summer 2025.

C. PCS/SCADA Network Improvements:
1. Principal Work Location: Throughout site.
2. Scope: Install new fiber between buildings and replace PCS network switches to improve system reliability.
3. Contract Time: Expected to start in Fall 2023.
4. Approximate Substantial Completion: Winter 2024.
5. Approximate Final Completion: Summer 2024.

D. Renewable Natural Gas Interconnection
1. Principal Work Location: To be determined in coordination with Design Builder.
2. Scope:
a. Providing interconnect equipment and facilities for connecting renewable natural gas infrastructure to the natural gas utility.
3. Contract times to be determined in coordination with Design Builder.

1.5 WORK BY OTHERS NOT UNDER OWNER'S CONTROL

A. Work by Utility Owners and Transportation Facility Owners:
1. Owner is not aware of any work to be performed at or adjacent to the Site by utility owners (not under Owner's control) or owners of transportation facilities (not under Owner's control).

1.6 WORK BY OWNER

A. Owner will perform the following in connection with the Work:
1. Operate all existing valves, flow-control gates, pumps, equipment, and appurtenances that will affect Owner's operations or facility processes, unless otherwise specified or indicated.

1.7 SEQUENCE AND PROGRESS OF WORK

A. Sequencing:
1. Incorporate sequencing of the Work into the Progress Schedule.

B. Requirements for sequencing and coordinating with Owner's operations, including maintenance of facility operations during construction, and requirements for tie-ins and shutdowns, are in Section 01 14 16 - Coordination with Owner's Operations.

1.8 DESIGN BUILDER'S USE OF SITE

A. Use of Site - General:
1. Limits on Design Builder's use of the Site are indicated in Section 01 14 19 - Use of Site, and as may be shown on the Drawings.

2. Design Builder shall share use of the Site with other contractors and others specified in Articles 1.3 through 1.6 (inclusive) of this Section.
3. Relocate stored materials and equipment that interfere with operations of Owner, other contractors, and others performing work for Owner.
4. Comply with restrictions set forth in Section 01 14 19 - Use of Site.

B. Owner will occupy the Site jointly with Design Builder during construction for performance of Owner's typical operations. Coordinate with Owner in all construction operations to minimize conflicts between Design Builder and Owner's employees and others under Owner's control. Owner will have Owner's suppliers for biosolids hauling, deliveries of chemicals, and other items accessing the Site from time to time. Possibly on a daily basis, Owner will need access for operations and maintenance of all existing equipment remaining in operation.

1.9 EASEMENTS AND RIGHTS-OF-WAY

A. Easements and Rights-of-Way - General:
1. Confine construction operations within Owner's property, public rights-of-way, easements obtained by Owner, and limits shown, and property for which Design Builder has made arrangements directly with property owner(s).
2. Use care in placing construction tools, machinery and equipment, excavated materials, and materials and equipment to be incorporated into the Work to avoid damaging property and interfering with traffic.
3. Do not enter private property outside the construction limits without permission from the owner of the property.

1.10 UTILITY OWNERS

A. Design Builder shall investigate all utilities (including Water Pollution Control Plant utilities) that may have Underground Facilities or other facilities in the vicinity of the Work.

B. Utilities and their owners indicated in the Contract Documents are for Design Builder's convenience. Neither Owner nor Program Manager will be liable to Design Builder or any utility owner for failure to indicate utility, its owner, or complete and correct contact information in the Contract Documents where Design Builder's reasonable and ordinarily-exercised diligence would reveal the presence of the utility and its owner. Nothing in the Contract mitigates Design Builder's responsibilities under the General Conditions, Section 01 71 33 - Protection of the Work and Property, and Laws and Regulations, including "call before you dig" regulations.

1.11 PERMITS

A. The Design Builder is responsible for obtaining all required permits for the Project (unless otherwise noted), including application development (including but not limited to exhibits, calculations, analysis, and data compilation), coordination as needed, submission of applications, and fees. The absence of a permit in the preliminary list does not relieve the Design Builder from obtaining the required permits for the Work.
1. The Owner will submit all VDEQ permits and is responsible for all direct communications with VDEQ and the Virginia Department of Health.
2. The Design Builder will obtain, pay, complete permit submittal packages and provide the Owner with a copy of all required permits.
3. Design Builder shall assist Owner with coordination and documentation required for VDEQ permits. This includes Certificate to Construct (CTC), Certificate to Operate (CTO), and Air Quality Permit.

B. Demolition
1. Abatement of asbestos and lead in existing structures is required prior to any demolition work. The Design Builder is responsible for the testing of hazardous materials, as necessary.

1.12 WORK HOURS

A. Unless authorized in advance by the Owner, on-site work shall be limited to 6:00 AM to 4:00 pm, Monday through Friday.

B. On-site work shall comply with all local ordinances, including Chapter 15 of the Arlington County Code (Noise Control).

C. The following are the Owner’s legal holidays. Shutdown work is not permitted during the Owner’s legal holidays.
   1. New Year’s Day (January 1st).
   2. Martin Luther King, Jr. Day (3rd Monday in January).
   3. Presidents Day (3rd Monday in February).
   4. Memorial Day (Last Monday in May).
   5. Juneteenth (June 19th).
   6. Independence Day (July 4th).
   7. Labor Day (1st Monday in September).
   8. Veterans Day (November 11th).
   9. Thanksgiving Day (4th Thursday in November).
   10. Friday after Thanksgiving Day.
   11. Christmas Day (December 25th).

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 14 16
COORDINATION WITH OWNER'S OPERATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for coordinating with Owner's operations during the Project.
   2. Requirements for tie-ins and shutdowns necessary to complete the Work without impact on Owner's operations except as allowed in this Specifications section.

B. Scope:
   1. Design Builder shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to coordinate with Owner's operations during the Work in accordance with this Specifications section.
   2. Except for shutdowns specified in this Specifications section, perform the Work such that Owner's facilities remain in continuous, satisfactory operation during the Project. Schedule and perform the Work such that the Work does not: impede Owner's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products or effluent, cause odors or other nuisances, affect the public health, safety, welfare, and convenience, and adversely affect the environment resulting in violation of Laws or Regulations.

C. Related Requirements: Include but are not necessarily limited to:
   1. Section 01 11 00 - Summary of Work.
   2. Section 01 51 05 - Temporary Utilities.
   3. Section 01 75 00 - Start-up and Commissioning Procedures.

1.2 REFERENCES

A. Terminology:
   1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Specifications section, they have the meaning indicated below:
      a. A "shutdown" is when a portion of the normal operation of Owner's facility, whether equipment, systems, or conduit (including piping and ducting), has to be temporarily suspended or taken out of service to perform the Work.
      b. A "tie-in" is a connection of new Work to existing facilities, including connecting to existing conduits (including piping and ducting), electrical systems, structural elements, process/mechanical elements, and other physical connections. Some tie-ins may require that the tie-in be made without an associated shutdown.

1.3 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Shutdown Planning Submittal:
      a. For each shutdown and tie-in, submit an inventory of labor, materials, and equipment required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for Owner to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.
      b. Furnish submittal to Owner not less than 30 days prior to proposed shutdown start date.
   2. Shutdown Notification:
      a. After Owner's acceptance of shutdown planning Submittal and prior to starting the shutdown, submit written notification to Owner and Program Manager of date and time

each shutdown is to start. Submit notification not less than 7 days in advance of each shutdown.

1.4 GENERAL CONSTRAINTS

A. The following constraints apply to coordination with Owner's operations:
   1. Operational Access: Owner's personnel shall have access to equipment and areas of the facility that remain in operation.
   2. Temporary Partitions and Enclosures: Provide temporary partitions and enclosures necessary to maintain dust-free, heated, and ventilated spaces in areas of the facility that are adjacent to the Work and that must be kept operational. Comply with Section 01 51 05 - Temporary Utilities.
   3. Schedule and perform equipment and system start-ups in accordance with Section 01 75 00 – Start-up and Commissioning Procedures. Equipment and systems shall not be placed into operation on Friday, Saturday, Sunday, or holidays without prior approval of Owner.
   4. Dead End Valves or Conduits:
      a. Provide blind flanges, watertight bulkheads, or valve at temporary and permanent terminuses of conduits, including piping and ducting.
      b. Blind flanges and bulkheads shall be suitable for the service and braced and blocked, as required, or otherwise restrained as necessary or as required by Owner.
      c. Temporary valves shall be suitable for their associated service. Where valve is provided at permanent terminus of conduit, including piping or ducting, also provide on downstream side of valve a blind flange with drain/flushing connection.
   5. Owner will assist Design Builder in dewatering process tanks, basins, conduits, and other work areas to be dewatered for shutdowns. Design Builder is responsible for confirming isolation and final cleaning. Flush, wash down, and clean tanks, basins, conduits (including piping), and other work areas.
   6. Maintain clean, dry work area by pumping and properly disposing of fluid and other material that accumulates in work areas.

1.5 TIE-INS

A. Design Builder shall perform tie-ins necessary and required to complete the Work.

1.6 SHUTDOWNS

A. Work requiring service interruptions for tie-ins shall be performed during scheduled shutdowns.

B. Work that may interrupt normal operations shall be accomplished at times convenient to Owner unless otherwise indicated in the Contract Documents.

C. If Design Builder's operations cause an unscheduled interruption of Owner's operations, immediately re-establish satisfactory operation for Owner.

D. Fines and Penalties Imposed by Authorities Having Jurisdiction:
   1. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of Owner's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by Design Builder if, in Owner's opinion, Design Builder did not comply with requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in performing the Work and complying with applicable permits, Laws, and Regulations.
   2. Owner may deduct as set-offs such amounts from payments due Design Builder.

E. Coordinate requirements for shutdowns with Design Professional, Program Manager and Owner. Where necessary, obtain Owner's interpretation or clarification before proceeding.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL PROVISIONS FOR COORDINATING WITH OWNER'S OPERATIONS

A. When possible, combine multiple tie-ins into a single shutdown to reduce impacts on Owner's operations and processes.

B. Operation of Existing Systems and Equipment during the Work:
   1. Do not shut off or disconnect existing operating systems or equipment, unless accepted by Owner in writing.
   2. Operation of existing systems and equipment will be by Owner unless otherwise specified or indicated.
   3. Where necessary for the Work, Design Builder shall seal or bulkhead Owner-operated gates and valves to prevent leakage that may affect the Work, Owner's operations, or both.
   4. Provide temporary watertight plugs, bulkheads, and line stops as necessary and as required. After completing the Work, remove seals, plugs, bulkhead, and line stops to satisfaction of Owner.

C. Bypassing:
   1. Diversion of flows around treatment processes is not allowed.

D. Performing the Work of this section constitutes Design Builder's approval of underlying work and field conditions prevailing at the time of the Work.

3.2 PREPARATION

A. Shutdowns - General Preparation:
   1. Coordinate shutdowns with Owner and Program Manager.
   2. Submit shutdown planning Submittals and shutdown notification Submittals in accordance with this Specifications section's "Submittals" Article.
   3. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, materials, equipment, spare parts, both temporary and permanent, necessary to successfully perform the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to commencing the associated shutdown. Demonstrate to Owner's satisfaction that Design Builder has complied with such requirements before commencing the shutdown.
   4. Owner shall have no duty to Design Builder to advise Design Builder of inadequate preparations by Design Builder. Design Builder is solely responsible for the means, methods, procedures, techniques, and sequences of construction.

B. Shutdowns of Electrical Systems:
   1. Comply with Laws and Regulations, including the National Electric Code.
   2. Design Builder shall lock out and tag circuit breakers and switches operated by Owner and shall verify that affected cables and wires are de-energized to ground potential before starting other Work associated with the shutdown.
   3. Upon completion of shutdown Work, remove the locks and tags and advise Owner that facilities are available for use.

3.3 DETAILED SHUTDOWN REQUIREMENTS

A. Detailed shutdown requirements are provided below for the Early Work. Detailed shutdown requirements for other Work will be developed through the Design Implementation Stage.

B. Centrate/Dewatering Building Drain Tie-in:
   1. General:
      a. Equipment Out of Service During Shutdown: All process equipment in Dewatering Building.

b. Procedure: Coordinate with Owner to shutdown dewatering facilities to perform tie-in.
c. Dates: No restriction other than during work week.
d. Time: Shutdown shall be performed at a time agreeable to the Owner.

2. Prior to Shutdown:
   a. Obtain Owner's acceptance of proposed shutdown planning Submittal and shutdown notification Submittal.
   b. Bring necessary piping, couplings, valves, equipment, and appurtenances to the work areas.
   c. Assist Owner in preparing to take equipment, tanks, basins, and conduits (including piping and ducting) temporarily out of service.
   d. Coordinate other tie-ins to be performed simultaneously.
   e. Install, check, and test the temporary pumping system.
3. During Shutdown:
   a. Provide necessary connections for the tie-in.
4. Following Shutdown:
   a. With Owner, return equipment and system to operation.
   b. Verify functionality of new drain systems.
   c. Verify that joints are watertight as applicable.
   d. Repair joints that are not watertight.

C. Centrate/Dewatering Building Drain Pump Bypass:
1. General:
   a. After the temporary centrate/Dewatering Building drain is installed and operational and the existing centrate/Dewatering Building drain is decommissioned, provide temporary pumping (including all controls and piping) to pump centrate/Dewatering Building drains from the Dewatering Building to the Primary Clarifier Effluent channel for 2 events per year, 4 days per event.
   b. Purpose: Temporary pumping of recycle streams to allow for raw influent sampling without recycles.
   c. System Capacity: 500 GPM average, 1,000 GPM maximum. Design Builder to determine head requirements.
   d. Fluid Pumped: Centrate/process drains.
   e. Controls: Provide complete control system to prevent drain backup in the drain suction lines.
   f. Suction Location: Centrate drain in Dewatering Building.
   g. Discharge Location: Primary Clarifier effluent channel.
   h. Flow Meter: Not required.
   i. Provide provisions for accommodating foam from the pumped centrate, including containment.

END OF SECTION

SECTION 01 14 19
USE OF SITE

PART 1 - GENERAL

1.1 SUMMARY

1. Section Includes:
1. Restrictions on Design Builder's use of the Site and premises.
2. Restrictions on use of existing buildings and structures, including:
    a. Permanent utilities and sanitary facilities.
    b. Existing elevators.
    c. Existing hoisting equipment.
    d. Program Manager's and Design Builder field offices.

B. Scope:
1. Design Builder shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to comply with restrictions on Design Builder's use of the Site and other areas.

C. Related Requirements: Include but are not necessarily limited to:
1. Section 01 51 05 - Temporary Utilities.
2. Section 01 52 11 - Program Manager's and Design Builder Field Office.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. American Society of Mechanical Engineers (ASME):
    a. B30.2, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist).
    b. B30.17, Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist).

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
    a. Site plan showing proposed location of field offices, storage trailers, staging and laydown areas, temporary sanitary facilities, fuel and oil storage, fueling location, bottle gas storage facilities, and other areas Design Builder proposes to occupy.
2. Testing Plans: Plan for load testing of Owner's hoisting equipment at the Site.

B. Informational Submittals: Submit the following:
1. Notices of Condition:
    a. Notice of condition of Owner's existing hoisting equipment that Design Builder proposes to use, together with written evaluation of condition of equipment including condition of equipment's safety devices.
2. Field Quality Control Submittals:
    a. After completion of Design Builder's use of Owner's hoist(s), submit load test report, including copy of certifications of test weights.
3. Hoist Manufacturer's Reports: Submit written report of results of each visit to Site by equipment manufacturer's service technician, including purpose and time of visit, tasks performed, and results obtained.
4. Qualifications Statements:
    a. Identification by name, qualifications, and experience of person that Design Builder proposes as Design Builder's operator of Owner's hoisting equipment.

1.4 USE OF PREMISES

A. Limit use of premises at the Site to work areas shown or indicated on the Drawings and as specified in this Section. Do not disturb portions of the Site beyond areas of the Work.
   1. Limits:
      a. Confine storage of materials and equipment, and locations of temporary facilities areas as follows:
         1) Design Builder's gang boxes and storage containers for tools in active use in the Work may be kept in reasonable quantity in the work areas as long as such items do not obstruct access to the facilities by Owner or occupants.
         2) Do not store items of any sort, whether temporarily or otherwise, in stairways and ramps, whether existing or under construction.
      b. Do not enter the following areas:
         1) Passenger elevators at the Site, unless such use is expressly allowed by other provisions of this Specifications section.
   2. Prohibitions:
      a. Do not use the Site for the following:
         1) Conducting Design Builder's business not related to the Project or other work for Owner.
         2) Overnight lodging or other, non-work use of the Site by workers or others for whom Design Builder is responsible, whether housed in recreational vehicles, other vehicles, tents, quarters in field offices or Design Builder-furnished temporary structures, or in work areas, is unacceptable.

B. Use of Existing Buildings and Structures: Maintain existing buildings and structures in weather-tight condition throughout construction unless otherwise indicated in the Contract Documents. Protect buildings, structures, and occupants during construction.
   1. Use of Existing Utilities, Sanitary Facilities, and First-aid Facilities:
      a. Refer to Section 01 51 05 - Temporary Utilities.
      b. Do not use permanent sanitary facilities, whether provided under the Project or existing prior to the Project, at the Site.
      c. Do not use permanent telephone, Internet, or other communications utilities and facilities at the Site, regardless of whether such services and facilities were provided under the Project or existed prior to the Project, except in cases of emergency.
      d. Do not use Owner's or occupants' first-aid facilities, except in cases of medical emergency. Promptly replenish used items and supplies with items identical to those used.
   2. Use of Elevators:
      a. Design Builder may use Owner's Dewatering Building Elevator for moving materials and equipment during construction. Elevators shall be available to Owner and occupants at all times unless otherwise arranged with Owner and Program Manager. Do not load elevators beyond posted capacity. Use of other elevators is not allowed.
   3. Use of Owner's Hoisting Equipment and Access to Work Areas for Loading:
      a. General Provisions:
         1) For each of Owner's hoisting systems used by Design Builder, Design Builder shall thoroughly check the equipment and submit to Program Manager written certification that Design Builder believes the equipment is sufficient for the intended use and that all safety mechanisms are in place and operating. If existing equipment has one or more deficiencies, notify Program Manager before attempting to use such equipment.
         2) When one or more deficiencies are noted in existing hoisting equipment prior to Design Builder's use thereof, Owner may authorize Design Builder to perform remedial work on the hoisting equipment under a Change Order or allowance authorization (if any).

3) Design Builder's person operating Owner's hoisting equipment shall be experienced with and qualified in using such equipment. Assign one person to operate Owner's hoisting equipment and advise Program Manager in writing of the identity and experience of the designated person.
4) Following completion of Design Builder's use of Owner's hoisting equipment, remedy damage and wear caused by Design Builder's use of equipment at no cost to Owner. Perform field quality control testing and inspections as indicated in Article 3.1 of this Specifications section; if not indicated in Article 3.1, perform field quality control tests as mutually agreed upon by hoisting equipment manufacturer's service technical and Program Manager. Submit results of field quality control testing to Program Manager.
5) Design Builder may use the hoisting equipment for moving materials and equipment during construction. Hoisting equipment shall be available to Owner and occupants at all times unless otherwise arranged with Owner and Program Manager. Do not load hoisting equipment beyond posted capacity.

4. Program Manager and Design Builder's Field Offices:
   a. Design Builder, Owner, and Program Manager shall agree on location of field offices during the Pre-Construction Services through the Design Builder's Site Logistics Plan.
   b. The space of the existing field office complex is available for field office use. The Design Builder shall investigate adequacy of existing utilities, including water, sewer, and electrical for use with new field offices. If this space is to be reused, the existing temporary offices shall be removed and new facilities shall be provided.

C. Promptly repair damage to premises, including existing structures, finishes, equipment, and other features, caused by construction operations. Upon completion of the Work, restore premises to specified condition; if condition is not specified, restore to pre-construction condition.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

3.1 FIELD QUALITY CONTROL

A. Site Tests of Owner's Hoisting Equipment after Use by Design Builder:

1. After Design Builder has finished using Owner's hoisting equipment and associated controls, perform at the Site the following field quality controls, including load-test of Owner's hoisting equipment in accordance with this Article 3.1 and Laws and Regulations including applicable building code.
2. Should testing indicate malfunction, make repairs and adjustments as necessary. Repeat testing and adjusting (at no additional cost to Owner) until, in Owner's opinion, Owner's hoisting equipment is functioning properly. Design Builder's obligations to remedy deficiencies in Owner's hoisting equipment will not be complete until field tests are successfully completed and acceptable documentation thereof is submitted to Program Manager.
3. Load Test:
   a. Perform load tests under supervision of hoisting equipment manufacturer's factory-trained service technician, in presence of Owner and Program Manager.
   b. Weights used in load testing shall be certified by a state or local bureau of weights and measures. Submit weight certification as part of load test report.
   c. Load testing shall comply with ASME B30.2 or ASME B30.17, as applicable, and the following:
      1) Power failure test with rated load: Load shall be held suspended when power is removed.

2) For Bridge Cranes: Bridge travel full length of runway with rated load, while verifying that all functions operate properly.
3) For Hoisting Equipment with Trolley: Trolley travel full length of rail or bridge (as applicable) with rated load, while verifying that all functions operate properly.
4) Hoist brake drift test with rated load: Lift weight, measure distance to floor, allow 5 minutes to elapse, and re-measure. Record the results measured. Criteria for Acceptance: No difference in measurements.
5) Motorized Hoists: Upper/lower limit switch test with no load.
6) Motorized Hoists: Emergency stop test with no load.

d. Load Test Report: Submit results of load testing in a report that lists tests performed, data collected, results of each test, and corrective actions taken (if any). Test report shall be signed by manufacturer's service technician present during testing. Submittal shall include an affirmative statement that, to best of Design Builder's knowledge, information, and belief, the hoisting equipment is in equal or better condition than when Design Builder first used such hoisting equipment, and that hoisting equipment complies with Laws and Regulations and requirements of the Contract Documents.

4. Remedy damage to and wear imposed on Owner's hoisting equipment at no additional cost to Owner. Remedy equipment in accordance with the Contract Documents. If not addressed in the Contract Documents, remedy damage and defects to pre-construction conditions, in accordance with recommendations of hoisting equipment manufacturer's written recommendations, using parts in accordance with hoisting equipment manufacturer's written recommendations. Do not void warranties in effect.

END OF SECTION

SECTION 01 31 13

PROJECT COORDINATION AND DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General requirements for:
      a. Project coordination.
      b. Coordination meetings.
      c. Coordination drawings and layout drawings.
      d. Photographic documentation.
      e. Project record documents.

B. Scope:
   1. Design Builder shall coordinate the Work, whether performed by Design Builder's employees or by Subcontractors, Suppliers, or others for whom Design Builder is responsible, to provide Work in accordance with the Contract Documents.
   2. Coordinate the Work with testing entities and inspectors (whether hired by Design Builder, Owner, or others) employed on the Project, forces of Owner and other contractors retained by Owner, and other entities with which the Work needs to be coordinated.
   3. Requirements for preconstruction meetings are in Section 01 31 19 - Project Meetings.
   4. Requirements for construction progress meetings are in Section 01 31 19 - Project Meetings.
   5. Design Builder shall perform construction photography and submit construction photographic documentation, including providing all labor, materials, equipment, and services required.
   6. Design Builder shall provide all labor, materials, equipment, and services to establish, maintain, continuously update, and submit to Program Manager Project record documents in accordance with the Contract Documents.

C. Related Requirements:
   1. Include, but are not necessarily limited to, the following:
      a. Section 01 11 00 - Summary of Work.
      b. Section 01 31 19 - Project Meetings.
      c. Section 01 45 16 - Design Builder Construction Quality Control.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination – General:
      a. In accordance with Section 01 11 00 - Summary of Work, Design Builder shall coordinate the Work with, and cooperate with, other contractors, utility owners and their contractors, Owner's workers at the Site, Program Manager, and other entities working at or adjacent to the Site.
   2. Advise other contractors (if any) of schedule for the Work to allow other contractors sufficient time to perform their work that must be performed prior to the Work. Coordinate and communicate with other contractors and other entities when the Work must be performed prior to the work of others and make good-faith efforts to avoid delaying work of others.
   3. Coordination, Inspection, and Observation to Ensure Quality:
      a. Design Builder shall continuously inspect the Work throughout the Project to ensure that the Work complies with the Contract Documents. Quality Control requirements are detailed in Section 01 45 16 – Design Builder Construction Quality Control.

b. Inspect (including testing, where required or necessary) substrates and surfaces on which the Work will be constructed, applied, adhered, or attached, to ensure substrate and surface conditions are appropriate for providing Work in accordance with the Contract Documents.

B. Coordination Meetings:
1. Design Builder's Coordination Meetings:
    a. Schedule, attend, chair, and actively participate in coordination meetings deemed appropriate by Design Builder for purposes of coordinating the Work of Design Builder's employees, Subcontractors, Suppliers, and others for whom Design Builder is responsible.
    b. Frequency, location, date, time, and duration of Design Builder's coordination meetings are at Design Builder's discretion. Record and distribute to attendees and other members of Design Builder's team a record of topics discussed, decisions made, and other relevant matters at Design Builder's coordination meetings.
    c. Owner and Program Manager will not attend Design Builder's coordination meetings.
2. Coordination Meetings with Other Contractors:
    a. Coordination meetings between the Design Builder and separate contractors may be necessary while performing the Work. When such meetings are deemed necessary by Owner, either Owner or Program Manager will advise Design Builder in writing of the location, date, time, duration, and frequency of such coordination meetings.
    b. Such coordination meetings, when held, are anticipated to be once per month or less-often, and held at the Site. During periods when increased coordination among the separate projects is necessary, such as when adjacent contractors are in close proximity to each other, the potential exists that more-frequent coordination meetings may be necessary, although such increased frequency is not anticipated to be for extended periods.
    c. Design Builder's project manager and site superintendent shall attend such coordination meetings required by Owner.
    d. Purpose of such coordination meetings will be to discuss scheduling and coordination of work by separate contractors and others as appropriate, sharing of space at the Site, and other coordination matters.
    e. Owner and Program Manager will attend such coordination meetings.
    f. Owner or Program Manager will chair the meetings and prepare and distribute to participants a record of the topics discussed and decisions made at such meetings.

C. Coordination Drawings and Layout Drawings:
1. With the Contract Documents and Shop Drawings, use coordination drawings and layout drawings for coordinating the Work of various trades.
2. Where coordination drawings or layout drawings are to be prepared by Subcontractors, ensure that each Subcontractor maintains required personnel, implements, equipment, and systems at Subcontractor's office and at the Site (as deemed appropriate by Design Builder).

D. Photographic Documentation:
1. Coordinate construction photography with progress of the Work. Unless otherwise required by the Contract Documents, do not cover or conceal the Work until construction photographic documentation has been properly obtained.
2. Coordinate dates and times for performing construction photography with Owner and Program Manager.

E. Project Record Documents:
1. Obtain necessary field measurements and record all data required for Project record documents before covering up the Work or building on subsequent phases of the Work.
2. After obtaining measurements and information, promptly record the data and information on Project record documents.

3. Where a licensed, registered professional land surveyor is retained on the Project, whether by Design Builder or others, to perform field measurements and record other data for as-constructed Project or Site conditions, coordinate with such entity and schedule and perform the Work accordingly. Allow surveyor sufficient time and proper conditions for performing surveyor's work. Assist the surveyor as necessary in performance of surveyor's responsibilities.
4. Monthly Status Evaluation:
   a. Not less than once per month, as a condition precedent to submitting Application for Payment, Design Builder's site superintendent will meet with either Program Manager at the Site to review status of Design Builder's Project record documents.
   b. When Design Professional Program Manager directs corrections to Project record documents, promptly make such corrections on the Project record documents. Design Professional's or Program Manager's directions or lack thereof do not in any way relieve or mitigate Design Builder's sole responsibility for the accuracy, completeness, and clarity of Project record documents.

1.3 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Preconstruction Photographic Documentation:
      a. Submit Electronic Documents (still photographs and video).
      b. Submit acceptable preconstruction photographic documentation prior to mobilizing to and disturbing the Site, and not later than the first progress payment request, unless other schedule for preconstruction photographic documentation is accepted by Program Manager.
   2. Construction Progress Photographic Documentation:
      a. Submit Electronic Documents (still photographs and video).
      b. Obtain construction progress photographic documentation at the frequency indicated in this Section. Coordinate submittal of construction progress photographic documentation with submittal of each progress payment requests.
   3. Qualifications Statements:
      a. Photographer: When requested by Program Manager, prior to starting photographic documentation Work, submit photographer qualifications and record of experience. List of construction photography experience shall include for each project:
         1) Project name and location.
         2) Nature of construction.
         3) Photographer's client with contract information.
         4) Approximate duration of photographer's services.

B. Closeout Submittals: Submit the following:
   1. Final Photographic Documentation:
      a. Submit Electronic Documents (still photographs and video).
      b. Submit acceptable final photographic documentation prior to requesting final inspection.
   2. Record Documentation:
      a. Prior to readiness for final payment, submit to Program Manager one copy of Project's final record documents and obtain Program Manager's acceptance of same. Submit complete record documents; do not make partial Submittals without Program Manager's concurrence.
      b. Submit the following Project record documents:
         1) Record Drawings, including those issued via Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.
         2) Record project manual, including Specifications, indicating changes made via Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.

c. Submit record documents with transmittal letter on Design Builder's letterhead in accordance with requirements in Section 01 33 00 - Submittal Procedures.

1.4 CONSTRUCTION PHOTOGRAPHY – GENERAL

A. Images - General:
1. Photographic documentation shall be in color.
2. Photographic images shall be suitably staged and set up ("framed"), focused, and have adequate lighting to illuminate the Work and conditions that are the subject of the photograph.
3. For still photographs and video, use digital camera equipment with resolution of not less than 16.0-megapixels.
4. Do not imprint date and time in the image.

B. Photographic Electronic Documents:
1. For each still photograph submitted, furnish high-quality, high-resolution digital image in JPEG (".jpg") file format compatible with Microsoft Windows 10 and higher operating systems.
2. GPS geo-tagging enabled and recorded with each image.
3. Image Resolution: Sufficient for clear, high-resolution digital images and prints. Minimum resolution shall be 600 dots per inch (dpi). Minimum size of digital images shall be:
   a. Non-Aerial Still Photographs: 8 IN by 10 IN.
   b. Aerial Photographs: 16 IN by 20 IN.
4. Electronic Document image filename shall describe the image; do not submit filenames automatically created by camera. For example, acceptable Electronic Document image filenames are, "Equipment Bldg. – Looking West at Blower 2.jpg" and "Main St.-Elm St. Intersection – Looking North.jpg."
5. Submittal of Electronic Documents Still Photographs:
   a. When use of online document management system is required by the Contract Documents, also save copy of Electronic Documents of photographic documentation in a directory for Design Builder's photographic images. Each time photographs are obtained, save the associated Electronic Document files in a new subdirectory named for the date and basic subject of the photographs. For example, "2022-06-30 – Site Work" and "2023-03-21 – New Control Room".
   b. Submit Electronic Documents of still photographs not more than 72 HRS after such images are obtained.

1.5 PRECONSTRUCTION PHOTOGRAPHIC DOCUMENTATION

A. Preconstruction Photographic Documentation:
1. Obtain and submit sufficient preconstruction photographic documentation to record conditions at the Site prior to construction. Photography shall document all work areas for the Project.
2. Preconstruction photography is separate from construction progress photographic documentation required in this Section.

B. Video:
1. Record preconstruction video at same time preconstruction still photographs are taken.
2. Preconstruction video shall show preconstruction conditions of all areas of the Project.

C. If disagreement arises on the condition of the Site and insufficient preconstruction photographic documentation was submitted prior to the disagreement, restore the property in question to extent directed by Program Manager and to Program Manager's satisfaction.

1.6 CONSTRUCTION PROGRESS PHOTOGRAPHIC DOCUMENTATION

A. Progress Photography:
1. Take still photographs not less often than once per month.

2. Obtain and submit interior and exterior photographic documentation of each building and structure in the work area as directed by Program Manager at the time photographs are taken.

1.7 FINAL PHOTOGRAPHIC DOCUMENTATION

A. Final Photography:
   1. Take still photographs at time and day acceptable to Program Manager. Do not take final photographs prior to Substantial Completion of the entire Project, removal of temporary facilities, and restoration. Work documented in final, still photographs shall be complete, including painting and finishing, furnishings, landscaping, and other visible Work.
   2. Obtain and submit aerial photographs of the Site following removal of temporary facilities and completion of restoration (including landscaping) using unmanned aerial vehicle (drone), with final photographic documentation Submittal. Submit one oblique photograph taken from each cardinal direction (i.e., north, south, east, and west). Obtain permits and approvals, as applicable, for required flyovers.

B. Video:
   1. Record final video at same time final, still photographs are taken.
   2. Final video shall show final conditions of all areas of the Project.

1.8 MAINTENANCE OF RECORD DOCUMENTS

A. Maintain in Design Builder’s field office, in clean, dry, legible condition, complete sets of the following record documents:
   1. Drawings, Specifications, and Addenda;
   2. Shop Drawings, Samples, and other Submittals, including records of test results, approved or accepted as applicable, by Program Manager;
   3. Change Orders, Work Change Directives, Field Orders, allowance authorizations;
   4. copies of all interpretations and clarifications issued;
   5. photographic documentation;
   6. survey data; and
   7. all other documents pertinent to the Work.

B. Provide files and racks for proper storage and easy access to Project record documents. File record documents in accordance with the edition of the Construction Specification Institute’s *MasterFormat* used for organizing the project manual, unless otherwise accepted by Program Manager.

C. Promptly make Project record documents available for observation and review upon request of Program Manager or Owner.

D. Do not use Project record documents for any purpose other than serving as Project record. Do not remove Project record documents from Design Builder’s field office without Program Manager’s approval.

1.9 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

A. Recording Changes, Field Conditions, and Other Information – General:
   1. At the start of the Project, label each record document to be submitted as, “PROJECT RECORD” using legible, printed letters. Letters on record copy of the Drawings shall be 2 IN high.
   2. Keep record documents current consistent with the progress of the Work. Make entries on record documents within 2 working days of receipt of information required to record the change, field condition, or other pertinent information.
   3. Do not permanently conceal the Work until required information has been recorded for Project record documents.

4. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from Design Professional-accepted Project record documents.
5. Marking of Entries:
   a. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to Project record documents.
   b. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be legible and sufficiently dark to allow scanning of record documents into legible electronic files in “portable document format” (.PDF) files.
   c. Date each entry on record documents.
   d. Indicate changes by drawing a “cloud” around the change(s) indicated.
   e. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

B. Drawings:
1. Record changes on copy of the Drawings. Submittal of Design Builder-originated or -produced drawings as a substitute for recording changes on a copy of the Drawings is unacceptable.
2. Record changes on plans, sections, elevations, schematics, schedules, and details as required for clarity, accuracy, and completeness, making reference dimensions and elevations (to Project datum) for complete record documentation.
3. Record actual construction including:
   a. Depths of various elements of foundation relative to Project datum.
   b. Horizontal and vertical location of Underground Facilities referenced to permanent surface improvements and Project elevation datum. For each Underground Facility, including pipe fittings, show and indicate dimensions to not less than two permanent, visible surface improvements.
   c. Location of exposed utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure and, where applicable, to Project elevation datum.
   d. Changes in structural and architectural elements of the Work, including changes in reinforcing.
   e. Field changes of dimensions, arrangements, and details.
   f. Changes made in accordance with Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.
   g. Changes in details on the Drawings. Submit additional details prepared by Design Builder when required to document such changes.
4. Recording Changes for Schematic Layouts:
   a. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical arrangement shall be determined by Design Builder subject to acceptance by Program Manager.
   b. Record on the Project record documents all revisions to schematics on the Drawings, including: piping schematics, ducting schematics, process and instrumentation diagrams, control and circuitry diagrams, electrical one-line diagrams, motor control center layouts, and other schematics when included in the Drawings. Show and indicate actual locations of equipment, lighting fixtures, in-place grounding system, and other pertinent data.
   c. When dimensioned plans and dimensioned sections or elevations on the Drawings show the Work schematically, indicate on the Project record documents, by dimensions accurate to within 1 IN in the field, centerline location of items of Work such as conduit, piping, ducts, and similar items
      1) Clearly identify each item of the Work by accurate notations such as “cast iron drain”, “rigid electrical conduit”, “copper waterline”, and similar descriptions.

2) Show by symbol or by note the vertical location of each item of the Work; for example, “embedded in slab”, “under slab”, “in ceiling plenum”, “exposed”, and similar designations. For piping not embedded, also indicate elevation dimension relative to Project elevation datum.
3) Descriptions shall be sufficiently detailed to be related to the Specifications.

d. Program Manager may furnish written waiver of requirements relative to schematic layouts shown on plans, sections, and elevations when, in Program Manager’s judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on such waiver(s) being issued.

5. Supplemental Drawings:
   a. In some cases, drawings produced during construction by Design Professional or Design Builder supplement the Drawings and shall be included with Project record documents submitted by Design Builder. Supplemental record drawings shall include drawings or sketches that are part of Change Orders, Work Change Directives, Field Orders, and allowance authorizations and that cannot be incorporated into the Drawings because of space limitations.
   b. Supplemental drawings submitted with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.

C. Specifications and Addenda:
1. Mark each Specifications section to record:
   a. Manufacturer, trade name, catalog number, and Supplier of each material and equipment item actually furnished.
   b. Changes made by Addendum, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 31 19
PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preconstruction, progress and other project meetings during the Construction Implementation Stage.

1.2 PRECONSTRUCTION MEETING

A. Meet with the Owner and Program Manager for a pre-construction conference at a time mutually agreed upon after the contract is awarded but before any work is performed.

B. The Program Manager will schedule a meeting of the Owner, Design Builder, Design Builder's Subcontractors, and their respective representatives.
   1. The purpose of the meeting will be to clarify construction contract administration procedures, establish lines of authority and communication, and identify duties and responsibilities of the parties.

C. The Program Manager will schedule the pre-construction conference after receipt of the Design Builder's draft proposed schedule.

D. Agenda:
   1. Procedural and Administrative:
      a. Personnel and Teams:
         1) Designation of roles and personnel.
         2) Limitations of authority of personnel, including personnel who will sign Contract modifications and make binding decisions.
         3) Subcontractors and Suppliers in attendance.
         4) Authorities having jurisdiction.
      b. Procedures for communications and correspondence, including electronic communication protocols.
      c. Copies of the Contract Documents and availability.
      d. The Work and Scheduling:
         1) General scope of the Work.
         2) Contract Times, including Milestones (if any).
         3) Phasing and sequencing.
         4) Preliminary Progress Schedule.
         5) Critical path activities.
      e. Safety:
         1) Responsibility for safety.
         2) Design Builder's safety representative.
         3) Emergency procedures and accident reporting.
         4) Emergency contact information.
         5) Confined space entry permits.
         6) Hazardous materials communication program.
         7) Impact of Project on public safety.
         8) Site-specific hazards.
         9) Hot work procedures.
      f. Permits.
      g. Review of insurance requirements and insurance claims.
      h. Coordination:
         1) Coordination of Subcontractors and Suppliers.

2) Construction coordinator (for projects with multiple prime construction contracts).
3) Coordination with Owner’s operations.
4) Progress meetings – schedule and frequency.
5) Coordination meetings.

i. Submittals:
1) Current critical Submittals:
a) Preliminary Schedule of Submittals.
b) Other schedules (Progress Schedule, Schedule of Values).
c) Preconstruction photographic documentation.
d) List of proposed Subcontractors and Suppliers.
e) List of emergency contact information.
f) Notice of elements of Design Builder’s safety program with which Owner and Program Manager are to comply.
g) Site use plan.
h) Form of Design Builder’s site superintendent’s daily reports.
2) Work not eligible for payment without approved or accepted Submittals (as applicable).
3) Submittal procedures.
a) Compliance with accepted Schedule of Submittals, including review of submittals requiring Owner review.
b) Actions required of Design Builder prior to furnishing Shop Drawings and other Submittals.
c) Design Builder’s Submittal approval stamp required; Design Builder’s coordination of Submittals.
d) Furnishing of Submittals.
e) Submittal types and meaning of Owner’s, Program Manager’s, and Design Professional’s action on each.
f) Resubmittals—responsibility for, limitations on quantity.
4) Identification of initial, critical Shop Drawings and product data.
5) Construction photographic documentation.

j. Substitutes, Design Changes and "Or-Equals":
1) Product options.
2) Procedures for proposing "or-equals".
3) Procedures for proposing substitutes.

k. Contract Modification Procedures:
1) Requests for Interpretation.
2) Written clarifications.
3) Design Change Notifications (DCNs).
4) Field Orders.
5) Proposal Requests.
6) Change Proposals.
7) Work Change Directives.
8) Contingency Authorizations.
9) Allowance Change Authorizations.
10) Change Orders.
11) Differing site conditions or discovery of Hazardous Environmental Condition.
12) Substantiating and documenting Change Proposals and Claims.
13) Claims.

l. Progress Payment:
1) Owner’s Project financing and funding, as applicable.
2) Owner’s tax-exempt status.
3) Preliminary Schedule of Values.
4) Procedures for measuring for payment (Unit Price Work).
5) Retainage.

6) Progress payment procedures; documents to accompany Applications for Payment.
7) Payment for stored items not yet installed.
8) Date of Owner's payments; payment is due.
9) Prevailing wage requirements and interviews.

m. Subcontractors and Suppliers:
   1) List of proposed Subcontractors and Suppliers; monthly updates.
   2) Coordination and management.
   3) Subcontracts and purchase orders.
n. Testing and inspections:
   1) Owner-hired and Design Builder-hired.
   2) Identification of Design Builder-hired special inspectors.
   3) Responsibility for advising testing entity and special inspectors of need for services.
   4) Results of code-required special inspections and tests.
   5) Prompt remedy of apparent defects.
   6) Notice of defective Work.
   7) Remedy of defective Work.
   8) Defective Work not eligible for payment.
   9) Covering up defective Work.
   10) Cost responsibility for defective Work and retesting/re-inspection.
o. Envision update.
p. Disposal of demolition materials.
q. Record documents.
r. Preliminary discussion of Contract closeout:
   1) Procedures for Substantial Completion.
   2) Partial utilization procedures; property insurance.
   3) Contract closeout requirements.
   4) Correction period; duration of Design Builder's general warranty and guarantee.
   5) Duration of bonds and insurance.

2. Code Officials:
   a. Municipal licenses.
   b. Municipal permits required.
      1) Permits required and status.
      2) Inspections for building code official.
   c. Right-of-way work permits; status of occupancy permit(s).
   d. Environmental permits:
      1) Stormwater discharges during construction.
      2) Erosion and sediment control permit.
      3) Spill prevention control and countermeasures plan (40 CFR 112).
      4) Air quality permitting.
3. Site Mobilization (if not covered in a separate meeting):
   a. Working days, working hours, and overtime.
   b. Use of Site and other areas; use of existing facilities; delivery coordination.
   c. Coordination with other projects.
   d. Field offices, storage trailers, and staging areas.
   e. Temporary facilities.
   f. Temporary utilities and limitations on utility use.
   g. Utility company coordination.
   h. Access to Site, access roads, and parking for construction vehicles.
   i. Traffic controls.
   j. Temporary controls:
      1) Erosion and sediment control; stormwater pollution prevention plans.
      2) Dust control and air pollution control (including emissions control).
      3) Water control (stormwater, surface water, groundwater).

4) Water pollution control; spill prevention control and countermeasures plan.
5) Solid waste control.
6) Pest control.
7) Other temporary controls.

k. Security; temporary security fencing (where required).
l. Storage of materials and equipment to be incorporated into the Work.
m. Protection of the Work and property; protective barriers.
n. Field engineering:
   1) Reference points and benchmarks.
   2) Surveys and layouts.
   3) Professional services for Design Builder’s means and methods (not delegated design).
   4) Design Builder’s site superintendent’s daily records and submittal requirements.
o. Site maintenance during the Project:
   1) Progress cleaning; removal of trash and debris.
   2) Snow and ice removal.
   3) Maintenance and cleaning of existing access roads and parking areas.
p. Restoration.

4. Next meeting.
5. Site visit, as necessary.

E. The Design Builder shall compile meeting minutes from the transcribed record of the meeting and electronically distribute copies to all participants.

F. Pre-Construction Conference Submittals:
   1. The names and telephone numbers of Design Builder’s Superintendent and Office Manager.
   2. List of personnel authorized to sign change orders, allowance change authorizations, and receive progress payments.
   3. The name, address and telephone numbers of two or more persons employed by the Design Builder who can be reached at any time of the day or night to handle emergency matters.
   4. A list of all subcontractors that will work on the project, a description of work they will perform, and a contact list for each subcontractor with phone numbers and address.
   5. A draft proposed Construction Schedule.
   6. Safety Data Sheets for all hazardous chemical products to be used by the Design Builder on this project.
   7. Temporary Erosion and Sediment Controls Plan.
   8. Traffic Control Plan.

1.3 PROGRESS MEETINGS

A. Monthly progress meetings will be held at a location determined by the Program Manager, unless otherwise arranged.

B. Attendees will include the Owner, Program Manager, Design Builder, subcontractors, and suppliers’ representatives as may be needed, other Contractors working at the site, and other interested or affected parties. Meetings shall be led by the Design Builder.

C. Preliminary Agenda: Be prepared to discuss in detail the topics indicated below. Revised agenda, if any, will be furnished to Design Builder prior to associated progress meeting(s). Progress meeting agenda may be modified by Program Manager during the Project as necessary.
   1. Review, comment, and amendment (if necessary) of minutes of previous progress meeting.
   2. Review of progress since the previous progress meeting.
   3. Planned progress through next progress meeting.
   4. Review of Progress Schedule:
      a. Review of the Contract Times; Design Builder’s ability to comply with Contract Times.
      b. Identification of critical path activities.
      c. Schedules for fabrication and delivery of materials and equipment.

   d. Corrective measures, if necessary, including recovery schedule(s).
5. Submittals:
   a. Review status of critical Submittals.
   b. Review revisions to Schedule of Submittals.
6. Contract Modifications:
   a. Requests for interpretation.
   b. Written clarifications.
   c. DCNs.
   d. Field Orders.
   e. Proposal Requests.
   f. Change Proposals.
   g. Work Change Directives.
   h. Allowance Change Authorizations.
   i. Change Orders.
   j. Claims.
7. Applications for progress payments:
   a. Status and deadline for submittal.
   b. Stored materials and equipment; observation by Program Manager; documents required.
   c. Set-offs to which Owner is entitled (as applicable).
   d. Other matters related to progress payments.
8. Problems, conflicts, and observations.
9. Quality standards, testing, and inspections.
10. Coordination between Project participants.
11. Site management issues, including vehicular access and parking, traffic control, security, status of temporary controls and temporary utilities, site maintenance and cleaning, and other Site matters.
12. Safety and protection.
13. Permits.
14. Construction photographic documentation.
15. Record documents status.
16. Completion matters (as appropriate):
    a. Status of checkout, start-up, field quality control activities.
    b. Status of training of facility O&M personnel and O&M manuals.
    c. Partial utilization; inspection for Substantial Completion.
    d. Punch list status (as applicable).
    e. Other closeout matters (if any).
17. Other business.

D. Bring a 6-week look ahead schedule to each meeting, including the following items:
1. Work completed last 2 weeks.
2. Work anticipated for the next 4 weeks ("Look Ahead").
3. Subcontractors on-site the prior week.
4. Subcontractors scheduled on-site for the next 4 weeks.
5. Contract document deficiencies or questions noted during prior week.
6. Anything that could impede the progress of the work or affect the critical path on the project schedule.
7. Corrective measures and procedures planned to regain planned schedule, cost or quality assurance, if necessary.
8. Report of any accidents, and any site safety issues that need to be addressed.

E. Other Agenda items to be discussed:
1. Review and revise as necessary and approve minutes of previous meetings.
2. Status of submittals of equipment and shop drawings.
3. Identify problems that impede planned progress.

4. Other current business.

F. Revision of Minutes:
   1. Unless revisions to published minutes are in writing prior to the next regularly scheduled progress meeting, the minutes will be accepted as properly stating the activities and decisions of the meeting.
   2. Revisions to minutes shall be settled as priority item of "old business" at the next regularly scheduled meeting.

G. Minutes of Meeting:
   1. The Design Builder shall compile minutes of each project meeting and electronically distribute copies to all participants.

1.4 OTHER MEETINGS

A. Other meetings will be required to facilitate progress of the Work. These include, but are not limited to the following:
   1. Weekly Plant Coordination Meetings:
      a. Coordinate and schedule with the Owner and Program Manager weekly plant operations coordination meetings.
      b. Develop a standing agenda, to include at a minimum the following topics:
         1) Safety – identify areas of current focus.
         2) Upcoming schedule – 2 week look-ahead.
         3) Utility tie-ins, shutdowns, road closures, and other plant impacts.
         4) Security and site maintenance.
         5) Coordination with other companies and contracts.
         6) Quality control.
         7) Training and commissioning.
         8) Action items.
      c. Meetings shall be no more than 1-hour in duration.
   2. Quality Control Meetings. See Section 01 45 16.
   3. Facility Start-up Planning and Coordination Meeting. See Section 01 75 00.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for Design Builder's construction Progress Schedules and related Submittals, including:
      a. Administrative requirements regarding progress Schedules.
      b. Qualifications of Progress Schedule preparer and related personnel.
      c. Submittals of Progress Schedules and associated schedule-related Submittals.
      d. Initial Progress Schedules.
      e. Look-ahead schedules.
      f. Progress Schedule updates.
      g. Narrative reports.
      h. Cost-loading of Progress Schedules.
      i. Time impact analyses.
      j. Recovery schedules.

B. Scope:
   1. Design Builder shall prepare and submit to Program Manager required Progress Schedules and related Submittals, as required by this Section and elsewhere in the Contract Documents. Maintain and update Progress Schedules and related Submittals throughout the Project.
   2. Progress Schedule shall be cost-loaded.
   3. Owner, Program Manager, and others involved with the Project have the right to rely on accuracy of Design Builder-prepared Progress Schedule.
   4. Program Manager's review or acceptance of the Progress Schedule or related Submittals, and Program Manager's comments on and expressed opinions concerning activities in the Progress Schedule and related Submittals, and progress of the Work, does not control Design Builder's independent judgment concerning construction means, methods, techniques, sequences and procedures, unless the associated means, method, technique, sequence, or procedure is required by the Contract Documents. Design Builder is solely responsible for complying with the Contract Times.

C. Related Requirements: Include, but are not necessarily limited to:
   1. Section 01 11 00 - Summary of Work.
   2. Section 01 14 16 - Coordination with Owner's Operations.
   3. Section 01 31 19 - Project Meetings.

1.2 REFERENCES.

A. Defined Terms and Terminology:
   1. Defined terms, indicated with initial capital letters, are indicated in the General Conditions, as may be modified by the Supplementary Conditions.
   2. Terminology: The following are not defined terms and are not indicated with initial capital letters but, when used in this Section, have the meaning indicated below, whether applied to the singular or plural thereof.
      a. "Activity" is an element of the Work that has the following specific characteristics: consumes time, requires resources, has a definable start and finish, is assignable, and is measurable.
      b. "Baseline Progress Schedule" means, in addition to the General Conditions' definition of "Progress Schedule", the version of the Progress Schedule (for the entire Project)

initially accepted by the Program Manager. In the event of subsequent modifications to the Project, Design Builder, and Program Manager may mutually agree that a subsequent revision of the Progress Schedule constitutes a new baseline Progress Schedule that supersedes the prior baseline Progress Schedule.

c. "Constraint" means an imposed date on the Progress Schedule or an imposed time between activities. The Contract Times are constraints.
d. "CPM Progress Schedule" means, in addition to the General Conditions' definition of "Progress Schedule", a computerized Progress Schedule in critical path method (CPM) format, for the entire Work, indicating interrelationships between elements of the Work; indicates sequences, dates, and durations for Work performed to date; indicates sequences, dates, and duration for incomplete Work yet to be performed; indicates constraints; and indicates the critical path for the Work.
e. "Critical path" is the continuous chain of activities, from start to completion of the Work, with the longest duration for completion within the Contract Times.
f. "Early finish" means the earliest date an activity can finish according to the assigned relationships among the activities in the Progress Schedule.
g. "Early start" means the earliest possible date an activity can start according to the assigned relationships among activities in the Progress Schedule.
h. "Float" means the time difference between the calculated duration of an activity chain on the Progress Schedule and the critical path.
i. "Late finish" means the latest date an activity on the Progress Schedule can finish without extending the Contract Times.
j. "Late start" means the latest date an activity on the Progress Schedule can start without extending the Contract Times.
k. "Network diagram" means a time-scaled logic diagram showing the durations and relationships of the activities on the Progress Schedule.
l. "Schedule date" (and similar terms, whether used in this Section or Project communications related to Progress Schedules) mean the "early start" and "early finish" date for the associated activity. "Late start" and "late finish" dates are for determining float and do not represent the schedule dates.
m. "Total float" means the total number of days an activity (or chain of activities) on the Progress Schedule can be delayed without affecting the Contract Times.
n. "Work areas" and "work system" means a logical breakdown of the Work elements or a group of activities which, when collectively assembled, are readily identifiable on the Project (for example: yard piping, a structure or building, a treatment process, or other logical grouping).

1.3 ADMINISTRATIVE REQUIREMENTS

A. General Provisions on Progress Schedules:
1. This Section augments requirements for the Progress Schedule, and Design Builder's control of the Work, indicated in the General Conditions, as may be augmented by the Supplementary Conditions.

B. Use of Float:
1. Float belongs to the Project and may be used by Design Builder or Owner to accommodate changes in the Work, or to mitigate the effect of events delaying the Work or compliance with the Contract Times.
2. Changes or delays that influence activities that have float and do not extend the critical path do not justify changes in the Contract Times.
3. Float Suppression: Pursuant to float sharing requirements of this Section, use of float suppression techniques in Progress Schedules, such as preferential sequencing logic, special lead/lag logic restraints, and extended activity durations are unacceptable.

C. Factors Affecting the Progress Schedule:
   a. In preparing and updating the Progress Schedule, take into consideration the following and other factors that have the potential to affect completion of the Work within the Contract Times:
      1) preparing and signing subcontracts and purchase orders,
      2) complying with Submittal requirements and Submittal review times,
      3) fabricating materials and equipment,
      4) source quality control (including required shop tests and inspections),
      5) shipping and deliveries,
      6) field quality control (including required field tests and inspections at the Site),
      7) Work by Subcontractors,
      8) coordination with others (such as other contractors including those indicated in Section 01 11 00 – Summary of Work, utility owners, and owners of transportation facilities),
      9) compliance with Laws and Regulations and permits,
      10) availability of construction equipment and machinery,
      11) abilities of workers,
      12) weather conditions,
      13) condition of the Site,
      14) seasonal restrictions,
      15) restrictions in operations at the Site and coordination with Owner's operations,
      16) training of facility operation and maintenance personnel,
      17) checkout,
      18) start-up, and
      19) adjusting and balancing.

D. Scheduling Workshop Conferences:
   1. Prior to preparing the preliminary Progress Schedule, Design Builder shall participate with Program Manager and Owner in one workshop conference, up to 4 HRS in duration, to discuss technical requirements relative to sequencing and organizing the Work, Progress Schedule development, and Progress Schedule procedures.
   2. Design Builder and Program Manager will mutually agree on the date, time, and location of scheduling workshop conference(s).
   3. Required Attendees:
      a. Design Builder's project manager, site superintendent, and Progress Schedule preparer.
      b. Program Manager
      c. Owner may attend scheduling workshop conferences.
   4. Program Manager will prepare minutes of the scheduling workshop conferences and distribute minutes to conference attendees and others as deemed appropriate by Program Manager.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Progress Schedule Preparer:
      a. Design Builder shall retain services of a scheduling consultant to, or shall self-perform, preparation and updating of the Progress Schedule using qualified personnel experienced in: (1) construction scheduling, (2) the scheduling software required for the Project, and (3) serving as Progress Schedule preparer on construction projects of similar type, size, and complexity as the Project.
      b. Progress Schedule preparer shall have not less than 5 years' experience using the required schedule software on construction projects of similar type, size, and complexity as the Project.

c. Prior to engaging a scheduling consultant or using a qualified, experienced employee, submit to Program Manager the following qualifications information:
   1) Name, employer, and business address of proposed Progress Schedule preparer and names, employer(s), and business address(es) of personnel who will be assigned to assist the preparer in developing and updating the Progress Schedule.
   2) Information sufficient to demonstrate that proposed Progress Schedule preparer and scheduling assistant personnel possess qualifications complying with this Section. For each person assigned, submit list of similar type, size, complexity, and construction contract amount for each project, together with project name, owner, location, and dates, and name(s) of scheduling personnel involved.

d. Program Manager's Review of Qualifications:
   1) Program Manager will complete review of Progress Schedule preparer qualifications within 3 business days of Program Manager's receipt of such qualifications.
   2) If qualifications are unacceptable, submit qualifications of acceptable personnel within 3 business days of Design Builder's receipt of Program Manager's non-acceptance.
   3) Program Manager's acceptance or non-acceptance of qualifications does not reduce or mitigate Design Builder's obligations under the Contract Documents.

e. If Design Builder intends to replace any Progress Schedule preparer personnel previously acceptable to Program Manager, submit qualifications of proposed replacement(s) in accordance with this Article.

1.5 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Qualifications Statements:
      a. Submit qualifications of Progress Schedule preparer, and other personnel that will assist Progress Schedule preparer in preparing and updating the Progress Schedule.
      b. Obtain Program Manager's acceptance of qualifications prior to starting preparation of preliminary Progress Schedule.
   2. Planned Work Schedule:
      a. Submit initial and updated (as necessary) planned work schedule, in accordance with this Section's "Progress Schedule" Article.
   3. Progress Schedule:
      a. Preliminary Progress Schedule with associated narrative report.
      b. Acceptable Progress Schedule ("baseline Progress Schedule") with associated narrative report.
   4. Look-Ahead Schedules:
      a. Submit 6-week look-ahead schedule at each construction progress meeting, in accordance with this Section's "Look-Ahead Schedules" Article.
   5. Progress Schedule Updates:
      a. Progress Schedule updates shall comply with requirements of this Section, and shall include updated Progress Schedule and narrative report.
      b. Submit updated Progress Schedule prior to each associated construction progress meeting. When a Progress Schedule remains unchanged from one construction progress meeting to the next, submit written statement expressly so stating. In addition to monthly Progress Schedule update Submittals, also bring to construction progress meetings the number of paper copies of the updated Progress Schedule indicated in Section 01 31 19 - Project Meetings.
   6. Time Impact Analyses: Submit in accordance with this Section.
   7. Recovery Schedules: Submit in accordance with this Section.

1.6 INITIAL CONSTRUCTION IMPLEMENTATION STAGE PROGRESS SCHEDULES

A. Applicability of this Article:
   1. This Article addresses the initial Progress Schedules and selected, related Submittals required at the outset of the Project's early work and/or construction phase, through Program Manager's acceptance of the Progress Schedule and its related Submittals.
   2. Subsequent Progress Schedule Submittals, including Progress Schedule updates, recovery schedules, and other schedule-related Submittals, shall comply with software, type, organization, content, and similar requirements of this Article.

B. Type and Organization of Progress Schedules:
   1. Prepare Progress Schedules using Oracle Primavera P6 software, unless other scheduling software is acceptable to Program Manager.
   2. Sheet Size: 22 IN by 34 IN, unless otherwise accepted by Program Manager.
   3. Time Scale: Indicate first date of each work week.
   4. Activity Assignments and Designations:
      a. Limit activities, where possible, excluding fabrication of materials and equipment, to durations not longer than 20 days. Activities shall be definable and measurable. For example, an activity described only as "Concrete" will likely be unacceptable.
      b. Assign to each activity an appropriate, unique numerical designation and description.
      c. Numerical designation shall incorporate the associated Specifications section number.
      d. Activity description shall include sufficient detail to clearly communicate the intended activity. Descriptions shall include identifiers for physical locations of work area or work system, such as (where appropriate) column lines, stationing (for linear projects), and elevations. Indicate unique description for each activity.
      e. Group deliveries of materials and equipment into a separate sub-schedule that is part of the Progress Schedule.
      f. Group construction into work area sub-schedules (that are part of the Progress Schedule) by activity.
      g. Clearly indicate, as activities separate from installation, necessary and required curing periods.
   5. Organization of Progress Schedules:
      a. Indicate interfaces and dependencies with preceding, concurrent, and follow-on activities, including those associated with the Work, other contractors at the Site, Owner, Program Manager, authorities having jurisdiction, and others as appropriate. Clearly indicate activities not under Design Builder's control.
      b. Progress Schedules shall be CPM Progress Schedules.
      c. Indicate on the separate Schedule of Submittals dates for submitting and reviewing design submittals, Shop Drawings, product data Submittals, Samples, and other required Submittals. Coordinate Progress Schedule with the Schedule of Submittals.
      d. Clearly indicate the critical path on the Progress Schedule.

C. Planned Work Schedule:
   1. Within 30 days of the GMP Amendment, indicate to Program Manager the work days and hours proposed by Design Builder. Also indicate planned non-work days, such as Design Builder's holidays, weekends, and the like.
   2. Enforce Subcontractors' and Suppliers' (when at the Site) compliance with Design Builder's work schedule submitted to Program Manager.
   3. In the event of changes, submit to Program Manager revised work schedule. Furnish such Submittal not less than 3 days prior to changing Design Builder's work schedule, except in event of unanticipated emergency.

D. Preliminary Progress Schedule:
   1. Within 10 days after the GMP amendment, Design Builder shall submit to Program Manager the preliminary Progress Schedule covering the entire Project, with associated schedule-related Submittals required in this Section's "Submittals" Article.

2. Submit preliminary Progress Schedule in accordance with Section 01 33 00 - Submittal Procedures. Also submit preliminary Progress Schedule in its native (executable) format generated by the scheduling software.
3. Program Manager will perform timely review of the preliminary Progress Schedule.
4. Preliminary Progress Schedule shall comply with the Contract Documents relative to Progress Schedules, but need not be cost-loaded.

E. Initial Acceptance of Progress Schedule:
   1. Not less than 10 days before submission of the first Application for Payment during the Construction Implementation Stage, a scheduling conference attended by Design Builder, Progress Schedule preparer, Program Manager, and others as appropriate will be held at the Site to review for acceptability to Program Manager the preliminary Progress Schedule and associated schedule-related Submittals. Following the scheduling conference, Design Builder shall have 10 days to make corrections and adjustments and to complete and resubmit the Progress Schedule and associated schedule-related Submittals. Design Builder will not be eligible for first progress payment until acceptable Progress Schedule and associated schedule-related Submittals are submitted to Program Manager and are acceptable to Program Manager.
   2. Submit acceptable Progress Schedule, together with associated schedule-related Submittals in accordance with this Section's "Submittals" Article and Section 01 33 00 - Submittal Procedures. Also submit acceptable form of Progress Schedule in its native (executable) format generated by the scheduling software.
   3. The Progress Schedule will be acceptable to Program Manager if it provides an orderly progression of the Work to completion within the Contract Times, in accordance with the Contract Documents.
   4. Initially-accepted Progress Schedule shall be identified as the baseline Progress Schedule.
   5. Basis for Payments:
      a. For Lump Sum Work:
         1) After the cost-loaded Progress Schedule is accepted by Program Manager, each of Contractor's progress payment request, for Work compensated on a lump sum basis will be on the basis of earned revenue as indicated in updates of the cost-loaded Progress Schedule and other relevant provisions of the Contract Documents.
         2) Until cost-loaded Progress Schedule is acceptable to Program Manager, basis for Contractor's progress payment requests for lump sum Work will be manually determined by Contractor, subject to Program Manager's recommendation to Owner, based on the Schedule of Values accepted by Program Manager.
      b. Unit Price Work and Cost-Plus-a-Fee:
         1) Determination of amounts eligible for payment for Unit Price Work and Work compensated on the basis of cost-plus-a-fee will be in accordance with the applicable provisions of the Contract Documents. Payment for such Work will not be determined using the cost-loaded Progress Schedule accepted by Program Manager.

F. Planned Completion Different from the Contract Times:
   1. If the Progress Schedule accepted by Program Manager indicates completion date(s) different than the Contract Times, the Contract Times are not thereby changed.
   2. Where the Progress Schedule accepted by Program Manager indicates date(s) by which the Work, or designated portion thereof, will (a) achieve a Contractually stipulated Milestone, or (b) be substantially complete, or (c) all the Work will be complete and ready for final payment, earlier than the Contract Times ("early completion date"), Design Builder shall, not less than 180 days prior to the associated Contract Time, prepare and submit a Change Proposal setting forth Design Builder's request to modify the Contract Times to an earlier date, which may or may not be the same as the scheduled early completion date. The Contract Times can be modified only via a Change Order.

3. In the event the Progress Schedule accepted by Program Manager indicates one or more early completion dates and the Contract Times have not been reduced, Owner may, at Owner's option, use available float without Owner being liable for Design Builder's costs to remain on-site, mobilized, and working (whether on the original scope of the Work or for modified Work) beyond the scheduled early completion date(s), as long as the Work will be completed within the Contract Times.
4. When the Work will not be completed within the Contract Times, the Contract Documents' provisions concerning delays and changes in the Contract Times govern.

1.7 LOOK-AHEAD SCHEDULES

A. Look-Ahead Schedules – General:
   1. Look-ahead schedules are short-duration, often more-detailed, time-based schedules for the Work to be performed during the coming month or other required span of the look-ahead schedule.
   2. Purpose of look-ahead schedules is to present for Project stakeholders, including Owner, Program Manager, Owner-hired testing and inspection entities, other contractors working at or adjacent to the Site, utility owners, transportation facility owners, and others as necessary, the Design Builder's detailed, time-based plan for performing the Work during the period covered by the time span of the look-ahead schedule.
   3. This Section's "Submittals" Article indicates the required span and frequency of look-ahead schedules.
   4. Each look-ahead schedule shall be fully coordinated and consistent with the current Progress Schedule update.
   5. Submit look-ahead schedules concurrent with construction progress meetings and Section 01 33 00 - Submittal Procedures. Also submit look-ahead schedules in native (executable) format.
   6. As handouts, bring to each construction progress meeting the quantity of paper copies of the new look-ahead schedule indicated in Section 01 31 19 - Project Meetings. If quantity is not indicated in Section 01 31 19 - Project Meetings, furnish quantity equal to typical number of attendees of progress meetings.

B. Organization and Content of Look-Ahead Schedules:
   1. Look-ahead schedules shall be prepared from the current Progress Schedule update, of the same type, using the same software, content, and organization required in this Section for initial Progress Schedules.
   2. Activity designations on look-ahead schedules shall incorporate the associated activity designations from the Progress Schedule.
   3. Sheet Size: Format look-ahead schedules to sheet size of 11 IN by17 IN, unless other sheet size is acceptable to Program Manager.
   4. Look-ahead schedules should generally be more-detailed than the Progress Schedule. Activity durations on look-ahead schedules should not exceed 5 days.

1.8 PROGRESS SCHEDULE UPDATES

A. Updates – General: The procedures below apply to both Design Implementation Stage and Construction Implementation Stage schedule updates.
   1. Update the Progress Schedule not less-often than once per month. If during progress of the Work events develop that necessitate changes in the initially accepted Progress Schedule (baseline Progress Schedule), identify updated Progress Schedules sequentially as "Progress Schedule Revision "1", "2", "3", and continuing in sequence as required. Number the Progress Schedule submittals in accordance with Section 01 33 00 - Submittal Procedures.
   2. Progress Schedule updates shall comply with this Section's requirements for initial progress Schedule, relative to type, required software, organization, content, and related matters.
   3. Starting with first Progress Schedule update, and continuing with each subsequent update, indicate on the Progress Schedule the actual start and finish dates of each activity that is completed or is currently underway. Inaccurate representation of completed or in-progress

activities will be grounds for Program Manager's non-acceptance of the Progress Schedule update.

4. Design Builder's Progress Schedule update shall include a narrative report in accordance with this Section. Narrative report shall include description of: progress achieved to date and status of each work area of the Project, planned progress for the upcoming period, identification of the critical path, current or potential delays, Change Orders (pending and approved since the previous Progress Schedule update), and other problems associated with performing the Work in accordance with the baseline Progress Schedule and complying with the Contract Documents, including the Contract Times. Indicate in the narrative report delays that have occurred since the previous updated Progress Schedule.
5. The update to the Progress Schedule shall be based on retained logic. Progress override logic is not allowed.
6. Submit to Program Manager updated Progress Schedule, together with associated schedule-related Submittals, in accordance with this Section's "Submittals" Article and Section 01 33 00 - Submittal Procedures. Also submit updated Progress Schedule in its native (executable) format generated by the scheduling software.

B. Monthly Construction Implementation Stage Schedule Meeting:
   1. During the month, utilizing the previous month's look-ahead schedule. Design Builder shall record the percent complete, start and finish dates of each scheduled activity with the remaining duration for each activity started but not completed, including activities associated with procurement of materials and equipment.
   2. On the same day each month, not less than 1 week prior to a progress meeting, Design Builder, Progress Schedule preparer, Program Manager, and others as appropriate shall meet at the Site to tour the Work to review and recommend updates to the Progress Schedule and progress information gathered by Design Builder during the month. After discussion of Design Builder's current progress information and attendees' review of the current status of the Work, Progress Schedule preparer shall appropriately and accurately update the Progress Schedule.

1.9 NARRATIVE REPORTS

A. Narrative Reports – General:
   1. Prepare and include with the preliminary Progress Schedule Submittal and each subsequent Progress Schedule Submittal, written narrative report describing the schedule-related constraints required by the Contract Documents and Design Builder's plan and schedule for complying with such requirements. Narrative reports shall also include required content indicated above in this Section's "Progress Schedule Updates" Article.
   2. Narrative report shall describe the methods of sequencing and operation, resources to be employed, time frames for the construction of each of the major work area or work system on the Project, and time frames for complying with the Contract Times and Design Builder's interim schedule milestones.
   3. Prepare narrative reports on Design Builder's company letterhead and clearly indicate the Progress Schedule revision and date associated with the narrative report.
   4. Narrative reports shall be written in English and typed. Use clear, concise, complete, and accurate language in narrative reports. Clearly indicate in narrative report the name of person preparing the narrative report and date of preparation
   5. Narrative report Submittals do not constitute contractual Change Proposals, nor are they notice of a Claim.
   6. Program Manager's receipt, review, and acceptance of narrative reports does not mitigate or reduce Design Builder's obligations to furnish contractually required notices.

1.10 COST-LOADING REPORTS

A. Cost Loading:
   1. Assign to each activity a total monetary amount commensurate with its value relative to the associated line item in the Schedule of Values accepted by Program Manager.

2. Use of cost-loaded Progress Schedule as basis for determining amounts eligible for progress payments is addressed in this Section's "Initial Progress Schedules" Article, in the provision on cost-loaded progress Schedules. Submit cost reports for the initially accepted cost-loaded (baseline) Progress Schedule and each subsequent update of the Progress Schedule.

1.11 TIME IMPACT ANALYSIS

A. Time Impact Analyses – General:
   1. Prepare and submit time impact analysis when one or more of the following occurs: (a) Change Proposal is prepared; (b) Work Change Directive is issued that will affect the Progress Schedule; or (c) when delays occur.
   2. Time impact analysis shall illustrate influence of each Change Order, Work Change Directive, allowance authorization, or delay, as applicable, on Design Builder's ability to comply with the Contract Times and Progress Schedule constraints.
   3. In performing time impact analysis, use Progress Schedule having revision date closest to and prior to the event giving rise to the delay or other change in the Work.
   4. Indicate in time impact analysis activities on the Project's critical path prior to the event giving rise to the delay or other Change in the Work; activities added, extended, or deleted as a result of the delay or change in the Work; and impact of such changes on the Project's critical path activities.
   5. Indicate in time impact analysis activities not within Design Builder's control.
   6. Time impact analysis shall demonstrate the time impact, based on date the Change Order, Work Change Directive, or allowance authorization was given to Design Builder or, as applicable, date the delay started to occur; the status of the Work at that time; and activity duration of affected activities. Activity duration used in time impact analysis shall be those included in most recent Progress Schedule update accepted by Program Manager, closest to start of the delay or start of the Change Order, Work Change Directive, or allowance authorization as adjusted by mutual, written agreement of the parties and Program Manager.
   7. If resource constraints are a part of the time impact analysis, the Program Manager reserves the right to require a full resource loaded schedule for comparison purposes.
   8. Timing of Time Impact Analysis:
      a. Submit time impact analysis with Change Proposal.
      b. When time impact analysis is not part of a Change Proposal, submit each time impact analysis within 30 days after the following, as applicable:
         1) Start of the delay.
         2) After Design Builder's receipt of Work Change Directive.
      c. When Design Builder does not submit time impact analysis for a specific change or delay, within the specified period for such submittal, such non-submittal will indicate extension of the Contract Times is not needed.

B. Evaluation by Program Manager and Acceptance:
   1. Program Manager's evaluation of each time impact analysis comprised of complete information will be completed in a timely manner (in accordance with the Contract Documents) after Program Manager's receipt.
   2. When time impact analysis is incomplete or otherwise inappropriate, Program Manager will furnish comments to Design Builder. When time impact analysis is complete and apparently appropriate, its acceptability will be indicated by associated Contract modification or allowance authorization.
   3. Changes in the Contract Times will be made only by Change Order.
   4. When mutual agreement is reached between the parties on effect of the change or delay in the Project, incorporate into the next Progress Schedule and update the associated fragnets illustrating the influence of changes and delays.

1.12 RECOVERY SCHEDULES

A. Recovery Schedules – General:
   1. When updated Progress Schedule indicates the ability to comply with the Contract Times falls 14 days or more behind schedule, and there is no excusable delay, Change Order, or Work Change Directive to support an extension of the Contract Times, Design Builder shall prepare and submit to Program Manager Design Builder’s recovery schedule.
   2. Recovery schedule is a Progress Schedule demonstrating Design Builder’s plan to accelerate the Work to achieve compliance with the Contract Times. If achieving the Contract Times is not feasible, Design Builder’s recovery schedule shall indicate Design Builder’s plan to recover as much of the lost time as possible to complete the Work as close as possible to the Contract Times.
   3. Submit recovery schedule within 10 days after submittal of updated Progress Schedule where need for recovery schedule is indicated.

B. Recovery Schedule Report:
   1. With each recovery schedule Submittal, include recovery schedule narrative report, manually prepared by Design Builder, on Design Builder’s company letterhead, indicating name of person responsible for preparing the recovery schedule and report.
   2. Recovery schedule report shall verbally indicate Design Builder’s plan for accelerating the Work and recovering lost time, and shall indicate the total number of days expected to be recovered by Design Builder’s implementation of the recovery schedule. Clearly indicate how the intended actions will recover lost time.
   3. Design Builder is fully responsible for complying with the Contract Documents, including the Contract Times.

C. Implementation of Recovery Schedule:
   1. At no additional cost to Owner, do one or more of the following, as appropriate: (a) furnish additional labor, (b) provide additional construction equipment and machinery, (c) provide suitable materials to accelerate the Work, (d) employ additional work shifts, (e) expedite procurement of materials and equipment to be incorporated into the Work or otherwise expedite delivery of such items, (f) provide other needed resources, and (g) provide other measures necessary to complete the Work within the Contract Times.
   2. Upon acceptance of recovery schedule by Program Manager, incorporate recovery schedule into the next Progress Schedule update.

D. Design Builder’s Failure to Recover Lost Time:
   1. Design Builder’s refusal, failure, or neglect to take appropriate measures to recover lost time, or to submit a recovery schedule, shall constitute reasonable evidence that Design Builder is not prosecuting the Work, or designated part of the Work, with diligence to ensure completion in accordance with the Contract Times. Such action or inaction by Design Builder shall constitute sufficient basis for Owner to exercise remedies available to Owner under the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Definition of various types of Submittals.
   2. Coordination requirements for Submittals.
   3. General provisions concerning Submittals.
   4. Schedule of Submittals.
   5. Design Builder’s preparation of Submittals, including:
      a. Numbering.
      b. Marking.
      c. Organization and content.
      d. Proposed “or-equals”, substitutes, and deviations from Contract requirements.
      e. Electronic Documents Submittals.
      f. Design Builder’s review and approval of each Submittal.
      g. Resubmittals.
   6. Design Builder’s transmittal of Submittals, including transmittal letters, transmittal and delivery method, and delivery of Samples, Closeout Submittals, and Maintenance Materials Submittals.
   7. Owner and Program Manager’s review, including:
      a. Timing.
      b. Meaning of Program Manager’s Submittal action code(disposition) assigned.
      c. Delivery of Program Manager’s responses on Submittals.

B. Scope:
   1. Design Builder shall provide all labor, materials, equipment, tools, services, incidentals, and other effort necessary to furnish Shop Drawings, product data Submittals, Samples, and other Submittals in accordance with the Contract Documents.
   2. This Section’s Article, “General Provisions Concerning Submittals” includes a summary of the Contract Documents’ locations of Submittals requirements.
   3. Shop Drawings, product data Submittals, Samples, and other Submittals, whether or not approved or accepted by Owner, are not Contract Documents. Owner’s review or comment on submittals, as applicable, of a Submittal does not alter or modify the Contract Documents.
   4. Owner has the right to rely on Design Builder’s representations and certifications made regarding each Submittal.

C. Related Requirements: Include but are not limited to:
   1. Section 01 32 16 - Construction Progress Schedule.

1.2 REFERENCES

A. References – Introduction:
   1. This Article presents definitions and terminology used in this Section and throughout the Contract Documents.
   2. Applicability of the Term “Submittals”: Where reference is made to Shop Drawings, product data Submittals, Samples, or other Submittals in this Section and elsewhere in the Contract Documents, the term “Submittals”, as defined in the Contract Documents, is intended. The foregoing applies regardless of whether such term is indicated with an initial capital letter, unless context of the subject provision clearly indicates otherwise.

3. Types of Submittals:
    a. Submittal types are classified as follows: (1) Action Submittals, (2) Informational Submittals, (3) Closeout Submittals, and (4) Maintenance Materials Submittals.
    b. Type of each required Submittal is indicated in the associated Specifications section. When Submittal type is not clearly indicated in the associated Specifications section, Submittal will be classified as indicated in this Article. Submit request for interpretation when Design Builder is uncertain of required Submittal type.
4. Design Implementation Stage submittals are not included herein. Refer to Attachment A to the Agreement (Scope of Work) for definition and review of Design Implementation Stage submittals.

B. Action Submittals:
1. Action Submittals require an explicit, written approval or other appropriate action by Design Professional or Owner (or other entity to whom the Submittal is required to be furnished, in accordance with the Contract Documents) before Design Builder may release the associated item(s) for raw materials procurement, fabrication, production, and shipping.
2. Unless otherwise indicated in the Contract Documents, Action Submittals include the following:
    a. Shop Drawings.
    b. Product data.
    c. Samples.
    d. Testing plans for quality control activities required by the Contract Documents.
    e. Delegated Designs: Delegated Submittals required by the Contract Documents.
3. General Conditions' requirements for Shop Drawings and Samples hereby apply to all Action Submittals.
4. Prior to the start of construction activities, Design Builder shall submit a list of all action submittals for Owner and Program Manager review. From this list of action submittals, the Owner will identify Critical Action Submittals that require joint Owner and Design Professional review prior to final Design Professional approval of the Action Submittal. Design Builder shall acknowledge agreement with the Critical Submittal Review through indicating such submittals on the final submittal list. Critical Action Submittals may include but are not limited to the following:
    a. Concrete mix designs.
    b. Hazardous material mitigation.
    c. Samples.
    d. Testing Plans.
    e. Delegated Designs, including earth retention and pipe stress analysis.
    f. Painting and Coatings.
    g. HVAC Equipment.
    h. Electrical Equipment.
    i. Process Control .
    j. Process equipment.
5. All Action Submittals not identified as Critical Action Submittals by the Owner shall be treated as Information Submittals for the Owner. Documentation of Design Professional review and approval for all Action Submittals (whether Critical or not) is required.

C. Informational Submittals:
1. Informational Submittals are so indicated in the Contract Documents. Unless otherwise indicated, Informational Submittals include certifications, evaluation reports, results of source quality control activities, results of field quality control activities, Supplier instructions, reports of Suppliers' visits to the Site, sustainable design Submittals (that are not Closeout Submittals), delegated design Submittals that are not "instruments of service" Submittals, qualifications statements, and others.

2. Informational Submittals, when submitted in accordance with the Contract and indicating full compliance with the Contract Documents, do not require explicit response from Program Manager or Owner (or other entity to whom the Submittal is to be delivered).
3. When Informational Submittal does not indicate full compliance with the Contract Documents, Program Manager (or other entity to which Submittal is to be delivered) will indicate the non-compliance in a written response to Design Builder.
4. Any specification reference requiring the Design Builder to submit information that is not specifically included under a Submittal heading shall be treated as an Informational Submittal.

D. Closeout Submittals:
1. Closeout Submittals are so indicated in the Contract Documents and are, in general, required before the associated Work is completed, unless earlier submittal is required by the Contract Documents.
2. Unless indicated otherwise in the Contract Documents, Closeout Submittals include maintenance contracts, operation and maintenance data, warranties, bonds (other than performance and payment bonds required prior to the start of construction), record documents, sustainable design closeout Submittals, software, keys, and others.
3. Closeout Submittals are processed in the same manner as described above for Informational Submittals.

E. Maintenance Materials Submittals:
1. Maintenance materials include spare parts, extra materials, tools, and similar items required to be furnished in accordance with the Contract Documents.
2. Furnish required physical maintenance materials, delivered to Owner at the location(s) indicated in the Contract Documents, for the corresponding required Maintenance Materials Submittals.
3. Maintenance Materials Submittals are documentation of delivery to Owner, and their acceptance of, required physical maintenance materials.
4. Maintenance Materials Submittals are processed in the same manner as described above for Informational Submittals.

F. Additional Terms:
1. The following terms have the meanings indicated below, regardless of whether such terms are indicated using initial capital letters, and apply to singular and plural of each:
   a. “Product data” means illustrations, standard schedules, performance charts, Supplier’s published instructions, brochures, diagrams, and other information furnished by Design Builder to illustrate or describe materials or equipment for some portion of the Work. In general, product data are manufacturers’ pre-published information on the items proposed to be incorporated into the Work. Product data include manufacturer’s catalog pages and similar documents with Design Builder-made markings and indications of proposed products and proposed options.
   b. The term “Shop Drawings”, defined in the General Conditions, is supplemented by the following: Shop Drawings include: (1) fabrication and assembly drawings, usually having a title block, or (2) schedules, prepared specifically for the Project. Here, “schedules” means a Project-specific summary of systems and components, such as a schedule of HVAC equipment, schedules of doors and door hardware, or windows, or a schedule of paint systems by room and surface, or other similar Project information in a tabular format. In contrast, construction Progress Schedules, Schedules of Submittals, and Schedules of Values are not Shop Drawings.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Furnish Submittals well in advance of need for the associated material or equipment, or procedure (as applicable), in the Work and with ample time necessary for delivery of

materials and equipment and to implement procedures following Design Professional’s and Owner’s approval or acceptance of the associated Submittal.

2. Work covered by a Submittal will not be included in payments by Owner until approval or acceptance (as applicable) of related Submittals has been obtained in accordance with the Contract Documents.

1.4 GENERAL PROVISIONS CONCERNING SUBMITTALS

A. Locations of Requirements:

1. Requirements concerning Submittals are generally located as follows:
    a. General Conditions, as may be modified by the Supplementary Conditions, applicable to the Project.
    b. This Section, which presents general requirements for Submittals applicable to the Project.
    c. Other Division 01 Specifications that include general requirements for certain types of Submittals, Section 01 78 23 - Operation and Maintenance Data, and others.
    d. The “Submittals” Article of the various Specifications sections, which indicates the required Submittals for the associated Work. Furnish all Submittals required by the Contract Documents regardless of whether explicitly indicated in the associated Specifications’ “Submittals” Article.

B. This Section augments and supplements the requirements of the General Conditions, as may be modified by the Supplementary Conditions, relative to Submittals.

1.5 SCHEDULE OF SUBMITTALS

A. Informational Submittals: Submit the following:

1. Schedule of Submittals:
    a. Timing:
        1) Furnish Schedule of Submittals within time frames indicated in the General Conditions, as may be modified by the Supplementary Conditions.
        2) Submit updated Schedule of Submittals with each submittal of the updated Progress Schedule.
    b. Content: In accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section. Requirements for content of preliminary Schedule of Submittals and subsequent Submittals of the Schedule of Submittals are identical. Identify on Schedule of Submittals all Submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Clearly indicate Submittals that are on the Project’s critical path. Indicate the following for each Submittal:
        1) Date by which Submittal will be received by Design Professional and/or Owner.
        2) Whether Submittal will be for a substitution or “or-equal”.
        3) Date by which Design Professional’s and/or Owner’s response is required. Allow not less than 28 days for Owner review, starting on Owner’s actual receipt of each Submittal. Allow increased time for large or complex Submittals.
        4) For Submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of others (if any).
        5) Identification of Critical Action Submittals that require joint Owner and Design Professional review prior to final Design Professional approval of the Action Submittal.
    c. Prepare Schedule of Submittals using same software, and in same format as construction progress schedule, specified for Progress Schedules in Section 01 32 16 - Construction Progress Schedule.
    d. Coordinate Schedule of Submittals with the Progress Schedule.
    e. Schedule of Submittals that is not compatible with the Progress Schedule, or that does not indicate Submittals on the Project’s critical path, or that places extraordinary

demands on Program Manager for time and resources, is unacceptable. Do not include Submittals not required by the Contract Documents.

f. In preparing Schedule of Submittals:
   1) Considering the nature and complexity of each Submittal, allow sufficient time for reviews and revisions.
   2) Allow reasonable time for: Owner's review and processing of Submittals, for Submittals to be revised and resubmitted, and for returning Submittals to Design Builder.
   3) Identify and accordingly schedule Submittals that are expected to have long anticipated review times.

1.6 PREPARATION OF SUBMITTALS

A. Prior to Submittal Preparation:
   1. The General Conditions, as may be modified by the Supplementary Conditions, address Design Builder's responsibility for submitting for Owner's acceptance identification of Subcontractors and Suppliers. Obtain Owner's acceptance before entering into subcontracts and purchase orders for the Work.
   2. Comply with the Contract Documents relative to terms and conditions of subcontracts and purchase orders for the Work.

B. Submittal Identification:
   1. Submittal Number: Shall be a unique number assigned to each individual Submittal. Assign Submittal numbers as follows:
      a. First part of Submittal number shall be the applicable Specifications section number, followed by a hyphen.
      b. Second part of Submittal number shall be a three-digit number (sequentially numbered from 001 through 999) assigned to each separate Submittal furnished under the associated Specifications section.
      c. Example: Submittal number for the third Submittal furnished for Section 10 14 00 - Signage, would be "10 14 00-003".
   2. Review Cycle Number: Each resubmittal of a given Submittal shall be indicated with a upper-case letter designation:
      a. Use capital letter "A" for the initial (first) submittal of the Submittal number.
      b. "B" shall indicate first resubmittal of the Submittal number.
      c. "C" shall indicate second resubmittal of the Submittal number.
   3. Examples:

EXAMPLE DESCRIPTION	SUBMITTAL IDENTIFICATION	
	SUBMITTAL NO.	REVIEW CYCLE
Initial (first) review cycle of the third Submittal furnished under Section 10 14 00 – Signage	10 14 00-003-	A
Second review cycle (first resubmittal) of third Submittal furnished under Section 10 14 00 - Signage	10 14 00-003-	B

C. Marking of Submittals:
   1. Mark on each page of each Submittal and each individual component submitted with Submittal number and applicable Specifications paragraph.
   2. Mark each page of each Submittal with the Submittal page number.
   3. Each Shop Drawing sheet shall have title block with complete identifying information satisfactory to Program Manager.

4. For product data Submittals, operation and maintenance data Submittals, and other Submittals:
   a. Mark options to be furnished using broad, dark arrows or “clouds” clearly drawn around the relevant text or diagrams. Do not use highlighter for indicating options and features.
   b. Indicate options and features not furnished using clear strikeouts through the text or diagrams.

D. Submittal Organization and Content – General:
   1. Page or Sheet Size; Furnish Submittals with one or more of the following page or sheet sizes: (a) 8.5 IN by 11 IN; (b) 11 IN by 17 IN; (c) 22 IN by 34 IN; unless another sheet size is acceptable to Design Professional.
   2. Language: All parts of each Submittal shall be in the English language.
   3. Units of Measurement: Clearly indicate units of measurement on Shop Drawings, product data Submittals, record documentation, and operation and maintenance data Submittals.
   4. Organize each Submittal logically to facilitate ease of understanding and review.
   5. To the extent practicable, arrange Submittal information in same order as requirements are written in the associated Specifications section.
   6. Each Submittal shall cover Work under only one Specifications section.
   7. To the extent practicable, package together Submittals for the same Specifications section. Do not furnish required information piecemeal.
   8. For large or complex Submittals, include a title page and table of contents.
   9. Include appropriately labeled fly sheets to separate distinct parts of each Submittal.
   10. Ensure legibility of all pages in each Submittal.
   11. Minimize extraneous and unnecessary information in Submittals for materials and equipment. Do not submit information not relevant to the Submittal and associated requirements of the Contract Documents.
   12. Design Builder’s, Subcontractor’s, and Supplier’s written comments on Shop Drawings and product data diagrams shall be colored green.
   13. Do not submit under Specifications sections with title that include “Basic Requirements”, unless the subject material or equipment is specified, in total, in a Specifications section with the words, “Basic Requirements” in its title.

E. Electronic Documents Submittals:
   1. Format: Electronic Documents Submittals shall be “portable document format” (.PDF) files unless expressly required otherwise by applicable provisions of the Contract Documents.
   2. Electronic Documents Submittals must be electronically searchable when delivered to Design Professional and other recipients.
   3. Organization and Content:
      a. Each Electronic Documents Submittal shall be one file; do not divide individual Submittals into multiple Electronic Documents files each unless file size will exceed 25 MB.
      b. When Submittal is large or contains multiple parts, furnish PDF file with suitably titled electronic bookmark for each section of the Submittal.
      c. Content shall be identical to paper or other original Submittal. First page of each Electronic Documents Submittal shall be the transmittal letter required in this section’s Paragraph 1.7.A.
   4. Quality and Legibility: Electronic Documents Submittal files shall be made from the original and shall be clear and legible. Markings applied by Design Builder, Subcontractor, or Supplier shall be clear, distinct, and readily apparent. Electronic Documents file shall be full size of original documents. Properly orient all pages for convenient reading on a computer display; do not furnish pages sideways or upside-down.
   5. Provide sufficient internet service, software, and systems for Design Builder with capability appropriate for transmitting the necessary files and receiving responses from Design Professional, Owner, or other entities.

6. Check not less than once per day for distribution of Electronic Documents Submittals responses and related Electronic Documents correspondence.

F. Proposed "Or-Equals", Substitutes, Design Changes and Deviations from Contract Requirements:
   1. "Or-Equals":
      a. The meaning of "or-equal" is addressed in the General Conditions.
      b. Design Builder's request for approval of "or-equals" is to be presented via the associated Action Submittal(s).
      c. Expressly and prominently indicate, "Proposed Or-Equal" on the associated Action Submittals when Submittal is for an "or-equal".
      d. Submittals requesting approval of an "or-equal" but not accompanied by the required, supplemental information will be deemed incomplete by Owner and returned to Design Builder without approval.
   2. Substitutes: In addition to the requirements of the General Conditions, the following substitution procedures shall be followed:
      a. Submitting Substitution Requests:
         1) Design Builder's substitution requests will be considered by Owner only during a period of 120 days after the Notice to Proceed for Construction Implementation, unless otherwise indicated. Submit Design Professional's concurrence with any proposed substitute request.
         2) Allow not less than 21 days for Owner's review of each substitute. Allow longer for larger, more-complex substitutes.
         3) Owner has no obligation to approve any substitute.
         4) Substitution requests will be accepted for consideration by Owner after the time limit indicated in the paragraph above this, when materials or equipment shown or indicated, and all associated "or-equals", are either:
            a) Unavailable; or
            b) Despite Design Builder's due diligence, are unavailable in time for the Work to be completed within the Contract Times.
         3) The foregoing notwithstanding, substitutes will not be approved when received after Design Builder has commenced the associated Work at the Site, where approval of the substitute would require rework or removing Work already installed.
      b. Design Builder's request for approval of substitute is separate from the associated Action Submittal(s). Action Submittals that request approval of a substitute when a separate, formal substitution request (furnished in accordance with the Contract Documents) was not previously furnished to Program Manager, followed by formal approval via an appropriate contract modification (typically either a Field Order or Change Order), will be deemed by Program Manager as non-compliant with the Contract Documents and will be returned to Design Builder without approval.
      c. Design Builder is solely responsible for delays incurred due to substitutes proposed via Submittals that have not been previously duly approved via an appropriate Contract modification.
      d. Action Submittals for items or procedures approved via an appropriate Contract modification shall include a copy of the Contract modification in which the substitute was approved.
   3. Design Changes:
      a. Submitting Design Change Requests:
         1) Submit any change to the design from the approved Issued for Construction documents to the Owner for approval through a Design Change Notification (DCN).
         2) Include with the DCN fully documented and compelling justification of the design change.

3) The Design Builder assumes all risks associated with obtaining Owner approval of any design change.
4) If a DCN requires a material change from what was reflected in permit applications to Code Officials, the DCN must also be approved by the appropriate Code Official if required by Laws and Regulations.
5) Design clarifications are not considered design changes. All design clarifications shall be documented by the Design Professional with copies provided to the Owner and Program Manager.

b. Design Professional:
1) Design Professional is responsible for design of the completed Project as a functioning whole and has responsible charge of the Project except for Work for which design responsibility is expressly delegated by the Contract Documents.
2) Do not retain services of any third-party design professional to prepare modifications of Design Professional's design of the completed Project as a functioning whole without Design Professional's express, written consent setting forth appropriate performance and design criteria for delegating the design of the substitute.
3) Demonstrate Design Professional approval of any submitted DCN.

c. Owner Requested Changes:
1) The Owner shall have the right to request changes to the design at any time prior to Final Completion per the General Conditions.

4. Submittals with Proposed Deviations from Contract Requirements:
a. When Submittal proposes deviations from requirements of the Contract Documents and Design Builder's approved Issued for Construction Documents, the Submittal shall clearly and expressly indicate each proposed deviation.
b. Also comply with this Section's provision, in the Article below, on Design Builder's transmittal letter expressly alerting Design Professional and Owner to the proposed deviations.
c. Comply with requirements of the Contract regarding substitutes and "or-equals".
d. When deviation is proposed, also appropriately revise text of Design Builder's approval, from that required below in this Article.
e. When Submittal includes deviations from Contract requirements and either the Submittal itself, Design Builder's transmittal letter, or both, do not comply fully with Contract requirements for indicating deviations in Submittals and giving separate written notice thereof, Design Professional's approval of such deviations will be deemed null and void unless Design Professional's written response to the Submittal has expressly acknowledged such deviation and indicated Design Professional's and Owner's approval thereof. The Design Builder is responsible for obtaining Owner's approval for such deviations, even if the submittal is not identified as a Critical Action Submittal.
f. Design Builder is solely responsible for delays and costs incurred due to any and all Submittals with deviations from Contract requirements that were not properly, expressly indicated and approved in accordance with the Contract Documents. Deviations not duly approved in accordance with the Contract Documents may be deemed defective Work. Design Builder is solely responsible for remedying defective Work and all associated cost and time impacts.

G. Design Builder's Approval of Submittals:

1. Design Builder's and their subcontractor shall confirm they have reviewed the submittals before transmitting Submittals to Program Manager and Owner. The Design Builder and their subcontractor shall review each Submittal to:
a. Ensure proper coordination of the Work.
b. Determine that each Submittal is in accordance with Design Builder's desires.
c. Verify that Submittal contains sufficient information for Design Professional and/or Owner to determine compliance with the Contract Documents.

2. Incomplete or inadequate Submittals will be returned without detailed review by Design Professional and/or Owner.
3. Design Builder’s Approval Stamp and Signature:
   a. Each Submittal furnished shall bear Design Builder’s approval stamp (or facsimile thereof) and signature, as evidence that the Submittal has been reviewed and approved by Design Builder and verified as complete and in accordance with the Contract Documents.
   b. Submittals without Design Builder’s approval and signature (as required by the contract Documents) will be returned to Design Builder without further review by Design Professional and/or Owner and deemed incomplete.
   c. Owner reserves the right to reject as incomplete Submittals where Design Builder’s approval signature appears computer-generated or reproduced without the active involvement or review of Design Builder’s signatory.
   d. Design Builder and subcontractor shall each provide approval containing the following text:

      Project Name: ____
      Design Builder’s Name: ____________________________________
      Contract Designation: _____________________________________
      Date: ____

      ------------------ *Reference* ---------------------

      Submittal Title: ____
      Specifications:
      Section: ____
      Page No.: ____
      Paragraph No.: ____
      Drawing No.: _________________ of ___________________
      Location of Work: ____

      Submittal No. and Review Cycle: ____________________________
      Coordinated by Design Builder with Submittal Nos.: ____________
      ____

      I hereby certify that Design Builder has satisfied Design Builder’s obligations under the Contract Documents relative to Design Builder’s review and approval of this Submittal, including: (1) reviewed and coordinated the Submittal with other Submittals and with the requirements of the Work and the Contract Documents; (2) determined and verified all: field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal, (b) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work, and (c) all information relative to Design Builder’s responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto; (3) confirmed the Submittal is complete with respect to all related data included in the Submittal; and (4) clearly and expressly indicated all proposed deviations (if any) from the requirements of the Contract Documents both in the Submittal itself and in the Submittal’s transmittal letter. Accordingly, this Submittal is hereby approved for Design Builder by:

      Approved for Design Builder by: _____________________________

H. Resubmittals:
   1. Design Builder shall furnish Submittals with such completeness, accuracy, and compliance with the Contract Documents to obtain Design Professional's and/or Owner's approval or acceptance, as applicable, without the total quantity of Submittals furnished, including all initial Submittals and all resubmittals, exceeding 150 percent of the number of Submittals indicated on the Schedule of Submittals initially accepted by Owner, plus a corresponding percentage of the quantity of Submittals required by Change Orders, Work Change Directives, and Field Orders.
   2. Do not increase the scope of prior review cycle of the same Submittal.
   3. Indicate on Design Builder's transmittal letter how Submittal was revised from previous review cycle of the Submittal and where the revisions or corrections are located within the resubmittal.
   4. Expressly address and provide response for all components previously transmitted by Design Professional and/or Owner on prior review cycles of the subject Submittal. Where resubmittal lacks complete response to prior comments, such resubmittal may be deemed as incomplete and returned to Design Builder without further review.
   5. Where part of the Submittal's prior review cycle was expressly approved or accepted, as applicable, do not include such items in subsequent resubmittals.
   6. Indicate, "Not Yet Resolved—To Be Resubmitted at a Later Date" for any items not approved in prior review cycle of the Submittal for items not included in the subject resubmittal. Design Professional and/or Owner reserve the right to deem incomplete Submittals "Not Approved" or "Revise and Resubmit". Furnishing incomplete or partial resubmittals is discouraged.
   7. After all Owner, Program Manager, and Design Professional's comments have been addressed, submit a complete Record submittal of the entire submittal.
   8. Resubmittal of Previously Approved or Accepted Items:
      a. Do not resubmit on a given item previously approved or accepted, without Design Professional's and Owner's advance consent. Consent will be given for bona-fide unavailability of a previously approved or accepted item where Design Builder has acted in good faith in a timely manner with due diligence to comply with the Contract Times.
      b. Destroy or conspicuously mark "SUPERSEDED" on all documents having previously received approval or acceptance, as applicable, that are superseded by a resubmittal.

1.7 TRANSMITTAL OF SUBMITTALS BY DESIGN BUILDER

A. Design Builder's Transmittal Letters for Submittals:
   1. Furnish separate transmittal letter with each Submittal. Transmittal letter's shall be consistently formatted for all submittals.
   2. At beginning of each transmittal, include a reference heading indicating: Design Builder's name, Owner's name, Project designation, Contract designation, transmittal number, and Submittal number (with review cycle).
   3. "Or-Equals": When the Submittal is proposing an "or-equal", expressly so indicate on transmittal form submitted by Design Builder.
   4. Proposed Deviations from Contract Requirements: When the Submittal proposes deviations from requirements of the Contract Documents, transmittal letter shall specifically describe each proposed deviation.

B. Submittal Specification:
   1. A copy of the submittal specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements shall be provided with every submittal.

C. Submittal Delivery Method:
   1. This provision presents general requirements for delivery or all Submittals unless otherwise required elsewhere in the Contract Documents.

2. Furnish Submittals as Electronic Documents.
3. Furnish Submittals to Design Professional, Owner, and each other entity indicated in the Contract Documents as receiving a Submittal directly from Design Builder.

D. Samples - Transmittal and Delivery:
1. Provide electronic documentation of all sample submittals. Include photographs of all samples submitted and (upon acceptance) clearly call out which samples were approved.
2. Labeling and Tagging Samples:
    a. Securely label or tag each Sample with Submittal identification number.
    b. Label or tag shall include clear space at least 4 IN by 4 IN in size for affixing Owner's review stamp indicating disposition assigned by Owner.
    c. Label or tag shall not cover, conceal, or alter Sample's appearance or features.
    d. Label or tag shall not be separated from the Sample.
3. Timing: Deliver required Samples concurrently with other Action Submittals required for the same element of the Work, unless other delivery time frame is indicated in the Schedule of Submittals accepted by Owner.
4. Quantity Required:
    a. Where the Contract Documents require a Sample as a field mock-up, provide Sample at the Site or in the Work at location acceptable to Owner. Provide the quantity of field mock-ups required by the contract Documents.
    b. For reasonably portable Samples, deliver the quantity of Samples required in the associated Specifications. If quantity of Samples is not indicated in the associated Specifications section, deliver to Owner not less than three identical Samples of each item for which Sample is required.
    c. Samples will not be returned to Design Builder. If Design Builder requires Sample(s) for Design Builder's use, so advise Owner in writing and furnish additional copies of the Sample. Design Builder is responsible for furnishing, shipping, and transporting additional Samples.
5. Locations for Delivery of Reasonably Portable Samples for Review:
    a. Deliver all physical Samples to Program Manager's field office at the Site.

E. Closeout Submittals –Transmittal and Delivery:
1. Furnish the following Closeout Submittals in accordance with general requirements for transmitting and delivering Submittals indicated above in this Article: maintenance contracts; warranty bonds (when required) and other bonds required for specific materials, equipment, or systems; warranty documentation; and sustainable design closeout documentation (when required). On documents such as maintenance contracts and bonds, include on each document furnished original ("wet") signature of entity issuing said document. When original "wet" signatures are required, furnish such Submittals to Owner both on original paper and as Electronic Documents, and to other entities furnish as indicated above in this Article for general requirements for Submittals.
2. Operations and Maintenance Manuals: Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.
3. Record Documents: Submit in accordance with Section 01 31 13 Project Coordination and Documentation.
4. Software: In addition to software installed on Owner's computer system, furnish number of copies of software required in the Specifications section where the software is specified. Preferred means of transmittal is via secure file transfer directly to Owner via secure file transfer method mutually acceptable to software developer and the receiving entity. When secure file transfer is used, submit to Program Manager documentation signed or electronically acknowledged by Owner that the files were received. Where such software is available only on the software developer's portable media, furnish such software on software developer's original, portable media, sealed in software developer's original, unopened, clearly labeled packaging.

F. Maintenance Materials Submittals – Delivery:
    1. Deliver physical maintenance materials required by the Contract Documents in accordance with applicable provisions of the Contract.
    2. Submit documentation of delivery of Maintenance Materials Submittals in accordance with general requirements for Submittals as indicated in this Section.

1.8 OWNER'S REVIEW OF SUBMITTALS

A. This Article applies to review of all Submittals by Owner or other entity to whom the Contract Documents require such Submittal be furnished.

B. Procedures for Design Professional's Review of Submittals shall be documented in the Design Specifications.

C. Timing:
    1. Timing of Owner's review will be in accordance with the Schedule of Submittals accepted by Owner.
    2. When Submittal is delivered to Owner on a date other than that indicated in the Schedule of Submittals accepted by Owner, duration of Owner's review may differ from that indicated in the Schedule of Submittals, based on Owner's and Program Manager's availability and resources. Owner will make good-faith effort to furnish responses to Submittals in a timely manner.
    3. Design Builder is responsible for communicating to Owner when a Submittal is on the Project's critical path.

D. Owner's Review:
    1. Markings:
        a. Comments or responses marked directly on Submittal by Owner (or other entity reviewing Submittal) will be colored blue.
        b. Owner may also present narrative comments on a comment sheet inserted by Owner or Program Manager into the Submittal. Such comments will be in blue text. When a separate comment sheet is included by Owner, such sheet will be clearly identified as Owner's and Program Manager's comments.
    2. Owner's review and disposition assigned to Submittal are subject to the following:
        a. Submittal disposition is subject to: Owner's comments on the Submittal; disclaimer language on Owner's Submittal transmittal letter; Owner's Submittal review stamp (when used) or equivalent (when used); and this provision.
        b. Owner's review is only for general compatibility with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents, and for general compliance with the information given in the Contract Documents.
        c. Design Builder shall be solely responsible for complying with the Contract Documents, as well as with Supplier instructions consistent with the Contract Documents, Owner's directions, and Laws and Regulations. Design Builder is solely responsible for obtaining, correlating, confirming, and correcting dimensions at the Site; quantities; information and choices pertaining to fabrication processes; means, methods, sequences, procedures, and techniques of construction; safety precautions and programs incident thereto; and for coordinating the work of all trades.
        d. Owner is not responsible for resubmittals not yet furnished by Design Builder or tracking Design Builder's progress on resubmittals.
    3. Documents not required by the Contract Documents but nonetheless furnished by Design Builder as submittals will not be reviewed by Owner or Program Manager.

E. Meaning of Submittal disposition Assigned by Owner:
    1. Critical Action Submittals:
        a. "Reviewed": Upon return of Submittal marked "Reviewed" and with Design Professional's Approval, order, ship, or fabricate materials and equipment included in

the Submittal or otherwise proceed with the Work in accordance with the Submittal and the Contract Documents.

b. "Reviewed as Noted": Upon return of Submittal marked "Reviewed as Noted" and with Design Professional's Approval, order, ship, or fabricate materials and equipment included in the Submittal or otherwise proceed with the Work in accordance with the Submittal and the Contract Documents, and in accordance with Owner's comments and notes indicated in Owner's Submittal response
c. "Revise and Resubmit": Upon return of Submittal marked "Revise and Resubmit", make the revisions necessary and indicated and resubmit to Owner.
d. "Not Approved": This disposition indicates material or equipment that cannot be approved. "Not Approved" disposition may also be applied to Submittals that are incomplete. Upon return of Submittal marked "Not Approved", repeat initial submittal procedure utilizing approvable material or equipment, with a complete Submittal clearly indicating all information required.

2. Informational, Closeout, and Maintenance Materials Submittals:
   a. "Accepted": Information included in Submittal complies with the applicable requirements of the Contract Documents and is acceptable. No further action by Design Builder is required relative to such Submittal, and the Work covered by the Submittal may proceed. Materials and equipment with Submittals with this disposition may be shipped or operated, as applicable. Submittals assigned "Accepted" by Owner (or other reviewing entity) does not indicate Owner's acceptance of the associated Work.
   b. "Not Acceptable": Submittal, or part thereof, does not indicate full compliance with applicable requirements of the Contract Documents and is not acceptable. Provide labor, materials, equipment, services, and incidentals necessary to properly and accurately revise Submittal and resubmit to indicate acceptability and compliance with the Contract Documents.
3. Other:
   a. "Submittal Not Reviewed": Documents so marked by Owner are not required by the Contract Documents. Submittals may also be marked with this disposition when information in the document was previously reviewed and approved or accepted by Owner, as applicable.

F. Distribution of Owner Responses:
1. Unless otherwise indicated in the Contract Documents, Owner, through the Program Manager, will distribute written responses (as Electronic Documents) to Submittals to the following:
   a. Design Builder.
   b. Owner.
   c. Program Manager's file.
2. Paper copies of Owner's Submittal responses will not be distributed unless otherwise required by the Contract Documents or otherwise agreed to by Owner.
3. Design Builder is responsible for forwarding Owner's Submittals responses to Subcontractors and Suppliers as appropriate, and for coordinating the Work of all trades.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 35 43.13

ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General responsibilities and enforcement concerning Constituents of Concern at the Site.
   2. Notifying Owner of Constituents of Concern at the Site.
   3. Hazard communication plan.
   4. Emergency/spill response plan.
   5. Storage of materials containing Constituents of Concern and storage of non-hazardous materials.
   6. Area for storing materials containing Constituent(s) of Concern.
   7. Verification of compliance.

B. Scope:
   1. Design Builder's responsibilities for remediating a known Hazardous Environmental Condition.
   2. Design Builder shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required to comply with requirements of this Section and related provisions of the General Conditions.
   3. In this Section's title, "hazardous materials" mean "Constituents of Concern" , defined as: Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.

C. Related Requirements:
   1. Include, but are not necessarily limited to:
      a. Section 01 35 44 - Spill Prevention Control and Countermeasures Plan.

1.2 BASIC RESPONSIBILITIES AND ENFORCEMENT REGARDING CONSTITUENTS OF CONCERN AT THE SITE

A. Scope – Basic Responsibilities:
   1. Design Builder shall develop, implement, and maintain throughout the Project a hazardous materials management program (HMMP) in accordance with Laws and Regulations and the Contract Documents.
   2. Constituents of Concern Brought to Site by Design Builder:
      a. Transport, handle, store, label, use, and dispose of materials containing Constituents of Concern in accordance with this Section, other applicable provisions of the Contract Documents, and Laws and Regulations.
   3. Constituents of Concern Generated by Design Builder:
      a. Materials containing Constituents of Concern shall be properly handled, stored, labeled, transported and disposed of by Design Builder in accordance with Laws and Regulations, and this Section.
      b. If Design Builder will generate or has generated materials containing Constituents of Concern at the Site or adjacent areas, obtain a USEPA identification number listing Design Builder's name and address of the Site as generator of the Constituents of Concern. Obtain identification number from state environmental agency or other

authority having jurisdiction at the Site. Submit identification number within time limit indicated in this Section's "Submittals" Article.

c. Design Builder is responsible for identifying, analyzing, characterizing, labeling, storing, transporting, and disposing of Constituents of Concern generated by Design Builder.

4. Cost Responsibility:
   a. Fines and civil penalties imposed on Owner or facility manager (if other than Owner) for Design Builder's violations, whether at the Site or other locations, and other costs incurred by Owner and facility manager associated with cleanup of a Hazardous Environmental Condition created or exacerbated by Design Builder shall be paid by Design Builder.
   b. If Design Builder has exacerbated a Hazardous Environmental Condition existing at the Site prior to the start of the Work, Design Builder shall pay Design Builder's appropriate share of costs associated with fines, civil penalties, and cleanup costs in proportion equal to the extent of costs for which Design Builder caused or exacerbated the Hazardous Environmental Condition and fines and civil penalties associated therewith.
   c. If Design Builder fails or refuses to pay such costs, Owner may pay the costs and deduct from payments due Design Builder a reasonable set-off.

B. Owner's Environmental Representative:
   1. Owner's environmental representative is the Pretreatment Program Coordinator, Arlington Water Pollution Control Bureau.

C. Enforcement of Laws and Regulations Regarding Constituents of Concern and Hazardous Environmental Conditions:
   1. To extent practicable, avoid creating or exacerbating situations causing or contributing to injury to persons, spills and emissions of Constituents of Concern, contamination of the Site and other areas, and damage (to property and the environment) caused by Hazardous Environmental Conditions.
   2. When Owner is aware of or suspects violations may have occurred or may occur, Owner will notify Design Builder, and authorities having jurisdiction, when Owner reasonably believes doing so is necessary or appropriate. However, no such right of Owner, or any entity for whom Owner is responsible, including Program Manager (or its consultants and subcontractors), is for benefit of Design Builder. Owner and any entity for whom Owner is responsible, including Program Manager, are not obligated to monitor presence of, use of, storage or handling of, Constituents of Concern at the Site or other areas, or present of a potential Hazardous Environmental Condition (except those known to Owner prior to the start of construction of the Project), or to act on behalf of Design Builder or anyone for whom Design Builder is responsible.

1.3 SUBMITTALS

A. Informational Submittals: Submit the following to the entity(ies) indicated for each:
   1. Indication of Constituents of Concern (including Chemicals) Proposed for Use at the Site:
      a. Submit to Owner's environmental representative.
      b. Submit the information required in sufficient time for Owner's review and acceptance not later than 3 days before bringing associated Constituent of Concern to the Site.
      c. Submittal Content:
         1) Current (dated within the past 2 years) safety data sheets (SDS, formerly "material safety data sheets") in accordance with 29 CFR 1910.1200 (OSHA Hazard Communication Standard).
         2) Manufacturer of material or equipment containing such substance.
         3) Supplier (if other than manufacturer).
         4) Container sizes and number of containers proposed to be at the Site.
         5) Minimum and maximum volume of material intended to be stored at the Site.

6) Description of process or procedures in which Constituent(s) of Concern will be used at the Site.

2. Material Containing Constituents of Concern Generated at the Site:
   a. Submit to Owner's environmental representative.
   b. Submit the information required prior to generating each associated Constituent of Concern at the Site or adjacent areas. Submit within not less than 48 HRS after Design Builder's receipt of associated analytical results.
   c. Submittal Content:
      1) For each Constituent of Concern generated at the Site or adjacent areas:
         a) USEPA identification number.
         b) Laboratory analysis results.
         c) Quantity, size, and location of storage containers at the Site or adjacent areas.
3. Permits:
   a. Submit to Owner's environmental representative.
   b. Submit within 48 HRS of obtaining each associated permit.
   c. Submittal Content:
      1) Copies of each permit obtained for storing, handling, using, transporting, and disposing of materials containing Constituents of Concern, obtained from authorities having jurisdiction.
4. Other Documents Required for the HMMP:
   a. Submit to Owner's environmental representative.
   b. Submit requested documents within 72 HRS of Design Builder's receipt of such request.
   c. Submittal Content:
      1) Submit requested HMMP documents, which may include emergency/spill response plan, communication plan, and other documents.

1.4 HAZARDOUS MATERIALS MANAGEMENT

A. Obtain Owner's environmental representative's acceptance before bringing to the Site each material containing a Constituent of Concern.

B. Hazard Communication Plan:
   1. Develop and implement a communication plan relative to materials containing one or more Constituents of Concern.
   2. Safety Data Sheet (SDS) Notebooks:
      a. Maintain at the Site not less than two notebooks containing:
         1) Inventory of materials containing a Constituent of Concern (including all chemicals).
         2) Current (dated within the past 2 years) SDS for all materials being used to accomplish the Work, whether or not defined as a Constituent of Concern.
      b. Keep one notebook in Design Builder's field office at the Site; keep second notebook at location acceptable to Owner's environmental representative.
      c. Keep notebooks up-to-date as materials are brought to and removed from the Site.

C. Emergency/Spill Response Plans:
   1. Develop, implement, and maintain an emergency/spill response plan, for each Constituent of Concern or each class or group of material containing a Constituent(s) of Concern, as applicable.
   2. Response plan shall include not less than the following:
      a. Description of materials and equipment available at the Site to contain or respond to emergencies related to or spills of the materials containing one or more Constituents of Concern.
      b. Procedures for notifying, and contact information for:
         1) Authorities having jurisdiction.
         2) Emergency responders.

3) Owner.
4) Program Manager
5) Design Professional.
6) The public, as applicable.
7) Other entities as necessary or required.

c. Response coordination procedures between Design Builder, Owner, and others as appropriate.
d. Site plan showing proposed locations of Constituents of Concern storage areas and location of spill containment/response materials and equipment, and location of stormwater drainage inlets, catch basins, and drainage routes, including storm sewers, ditches and swales, and surface waters.
e. Description of Constituent of Concern handling and emergency/spill response training provided to Design Builder's and Subcontractors' workers, in accordance with 29 CFR 1926.21(b) ("Employer Responsibility") and other Laws and Regulations.
f. Comply with Section 01 35 44 - Spill Prevention Control and Countermeasures Plan.

D. Storage of Materials Containing Constituents of Concern and Storage of Non-Hazardous Materials:
1. Vessels containing materials with a Constituent of Concern shall bear applicable, clearly visible NFPA hazard diamonds.
2. Container Labeling:
a. Properly label each container of combustible materials, whether or not classified as containing a Constituent of Concern.
b. Stencil Design Builder's name and, as applicable, Subcontractor's name, on:
1) Each vessel containing a Constituent of Concern; and
2) For non-hazardous materials, on each container over 5-GAL capacity.
c. Each container shall have securely-attached label clearly identifying contents. Also label containers that are filled from larger containers.
d. If Owner becomes aware of unlabeled containers at the Site, Owner's environmental representative will so advise Design Builder, although Owner's personnel are not obligated to do so. Properly label each container within 1 HR of receipt of such notice from Owner, or remove container from the Site and adjacent areas.
e. Properly dispose of materials containing Constituents of Concern, in accordance with Laws and Regulations, at a location other than the Site and adjacent areas.
3. To greatest extent possible, store at off-site location materials containing a Constituent of Concern until required for use in the Work.

E. Area for Storing Materials Containing Constituent(s) of Concern:
1. Maintain designated storage area for materials containing one or more Constituents of Concern. Storage area shall include secondary containment to prevent release of spilled or leaking substances. Storage area shall include barriers to prevent vehicles from colliding with storage containers, and shall include protection from environmental effects such as elements, temperature, sunlight, and other environmental effects.
2. Provide signage in accordance with Laws and Regulations, clearly identifying the storage area.

F. Verification of Compliance:
1. Not less than monthly, Design Builder's safety representative shall meet with Owner's environmental representative at the Site to:
a. Review Design Builder's HMMP documents.
b. Review HMMP procedures.
c. Inspect storage areas and the Site in general, to verify compliance with this Section.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 35 44

SPILL PREVENTION CONTROL AND COUNTERMEASURES PLAN

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for Design Builder's spill prevention control and countermeasures, in accordance with 40 CFR 112 and other Laws and Regulations.

B. Scope:
   1. Design Builder shall provide all labor, materials, equipment, tools, professional services (when necessary or required), and incidentals as shown, specified, and required to comply with Laws and Regulations regarding spill prevention, control, and countermeasures (SPCC) planning and compliance, including 40 CFR 112.
   2. Design Builder shall determine whether a SPCC plan is necessary. If SPCC plan is necessary, Design Builder shall prepare, implement, and maintain SPCC plan in accordance with Laws and Regulations.
   3. Existing SPCC Plan: Owner's existing facility has an existing SPCC plan, administered and maintained by Owner. Design Builder's SPCC plan shall be consistent with facility's existing SPCC plan. Copy of facility's existing SPCC plan and related documents (if any) are available upon request to the Owner.

1.2 REFERENCES

A. Terminology:
   1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Section have the meaning indicated below:
      a. "Oil" has the meaning set forth in Laws or Regulations and generally includes petroleum products, fuel oil, hydraulic fluid, oil sludge, oil refuse, oil mixed with wastes other than dredged material, synthetic oil, vegetable oil, animal fats and oils, and other oils defined in Laws and Regulations.
      b. "Navigable waters of the United States" includes navigable waters of the United States, contiguous zones, and associated shorelines, as set forth in Laws and Regulations.
      c. "SPCC" means "spill prevention control and countermeasures".
      d. "SPCC plan" means a SPCC plan complying with this Section and Laws and Regulations.

1.3 DETERMINATION OF NEED FOR SPCC PLAN FOR PROJECT

A. Determination of Need for SPCC Plan:
   1. Design Builder shall determine need for SPCC plan for the Project.
   2. On-site oil storage thresholds at which a SPCC plan is necessary are indicated in this Article.
   3. Depending on Site conditions and oil storage at the Site and other factors, the Project may: (a) not need a SPCC plan, or (b) need a SPCC plan prepared by a Design Builder-hired professional engineer, or (c) need part of the SPCC plan prepared by a Design Builder-hired professional engineer. When Design Builder-hired professional engineer is not necessary for all or part of a required SPCC plan, Design Builder may self-prepare and self-certify SPCC plan elements not prepared by Design Builder's professional engineer.
   4. Design Builder's Professional Engineer:
      a. If the Site will include storage of more than 10,000 GAL of oil, as defined in Laws and Regulations, in aboveground storage, or if the Site does not comply with oil discharge history criteria of 40 CFR 112, Design Builder shall retain a qualified professional engineer to determine need for SPCC plan for the Project and, if SPCC plan is

necessary, Design Builder's professional engineer shall prepare or supervise preparation of Design Builder's SPCC plan.
b. Qualifications requirements and basic responsibilities of Design Builder's professional engineer are set forth in this Section's "Quality Assurance" Article.
c. If a professional engineer is not required to prepare the entirety of the Project's SPCC plan, but the SPCC plan includes environmentally-equivalent SPCC measures (as set forth in Laws or Regulations), or impracticality determinations (in accordance with Laws or Regulations), then Design Builder shall retain a qualified professional engineer to prepare and certify those portions of the SPCC plan dealing with environmentally equivalent measures and impracticality determinations; the balance of the SPCC plan may be prepared by and be self-certified by Design Builder.
5. Submit to Program Manager letter presenting results of evaluation of whether a SPCC plan is necessary for the Project, in accordance with Laws and Regulations.

B. SPCC plan is necessary when the Project activities at the Site meet the following criteria:
1. The Site and activities thereon are not exempt from Laws and Regulations relative to SPCC planning and implementation.
2. Oil is stored, used, transferred, or otherwise handled at the Site, unless otherwise exempted by Laws or Regulations.
3. Maximum oil storage capacity at the Site equals or exceeds either of the following thresholds: 42,000 GAL of completely-buried capacity, or 1,320 GAL of aboveground capacity. Capacity includes total storage tank volume and operational storage volume at the Site for Design Builder, other prime contractors, and Subcontractors, including bulk storage tanks, containers with 55-GAL storage capacity and larger, mobile tanks located at the Site, and other containers covered by Laws or Regulations. Exempt from the storage capacity determination are motive storage containers, such as those integral to construction equipment and vehicles.
4. There is reasonable expectation, based on location of the Site, that oil spill would reach navigable waters of the United States (or contiguous zones or adjoining shorelines).

C. Reassessment of Need for SPCC Plan after Initial Determination that SPCC Plan is not Needed:
1. After initial determination that SPCC plan is not necessary, Design Builder shall ensure that conditions that preclude the need for SPCC plan for the Project, including the activities of Design Builder, all other prime contractors (if any), and Subcontractors working on the Project at the Site, are maintained throughout the Project's duration.
2. Should changes that affect the storage, use, or handling of oil at the Site occur, reassess the need for SPCC plan for the Project at no additional cost to Owner and submit written reassessment to Program Manager.

1.4 QUALITY ASSURANCE

A. Qualifications:
1. Design Builder's Professional Engineer:
a. When required by Laws and Regulations, engage a licensed, registered professional engineer legally qualified to practice in the jurisdiction where the Site is located and experienced in performing engineering services of the type required. Submit qualifications data.
b. Responsibilities include but are not necessarily limited to:
1) Carefully reviewing Laws and Regulations relative to SPCC.
2) Preparing written requests for interpretations of the Contract Documents relative to SPCC for submittal to Program Manager by Design Builder, and obtaining from authorities having jurisdiction clarifications regarding Laws and Regulations as required.
3) Preparing or supervising the preparation of letter-report evaluation of need for Design Builder's SPCC plan in accordance with the Contract Documents.

Evaluation shall include professional engineer's seal or stamp, registration number, and original signature.

4) When Design Builder's SPCC plan is necessary, preparing, supervising the preparation of, or reviewing Design Builder's SPCC plan (or designated portions thereof when oil storage at the Site will be less than the threshold indicated in this Section or Laws and Regulations) in accordance with the Contract Documents. Design Builder's SPCC plan (or designated portions thereof) shall include professional engineer's seal or stamp, registration number, and original signature.
5) Periodically re-evaluating the need for Design Builder's SPCC plan and issuing findings as letter-reports with seal or stamp, license number, and signature. When Design Builder's SPCC plan is required, periodically evaluating Design Builder's SPCC plan and providing recommendations for compliance with Laws and Regulations, in accordance with the Contract Documents.
6) Certifying that:
    a) it is familiar with the Laws and Regulations, including 40 CFR 112, and
    b) it has visited, examined, and is familiar with the Site, planned modifications to the Site under the Project as such modifications pertain to SPCC Laws and Regulations, and
    c) it has performed the evaluations and prepared Design Builder's SPCC plan in accordance with the Contract Documents, and
    d) procedures for required testing and inspections have been established, and
    e) the said evaluations and Design Builder's SPCC plan are adequate for the Project, and
    f) the said evaluations and Design Builder's SPCC plan comply with Laws and Regulations, applicable industry standards, and to prevailing standards of practice.

1.5 SUBMITTALS

A. Furnish Submittals required under this Section to Owner's environmental representative indicated in Section 01 35 43.13 - Environmental Procedures for Hazardous Materials.

B. Submittals: Submit the following:
1. Certifications:
    a. With each evaluation letter and Design Builder's SPCC plan Submittal, include certification signed by preparer of Submittal that the Submittal complies with the Contract Documents and Laws and Regulations. Signature on all certifications shall be original.
2. Evaluations:
    a. Submit letter presenting results of evaluation of whether Design Builder's SPCC plan is required for the Project. Submit evaluation not later than 14 days after the Contract Times commence running, unless longer time is allowed (in writing) by Owner or Program Manager.
    b. Submit updated evaluations as required when conditions at the Site change. Submit updated evaluation not later than 7 days after the conditions at the Site changed, or within 7 days of Owner's or Program Manager's request, unless longer time is allowed (in writing) by Owner or Program Manager.
    c. Owner and Program Manager have no responsibility for completeness, accuracy, or appropriateness of Design Builder's evaluations, and Design Builder and Subcontractors (as applicable) have full responsibility and all liability associated therewith.
3. Design Builder's SPCC Plan: When SPCC Plan is required:
    a. Submit jointly to Owner. Submit within 14 days of Owner's acceptance of evaluation Submittal.

b. Limitations Regarding Reviews:
   1) Reviews and comments (if any) by Owner on Design Builder's SPCC plan Submittal are not for benefit of Design Builder, Subcontractors, or anyone else for whom Design Builder may be responsible.
   2) Such reviews and comments (if any) shall not impose on Owner or Program Manager any obligation to evaluate the completeness, accuracy, or appropriateness of Design Builder's SPCC plan.
   3) Design Builder, together with Subcontractors (as applicable), bears full responsibility and all liability for completeness, accuracy, and appropriateness of Design Builder's SPCC plan.

4. Record of Distribution of Design Builder's SPCC Plan:
   a. When Design Builder's SPCC plan is required, submit copies of letters transmitting Design Builder's SPCC plan and amendments (if any) to other prime contractors and Subcontractors working at the Site.
5. Qualifications Statements:
   a. Submit qualifications of Design Builder's professional engineer, when requested by Owner or Program Manager.

1.6 DESIGN BUILDER'S SPCC PLAN AND IMPLEMENTATION

A. When Design Builder's SPCC plan is required, develop the SPCC plan and submit for acceptance to entity indicated in this Section's "Submittals" Article. Design Builder's SPCC plan shall be specific to the Site and the Project and shall include the following:
   1. Seal or stamp, original signature, date, and license number of Design Builder's professional engineer, when self-certification by Design Builder is not allowed by Laws and Regulations.
   2. Site plan identifying the name (or tag number) and location of each tank and container that will contain a substance regulated in 40 CFR 112 and other Laws and Regulations, including aboveground and buried tanks. Site plan shall indicate general directions of stormwater runoff, including storm sewers, drainage inlets, and catch basins. Show arrows indicating directions of stormwater flow. Show and label all storm sewer outfall locations.
   3. For each tank and container shown or indicated on the Site plan, include a table indicating tank or container's name and tag number, type of oil stored therein, and maximum storage capacity in gallons. Indicate total storage capacity of all regulated tanks and containers at the Site covered by SPCC Laws and Regulations.
   4. Predictions of direction, rate of flow, and total quantity of oil that could be discharged from the Site as result of storage tank or container failure.
   5. Operating procedures that prevent oil spills, including procedures for oil handling, details of secondary containment structures at fuel and oil transfer areas, and details and descriptions of equipment to be used for oil handling, including piping.
   6. Control Structures and Secondary Containment:
      a. Show details of and indicate descriptions of control measures to be provided at the Site by Design Builder to prevent spill from reaching navigable waters of the United States, including secondary containment and diversionary structures.
      b. For on-shore Sites, use not less than one of the following: dikes, berms, or retaining walls; curbing; culverts, gutters, or other drainage systems; weirs, booms, or other barriers; spill diversion ponds; retention ponds; or sorbent materials or methods.
      c. Where appropriate, Design Builder's SPCC plan shall clearly demonstrate that containment or diversionary structures or equipment are not practical.
      d. Include brittle fracture evaluation, where necessary, for field-constructed aboveground storage containers undergoing repair, alteration, construction, or change in service.
   7. Plans for countermeasures to contain, clean up, and mitigate effects of oil spills that reach navigable waters of the United States, including written commitment of manpower, equipment, and materials to quickly control and remove spilled oil. Include estimation of time required to contain spills after spill occurs.

8. Contact list and telephone numbers for facility response coordinator, National Response Center, cleanup Subcontractors, and all appropriate federal, state, and local authorities having jurisdiction to be contacted in event of spill or discharge.
9. Program for monthly inspections of the Site by Design Builder for compliance with Design Builder's SPCC plan and Owner's SPCC plan (as applicable). Advise Owner in writing of each inspection not less than 72 HRS prior to each inspection.
10. Measures for Site security relative to oil storage.
11. Procedures for safely handling mobile containers such as totes and drums, and procedures for refueling vehicles and construction equipment and machinery at the Site.
12. Procedures and schedules for periodic testing of integrity of tanks and containers, and associated piping and valves.
13. Plans for bulk storage container compliance with Laws and Regulations and the Contract Documents.
14. Plans for personnel training and oil spill prevention briefings.
15. For SPCC plans that do not follow the format indicated in Laws and Regulations, provide cross-reference to requirements of Laws and Regulations, including 40 CFR 112.7.

B. Obtain acceptance of Design Builder's SPCC plan by entity indicated in this Section's "Submittals" Article, for coordination with Owner's Site-specific SPCC plan, if any.

C. Design Builder's SPCC plan shall be reviewed by Design Builder's professional engineer (when professional engineer is required) and Owner every 5 years, as applicable, unless more-frequent reviews or updates are required by Laws or Regulations. Design Builder shall perform updates and revisions of Design Builder's SPCC plan as necessary and submit same in accordance with the provisions of this Section for submittal and acceptance of Design Builder's initial SPCC plan.

D. Post a copy of Design Builder's accepted, certified SPCC plan in conspicuous location at the Site and furnish copies to Owner and Subcontractors as appropriate. All contractors shall comply with Design Builder's SPCC plan.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 SPILL OR VIOLATION OF CONTRACTOR'S SPCC PLAN

A. In event of violation of Design Builder's SPCC plan or release of oil attributable to construction or related activities, Design Builder shall:
1. Notifications:
    a. Immediately issue oral advisories and written notifications to Owner and other authorities in accordance with Laws and Regulations, including 40 CFR 110 and 40 CFR 112.
    b. When required by Laws and Regulations, report to National Response Center, USEPA, and other authorities having jurisdiction, if any.
2. Perform spill cleanup promptly and in accordance with Laws and Regulations, Design Builder's SPCC plan, and requirements of authorities having jurisdiction.
3. Pay fines and civil penalties (or responsible portion thereof) imposed on Owner by authorities having jurisdiction, and pay costs associated with cleanup of spills. If Design Builder fails to promptly pay such costs, Owner may withhold such amounts from payments due Design Builder, as one or more set-offs.

B. Should cleanup of spills attributable to Design Builder be necessary, Design Builder will not be entitled to any associated increase in the Contract Price or Contract Times. Should Design Builder share responsibility for spill and cleanup with another entity, changes in Contract Price and Contract Time, if any, will be proportionate to other entity's responsibility.

END OF SECTION

SECTION 01 41 26

STORMWATER POLLUTION PREVENTION PLAN AND PERMIT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for compliance with the Project's Stormwater Pollution Prevention Plan (SWPPP) and its revisions, Laws and Regulations, and permit(s) applicable to the Project, including:
      a. Design Builder's general responsibilities for stormwater discharges associated with construction activity.
      b. Inspection, during construction, of stormwater controls and temporary erosion and sediment controls, and associated repair and maintenance.

B. Scope:
   1. Design Builder shall provide all labor, materials, tools, equipment, services, and incidentals necessary and required to fulfill Design Builder's responsibilities under this Section, including complying with the applicable Virginia Pollution Discharge Elimination System (VPDES) general permit for stormwater discharges associated with construction activity ("stormwater permit") administered by Virginia Department of Environmental Quality for the Project.
   2. Requirements of this Section are in addition to, and do not supersede or conflict with, requirements of other Specifications, including:
      a. Section 01 57 05 - Temporary Controls, including requirements for controlling stormwater during construction and temporary erosion and sediment controls.

C. Related Requirements:
   1. Include, but are not necessarily limited to:
      a. Section 01 57 05 - Temporary Controls.

1.2 REFERENCES

A. Relevant Documents:
   1. Stormwater Permit for the Project:
      a. Application for the Project's stormwater permit shall be prepared by Design Builder's Engineer for the Owner and, prior to construction, and submitted to the authority having jurisdiction.
      b. Any revisions, modifications, administration, and all other miscellaneous requirements associated with the permit shall be the Design Builder's responsibility.
   2. Erosion and Sediment Control Permit:
      a. Application for the Project's erosion and sediment control permit shall be prepared by the Design Builder's Engineer for the Owner and, prior to construction, shall be submitted to Arlington County Permit Office, which is the authority having jurisdiction over erosion and sediment control during construction.
      b. Erosion and sediment control permit are part of the Contract Documents and is an attachment to this Section.

1.3 DESIGN BUILDER'S GENERAL RESPONSIBILITIES UNDER THIS SECTION

A. The Contract Price includes all labor, material, tools, equipment, services, and incidental costs necessary for:
   1. Preparing SWPPP and other documents.
   2. Installing and maintaining structural and non-structural items used in complying with the SWPPP and its revisions.

3. Other administrative Work required.
4. Clean-up, disposal, and repairs following precipitation events or spills caused by Design Builder (including all subcontractors).
5. Implementing and maintaining “best management practices”, as defined in applicable permits and Laws or Regulations, to comply with requirements that govern stormwater discharges at the Site.
6. Complying with other requirements of this Section.

B. Stormwater Pollution Prevention and Approval of System Owner:
1. Prevent erosion on the Site and discharge of sediment to surface waters, drainage routes, streets and rights-of-way, and private property, including dewatering operations.
2. Prevent on-site trash, debris, and other pollutants from leaving the Site via stormwater runoff.
3. Provide berms, swales, and other appropriate methods of directing stormwater around work areas to appropriate drainage routes.
4. Prior to starting the Work associated with such discharge of stormwater, construction-related discharges to publicly-owned conveyance or treatment systems shall be approved by owner of system to which the discharge will be directed.

C. Water Quality:
1. Do not cause or contribute to a violation of water quality standards, Laws or Regulations, or the Project’s stormwater permit.
2. Notify Program Manager of revisions to the SWPPP, update the SWPPP, and implement SWPPP changes necessary to prevent any violations of the stormwater permit.

D. Liability for Costs Incurred due to Violations:
1. Design Builder shall pay civil penalties and other costs incurred by Owner, including additional engineering and inspection services, associated with non-compliance with applicable permits related to stormwater discharges associated with construction activity and erosion and sediment controls associated with the Project.
2. Owner may deduct such amounts, as one or more set-offs, from payments due Design Builder for the Project.

E. Inspections and Recordkeeping:
1. Perform inspections of stormwater, and erosion and sediment controls.
2. Prepare and maintain records of stormwater inspections.
3. Maintain records of maintenance of stormwater controls and temporary erosion and sediment controls, SWPPP Revisions, and other records required and shall keep these records and copies of all documents that make up the SWPPP at the construction site and available to the Owner, Program Manager, and authority having jurisdiction that may need to review them.

F. Coordination:
1. Coordinate requirements of this Section with Project requirements, such as, earthwork, temporary erosion and sediment controls, demolition, etc.
2. Implement SWPPP controls and practices prior to starting other Work at the Site.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Comply with Laws and Regulations, including federal, state, and local, relative to stormwater discharges associated with construction activity, and associated restoration. Comply with applicable permits.

1.5 SUBMITTALS

A. Informational Submittals: Submit the following:
1. Documentation of stormwater permit.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 INSPECTIONS AND REPAIRS

A. Perform site inspections and assessments of the Site as required by the Project's stormwater permit. Inspections and assessments shall be by Design Builder's personnel.

B. Maintain at the Site a copy of stormwater Site plans from each stormwater inspection and submit each stormwater Site plan to Program Manager. Design Builder shall maintain at the Site a log book with a copy of each Stormwater Inspection Report.

C. Cooperate with representatives of authorities having jurisdiction during their periodic visits to the Site, and promptly furnish information requested by authorities having jurisdiction.

D. Repair physical controls of stormwater pollution, including (but not limited to temporary erosion and sediment controls), in accordance with contract requirements and to the satisfaction of the authority having jurisdiction.

END OF SECTION

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SECTION 01 45 16
DESIGN BUILDER CONSTRUCTION QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: General requirements for Design Builder Construction Quality Control system, include responsibilities for inspections, tests, certificates and reports.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

C. The Design Builder is responsible for quality control and shall establish and maintain an effective quality control system in compliance with these specifications. The Design Builder Quality Control (DBQC) system shall consist of plans, procedures, and organization necessary to provide materials, equipment, workmanship, fabrication, construction, and operations, both on-site and off-site, that complies with contract requirements and is keyed with the construction schedule. The Design Builder shall review and certify as correct and complete, and in compliance with contract requirements, all shop drawings and lists of materials, fixtures, and equipment as required by technical specifications.

D. Quality Control is the sole responsibility of the Design Builder. The Owner (through the Program Manager) will perform Quality Assurance to verify compliance with the Design Builder's Quality Control Plan.

E. Recurring Deficiencies: If recurring deficiencies indicate that the DBQC System is not adequate, corrective action shall be taken as directed by the Owner. Progress payments may be withheld until such corrective action has been completed.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM C1077 – Standard Practice for Laboratories Testing Concrete and Concrete Aggregate for Use in Construction and Criteria for Laboratory Evaluation.
   2. ASTM D3740 – Evaluation of agencies engaged in Testing and/or Inspection of soil and rock as used in engineering design and construction.
   3. ASTM E 329 – Evaluation of testing and inspection agencies as used in construction.

B. Referenced Specifications:
   1. USACE United Facilities Guide Specification 01 45 00.00 10 (as used for construction projects)

C. The Design Builder shall perform internal Quality Assurance audits on a regular basis, no less than semi-annually.
   1. Audits shall be conducted by senior level quality control representative not regularly affiliated with the project.
   2. Audits shall review compliance with the project DBQC Plan.
   3. Submit the results of the audit to the Owner for review.
      a. Identify corrective actions required and dates required for completion.
   4. If recurring deficiencies occur and if directed by the Owner, the Design Builder shall conduct audits on a quarterly basis.

1.3 DEFINITIONS

A. Definable Feature of Work (DFOW): A DFOW is a task which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section.

B. Quality Control (QC) system: The QC system consists of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Submit Design Builder's Quality Control (DBQC) Plan describing the administration of the DBQC program. The DBQC shall be submitted during the Pre-Construction Phase. Include the following:

1. The procedures, instruction, and reports that will be used to assure compliance with the Contract Documents. As a minimum, include the following:
    a. Description of the Design Builder's quality control organization.
    b. An organizational chart showing responsibilities and lines of authority.
    c. Authority of DBQC staff to implement quality control for this project.
2. For each person assigned QC responsibilities on this project, identify the following:
    a. Name.
    b. Qualifications (in resume format).
    c. Project duties and responsibilities.
    d. Authorities.
3. A "Letter of Authorization" signed by an officer of the firm appointing the DBQC manager for the project:
    a. Describe DBQC manager's specific responsibilities for this project.
    b. Delegate sufficient authorities to the DBQC manager to enable that person to perform the assigned duties.
    c. Include the authority to "Stop Work" when it is not in compliance with the Contract Requirements.
4. Copies of "Letters of Direction" from the DBQC manager to each of the various QC representatives outlining their individual duties and responsibilities.
5. Outside organizations that will assist the Design Builder with implementation of the DBQC plan. This should include consulting engineers, testing laboratories, architects, etc:
    a. Provide the name and address of each organization.
    b. Identify the specific services provided by each firm.
6. Each major subcontractor that will be used on the project:
    a. Provide the name and address.
    b. Describe the services to be provided.
7. A detailed description of the procedures that will be followed to ensure that shop drawings, samples, product data, administrative submittals and similar items meet the Contract requirements:
    a. Identify the name(s) of personnel authorized to review submittals.
    b. Identify the name(s) of personnel authorized to certify for the Design Builder that submittals meet with the Contract requirements.
8. Identify the following for each specification section:
    a. Personnel authorized to review submittals.
    b. Personnel who will inspect Work provided.
    c. Personnel or firms that will perform on-site, laboratory or factory testing.
9. A detailed description of the procedures that will be used to document quality control operations, inspections, and testing. Include a copy of all forms and reports used for these purposes.
10. A testing plan that addresses facilities, processes, equipment and material. Identify all tests required by the Contract Documents.

11. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.
12. Procedures for tracking construction deficiencies from identification through acceptable corrective action. Establish verification procedures that identified deficiencies have been corrected.
13. Reporting procedures, including proposed reporting formats.
14. A list of the definable features of work.
15. Develop and maintain a submittal status log for the duration of the project:
    a. List all required submittals by Specification Section.
    b. Identify actions required by the Design Builder, the Design Professional, the Owner, and the Program Manager.
    c. Submit an updated log with each payment application.
16. The Owner shall accept the DBQC plan prior to the Design Builder beginning construction work:
    a. Acceptance of the DBQC plan shall be conditional, predicated upon satisfactory performance during the Work.
    b. Owner may require changes in the plan, including the replacement of QC personnel, in order to obtain the specified quality of Work.
    c. The Design Builder shall notify the Owner in writing at least 7 days prior to changing the approved DBQC plan. Such changes shall be subject to the acceptance of the Owner.

C. Quality Control Daily Reports including:
1. Submit electronically within 24 HRS of the date covered by the report. No detailed report is required to be submitted for days on which no work is performed. Indicate in electronic project management system those days for which no work was performed (including weekends and holidays).
2. Include a statement that equipment and materials incorporated in the work and workmanship comply with the contract.
3. Electronically submitted by the DBQC Manager and time stamped with date of submittal.
4. Include:
    a. Subcontractor and their area of responsibility:
        1) Describe the trades working on the project.
    b. Description of the work performed each day:
        1) Provide location and identify the personnel performing the work.
        2) Include both conforming and non-conforming work.
    c. Total number of personnel working on the project each day:
        1) Total number of personnel by craft.
        2) Separate totals for office, supervisory, and direct labor personnel.
    d. Weather conditions each day and identify any delays encountered.
    e. Major construction equipment used on the work each day. Separate all idle construction equipment.
    f. Test and/or control activities performed with results and reference specifications/drawing requirements:
        1) Identify control phase (Preparatory, Initial, Follow-up).
        2) List deficiencies noted with corrective action.
    g. Quantity of materials and equipment received at the site with statement as to acceptability, storage, and reference to specifications/drawing requirements.
    h. Submittals and deliverables reviewed, with contract reference, by whom, and action taken.
    i. Off-site surveillance activities, including actions taken.
    j. Job safety evaluations stating what was checked, the results, and any instructions or corrective actions taken.
    k. Instructions given/received and conflicts in Contract Documents.

l. Records:
   1) Daily test information sheets.
   2) Factory test results.
   3) Off-site inspection reports.
   4) Manufacturer’s certifications.
   5) Field test and laboratory results.
   6) Documentation required elsewhere in the Contract Documents.

D. Maintain DBQC records on-site in a central location:
   1. Identify each record and ensure that it is traceable to a specific requirement cited on either the Drawings or in the Specifications.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Establish and maintain an effective quality control (QC) system:
   1. The project superintendent will be held responsible for the quality of work and is subject to removal by the Owner for non-compliance with the quality requirements specified in the contract.
   2. In this context the highest-level manager responsible for the overall construction activities at the site, including quality and production, is the project superintendent.
   3. The project superintendent must maintain a physical presence at the site at all times and is responsible for all construction and related activities at the site, except as otherwise acceptable to the Owner.

3.2 PRELIMINARY DBQC COORDINATION MEETING

A. DBQC representative shall meet with the Owner and Program Manager before construction begins and at least 5 days after submitting the final DBQC plan to discuss quality control requirements for the project and develop a mutual understanding of the Design Builder’s overall approach to quality control.

B. Establish the following during the meeting:
   1. Schedule for future DBQC meetings (bi-weekly, monthly, or as required by the Owner or Program Manager).
   2. Procedures for submitting reports, records, and other required documents.
   3. Agree upon DFOW.
   4. Special Inspection coordination (refer to Section 01 45 33).

C. The DBQC representative shall develop an agenda for each DBQC meeting and distribute copies to the Owner and Program Manager for review at least 5 calendar days prior to the meeting.

D. The DBQC representative shall develop minutes for each DBQC meeting. Distribute copies to all in attendance within 5 calendar days of the meeting.

3.3 DESIGN BUILDER QUALITY CONTROL ORGANIZATION

A. General:
   1. The requirements for the DBQC organization are a DBQC Manager, Safety and Health Manager, and sufficient number of additional qualified personnel to ensure safety and contract compliance.
   2. The Safety and Health Manager must receive direction and authority from the DBQC Manager and serve as a member of the DBQC staff.
   3. Personnel possessing specialized skills to assure the required work is being performed properly will also be included as part of the DBQC organization.

4. The DBQC staff must maintain a presence at the site at all times during progress of the work and have complete authority and responsibility to take any action necessary to ensure contract compliance.
5. The DBQC staff will be subject to acceptance by the Owner.
6. Provide adequate office space, filing systems, and other resources as necessary to maintain an effective and fully functional DBQC organization.
7. Promptly complete and furnish all letters, material submittals, shop drawing submittals, schedules, and all other project documentation to the DBQC organization.
8. The DBQC organization shall be responsible to maintain these documents and records at the site at all times.

B. DBQC Manager:
1. Identify as DBQC Manager an individual within the on-site work organization who is responsible for overall management of DBQC and have the authority to act in all DBQC matters for the Design Builder.
2. The DBQC Manager must have a minimum of 10 years construction experience on construction similar to this contract.
3. The DBQC Manager must be on the site at all times during construction and be employed by the Design Builder.
4. The DBQC Manager must be assigned no other duties.
5. The DBQC Manager must not report directly to any field personnel. The DBQC Manager must report through an off-site executive of the Design Builder.
6. Identify in the plan an alternate to serve in the event of the DBQC Manager's absence. The requirements for the alternate are the same as the DBQC Manager.

C. DBQC Personnel:
1. In addition to DBQC personnel specified elsewhere in the contract, provide as part of the DBQC organization specialized personnel to assist the DBQC Manager for the following areas: process, electrical, mechanical, civil, structural, and architectural.
2. These individuals must: be directly employed by the Design Builder and may not be employed by a supplier or subcontractor on this project; be responsible to the DBQC Manager; be physically present at the construction site during work on their areas of responsibility; have the necessary education and/or experience in accordance with the experience matrix listed herein.
3. These individuals may perform other duties but must be allowed sufficient time to perform their assigned quality control duties as described in the DBQC Plan.
4. A single person may cover more than one area provided that they are qualified to perform DBQC activities in each designated area and that workload allows.

D. Organizational Changes:
1. Maintain the DBQC staff at full strength at all times.
2. When it is necessary to make changes to the DBQC staff, revise the DBQC Plan to reflect the changes and submit the changes to the Owner for acceptance.

3.4 PHASES OF CONTROL

A. At least three phases of control must be conducted by the DBQC Manager for each DFOW as follows:

B. Preparatory Phase: This phase is performed prior to beginning work on each DFOW, after all required plans/documents/materials are approved/accepted, and after copies are at the work site, including:
1. A review of each paragraph of applicable specifications, reference codes, and standards. Make available during the preparatory inspection a copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field. Maintain and make available in the field for use by Owner until final acceptance of the work.

2. Review of the contract drawings.
3. Check to ensure that all materials and/or equipment have been tested, submitted, and approved.
4. Review of provisions that have been made to provide required control inspection and testing.
5. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.
6. Examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.
7. Review of the appropriate activity hazard analysis to ensure safety requirements are met.
8. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.
9. Discussion of the initial control phase.
10. The Owner must be notified at least 72 HRS in advance of beginning the preparatory control phase.
11. Include a meeting conducted by the DBQC Manager and attended by the superintendent, other DBQC personnel (as applicable), and the foreman responsible for the definable feature.
    a. Document the results of the preparatory phase actions by separate minutes prepared by the DBQC System Manager and attach to the daily DBQC report.
    b. Instruct applicable workers as to the acceptable level of workmanship required in order to meet contract documents.

C. Initial Phase: This phase is accomplished at the beginning of a DFOW. Accomplish the following:
1. Check work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.
2. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.
3. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.
4. Resolve all differences.
5. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
6. The Owner must be notified at least 24 HRS in advance of beginning the initial phase.
7. Prepare separate minutes of this phase by the DBQC Manager and attach to the daily DBQC report.
    a. Indicate the exact location of initial phase for future reference and comparison with follow-up phases.
8. The initial phase should be repeated for each new crew to work on-site, or any time acceptable specified quality standards are not being met.

D. Follow-up Phase:
1. Perform daily checks to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work.
2. Record the checks in the DBQC documentation.
3. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of work which may be affected by the deficient work.
4. Do not build upon nor conceal non-conforming work.

E. Additional Phases: Conduct additional preparatory and initial phases on the same DFOW if:
1. The quality of ongoing work is unacceptable.
2. There are changes in the applicable DBQC staff, on-site production supervision or work crew.

3. Work on a definable feature is resumed after a substantial period of inactivity.
4. Or other problems develop.

3.5 TESTS

A. Refer to Section 01 45 33 for Special Inspection requirements and coordination.

B. Testing Procedure:
   1. Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements.
   2. Provide at least 24 HRS' notice to Program Manager prior to when specified testing is required.
   3. Upon request, furnish to the Owner duplicate samples of test specimens for possible testing by the Owner.
      a. Owner will make test results available to Design Builder.
      b. Testing to satisfy Design Builder's internal Quality Control procedures shall be Design Builder's responsibility.
   4. Provide labor and materials, and necessary facilities at the site as required by the Owner and the testing laboratory
   5. Testing includes operation and/or acceptance tests when specified. Refer to Section 01 75 00.
   6. Perform vibration monitoring per Section 01 71 33 – Protection of the Work and Property.

C. Perform the following activities and record and provide the following data:
   1. Verify that testing procedures comply with contract requirements.
   2. Verify that facilities and testing equipment are available and comply with testing standards.
   3. Check test instrument calibration data against certified standards.
   4. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
   5. Record results of all tests taken, both passing and failing on the DBQC report for the date taken:
      a. Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
      b. If approved by the Owner, actual test reports may be submitted later with a reference to the test number and date taken.
      c. Provide an information copy of tests performed by an off-site or commercial test facility directly to the Owner.
      d. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

D. Testing Agency:
   1. Use an independent commercial testing laboratory for all testing to demonstrate compliance with the Contract Documents.
   2. The laboratory shall have performed previous satisfactory work for the Owner or be certified by the National Voluntary Laboratory Accreditation Program, Telephone (301) 975-4016 or the Washington Area Council of Engineering Laboratories Inc., Telephone (301) 588-8668.
   3. The independent testing agency performing electrical inspections and tests shall be a member of the National Electrical Testing Association.
   4. Testing agencies shall be approved by the Owner prior to use.

3.6 MANUFACTURER'S FIELD SERVICES

A. Require supplier and manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to make appropriate recommendations.

B. Representative shall submit written report to the Owner listing observations and recommendations. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions.

3.7 OWNER'S RIGHTS

A. The Owner, the Program Manager, and Code Officials have the right to inspect all material and equipment at all stages of development or fabrication.
1. They shall be allowed unrestricted access to the site and to the Design Builder's and Supplier's shops to conduct such inspections.
2. On-site work will be subjected to continual inspection.
3. Inspection by the Owner or others will not release the Design Builder from responsibility or liability with respect to material or equipment.
4. The Owner shall provide the Design Builder a minimum of 24 HRS' notice prior to unscheduled off-site inspections.

B. Through the Program Manager, the Owner will designate a dedicated Quality Assurance (QA) Manager for the Work. The DBQC team shall fully cooperate with the Owner's QA Manager, including, but not limited to:
1. Allowing unimpeded access to all areas of the Work.
2. Providing real-time access to all QC documents developed by the QC team.
3. Providing reasonable advance notice of all QC activities, including compliance with the notice requirements given herein.
4. Establishing procedures for identifying and documenting non-conforming work.
5. Developing and utilizing an appropriate escalation process to resolve disagreements between field personnel.

C. When local codes or laws require approval and inspection of the Work by other agencies or organizations before installation or operation, the Design Builder shall obtain such approval and submit one signed original and three copies of the approval to the Program Manager.

END OF SECTION

SECTION 01 45 33
SPECIAL INSPECTIONS AND TESTING PROGRAM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Design Builder responsibilities for special inspection and testing.
   2. Special Inspection program and reporting requirements.
   3. Attachment A to this Specification Section includes Special Inspector qualifications, reporting requirements, and material specific inspections and tests.
      a. This information is for the Contractor reference only and is not part of the Contract Documents.
      b. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.
      c. The Service Provider(s) responsible for the Owner-provided Services will be selected after Contract award.

B. Purpose:
   1. This Document was developed to address the requirements of the 2018 Virginia Uniform Statewide Building Code (VUSBC), section 1704, including:
      a. One or more special inspectors will be hired by the Owner or the Owner's Agent to provide inspections during constructions on the types of work listed under Section 1704.
   2. A Statement of Special Inspections shall be submitted to the Building Code Official by the Design Professional as a condition for permit issuance. Refer to the Arlington County Department of Community Planning, Housing, and Development Inspection Services Division Pre-Construction Manual. Attachment A includes a list of the minimum qualifications of the individuals, approved agencies or firms intended to be retained for conducting such inspections.

C. Related Specification Sections include but are not necessarily limited to:
   1. 01 45 16 – Design Builder Construction Quality Control.

1.2 DEFINITIONS

A. Special Inspector: Representative of the Owner approved inspection agency designated for that portion of the work.

B. Testing Agency: Approved agency, not affiliated or hired by the Contractor, which is responsible for the materials testing requirements of the project including but not limited to concrete cylinder breaks, soils testing, and masonry materials testing.

C. Statement of Special Inspections: Document provided to the Building Code Official outlining special inspections and tests to be done on the project and frequency of required test.

D. Soils Engineer or Geotechnical Engineer: For the purposes of Special Inspection "Soils Engineer," "Geotechnical Engineering," and "Special Inspector" shall be interchangeable as pertains to the Design Professional specifications.

E. NICET: National Institute for Certification in Engineering Technologies.

1.3 DESIGN BUILDER'S RESPONSIBILITIES

A. Cooperate with testing agency personnel, special inspector, and agents of the Building Code Official and provide access to the work.
   1. Providing access to the work shall include all labor and facilities to perform inspections and tests as listed in the specifications for the duration of the inspections or tests involved.
   2. Provide means to obtain and handle samples taken on-site.
   3. Provide a Statement of Responsibility as described by Chapter 17 of the Building Code.
   4. Provide two printed copies of approved documents (submittals, details, etc.) to the testing agency personnel at the time of inspection.

B. Attend a pre-construction meeting to coordinate and clarify inspection and testing procedures, requirements.

C. Notify special inspector and/or testing agency of work to be inspected/tested minimum of 24 HRS prior.

D. Work for which special inspections are required shall remain accessible and exposed for the purposes of special inspections until completion of required special inspections.

E. Any portion of work that is not in conformance shall be corrected and re-inspected. Such portions of the work shall not be covered or concealed until authorized by Owner's Representative.

F. Work to be inspected should be complete prior to inspector's arrival on-site.

G. Special Inspection is intended to be an independent quality assurance. Special Inspections shall not relieve the Design Builder of any quality assurance, quality control, workmanship, or warranty responsibilities. Design Builder's own personnel shall review all work to be inspected for conformance with Contract Documents prior to calling for inspection.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with Laws and Regulations and applicable codes relative to Special Inspections. Comply with applicable permits.

1.5 REPORTING DUTIES AND AUTHORITY

A. A pre-construction meeting to coordinate and clarify inspection, testing, and procedural requirements will be held.
   1. The meeting is to be attended by:
      a. Owner.
      b. Design Professional.
      c. Program Manager.
      d. Building Code Official or designee.
      e. Testing Agency and Special Inspectors.
      f. Design Builder.
      g. Appropriate Sub-contractor(s).

B. Special Inspector shall report all deficient work to the Design Builder and Program Manager as soon as possible.
   1. Deficient work that has been covered up or concealed prior to re-inspection shall be reported to the Design Professional, Program Manager and the Building Code Official.

C. Special Inspector does not have authority to stop work or modify the requirements of the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

ATTACHMENT A TO SECTION 01 45 33

SPECIAL INSPECTIONS, INSPECTOR QUALIFICATIONS AND REPORTING REQUIREMENTS

PART 1 - GENERAL

1.1 QUALIFICATIONS

A. Qualifications stated here are the minimum recommended. If the Building Code Official or Design Professional have more stringent qualifications, the more stringent qualifications will take precedence.

B. All Special Inspections and Testing to be done under the direction of a Professional Engineer or Registered Architect registered in the Commonwealth of Virginia herein referred to as Registered Professional for Special Inspections (RPSI).

C. Soil, concrete, masonry, mortar, grout, steel and aluminum related testing.
   1. The Testing Agency shall have a minimum of 10 years’ experience in the testing of these materials.
   2. The Testing Agency’s technician(s) conducting this testing:
      a. Shall have a minimum of 5 years’ experience in the testing of soil, concrete, mortar, grout, steel and aluminum as appropriate.
   3. Concrete related work:
      a. International Code Council certification for Reinforced Concrete and American Concrete Institute Concrete Field Testing Technician – Grade 1.

D. Special Structural Inspections:
   1. Professional Engineers or Architects, licensed in the Commonwealth of Virginia, may perform special inspections in accordance with their license qualifications.
   2. Other individuals, working under the direct supervision of a licensed engineer and meeting the following qualifications, may perform special inspections.
   3. Soils related work:
      a. NICET Level II Certification in geotechnical engineering technology/construction; or
      b. Registered Geologist; or
      c. Engineer Intern under the direct supervision of a Licensed Professional Engineer.
   4. Concrete related work:
      a. International Code Council certification for Reinforced Concrete Special Inspector or American Concrete Institute Concrete Construction Special Inspector.
      b. Alternatively, may be an Engineer Intern under the direct supervision of a Licensed Professional Engineer.
   5. Precast concrete erection related work:
      a. Engineer Intern under the direct supervision of a Licensed Professional Engineer.
   6. Precast concrete erection welding:
      a. American Welding Society as a Certified Welding Inspector; or
      b. International Code Council Structural Steel and Welding Certification and American Welding Society Qualified and 1 year of related experience; or
      c. NDT Level II or II Certificate (for non-destructive testing only).
   7. Masonry related work:
      a. Shall be certified by the International Code Council or American Concrete Institute for structural masonry and 1 year of related experience.
      b. Alternatively, may by an Engineer Intern with a minimum of 2 years appropriate training.
   8. Steel and aluminum related work:
      a. Frame and material verification.

b. Welding:
   1) American Welding Society as a Certified Welding Inspector; or
   2) International Code Council Structural Steel and Welding Certification and American Welding Society Qualified and 1 year of related experience; or
   3) NDT Level II or II Certificate (for non-destructive testing only).
c. High strength bolting:
   1) International Code Council Structural Steel and Welding Certification and 1 year related experience.
   2) Alternatively, may be an Engineer Intern with appropriate training.
d. Spray-applied fireproofing related work:
   1) International Code Council Spray-Applied Fireproofing Certification; or
   2) Alternatively, may be an Engineer Intern with appropriate training.

9. Fire resistive coating (intumescent paint) related work:
   a. International Code Council Spray-Applied Fireproofing Certification and 3 years of related experience; or
   b. International Code Council Fire Inspector 1 Certification and 3 years of related experience.
10. Other equivalent certifications will not be acceptable unless approved by the Engineer.

1.2 REPORTING DUTIES AND AUTHORITY

A. Special Inspector shall report all deficient work to the Design Builder as soon as possible.
   1. Deficient work that has been covered up or concealed prior to re-inspection shall be reported to the Design Professional, Program Manager, and the Building Code Official.

B. Special Inspector does not have authority to stop work or modify the requirements of the Contract Documents.

1.3 MATERIAL SPECIFIC SPECIAL INSPECTIONS AND TESTS

A. Material specific requirements for special inspection and testing shall be listed in the Design Professional’s technical specifications. Special inspection and testing requirements shall be located in each appropriate technical specification under "SOURCE QUALITY CONTROL," "FIELD QUALITY CONTROL" and/or "QUALITY ASSURANCE" as appropriate for each material.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF ATTACHMENT A

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SECTION 01 51 05
TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Temporary electricity.
   2. Temporary lighting.
   3. Temporary communications.
   4. Temporary heating, cooling, ventilating, and temporary enclosures.
   5. Temporary water supply.
   6. Temporary sanitary facilities.
   7. Temporary first-aid facilities.
   8. Temporary fire protection.

B. Scope:
   1. Design Builder shall provide all temporary utilities and temporary facilities required for the Project, including those indicated in this Specifications section.
   2. Make all arrangements with utility owners for temporary utilities and with others as appropriate for temporary facilities. Obtain required permits and approvals for temporary utilities and temporary facilities.
   3. Pay all service costs for utilities and facilities indicated in this Specifications section as Design Builder’s responsibility, including cost of electricity, water, fuel, and other utility services and temporary facilities required for the Work.
   4. Continuously maintain adequate temporary utilities and temporary facilities for all purposes for the Project, until removal of temporary utilities and temporary facilities. At minimum, provide and maintain temporary utilities and temporary facilities through Substantial Completion and removal of temporary field offices and sheds unless otherwise approved in writing by Program Manager.
   5. Maintain, including cleaning, temporary utilities and temporary facilities, and continuously provide consumables as necessary.
   6. Temporary utilities and temporary facilities shall be adequate for personnel using the Site and the needs of the Project.
   7. Provide temporary utilities and temporary facilities in compliance with Laws and Regulations and requirements of authorities having jurisdiction and, when applicable, requirements of utility owners.

1.2 REQUIREMENTS FOR TEMPORARY UTILITIES AND TEMPORARY FACILITIES

A. Temporary Electricity:
   1. Provide temporary electric service necessary for the Work, including continuous power for temporary field offices and sheds. Provide temporary outlets with circuit breaker protection and ground fault protection.
   2. Temporary Electricity for Field Offices and Sheds:
      a. Design Builder may restore and reuse the existing electrical feed for temporary power for field offices and sheds. Design Builder is responsible for field investigations and confirmation of power availability.
      b. Provide temporary electric service and convenience outlets in Program Manager’s field office in accordance with Section 01 52 11 - Program Manager’s and Design Builder’s Field Office.
   3. Temporary Electricity for Work in Existing Buildings:
      a. Contractor may use existing 120 V convenience receptacles in Owner’s existing building spaces for items such as small hand tools.

b. Contractor shall provide its own temporary electric power source independent of Owner’s system for uses such as welding and other temporary electricity demands requiring greater than 120 V, single-phase power, and during times when power to existing facility is completely shut down.

B. Temporary Lighting:
1. Provide temporary lighting at the Site of not less than the greater of (1) Laws and Regulations, and (2) the following:
a. Five foot-candles for open areas, 10 foot-candles for shops, and 25 foot-candles for stairs.
b. Provide not less than one 300 W lamp every 15 FT in indoor work areas.
c. Where temporary lighting is required in office or laboratory areas occupied by Owner: 40 foot-candles at a height of 2.5 FT above the finished floor.
d. Night Security Lighting: Five foot-candles within 50 FT of all parts of the Site during hours of darkness, controlled by photocell.
2. Do not work in areas with insufficient lighting. Where lighting is insufficient for the work activities to be performed, provide additional temporary lighting.
3. Provide temporary lighting sufficient for observation of the Work by Program Manager and inspection by Design Builder, entities performing code-required tests and special inspections, and authorities having jurisdiction. Where required by Program Manager, provide additional temporary lighting.
4. Provide temporary lighting for Program Manager’s field office in accordance with Section 01 52 11 - Program Manager’s and Design Builder’s Field Office.

C. Temporary Communications:
1. Provide temporary internet service and communications for Program Manager’s field office in accordance with Section 01 52 11 - Program Manager’s and Design Builder’s Field Office.

D. Temporary Heating, Cooling, Ventilating, and Enclosures:
1. Provide sufficient temporary heating, cooling, and ventilating and temporary enclosures to ensure safe working conditions and prevent damage to existing property and the Work.
2. Except where otherwise specified, temporary heating shall maintain temperature of the space served between 50 DegF and maximum design temperature of building or facility and its contents.
3. Maintain temperature of areas occupied by Owner’s personnel or electronic equipment, including offices, lunch rooms, locker rooms, toilet rooms, and rooms containing computers, microprocessors, and control equipment, between 65 DegF and 75 DegF with relative humidity less than 65 percent.
4. Required temperature range for storage areas and certain elements of the Work, including preparation of materials and surfaces, installation or application, and curing as applicable, shall be in accordance with Supplier’s recommended temperature and humidity ranges for storage, application, or installation, as appropriate.
5. Provide temporary ventilation sufficient to prevent accumulation in construction areas and areas occupied by Owner of hazardous and nuisance levels or concentrations of dust and particulates, mist, fumes, vapors, odors, and gases, associated with construction. Similarly, provide temporary ventilation for building or structure spaces temporarily without ventilation due to the Work.
6. Temporary Enclosures:
a. Provide temporary enclosures and partitions required to maintain required temperature and humidity.
b. Temporary enclosures shall be sufficiently sturdy and durable for the intended use and duration. Maintain and repair temporary enclosures as necessary.
7. Provide temporary heating, cooling, and ventilating for Program Manager’s field office in accordance with Section 01 52 11 - Program Manager’s and Design Builder’s Field Office.

E. Temporary Water:
   1. General:
      a. Provide temporary water service and facilities including piping, valves, meters if not provided by owner of existing waterline, backflow preventers, pressure regulators, and other appurtenances. Provide freeze-protection as necessary to prevent freezing of temporary services.
      b. Continuously maintain adequate water flow and pressure for all purposes during the Project, until removal of temporary water systems.
   2. Water for Construction Purposes:
      a. Provide water for Site maintenance and cleaning and, water necessary for construction activities, and water for disinfecting and testing of systems.
      b. Design Builder may use existing hose bibs for short-term wash-downs and intermittent use of water for work areas in existing building and existing structures. Obtain consent of Program Manager and Owner if connections to existing hose bibs and similar existing connections will be used for more than 1 day at a time. Hose bibbs may be connected to plant effluent and should not be considered potable water.
   3. Water for Human Consumption and Sanitation:
      a. Provide potable water in accordance with Laws and Regulations for consumption by personnel at the Site, for field offices, and for sanitary facilities.
      b. When necessary, provide bottled, potable water for use and consumption by personnel at the Site, including Design Builder, Program Manager, and visitors to the Site.
      c. Provide temporary water for Program Manager's field office in accordance with Section 01 52 11 - Program Manager's and Design Builder's Field Office.

F. Temporary Sanitary Facilities:
   1. Provide suitably-enclosed chemical or self-contained toilets for Design Builder's employees, Subcontractors, Suppliers, and visitors to the Site. Location of temporary toilets shall be acceptable to Owner and Program Manager.
   2. Refer to Paragraph 1.2.E of this Specification Section for requirements for temporary water service intended for human consumption during construction.
   3. Provide suitable temporary washing facilities for employees and visitors.
   4. Provide temporary sanitary facilities for Program Manager's field office in accordance with Section 01 52 11 - Program Manager's and Design Builder's Field Office.

G. Temporary First-aid Facilities:
   1. Provide temporary first-aid stations at or immediately adjacent to the Site's work areas, and inside Design Builder's field office. At least one first aid location should include an Automated External Defibrillator (AED). Locations of temporary first-aid stations shall be determined by Design Builder's safety representative. Replenish supplies in first-aid stations as items are used, prior to expiration of items, and as necessary. Monitor and log inventory of supplies in temporary first-aid stations.
   2. Provide list of emergency telephone numbers at each hardwired telephone at the Site.

H. Temporary Fire Protection:
   1. Provide temporary fire protection in accordance with Laws and Regulations and the requirements of this Specifications section.
   2. For work areas without standpipe fire protection systems, during construction provide portable fire extinguishers rated not less than 2A or 5B in accordance with NFPA 10 – Portable Fire Extinguishers, for each temporary building and for every 3,000 SQFT of floor area under construction.
   3. Provide Class A (ordinary combustibles), Class B (combustible liquids and gases), and Class C (electrical equipment) fire extinguishers as necessary.
   4. Comply with NFPA 241 – Standard for Safeguarding Construction, Alternation, and Demolition Operations, and requirements of fire marshals and authorities having jurisdiction at the Site.

5. Provide temporary fire protection for Program Manager’s field office in accordance with Section 01 52 11 - Program Manager’s and Design Builder’s Field Office.

1.3 USE OF OWNER’S SYSTEM

A. Existing Utility Systems: Do not use systems in existing buildings or structures for temporary utilities without Owner’s written permission and mutually acceptable basis agreed upon by the parties for proportionate sharing of costs between Owner and Design Builder.

B. Use of Permanent Utility Systems Provided Under the Project:
   1. Permanent electrical, lighting, water, heating, ventilating, and fire protection systems and first-aid facilities may be used to provide temporary utilities and temporary facilities if the following are met:
      a. Obtain Owner’s written permission to use permanent systems.
      b. Permanent systems to be used for temporary utilities or temporary facilities shall be substantially complete, including complete functionality of all controls.
      c. Design Builder shall pay all costs while using permanent system, including operation, maintenance, replacement of consumables, and provide replacement parts.
   2. Do not use the following permanent facilities:
      a. Telephone and communication facilities.
      b. Sanitary facilities.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for temporary utilities and temporary facilities:
   1. May be new or used but, if used, shall be in good condition;
   2. Shall be adequate for purposes intended;
   3. Shall not create unsafe or unsanitary conditions; and
   4. Shall comply with Laws and Regulations.

B. Provide required materials, equipment, and facilities, including piping, cabling, supports, controls, and appurtenances.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install temporary utilities and temporary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.

B. Location of Temporary Utilities and Temporary Facilities:
   1. Locate temporary systems for proper function and service.
   2. Temporary systems shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility owners and others.
   3. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.

C. Modify and extend temporary systems as required by progress of the Work.

3.2 USE

A. Maintain temporary systems to provide safe, continuous service as necessary and as required.

B. Properly supervise operation of temporary systems:
   1. Enforce compliance with Laws and Regulations.
   2. Enforce safe practices.

3. Prevent abuse of services.
4. Prevent nuisances and hazards caused by temporary systems and their use.
5. Prevent damage to finishes.
6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.

C. At end of each work day, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient for continuous operation.

3.3 REMOVAL

A. Completely remove temporary utilities, temporary facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not otherwise specified, restore to preconstruction condition.

B. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner. If utility owner will perform such work, coordinate with and pay utility owner for such work.

C. Where permanent utilities and systems were used for temporary utilities, upon Substantial Completion replace all consumables such as filters and light bulbs and parts used during the Work.

END OF SECTION

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SECTION 01 52 11

PROGRAM MANAGER'S AND DESIGN BUILDER'S FIELD OFFICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for Program Manager’s field office at the Site, provided by Design Builder, including:
      a. Physical requirements for field office and related site improvements.
      b. Utilities, environmental controls, and similar services for field office.
      c. Furniture and furnishings for Program Manager’s field office.
      d. Requirements for Design Builder’s field office.
      e. Removal of field offices and associated restoration.

B. Scope:
   1. Design Builder shall provide temporary field office with furniture, furnishings, equipment, services, consumables, and other requirements of this Section, for Program Manager’s sole use during the Project’s construction.
   2. Program Manager’s field office shall be complete and fully functional 30 days prior to start of Early Work construction.
   3. Obtain and pay for required permits and utilities.

C. Related Requirements:
   1. Section 01 51 05 - Temporary Utilities.
   2. Section 01 55 13 - Vehicular Access and Parking.
   3. Section 01 71 33 - Protection of the Work and Property.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate with Owner, other Design Builders, and others using the Site, the location of Program Manager’s field office and related temporary facilities.
   2. Location of Program Manager’s field office is addressed in this Section’s Article 3.1 (“Installation”).

B. Staffing:
   1. Not less than one Design Builder staff member shall be reasonably present at, or in reasonable proximity to, Design Builder’s field office during normal working hours when work is in progress.
   2. When Design Builder’s staff are absent from, and not within reasonable proximity to, Design Builder’s field office, provide clearly legible sign, each entrance to Design Builder’s field office, indicating specific location on-site of Design Builder’s site superintendent, together with (a) valid mobile phone number of Design Builder’s site superintendent, and (b) Design Builder's 24-hour, 7-day per week emergency contact telephone number.

1.3 SUBMITTALS

A. Action Submittals: Obtain Program Manager’s approval of the following prior to installing Program Manager’s field office at the Site and prior to obtaining furniture, furnishings, and equipment required by this Section:
   1. Field Office Submittal: Submit all of the following as one Submittal which shall include:
      a. Site plan indicating proposed location of Program Manager’s field office, parking for Program Manager’s field office, facilities related to Program Manager’s field office, and material of both field office parking and sidewalk or walkway to Program Manager’s field office.

b. Layout and Physical Attributes Shop Drawings of Program Manager's Field Office:
    1) Information on proposed field office size, construction, exterior appearance, interior finishes, and field office security measures.
    2) Proposed layout of interior of Program Manager's field office, showing location of offices, common areas, restroom, closet, other areas required (if any), with dimensions indicated for each. Show locations of interior partition walls, doors (including direction of opening), and windows.
c. Exterior Sign Shop Drawing:
    1) Indication of size, material, and thickness of exterior sign for Program Manager's field office.
    2) Proposed layout of field office exterior sign, showing all text, font, character sizes, colors, and graphics (if any).
d. Utilities:
    1) Proposed type of internet service; name of proposed internet service provider; and product data and technical information on equipment required for internet service.
e. Furniture and Furnishings: Product data and technical information for:
    1) Desks.
    2) Chairs (desk chairs, office chairs, folding chairs).
    3) Tables.
    4) File cabinets and storage cabinet.
    5) Racks.
    6) Field office safety items and equipment required in this Section.
f. Equipment: Product data and technical information for:
    1) Copier-printer-scanner.
    2) Weather monitoring equipment.
    3) Microwave oven.
    4) Refrigerator.
    5) Dishwasher.
    6) Coffee maker.
    7) Other equipment required in this Section.

PART 2 - PRODUCTS

2.1 FIELD OFFICE CONSTRUCTION AND SITE REQUIREMENTS

A. Site Requirements at Field Office:
1. Vehicle Parking:
    a. Allocate total of six reserved parking spaces for use by Program Manager and Owner in close proximity to Program Manager's field office.
    b. Vehicle parking spaces shall be not less than 9 FT wide.
    c. Parking area shall be paved with crushed stone, asphalt concrete, concrete, or other material approved by Program Manager.
    d. Comply with Section 01 55 13 - Vehicular Access and Parking. Provide reasonably smooth surface for vehicles.
    e. Provide parking area with safe layout, suitable for vehicle entry to temporary or permanent travelled ways, as applicable, with sufficient space for reasonable vehicle maneuvering.
    f. Parking area shall be properly drained and free of standing water during wet weather.
2. Walkway or Sidewalk to Field Office Entrance:
    a. Provide sidewalk or walkway, not less than 4 FT wide, of crushed stone, asphalt concrete, concrete, or other material approved by Program Manager.
    b. Provide sidewalk or walkway for full distance between parking area and entrance to Program Manager's field office.

2.2 DESIGN BUILDER'S FIELD OFFICE AND WORK SHEDS

A. Establish at site of Project.

B. Design Builder's field office(s) shall be located in the area approved by Owner during the Design Implementation Stage.

C. Equipment: As required by the Design Builder to comply with the Contract Documents and to execute the Work.

D. Ensure attendance at this office during the normal working day.

E. At this office, maintain complete field file of Shop Drawings, posted Contract Drawings and Specifications, and other files of field operations including provisions for maintaining "As Recorded Drawings."

F. Furnishings and Equipment:
   1. Sign for Field Office(s):
      a. Provide on exterior of Design Builder's field office, at location plainly visible for visitors, an identification sign displaying Design Builder's company name.
      b. Maximum size of sign shall be 4 FT by 3 FT.
      c. Provide highly visible, plainly legible, text on contrasting background color.
      d. Sign shall be suitable for outdoor use for the duration of the Project.
   2. Conference Facilities:
      a. Provide in Design Builder's field office conference area with conference table and chairs sufficient for 16 people, unless Design Builder requires greater space and furniture for Design Builder's purposes.
   3. Provide other furnishings and equipment deemed necessary and appropriate by Design Builder.
   4. Personal Protective Equipment for Use by Visitors:
      a. Furnish and maintain at Design Builder's field office 10 protective helmets (hard hats and other appropriate personal protective equipment (including disposable hearing protection) deemed necessary by Design Builder, for use by visitors to the Site.

G. Storage and Work Sheds – General:
   1. Provide storage and work sheds sized, furnished, and equipped to accommodate personnel, materials, and equipment used in the Work, including temporary utility services and facilities necessary for environment and sufficient for personnel, materials, and equipment.
   2. Provide in accordance with Laws and Regulations.
   3. Storage sheds used for storing materials and equipment to be incorporated into the Work shall comply with Section 01 66 00 – Product Storage and Handling Requirements, and other requirements of the Contract Documents.

2.3 PROGRAM MANAGER'S FIELD OFFICE

A. One field office at location approved by Owner and Program Manager.

B. Separate from Design Builder's field office.

C. General Construction:
   1. New or reconditioned mobile office trailer.
   2. Baked enamel aluminum siding.
   3. 3-1/2 IN foil-backed fiberglass insulation throughout.
   4. Interior paneling.
   5. Vinyl tile flooring.
   6. 8 FT high acoustic tile ceiling.
   7. Four private office areas, a clerk/reception/file area, a conference room area, and a plan room (size of two offices).

8. Kitchen area the minimum size of one private office consisting of a stainless steel sink with hot and cold running water, Formica countertops with a minimum of 18 sf of surface area, and a minimum of 84 cf of cabinet space.
9. Private restroom (ADA compliant) with four-drawer sink base unit with stainless steel sink and Formica top, two double wall-mounted cabinets above sink/utility area.
10. Windows:
    a. Minimum one per office and plan room.
    b. Minimum two in conference room.
    c. Combination screen-storm windows.
    d. Provide horizontal louver blinds on each window.
11. Nominal 64 FT long and 24 FT wide.
12. Two exterior doors (with cylinder deadbolt locks) with outer screens, exterior lights and exterior aluminum or wood landing, stairs and handrail to meet OSHA requirements.
13. Anchored to withstand 110 mile per hour wind.
14. Provide security system with intrusion and smoke alarms that is monitored continuously by the Design Builder.

D. Electrical System:
1. All fixtures, outlets, and wiring of Underwriters Laboratories, Inc. (UL) approved devices.
2. All circuits protected by circuit breakers; fuses are not acceptable.
3. Electrical system shall meet requirements of the latest National Electric Code (NEC).
4. System suitable for 220 V, 3 PH service.
5. Any transformers or other devices required to match this supply to the mobile office shall be provided and connected.
6. Provide a circuit breaker for the incoming service.
7. Each interior room except the washroom shall have at least four (4) 110 V duplex electrical convenience outlets.
8. Kitchen area to have a minimum of two 20 amp circuits.

E. Central Combination Electric Heating, Air-Conditioning System:
1. One at each end of trailer with two thermostats.
    a. Fan-forced air.
    b. Thermostatically controlled.
2. Individual room units are not acceptable.
3. Freeze protect and insulate all piping.
4. System sized to maintain 75 DegF constant temperature in each room.

F. Lighting System:
1. LED type producing 100 foot-candles at desk top height.
2. Ample ceiling fixtures provided to ensure adequate lighting throughout.

G. Standard Washroom:
1. Flush toilet, sink, hot and cold running water.
2. Electric water heater.
3. Mirror.
4. Electric ceiling or wall vent.
5. Sound insulated partitions.

H. Furnishings:
1. For each office, plan room, and reception area:
    a. Double pedestal desk. Size 60 IN by 30 IN.
    b. Book case, 36 IN wide, 48 IN high, 12 IN deep with two moveable shelves.
    c. Ergonomic swivel chair with arm rests and two guest chairs.
2. Conference room table, 16 FT long with eighteen conference room chairs.
3. One book case, 36 IN wide, 84 IN high, 12 IN deep with six moveable shelves.
4. Four 36 IN x 72 IN folding tables; eight 36 IN x 24 IN folding tables.

5. One 48 IN x 60 IN and eight 36 IN x 24 IN liquid marking boards with minimum four-color set of compatible markers.
6. Five 36 IN X 24 IN cork boards.
7. Eight four-drawer legal size vertical filing cabinets.
8. Four four-drawer legal size lateral file cabinets 42 IN wide.
9. Ten folding chairs.
10. Two drawing/drafting tables and two drawing stools.
11. Two rolling stand plan racks with 12 hangers and clamps, height adjustment up to 60 IN and a depth of 43 IN, holds up to 1200 sheets.
12. Three supply storage cabinets, 24 IN wide x 66 IN high x 14 IN deep.
13. Twelve single pocket wall files.
14. One PVC shelving unit, 36 IN wide x 72 IN high x 14 IN deep with five shelves.
15. Twelve wire stackable side load letter trays.
16. Two 12 IN diameter quartz movement battery powered wall clocks.
17. Twelve coat hooks and hangers.
18. One storage cabinet, 36 IN wide x 42 IN high x 18 IN deep.
19. One upright refrigerator/freezer, 20 cubic feet capacity minimum.
20. One microwave oven, 1.5 cubic feet minimum.
21. One coffee maker, 10 cup minimum and supplies.
22. Ten PVC waste receptacles, two of which are to be tall kitchen.

I. Communications:
   1. Provide independent internet service with minimum 300 Mbps download speed, 16 port network switch, hardwire connection to each office, reception area, and plan room, and wireless internet router for computers.

J. Safety Equipment.
   1. One 10 LB ABC dry powder fire extinguisher, upright and fully charged, in an easily accessible location.

K. Consumables: Provide the following consumables as needed:
   1. Paper towels, anti-bacterial liquid soap, toilet tissue, and cleaning supplies for field office restroom.
   2. Batteries for smoke detectors and other battery-powered items furnished by Design Builder.
   3. Replace fire extinguishers upon expiration.

L. Maintenance:
   1. Design Builder shall provide all maintenance and upkeep of trailer and equipment.
      a. Equipment breakdowns shall be repaired promptly by Design Builder.
   2. Janitorial service.
      a. Weekly:
         1) Floor sweeping using dust suppressing compound.
         2) Wet mopping with floor detergent.
         3) Clean and sanitize washroom.
      b. Inclement weather: Conduct weekly requirements on daily basis.
      c. Monthly: Wash windows and clean window blinds.
      d. Provide normal and customary toilet supplies.
   3. Pay all utilities costs.
   4. Maintain at least until acceptance of the entire work by the Owner.

M. Exterior Sign for Program Manager’s Field Office:
   1. Provide exterior sign for Program Manager’s field office, approved by Program Manager. Sign shall be durable, weatherproof, suitable for long-term exposure to sunlight, precipitation, wind, windborne grit, and other local atmospheric elements.
   2. Exterior sign shall be not less than 3 FT high by 4 FT wide, installed at location determined by Program Manager at the Site.
   3. Sign shall be in color, as presented in the layout below.

4. Sign layout and general proportions shall be as presented below. Text of first line and last line shall be Arial font. Text size and size of graphic shall be proportionate to the layout below. Program Manager will furnish to Design Builder Electronic Documents file(s) of Program Manager's "third party logo package" for use in preparing the sign, together with Program Manager's standard, published instructions on use of Program Manager's logo. Design Builder shall comply with Program Manager's written instructions for using Program Manager's logo.

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N. Comply with Section 01 51 05 - Temporary Utilities.

O. Should actions of utility owner(s) delay completion of Program Manager's field office, Design Builder shall provide temporary electricity, heat, water, sanitary facilities, and communications service as necessary at no additional cost to Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location:
1. Locate Program Manager's field office in accordance with decisions made during Pre-construction Services.
2. Provide Program Manager's field office nearby Design Builder's field office.
3. Provide field office with convenient, nearby parking for Program Manager, in accordance with Section 01 55 13 - Vehicular Access and Parking.
4. Location of Program Manager's field office shall be acceptable to Program Manager.

B. Preparation:
1. Prepare the site where Program Manager's field office will be installed as necessary and required by the Contract Documents. Minimize extent of site disturbance for Program Manager's field office. Where site preparation for Program Manager's field office results in disturbance of existing ground cover, comply with Laws and Regulations, required permits, and requirements of the Contract Documents regarding soil disturbances and temporary erosion and sediment controls.
2. Provide firm, compacted subgrade for Program Manager's temporary field office.
3. Provide temporary utilities in accordance with Section 01 51 05 - Temporary Utilities, and requirements of utility owner.

C. Installation:
   1. Install Program Manager's temporary field office and related facilities in accordance with Laws and Regulations. Install Program Manager's field office level and in structurally sound manner.
   2. Install materials and equipment, including prefabricated structures, in accordance with manufacturer's instructions.
   3. Verify operation of all systems, including electrical power supply to lighting and convenience receptacles in field office; proper operation of field office's heating, ventilating, and air conditioning system; proper plumbing with freeze protection (where necessary); and proper operation of all other equipment provided by Design Builder for Program Manager's field office.
   4. Install in Program Manager's field office furniture, furnishings, equipment, and appurtenances required in this Section. Install at locations directed by or otherwise acceptable to Program Manager.
   5. Remove from Program Manager's field office packing materials and boxes for furniture, furnishings, and equipment.
   6. Where furniture, furnishings, and equipment provided by Design Builder will become Owner's property, temporarily store original packaging and boxes for such items and deliver such items to Owner in such boxes and packaging, where appropriate.

3.2 REMOVAL AND RESTORATION

A. Removal:
   1. Do not remove Program Manager's field office or Design Builder's field office until after Substantial Completion of the entire Work, unless otherwise approved by Program Manager.
   2. On date acceptable to Program Manager, fully remove Program Manager's field office, Design Builder's field office(s) and restore areas prior to final inspection.
   3. When required by the Contract Documents to deliver to Owner or facility manager certain equipment provided for Program Manager's field office, carefully remove such items, return to original boxes, and deliver to Owner or facility manager (as applicable) at location indicated by Owner or facility manager. Deliver such items complete with all accessories and manufacturer's operation and maintenance instructions.

B. Restoration:
   1. Restore areas occupied by Program Manager's field office, Design Builder's field office(s) and related facilities. Restore areas damaged or disturbed during installation, maintenance, and removal of Program Manager's field office and related facilities.
   2. Restore to condition in accordance with the Contract Documents. If not expressly required otherwise, restore to preconstruction condition.
   3. Restore subject to approval of the owner of affected property. Remedy damage in accordance with Section 01 71 33 - Protection of the Work and Property, and other provisions of the Contract Documents.

END OF SECTION

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SECTION 01 55 13
VEHICULAR ACCESS AND PARKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
  1. General requirements for:
     a. Design Builder's access to the Site.
     b. Design Builder's use of existing access roads and parking areas.
     c. Traffic controls for access roads and parking areas.
     d. Maintenance of vehicle access roads and parking areas.
     e. Off-site haul routes.
     f. Removals and restoration.

B. Scope:
  1. Design Builder shall provide temporary signage on existing access roads, construction roads, walks, parking areas, and appurtenances necessary and required during the Project for use by Design Builder, Owner and entities for which they are responsible, and emergency vehicles.
  2. Temporary access roads and parking areas shall be designed and maintained by Design Builder and shall be fully passable to vehicles in all weather conditions.
  3. After the entire Project is substantially complete, existing access roads and parking areas may be used by Design Builder when such use does not impair or restrict operations at the Site by Owner.
  4. Design Builder shall make arrangement for off-site haul routes and shall comply with restrictions on haul routes imposed by authorities having jurisdiction and the Contract Documents.

C. Related Requirements:
  1. Include but are not necessarily limited to:
     a. Section 01 14 19 - Use of Site.
     b. Section 01 57 05 - Temporary Controls.
     c. Section 01 71 33 - Protection of the Work and Property.

1.2 SUBMITTALS

A. Informational Submittals: Submit the following:
  1. Map of proposed off-site haul routes, together with list of right-of-way owner for each roadway proposed as off-site haul routes and indication of other authorities, if any, having jurisdiction over off-site haul routes. Furnish such Submittal, acceptable to Program Manager, prior to furnishing the Submittals indicated immediately below this paragraph.
  2. Written permit or permission for use of off-site haul routes, issued by authorities having jurisdiction. Furnish such Submittals acceptable to Program Manager prior to commencing use of off-site haul routes.

PART 2 - PRODUCTS

2.1 TEMPORARY ACCESS ROADS AND PARKING AREAS

A. Materials:
  1. Temporary access roads and parking areas shall be of materials that are either new or of good quality and sufficient for the intended purpose, load-bearing capacity, and frequency and duration of use.

2. Use materials that limit emissions of dust to be consistent with air quality Laws and Regulations and to avoid creating nuisances, inconvenience, and undue additional maintenance requirements on-site, on adjacent properties, and at downwind properties.
3. Where deemed necessary by the Design Professional, provide temporary geotextile or other appropriate materials to stabilize subgrade and subbase of temporary access roads and parking areas.

2.2 TEMPORARY TRAFFIC CONTROLS FOR ACCESS ROADS AND PARKING AREAS

A. Traffic controls shall comply with requirements of authorities having jurisdiction. When such authority is Owner, and no other applicable requirements are indicated in the Contract Documents or applicable permits, comply with:
   1. Standard specifications of Arlington County and Virginia Department of Transportation (VDOT); and
   2. Manual of Uniform Traffic Control Devices (MUTCD), by the United States Department of Transportation (USDOT) Federal Highway Administration (FHWA).

2.3 TEMPORARY ACCESS GATES

A. Temporary Access Gates – General:
   1. Provide temporary gates appropriate for construction of the Project and passage of necessary construction vehicles, construction equipment and machinery, deliveries of temporary facilities, and deliveries of materials and equipment to be incorporated into the Work.

PART 3 - EXECUTION

3.1 ACCESS TO THE SITE

A. Site Access – General:
   1. Light Vehicles:
      a. Access to Site for Design Builder's workers' personal vehicles and Design Builder's light vehicles (including Subcontractors and Suppliers) shall be via an existing access gate agreed upon during Pre-construction Services (referenced herein as, "light vehicle gate"). Post temporary signage at this gate reading, "Project Staff Entrance" or other wording acceptable to Program Manager.
      b. Weight limit for access via the light vehicle gate is a total loaded vehicle weight of 5 tons.
   2. Heavy Vehicles:
      a. Design Builder's construction equipment and vehicles that exceed the weight limit for or exceed the space available at the light vehicle gate, and deliveries of materials and equipment to be incorporated into the Work, shall be via an existing access gate agreed upon during Pre-construction services. Post temporary signage at this gate reading, "Project Truck Deliveries" or similar wording acceptable to Program Manager.
      b. Weight Limit: Design Builder and Owner will agree on weight limit (per axle) for access to the Site via the heavy vehicle gate.
   3. Design Builder is responsible for coordinating deliveries, whether Light Vehicles or Heavy Vehicles, through the appropriate gate. Design Builder is responsible for establishing proper addresses to manage such deliveries.

3.2 USE OF EXISTING ACCESS ROADS AND PARKING AREAS

A. Existing Access Roads and Parking Areas – General:
   1. Use of Existing Access Roads:
      a. Design Builder is allowed to use Owner's existing access roads, starting on the Effective Date of the Contract and after complying with other Contract requirements relative to starting the Work at the Site.

2. Existing Parking Areas for Use by Design Builder:
    a. Design Builder is allowed use of the existing East 31st Street S. Parking Lot (approximately 0.4 acres) for parking of Design Builder's workers' vehicles and construction vehicles. If designated existing parking area is insufficient for Design Builder's purposes, either provide temporary parking at the Site or parking at off-site location. Do not park outside of designated parking areas.
3. Restrictions:
    a. Prevent interference with traffic on existing access roads and parking areas. Always keep access roads and entrances serving the Site clear and available to Owner and their respective employees, suppliers, and consultants; emergency vehicles; and other contractors.
    b. Do not use access roads or Site entrances for parking or storage of materials or equipment.
    c. Obey posted speed limits. If the Site has no posted speed limit, restrict traffic of Design Builder's personnel, construction vehicles and equipment, deliveries, and haul-trucks to maximum speed of 15 miles per hour on access roads at the Site.
    d. Schedule deliveries to minimize use of existing access roads and Site entrances.
    e. Use only rubber-tire vehicles on existing roads and parking areas. Do not use tracked (caterpillar-type) vehicles or equipment on existing pavement unless such pavement will be replaced by Design Builder. Maintain existing pavement for safe access by Owner and their respective employees, suppliers, and consultants; emergency vehicles; and other contractors.
    f. Remedy damage to existing access roads and parking areas caused by Design Builder's operations.
4. Design Builder shall indemnify and hold harmless Owner, Program Manager, and their respective consultants and subcontractors from expenses and losses caused by Design Builder's operations over existing access roads and parking areas.

3.3 TEMPORARY ACCESS ROADS AND PARKING AREAS

A. Temporary Access Roads and Parking Areas – General:
    1. Show proposed locations of temporary access roads and parking areas on site plan. Indicate number of proposed parking spaces and changes (if any) to site maintenance procedures. Indicate the scheduled dates the temporary access roads and parking areas will be established, in use, and removed. Indicate proposed measures for restoring such areas after removal of temporary access roads and parking areas.
    2. Where temporary access roads or parking areas connect to existing public road or highway, obtain approval of right-of-way owner prior to constructing the associated access road or connection to the existing pavement. Comply with Laws and Regulations and requirements of authorities having jurisdiction.

B. Temporary Access Roads and Parking in Areas Different from Permanent Pavement:
    1. Provide temporary access roads and parking areas adequate to support and withstand traffic loads during the Project. Locate temporary access roads and parking areas within the construction limits shown or indicated in the Contract Documents.
    2. Perform clearing and grubbing as required and properly dispose of resulting materials. Stockpile at the Site existing topsoil appropriate for use in restoring disturbed areas.
    3. Provide reasonably-level, graded, well-drained subgrade of satisfactory soil material, compacted to not less than 95 percent of maximum dry density in the upper 6 IN.
    4. To support loads and provide separation between subgrade and subbase materials, provide geosynthetic separation fabric for all temporary access roads and parking areas outside of locations of permanent pavement.
    5. Subbase:
        a. Provide subbase material not less than 6 IN thick, roller-compacted to a level, smooth, dense surface.

b. Subbase for temporary access roads and parking areas traveled by construction vehicles shall be adequate for loads and traffic served.

C. Temporary Access Roads and Parking in Same Areas as Permanent Pavement:
1. Provide temporary access roads and parking areas adequate to support and withstand traffic and construction loads during the Project. Locate temporary access roads and parking areas in same locations as permanent access roads and parking areas. Extend temporary access roads and parking areas, within construction limits shown or indicated in the Contract Documents, as necessary for construction operations.
2. Coordinate elevations of temporary access roads and parking areas with permanent roads and parking areas.
3. Prepare subgrade, subbase, and base for temporary access roads and parking areas in accordance with the Contract Documents' requirements for areas of permanent pavement.
4. Provide geosynthetic separation fabric on compacted subgrade for subbase support and separation of subbase and subgrade materials.
5. Re-condition granular subbase of temporary access roads and parking areas, including removing and properly disposing of granular material that has become intermixed with soil, re-grading, proof-rolling, compacting, and testing.

3.4 TRAFFIC CONTROLS FOR ACCESS ROADS AND PARKING AREAS

A. On-site Traffic Controls – General:
1. Provide temporary traffic controls at intersections of temporary access roads and parking areas with each other, including intersections with other temporary access roads, intersections with public roads, and intersections with permanent access roads at the Site.
2. Provide temporary warning signs on permanent access roads, and provide temporary stop signs for traffic on temporary access roads where required and at entrances to permanent pavement.
3. Comply with requirements of authorities having jurisdiction. When such authority is the Owner, and no other requirements are indicated in the Contract Documents or applicable permits, comply with the standard specifications of the applicable state or provincial (as applicable) department of transportation and the MUTCD.
4. Provide temporary signs indicated maximum allowable speed limit on temporary access roads.

3.5 MAINTENANCE OF VEHICLE ACCESS AND PARKING AREAS

A. Maintenance of Vehicle Access and Parking Areas – General:
1. Maintain temporary access roads and parking areas to continuously provide at the Site access for construction vehicles and trucks, Owner's vehicles, deliveries for Owner, emergency vehicles, and parking areas for Owner's personnel.
2. Public roads shall be passable at all times unless a road closure is allowed in writing by authority having jurisdiction.
3. Refer to cleaning and dust control provisions of this Article.

B. Maintenance of Existing Access Roads and Parking Areas Used by Design Builder:
1. Unless otherwise indicated in the Contract Documents, Owner will perform routine maintenance of access roads and parking areas, existing prior to the start of construction, during the Project. Design Builder is responsible for dust control and cleaning existing paved areas used by Design Builder.

C. Maintenance of Temporary Access Roads and Parking Areas:
   1. Design Builder is fully responsible for maintaining temporary access roads and parking areas until either; (a) temporary access roads and parking areas are removed, or (b) when Owner has indicated in writing that temporary access roads and parking areas may remain following final payment, Design Builder shall maintain such areas until final payment becomes due under the Contract.
   2. When temporary access roads or parking areas become muddy, remove the mud and soil material down to hard, competent surface as often as necessary. Avoid nuisances and unnecessary tracking of mud and dirt onto permanent pavement.
   3. When granular material of temporary access roads and parking areas without hard surfacing becomes intermixed with soil, or when temporary access roads otherwise create a nuisance, remove intermixed granular-and-soil material and replace with clean granular material as necessary and required.
   4. Provide snow and ice removal for temporary access roads and parking areas. Properly dispose of such materials, in accordance with Laws and Regulations. Do not create traffic hazards, such as areas of reduced visibility, caused or exacerbated by locations of displaced snow and ice. Dispose of such materials off of existing pavement and off of temporary access roads and parking areas.

D. Cleaning and Dust Control – All Vehicle Access and Parking Used by Design Builder:
   1. Cleaning:
      a. Clean paved surfaces over which construction vehicles, construction equipment, and construction machinery travel.
      b. Clean paved areas using vacuum powered street sweeper, when visible soil materials are tracked onto pavement.
      c. Clean the following surfaces:
         1) Roads within limits of the Project.
         2) Permanent roads at the Site between the Site entrance and work areas, and between the Site entrance and construction parking and areas used for staging, storage, and laydown.
         3) Public roads that require sweeping and cleaning due to construction operations.
   2. Dust Control:
      a. Control dust resulting from construction activities to prevent nuisances, violations of air quality Laws or Regulations, and adverse health effects at and adjacent to the Site and in downwind areas.
      b. Comply with Section 01 57 05 - Temporary Controls.

E. Protection of Underground Facilities:
   1. Regarding construction traffic, vehicles, construction equipment and machinery, and parking and protection of Underground Facilities, comply with the General Conditions, as may be modified by the Supplementary Conditions, Section 01 71 33 - Protection of the Work and Property, and other requirements of the Contract Documents.
   2. Where existing Underground Facilities are close to the ground surface over which construction equipment or machinery, other construction vehicles, or traffic will pass, protect the Underground Facilities, including providing temporary bridging, as necessary.

3.6 OFF-SITE HAUL ROUTES

A. Off-site Haul Routes – General:
   1. Submit to Program Manager recommended haul rates, including copy of each permit or written permission necessary for use of off-site haul routes.
   2. Where required by Laws or Regulations, or by one or more authorities having jurisdiction, obtain, pay for, and comply with permits and orders of authorities having jurisdiction regarding use of off-site haul routes.
   3. Unless expressly allowed otherwise by authorities having jurisdiction or the express provisions of the Contract Documents, to the extent practicable, avoid routing construction

traffic through residential areas and other areas sensitive to noise, vibration and vehicle exhaust emissions.

4. Restrict use of off-site haul routes to days and hours of construction allowed.
5. Coordinate with authorities having jurisdiction on traffic haul routes prior to establishing a guaranteed maximum price. Coordination activities include but are not limited to, use of haul routes, temporary traffic measures and control, other planned work, permits, and other miscellaneous restrictions required by the authority(ies) having jurisdiction.
6. In transporting spoil and waste materials from the Site and transporting materials and equipment to the Site, avoid creating or contributing to potential Hazardous Environmental Conditions. Properly secure loads to prevent airborne particulates, liquids, slurries, and solid matter from discharging from Design Builder's vehicles along haul routes. Design Builder's responsibilities for Hazardous Environmental Condition caused by Design Builder are set forth in the General Conditions, as may be modified by the Supplementary Conditions, and may be further augmented elsewhere in the Contract Documents.

B. Remedy of Damaged Existing Paving:
1. Comply with Section 01 71 33 - Protection of the Work and Property, and other applicable provisions of the Contract Documents.
2. Design Builder shall indemnify and hold harmless Owner, facility manager (if other than Owner), Program Manager, and their respective consultants and subcontractors from expenses and losses caused by Design Builder's operations on off-site haul routes.

C. Project-Specific Haul Routes:
1. Design Builder shall arrange off-site haul routes.

3.7 REMOVAL AND RESTORATION

A. Removals: When no longer needed for the Project and prior to eligibility for final inspection:
1. Remove temporary access roads, walks, and parking areas that are not intended for, or acceptable for, integration into permanent pavement. Return areas of temporary access roads, walks, and parking to preconstruction condition unless otherwise required by the Contract Documents.
2. Remove temporary gates, fencing, and traffic controls associated with Design Builder's vehicular access and parking areas.
3. Where areas of temporary access roads and parking will be permanently landscaped, remove pavement, granular subbase, geosynthetic materials, soil, and other materials that do not comply with the Contract Documents regarding fill, subsoil, and landscaping.
4. Remove and properly dispose of all materials contaminated with oil, bitumen, or other petrochemical compounds resulting from Design Builder's operations, and other substances. These substances are considered contaminants and may impair growth of plants and lawns or quality of soil or groundwater.

B. Restoration:
1. Restore to preconstruction conditions existing roads, walks, and parking areas damaged by Design Builder, subject to approval of the owner of affected roads, walks, and parking areas. Remedy damage in accordance with Section 01 71 33 - Protection of the Work and Property, and other provisions of the Contract Documents.

END OF SECTION

SECTION 01 57 05
TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for temporary controls during construction, including:
      a. Temporary erosion and sediment controls.
      b. Noise control.
      c. Dust control.
      d. Temporary pest and rodent controls.
      e. Water control, including stormwater, surface water, and groundwater.
      f. Pollution control, including solid waste, water pollution, atmospheric pollution, and other types of pollution.
      g. Odor control.

B. Scope:
   1. Design Builder shall provide and maintain materials, equipment, labor, services, and temporary construction as necessary and required to control environmental conditions at the Site and adjacent areas during construction.
   2. Design Builder shall pay all costs, including fines and civil penalties, if any, for failure to implement and maintain temporary controls in accordance with the Contract Documents and Laws and Regulations. Design Builder is not eligible for increase in Contract Price or Contract Times due to failure to comply with requirements for temporary controls.
   3. Maintain temporary controls until no longer necessary or required. Provide temporary controls at all times when Design Builder is working at the Site.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with applicable provisions and recommendations of the following:
      a. Erosion and sediment control requirements of Code Officials.
      b. Chapter 15 of Arlington County Code (Noise Control).
      c. Other local Laws or Regulations applicable to temporary controls.

1.3 SUBMITTALS

A. Action Submittals:
   1. Submit the following:
      a. Shop Drawings:
         1) Plan for construction staging and maintenance of the Site relative to erosion and sediment controls. Indicate on a site plan approximate areas of planned disturbance of soils and soil cover over time during the Project. For areas not indicated in the Contract Documents as being disturbed and that Design Builder proposes to disturb, Shop Drawing shall include proposed erosion and sediment control measures for the additional areas.
         2) Location and details of each temporary settlement basin.
      b. Product Data:
         1) Silt fencing materials.
         2) Other materials proposed for temporary erosion and sediment controls, when requested by Design Professional or Program Manager.

B. Informational Submittals:
  1. Submit the following:
    a. Procedural Submittals:
      1) Proposed dust control measure, when Submittal is requested by Program Manager.
    b. Field Quality Control:
      1) When requested by Program Manager, promptly obtain and submit results of field measurements and field test data substantiating compliance of Design Builder's temporary controls with the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS

A. Materials for temporary erosion and sediment controls shall be as shown or indicated on the Design Professional's Drawings and Specifications.

PART 3 - EXECUTION

3.1 NOISE CONTROL

A. Noise Control – General:
  1. Design Builder's vehicles, construction equipment, and machinery shall minimize noise emissions to greatest degree practicable. When necessary, provide mufflers and silencers on construction equipment, machinery, and vehicles, and provide temporary sound barriers sound-absorbing blankets, sound-reducing enclosures, modified backup alarms, and other mitigation measures when necessary.
  2. Noise threshold levels shall comply with Laws and Regulations, including (a) OSHA requirements and recommendations, and (b) local ordinances including Chapter 15 of Arlington County Code or other Laws or Regulations.
  3. Noise emissions shall not interfere with the work of Owner or others. The use of noise-producing signals, including horns, whistles, alarms, and bells shall be for safety warning and emergency purposes only.
  4. Music or entertainment systems, including personal and vehicle radios, media players, and the like, when used, shall not be audible at the property line and shall not disturb others at the Site.
  5. Field Quality Control of Noise:
    a. If Owner or Program Manager believes potential exists that allowable noise levels are being exceeded, Design Builder will be required to, and shall promptly perform, appropriate noise monitoring in presence of Owner or Program Manager and shall submit written results to Program Manager.
    b. Owner and Program Manager reserve the right to perform independent noise monitoring at any time during the Work.
  6. If noise level exceeds allowable maximum, Design Builder shall immediately cease the activity emitting the excessive noise and promptly implement noise-mitigating measures to comply with noise limitations.

3.2 DUST CONTROL

A. Dust Control – General:
  1. Control objectionable dust caused by Design Builder's operation of vehicles and construction equipment and machinery, site clearing, demolition, cleaning, and other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of Program Manager and approval of authorities having jurisdiction.
  2. Design Builder shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on-site and off-site damage, inconvenience, nuisances, and health hazards associated with dust emissions from Design Builder's activities.

B. Dust Control Methods:
   1. Dust control may be accomplished by irrigation in which the dust-prone work activity or area of the Site is sprinkled with water until the surface is moist.
   2. Apply dust controls as frequently as necessary or required without creating inconveniences, nuisances, or hazards, such as excessive mud and ponding of water at or adjacent to the Site. Do not use water for dust control when water will cause hazardous or objectionable conditions such as ice, mud, ponds, and pollution.
   3. Provide dust control that is non-polluting and does not contribute to tracking-out of dirt, mud, and dust onto pavement.
   4. Do not allow water used for dust control to discharge to stormwater drainage system or surface waters.
   5. Where appropriate, reduce travel speed of construction vehicles and construction equipment to reduce the potential for dust emissions arising from vehicle and equipment passage.
   6. Where appropriate, apply gravel or other appropriate binder to access roads and parking areas.

C. Removal of Dust and Dirt from Pavement and Other Travelled Ways:
   1. Remove dust, mud, and dirt from roads, parking areas, and other travelled ways.
   2. Perform dust and dirt removal from travelled ways by mechanical wet vacuum sweeping or other method acceptable to Program Manager.
   3. Remove mud from roads, parking areas, and other travelled ways by appropriate means, including scraping. Avoid damaging surface of travelled way. Remedy damage to roads, parking areas, and travelled ways resulting from mud removal activities.

D. Removal of Dust and Dirt from Buildings and Structures:
   1. When dust and dirt from Design Builder’s activities has accumulated to a noticeable or objectionable extent (compared with preconstruction conditions) on buildings or structures, remove the dust and dirt caused by Design Builder’s operations by appropriate methods, including power-washing using mild detergent. Remedy damage caused by dust, dirt, and power-washing.
   2. Dust in sensitive equipment, such as electrical and control panels, instruments, HVAC systems and other equipment shall be cleaned by a Subcontractor specializing in cleaning such items.
   3. During the Project, remove objectionable and noticeable dust, dirt, and mud in areas occupied by Owner or facility manager, and Design Builder’s work areas, resulting from Design Builder’s activities. Owner and facility manager will take reasonable measures to avoid tracking dust, dirt, and mud into their occupied areas.

3.3 PEST AND RODENT CONTROL

A. Pest and Rodent Control – General:
   1. Provide pest and rodent controls as necessary to prevent infestation of the Site, storage areas, and adjacent areas.
   2. Pests and rodents include, but are not limited to: flies, mosquitoes, gnats, midges, stinging insects, other insects and the like, worms, rats, mice, moles, voles, and similar animals, objectionable numbers and species of birds, and others.
   3. Implement appropriate pest and rodent controls when pests, rodents, or both are apparent at the Site or off-site storage, staging, or laydown areas.
   4. Control or remove pests and rodents from adjacent properties when Design Builder’s activities have fostered or exacerbated pest or rodent problems. For example, ground vibration, such as that associated with horizontal directional drilling, may cause migrations of subterranean animals such as moles and voles. Coordinate with affected property owners regarding appropriate control methods, materials, equipment, and disposal techniques.

B. Methods, Materials, and Equipment for Pest and Rodent Control during Construction:
   1. Employ methods and use materials and equipment for pest and rodent control that do not adversely affect conditions at the Site or on adjacent and nearby properties.

2. Do not use control methods or poisons injurious to household pets or animals other than targeted pests and rodents.
3. Avoid control methods that present hazards to humans, including children.

C. Disposal of Pests and Rodents:
1. In accordance with Laws and Regulations, promptly and properly dispose of pests and rodents trapped or otherwise controlled. Do not bury or dispose of deceased animals at the Site or in adjacent areas.

3.4 WATER CONTROL

A. Water Control – General:
1. During the Project, provide methods to appropriately control stormwater, surface water, water from excavations and structures, groundwater flows altered by Design Builder's activities, and groundwater discharges from the Site, to prevent damage to the Work, the Site, adjacent properties, and downstream properties.
2. Control trenching, filling, and grading to direct water away from excavations, pits, tunnels and other construction areas, and prevent water from entering existing buildings and structures.
3. Properly manage and control stormwater, surface water, and groundwater entering the Site from upstream, where such flows or discharges have potential to affect the Work or to be exacerbated by Design Builder's activities.
4. Avoid ponding of water on-site, except in specially-designated, temporary settlement basins. Where water ponding occurs during construction, perform rough grading to eliminate ponding.
5. Prevent water from discharging onto roads, parking areas, paved or finished areas, and other travelled ways. Prevent stormwater runoff from discharging across access roads and parking areas.

B. Materials, Equipment, and Facilities for Water Control:
1. Provide, operate, and maintain materials, equipment, and facilities of adequate size, materials, and capacity to control stormwater, surface water, groundwater, and discharges from tanks.

C. Discharge and Disposal of Water during Construction:
1. Discharge stormwater, surface water, and groundwater from the Site, and discharges of clean water from tanks, to proper discharge locations, in accordance with Laws and Regulations and the Contract Documents.
2. Prevent damage and nuisances arising from water discharges on the Site and discharges from the Site.
3. Dispose of water in manner that avoids flooding, erosion, sediment transport, and other damage, in accordance with Laws and Regulations.
4. Avoid overland discharges from the Site and construction activities to adjacent properties,
5. Water discharges from the Site and construction activities shall be via a stormwater drainage route or conduit with sufficient capacity for the flow under associated weather and flow conditions and in accordance with requirements of authorities having jurisdiction
6. Do not discharge stormwater, surface water, groundwater, or clean water from tanks, into sanitary sewers. Obtain consent of sewerage system owner before discharging such flows into existing combined sewers.
7. Obtain sewerage system owner's consent and approval before discharging polluted water to sewerage system.

3.5 POLLUTION CONTROL

A. Pollution Control – General:
1. Provide means, methods, and facilities necessary and required to prevent contamination of soil, water, and atmosphere caused by accumulation or discharge of substances and

materials that are either noxious, polluting, or both, from or caused by construction and related activities.
2. Construction equipment and machinery shall comply with Laws and Regulations.
3. Comply with Section 01 35 43.13 - Environmental Procedures for Hazardous Materials.

B. Spills and Contamination:
1. Perform emergency containment, cleanup, and remedy of spills and contamination resulting from construction and related activities. Promptly remove and properly dispose of contaminated soils and liquids.
2. Excavate contaminated material and properly dispose of off-site, and replace with suitable compacted fill and appropriate cover.
3. Comply with Section 01 35 44 - Spill Prevention Control and Countermeasures Plan.

C. Protection of Surface Water and Groundwater:
1. Provide and maintain appropriate, temporary measures to prevent harmful substances from entering surface water, groundwater, and drinking water. Prevent disposal of wastes, effluents, chemicals, and the like into or adjacent to groundwater, surface water, drainage routes (including swales, ditches, and storm sewers) and drinking water.
2. Obtain sewerage system owner’s consent and approval prior to discharging into sanitary sewers or combined sewers. Do not discharge pollutants not in accordance with Laws and Regulations into combined sewers, or sewers tributary to combined sewers, when wet weather overflows to receiving waters may occur.

D. Atmospheric Pollutants:
1. Provide and maintain temporary controls for atmospheric pollutants resulting from construction and related activities, whether to outdoor or indoor atmospheres.
2. Prevent harmful dispersal of pollutants into atmosphere.
3. Do not discharge exhaust from internal combustion engines or combustion operations into buildings, structures, or near ventilation intakes for buildings or structures.
4. Prevent toxic and noxious concentrations of chemicals, fumes, and vapors.

E. Solid Waste:
1. Provide and maintain temporary controls for managing solid waste related to the Work.
2. Prevent solid waste from:
   a. Becoming airborne or blowing in the wind.
   b. Being inadvertently transmitted to adjacent, off-site properties, and areas of the Site not part of the Project.
   c. Being deposited in or discharging to surface waters, open process tanks, and drainage routes.
3. Properly handle and dispose of solid waste. Burning or burying solid waste, including unused materials, at the Site or adjacent areas is prohibited.
4. Do not mix or store in the same container solid waste containing Constituents of Concern (and constitutes, or may constitute, a Hazardous Environmental Condition) with solid waste that does not contain Constituents of Concern.
5. Store solid waste in appropriate, covered, containers.
6. Promptly, and at regular intervals, remove solid waste from the Site for transport and disposal in accordance with Laws and Regulations.

3.6 ODOR CONTROL DURING CONSTRUCTION

A. Odors – General:
1. Avoid discharges of unpleasant or noxious odors from construction and related activities, including temporary operations. When nature of the Work is such that odor generation is unavoidable, provide appropriate temporary controls for odors.

2. Give priority to avoiding odor generation, followed by:
   a. Counteracting (treating the cause of) odors.
   b. Containing odors.
   c. Odor masking as the last resort for odor control.

3.7 EROSION AND SEDIMENT CONTROLS

A. Installation and Maintenance of Temporary Erosion and Sediment Controls – General:
1. General Provisions:
   a. Provide temporary erosion and sediment controls as shown and indicated on the Drawings and as indicated in this Section and elsewhere in the Contract Documents, and as necessary for compliance with Laws and Regulations.
   b. Provide erosion and sediment controls as the Work progresses into areas where ground cover was previously undisturbed.
   c. Use necessary and required methods to appropriately control erosion and sediment transport in stormwater runoff, including using soil conservation-oriented construction practices (including scheduling and sequencing), vegetative measures, and temporary physical controls.
   d. Use best management practices (BMP) in accordance with Laws and Regulations, and regulatory requirements indicated in this Section's "Quality Assurance" Article (unless more-stringent requirement are shown or indicated in the Contract Documents), to control erosion and sediment transport in stormwater runoff during the Project.
   e. Plan and execute disturbances of soils and soil cover, and earthwork by methods to control stormwater runoff from exposed soil (including stockpiles, borrow areas, and spoil disposal areas), banks of surface waters affected by the Work, and discharges of groundwater, to prevent erosion and sediment transport.
   f. Where areas must be cleared for storage of materials or equipment, or for temporary facilities, provide measures for regulating stormwater discharges and controlling erosion and sediment transport. When plans for temporary erosion and sediment controls were sealed and signed by Design Professional, such methods are subject to Design Professional's approval or acceptance, as applicable.
   g. Provide erosion and sediment controls, including stabilization of soils, at the end of each workday.
2. Coordination:
   a. Coordinate temporary erosion and sediment controls with this Section's requirements on water control and Section 01 41 26 - Stormwater Pollution Prevention Plan and Permit.
   b. Coordinate temporary erosion and sediment controls with construction of permanent drainage facilities, permanent erosion controls and soil stabilization (if any), and other Work, to the extent necessary for effective and continuous erosion and sediment controls.
3. Before commencing activities that will disturb soil or soil cover at the Site or other areas to be occupied by Design Builder during the Project, provide all appropriate temporary erosion and sediment controls required by the Contract Documents for the areas where soil or soil cover will be disturbed.
4. Vegetation Removal and Disturbance:
   a. Remove only those shrubs, grasses, trees, and other vegetation that must be removed for construction.
   b. Protect undisturbed vegetation. Do not wantonly or unnecessarily drive construction vehicles and equipment over undisturbed vegetation and soil cover.
   c. Promptly stabilize exposed soil where vegetation or soil cover was unnecessarily disturbed. Fill and restore ruts and damage to vegetation and soil cover caused by wanton or unnecessary passage of construction vehicles and equipment.

5. Access Roads and Parking Areas:
   a. When possible, locate and construct temporary access roads and parking areas to avoid adverse effects on the environment.
   b. Provide measures to regulate drainage, avoid erosion and sediment transport in stormwater runoff, and minimize damage to vegetation and soil cover.
6. Earthwork and Temporary Controls:
   a. Perform excavation, fill, and related activities in accordance with the Design Professional’s specifications.
   b. Temporary erosion and sediment control measures may include, but are not limited to, using berms, swales and ditches, silt fencing, straw bale sediment barriers, gravel or crushed stone, mulching and soil stabilization, slope drains, and other methods. Apply such temporary measures to erodible soils and other erodible materials exposed by construction activities.
   c. Minimize areas of bare soil exposed at one time. Provide fills and spoil areas by selectively placing fill and spoil materials to reduce or eliminate exposed erodible soils.
   d. Exercise special care on and above steep slopes, where disturbance of vegetation and soil cover shall be minimized to greatest extent reasonably practicable.
   e. Protect stockpile storage not in active use by providing suitable, durable covering to prevent sediment transport in stormwater runoff and windblown transport. Covering shall be suitable for outdoor exposure.
7. Inspection and Maintenance:
   a. Periodically inspect areas of non-stabilized, erodible soils, including all areas of soil cover disturbance and stockpiles, for evidence of start of erosion and sediment transport. Promptly implement corrective action as necessary and appropriate to control erosion and sediment transport. Continue inspections and corrective action until soils are permanently stabilized and permanent vegetation has been appropriately established.
   b. Inspect not less often than the frequency indicated in Section 01 41 26 - Stormwater Pollution Prevention Plan and Permit.
   c. Repair or replace damaged erosion and sediment controls within 24 HRS of Design Builder becoming aware of such damage.
   d. Periodically remove sediment that has accumulated in or behind sediment and erosion controls. Remove sediment not less often than when sediment is at approximately one-half of storage capacity of associated control element, unless more-frequent interval is indicated elsewhere in the Contract Documents. Properly dispose of sediment.
8. Duration of Temporary Erosion and Sediment Controls:
   a. Maintain temporary erosion and sediment controls in effective, working condition until soil cover of the associated stormwater drainage area has been permanently stabilized.
9. Work Stoppage:
   a. If the Work is temporarily stopped or suspended for any reason, Design Builder shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.
   b. When temporary erosion and sediment controls remain in place during periods of stopped or suspended Work, continue to perform Design Builder’s obligations relative to periodic inspection and maintenance of temporary erosion and sediment controls, including removal of accumulated sediment.
10. Failure to Provide Adequate Temporary Erosion and Sediment Controls:
    a. If Design Builder repeatedly fails to satisfactorily control erosion and sediment transport in stormwater runoff, Owner reserves the right to use Owner's own forces or employ a third-party contractor for temporary erosion and sediment control. Owner’s costs for such work, including engineering and inspection costs, will be deducted from amounts due Design Builder, as set-offs in accordance with the Contract Documents.

B. Erosion and Sediment Control Permit:
   1. Comply with permit requirements in the Erosion and Sediment Control permit.

3.8 REMOVAL OF TEMPORARY CONTROLS

A. Removals – General:

1. Unless otherwise indicated elsewhere in this Section in requirements for respective temporary controls, upon completion of the associated Work and when temporary controls are no longer necessary, remove temporary controls and restore the Site to condition in accordance with the Contract Documents; if condition is not shown or indicated, restore the Site to pre-construction condition.
2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls.

END OF SECTION

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Common requirements for materials and equipment.
   2. Compatibility of materials and equipment.

1.2 REQUIREMENTS FOR MATERIALS AND EQUIPMENT

A. Furnish materials and equipment that:
   1. Have not been previously incorporated into another project or facility; and
   2. have not changed ownership after initial shipment from the manufacturer’s factory or facility; and
   3. if stored since their manufacture or fabrication, have, while in storage, been properly maintained and serviced in accordance with the manufacturer’s recommendations for long-term storage; submit documentation as required by Program Manager that such maintenance and service has been performed; and
   4. that the item(s) have not been subject to degradation or deterioration since manufacture; and
   5. are the current model(s) or type(s) furnished by the Supplier.

B. To the extent possible, furnish from a single source manufacturer those materials and equipment that are of the same generic kind and/or type. This includes but are not limited to:
   1. Piping;
   2. Valve types;
   3. Valve actuators;
   4. Instrumentation; and
   5. Equipment.

C. Furnish materials and equipment complete with accessories, trim, finish, fasteners, and other items shown, indicated, or required for a complete installation for the indicated use and performance.

D. Visual Matching: Furnish materials and equipment that match existing construction and are approved by Program Manager and Owner.

E. Where the Contract Documents include the phrase “as selected” for color of materials or equipment, finish pattern, option, or similar phrase, furnish materials and equipment selected by Program Manager and Owner.

F. Safety guards – Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating parts on all sides. Design such parts for easy installation and removal.

G. Special tools, accessories, and spare parts:
   1. Furnish to the Owner all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first year of lubrication of equipment after field testing), light bulbs, fuses, wrenches, valve keys, belts, special tools, and manufacturer recommended spare parts.

H. Lubricants:
   1. Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, start-up, and operation until final Owner acceptance.
   2. Lubricants shall require no more than weekly maintenance during continuous operation.

3. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
4. Provide constant-level oilers or oil-level indicators for oil lubrication systems.
5. For grease-type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to a convenient location with suitable grease fitting.

I. Equipment Layout:
1. Provide a minimum clearance of 3 FT between equipment in other structures, walls, equipment, piping, and appurtenances.
2. In addition to the minimum clearance, provide adequate clearance for equipment removal and maintenance activities.
3. Prepare PDF packages for facilities that are red lined illustrating proper clearances have been designed for equipment, valves, and instrumentation. Show how equipment is removed from the facility and how maintenance is achieved. As part of the PDF packages, attach documentation from the manufacturer stating the required maintenance and clearances required.

1.3 COMPATIBILITY

A. Similar materials and equipment by the same Supplier shall be compatible with each other, unless otherwise indicated in the Contract Documents or approved by Program Manager.

B. Furnish materials and equipment compatible with items previously selected or installed on the Project.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
  1. General requirements for:
    a. Payment considerations for stored materials and equipment.
    b. Handling of materials and equipment.
    c. Storage of materials and equipment, including:
      1) General provisions for storage.
      2) Storage locations.
      3) Protection of stored items.
      4) Storage of items containing Constituents of Concern.
      5) Outdoor, uncovered storage.
      6) Outdoor, covered storage.
      7) Fully-protected storage.
      8) Removal of temporary storage facilities and restoration of storage areas.
    d. Maintenance of storage.

B. Scope:
  1. Design Builder shall provide all labor, materials, equipment, tools, services, lands, and incidentals necessary and required to store and handle materials and equipment to be incorporated into the Work, and other materials and equipment at the Site, adjacent areas, and off-site storage areas.
  2. Comply with Section 01 71 33 - Protection of the Work and Property, relative to handling and storing materials and equipment.

C. Related Requirements: Include but are not limited to:
  1. Section 01 35 43.13 - Environmental Procedures for Hazardous Materials.
  2. Section 01 55 13 - Vehicular Access and Parking.
  3. Section 01 57 05 - Temporary Controls.
  4. Section 01 71 33 - Protection of the Work and Property.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment:
  1. Materials and equipment delivered but not suitably stored and protected will not be eligible for payment.
  2. Program Manager may recommend reduction in payment, and Owner may reduce payments to Design Builder (“set-offs”) by an appropriate amount when stored items are subsequently revealed to be improperly stored or protected.
  3. Payment for Suitably Stored Items:
    a. Requirements for payment for materials and equipment delivered and suitably stored, but not yet incorporated into the Work, are in the General Conditions.
    b. Materials and equipment delivered and suitably stored, but not yet incorporated into the Work, will not be eligible for payment until the inspection upon delivery, is completed and Program Manager concurs that such items generally appear to be in good condition, in accordance with the Contract Documents, and are of the required quality and quantity.

1.3 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Affidavits of Inspection and Maintenance Performed on Mechanical and Electrical Equipment in Long-Term Storage:
      a. Submit in accordance with requirements of Article 3.1 of this Section.
   2. Other Records of Inspection and Maintenance of Stored Materials and Equipment:
      a. Establish and maintain such records as required by this Section.
      b. Submit to Program Manager or Owner (as applicable) within 3 days of Design Builder’s receipt of such request.

1.4 HANDLING

A. Handling of Materials and Equipment – General:
   1. Handle materials and equipment to be incorporated into the Work in accordance with the Contract Documents and manufacturer’s written instructions.
   2. During handling and assembling of materials and equipment:
      a. Maintain validity of manufacturers’ warranties.
      b. Comply with:
         1) Section 01 71 33 - Protection of the Work and Property.
      c. Do not drop, drag (without appropriate rollers or skids), or scrape materials and equipment.
      d. Use proper construction equipment and machinery, and tools, operated by sufficient number of qualified personnel.
      e. Maintain materials and equipment in neutral position.
      f. Do not exert undue stress on materials and equipment.
      g. Do not deform, bend, or damage materials and equipment.
      h. Do not deform or mar shafts, bearings, or other parts.

B. Additional Requirements for Hoisting and Lifting:
   1. When lifting or hoisting, support materials and equipment from appropriate lifting points using proper hooks and suitable nylon lifting straps, chains, and cables. Do not mar or scrape surfaces of materials and equipment during handling.
   2. For work in existing facilities, comply with Section 01 14 19 - Use of Site, regarding use of Owner’s existing hoisting equipment and elevators, as applicable.
   3. Do not support rigging from building or structure without written approval of Design Professional.
   4. Design Builder is responsible for and shall remedy damage to building, structure, and existing hoisting equipment and elevators, resulting from Design Builder’s operations, in accordance with Section 01 71 33 - Protection of the Work and Property.

1.5 STORAGE

A. Storage – General:
   1. Design Builder shall make all arrangements and provide all measures necessary and required for, and pay all costs associated with, storing materials and equipment.
   2. Store materials and equipment in accordance with the Contract Documents and manufacturer’s written instructions. In event of conflict between the Contract Documents and manufacturer’s written instructions regarding storage and protection, comply with the more stringent, more protective requirements.
   3. Comply with Section 01 71 33 - Protection of the Work and Property.
   4. Records:
      a. Establish and maintain up-to-date account of materials and equipment in storage, to facilitate preparation of progress payment requests, if the Contract Documents provide for payment for materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing.

b. Submit affidavits of inspection and maintenance of mechanical and electrical equipment in long-term storage in accordance with this Section's Article 3.1 ("Maintenance of Storage").

5. Arrange stored materials and equipment to allow easy access for observation or inspection by Owner, Program Manager, Owner-hired testing and inspection entities, and authorities having jurisdiction.
6. Inspect and maintain stored materials and equipment in accordance with this Section's Article 3.1 ("Maintenance of Storage").

B. Storage Location:

1. Area(s) available at the Site for storing materials and equipment are addressed in Section 01 14 19 - Use of Site.
2. When on-site storage is insufficient, Design Builder shall provide additional lands for storage facilities as necessary and required for the Work.
3. Restrictions on Storage Locations:
   a. Do not store materials or equipment in structures being constructed unless approved by Program Manager in writing.
   b. Do not use lawns, landscaped areas, or private property for storage without written permission of property owner.
   c. Comply with:
      1) Section 01 14 19 - Use of Site.
      2) Section 01 55 13 - Vehicular Access and Parking.
      3) Section 01 71 33 - Protection of the Work and Property.

C. Protection of Stored Items – General:

1. Store materials and equipment indicated below to ensure preservation of quality and fitness for intended uses in the Work, including proper protection against damage and deterioration resulting from: water (including precipitation, flood, and other), moisture, humidity, wind, dust, freezing, and outdoor ambient air high temperature as high as 105 DegF. Temperature and humidity inside crates, containers, storage structures, and packaging may be significantly higher than outdoor ambient air temperature.
2. Store in indoor, climate-controlled storage all materials and equipment subject to damage or deterioration by water, moisture, humidity, heat, cold, and other elements, unless otherwise acceptable to Owner and Program Manager.
3. Do not open manufacturer's crates, containers, and packaging until time of installation, unless recommended by the manufacturer or otherwise required in the Contract Documents.
4. Store all materials and equipment off the ground (or floor) on raised supports such as skids or pallets.
5. Electrical Equipment, Instrumentation and Controls, Items Containing Computer Chips, Solid-State Devices, and Other Electronics:
   a. Design Builder shall obtain, coordinate, and comply with specific temperature, humidity, and environmental limitations on materials and equipment, because temperature inside cabinets and components stored in warm temperatures can approach 200 DegF.
   b. Protect from water, moisture, humidity, dust, heat, cold, and other potentially harmful elements and environments. Space heaters provided in equipment shall be connected and operating at all times until equipment is connected to active, permanent, electrical power.
   c. Provide inside each electrical panel, control panel, and other enclosures with electronic device(s) each of the following: (1) desiccant, (2) volatile corrosion inhibitor (VCI) blocks, (3) moisture indicator, and (4) maximum- and minimum-indicating thermometer.
   d. Check panels and equipment not less than once per month. Replace desiccant, VCI, and moisture indicator the earlier of: (1) as often as necessary, or (2) every 6 months.

e. Establish and maintain certified record of daily maximum and minimum temperature and humidity in storage facility. Such records shall be available for Program Manager's and Owner's inspection upon request. Certified record of monthly inspection, noting maximum and minimum temperature for month, condition of desiccant, VCI, and moisture indicator, shall be available to Program Manager and Owner upon request.

6. Finished Surfaces:
   a. Protect finished surfaces against impact, abrasion, discoloration, and other damage.
   b. Remedy, in accordance with requirements of item manufacturer and finishing system manufacturer damaged, marred, or deteriorated finishes, to Program Manager's satisfaction.
7. Design Builder is fully responsible for loss, damage, and deterioration, including theft and vandalism, to stored materials and equipment.

D. Storage of Materials or Equipment Containing Constituents of Concern:
   1. Prevent contamination of personnel, storage areas, the Site, and adjacent areas.
   2. Comply with Laws and Regulations, Section 01 35 43.13 - Environmental Procedures for Hazardous Materials, and other provisions of the Contract Documents relative to Constituents of Concern and Hazardous Environmental Conditions.

E. Uncovered Storage:
   1. The following materials may be stored outdoors without cover on supports, so there is no contact with the ground:
      a. Reinforcing steel.
      b. Precast concrete materials.
      c. Structural steel.
      d. Metal stairs.
      e. Handrails and railings.
      f. Grating.
      g. Checker plate.
      h. Metal access hatches, such as floor doors, roof hatches, and the like.
      i. Castings.
      j. Fiberglass items.
      k. Rigid electrical conduit, except PVC-coated conduit.
      l. Fencing intended for permanent, outdoor installation.
      m. Piping, except PVC or chlorinated PVC (CPVC) pipe.

F. Covered Storage:
   1. The following materials and equipment may be stored outdoors on supports and completely covered with covering impervious to water:
      a. Grout and mortar materials.
      b. Masonry units.
      c. Metal decking.
      d. Rough lumber.
      e. Soil materials and granular materials such as aggregate.
      f. PVC and CPVC pipe.
      g. PVC-coated electrical conduit.
      h. Filter media.
      i. Plastic media, such as used in odor control scrubbers.
   2. Properly and fully secure covers against coming loose in strong winds.
   3. Install coverings properly sloped to prevent accumulation of water.
   4. Loose Soil Material and Loose Granular Material:
      a. Store such materials in well-drained areas.
      b. Prevent mixing of such materials with foreign matter. Provide underlying separation layer or store on solid, impervious surface, where appropriate.

c. Provide temporary erosion and sediment controls for stockpiled soil materials in accordance with Section 01 57 05 - Temporary Controls.

G. Fully Protected Storage:
1. Store all materials and equipment not indicated in the provisions above regarding uncovered storage and covered storage on supports, in buildings, trailers, or other suitable temporary storage facility with concrete or wood flooring, solid and impervious roof, and fully closed walls on all sides.
2. Covering with visqueen plastic sheeting or similar material in storage space without floor, roof, and walls is unacceptable.
3. Provide heated storage for materials and equipment that could be damaged or deteriorate by low temperatures or freezing.
4. Provide air-conditioned storage for materials and equipment that could be damaged or deteriorate by high temperature or humidity.
5. Protect mechanical and electrical equipment from being contaminated by dust, dirt, and moisture.
6. Maintain temperature and humidity at levels recommended by materials and equipment manufacturers.
7. Prevent infestation of stored items by pests and rodents. Promptly and properly remedy such infestation when apparent.

H. Removal of Temporary Storage Facilities and Restoration of Storage Areas:
1. Completely remove temporary storage facilities when no longer necessary for the Work.
2. Restore areas used for storage and areas occupied by temporary storage facilities, in accordance with the Contract Documents, including Section 01 71 33 - Protection of the Work and Property.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 MAINTENANCE OF STORAGE

A. On a scheduled basis, periodically inspect stored materials and equipment to ensure that:
1. Condition and status of storage facilities is adequate to provide required storage conditions.
2. Required environmental conditions are maintained on continuing basis.
3. Materials and equipment exposed to weather elements or other environment are not adversely affected.

B. Mechanical and Electrical Equipment in Long-Term Storage:
1. Meaning of the term “long-term storage” is as established in written instructions of manufacturer of associated materials or equipment.
2. Mechanical and electrical equipment requiring long-term storage shall have complete manufacturer’s written instructions for servicing each item, with notice of enclosed instructions shown on exterior of crate, container, or packaging.
3. Frequency of inspections and maintenance of stored items shall be in accordance with manufacturer’s written instructions.
4. For mechanical equipment with bearings and shafts, manually rotate shaft during inspection and maintenance, as recommended by equipment manufacturer.
5. Space heaters that are part of electrical equipment shall be connected and operated continuously until equipment is connected to permanent electrical power supply.
6. Other requirements for maintenance during storage of electrical equipment, instrumentation and controls, items with computer chips, solid-state devices and other electronics are in this Section’s provision on general protection during storage.

C. Affidavits:
   1. Submit to Program Manager affidavit for each time maintenance and inspection was performed on materials and equipment in long-term storage. Affidavit shall be signed by Design Builder and entity performing the inspection and maintenance on the stored items.
   2. Indicate on affidavit:
      a. Date of inspection.
      b. Personnel involved and employer of each.
      c. Condition of storage environment.
      d. Specific stored items inspected, equipment condition, problems observed, problems corrected, maintenance tasks performed, and other relevant information.
      e. Signature of Design Builder’s person responsible for the inspection and maintenance.
      f. Signed and notarized statement by items’ manufacturer indicating whether storage conditions and tasks performed are suitable for continued compliance with manufacturer’s warranties.
   3. Submit each affidavit, complete, not later than 7 days after performing associated inspection and maintenance.

END OF SECTION

SECTION 01 71 33

PROTECTION OF THE WORK AND PROPERTY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General requirements for protecting the Work and property, including:
      a. Accessing or entering property.
      b. Temporary barricades and temporary warning lights and signs.
      c. Responsibility to remedy damaged property.
      d. Protecting natural habitats, including trees, plants, lawns and meadows, and wildlife.
      e. Protecting Underground Facilities.
      f. Protecting existing surface structures.
      g. Protecting floors, walls, and roofs.
      h. Protecting other installed items and landscaping.
      i. Vibration and Movement Limits and Monitoring.
      j. General requirements for security during the Project.
      k. Site access security procedures.
      l. Temporary security fencing.

B. Scope:
   1. This Section augments requirements of the General Conditions as may be modified by the Special Conditions regarding protection of the Work and property, including Underground Facilities.
   2. Design Builder shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required for protecting the Work and property in accordance with the Contract Documents.

C. Related Requirements: Include, but are not necessarily limited to:
   1. Section 01 55 13 - Vehicular Access and Parking.
   2. Section 01 57 05 - Temporary Controls.
   3. Section 01 66 00 - Product Storage and Handling Requirements.

1.2 PROTECTION – GENERAL

A. Design Builder shall provide all precautions and programs and perform all actions necessary to protect personnel health and safety, and to protect the Work and all public and private property and facilities from damage, in accordance with the Contract Documents, Laws and Regulations, and other applicable requirements.

B. To prevent damage, injury, and loss, Design Builder's actions shall include the following:
   1. Providing measures for safety of all personnel at and adjacent to the Site, whether engaged in performing the Work, operating or maintaining the facility, or performing other functions for Owner or others.
   2. Storing construction equipment, machinery, tools, and similar items, materials and equipment to be incorporated into the Work, supplies, and other items in an orderly, safe manner that does not unduly interfere with progress of the Work or work of others, including Owner and facility manager (if other than Owner).
   3. Suitably storing materials and equipment to be incorporated into the Work, in accordance with the Contract Documents, including Section 01 66 00 - Product Storage and Handling Requirements.
   4. Placing upon the Work or any part thereof only loads consistent with the safety and integrity of that portion of the Work and existing construction and facilities.

5. Frequently removing and disposing of rubbish, scrap materials, and debris from Design Builder’s operations.
6. Providing temporary controls, including controlling pests and rodents, in accordance with the Contract Documents, including Section 01 57 05 - Temporary Controls.

1.3 GENERAL PROVISIONS FOR SECURITY DURING THE PROJECT

A. Security – General:
   1. Design Builder shall safely guard all the Work, the Project, materials, equipment, and property from loss, theft, damage, and vandalism by any and all persons and cause, until all Design Builder demobilizes off-site or unless otherwise agreed upon by Owner and Design Builder.
   2. Design Builder’s duty includes safely guarding Owner’s property in vicinity of the Work and Project, and other private property in the vicinity of the Project, from injury and loss in connection with performance of the Project, theft, vandalism, and other causes.
   3. Employ security personnel as necessary to provide required security and prevent unauthorized entry to the work areas.
   4. Provide temporary fencing in accordance with the Contract Documents.
   5. Design Builder’s security measures shall be at least equal to those usually provided by Owner to protect existing facilities during normal operation.

B. Existing Security at the Site:
   1. Owner’s facility includes a perimeter security fence and a guardhouse at Gate 6 and Gate 8, staffed during normal business hours. Owner’s security personnel record entry to and departure from the facility of all visitors, and obtain Owner’s approval for allowing visitors on-site.
   2. All other gates are normally closed and allow entry through automated gate cards only.

C. Restrictions:
   1. At all times when Design Builder’s workers and personnel are at the Site or adjacent areas, no weapons, explosives, drugs, alcohol, stolen goods or criminal activity are allowed.
   2. Design Builder’s personnel shall not access the Site outside normal working hours without express knowledge of and consent of Site security personnel and Design Builder.

1.4 SUBMITTALS

A. Action Submittals:
   1. Submit the following:
      a. Shop Drawings:
         1) Temporary Fencing: Submit site plan drawings showing proposed locations and extent of temporary site security fencing and each opening therein.
      b. Product Data:
         1) Temporary Fencing: Manufacturer’s literature, specifications, and installation instructions for temporary site security fencing proposed.

B. Informational Submittals:
   1. Submit the following:
      a. Employee Information:
         1) Submit to Owner the following:
            a) Format of employee background data and proposed approach for performing employee background checks.
            b) Background data for employees to whom identification badges will be issued.
            c) Updated listing of personnel to whom identification badges have been issued. Submit updated listing within 24 HRS of a change in the list or change in an employee’s Site access status.

b. Security Plan:
   1) Submit the following to Owner:
      a) Design Builder's initial security plan Submittal, in accordance with Paragraph C of this Section’s Article, “Design Builder’s Site Access and Security Procedures”.
      b) Updates to Design Builder’s security plan, as required in this Section.

1.5 DESIGN BUILDER’S SITE ACCESS AND SECURITY PROCEDURES

A. Comply with Section 01 55 13 - Vehicular Access and Parking.

B. Comply with Owner’s security procedures and access restrictions at the Site throughout the Project. Comply with the following:
   1. Personnel Identification:
      a. All Design Builder personnel, including Subcontractors, Suppliers, and others associated with the Project, shall wear badge, hard hat, or other means identifying their company and their name.
   2. Vehicle Identification:
      a. While at the Site, all Design Builder, Subcontractor, and Supplier vehicles, including workers’ personal vehicles and all mobile construction equipment, shall display vehicle identification.
   3. Parking:
      a. Do not park outside of designated Design Builder parking areas.
      b. Personal vehicles are not allowed outside the contractor parking area.

C. Security Plan:
   1. Submit to Owner a written narrative-type security plan addressing the following:
      a. Project name and description.
      b. Design Builder name and contact information.
      c. List of proposed Subcontractors and Suppliers that will access the Site.
      d. List of all vehicles and construction equipment that will remain on-site during the Work.
      e. Design Builder’s emergency contact information for 24-HR use.
      f. Site layout plan drawing.
      g. Design Builder's planned work schedule (days and hours) and Progress Schedule required in Section 01 32 16 - Construction Progress Schedule.
      h. Design Builder’s security plan, personnel responsible for security, and proposed actions in event of security breach. Describe probable effect on facility's security (such as need for increased patrols) and how security breaches will be evaluated and the process improved.
   2. Updates:
      a. Updated listing of personnel to whom identification badges have been issued. Submit updated listing within 24 HRS of a change in the list or change in an employee’s Site access status.
      b. Submit updated list of vehicles for which vehicle identification has been issued.

PART 2 - PRODUCTS

2.1 TEMPORARY BARRICADES

A. Materials and Construction:
   1. Temporary barricades shall be of materials that are either new or of good quality and sufficient for the intended purpose, exposure, and duration of use.
   2. Provide temporary barricades of sturdy materials of grade, thickness, and durability sufficient for the probable loads to which they will be subject. Temporary barricades intended for fall prevention, such as railings and handrails on temporary stairs and

temporary walkways and at openings, shall be in accordance with Laws and Regulations, including the applicable building and safety codes.

3. Color: Use appropriately colored and reflective barricades, or paint barricades accordingly, to be visible at night and during periods of low visibility.
4. Where owner of transportation right-of-way or transportation facility having jurisdiction or other authority having jurisdiction requires compliance with standards more stringent than the Contract Documents, comply with both the Contract Documents and requirements of the authorities having jurisdiction.

2.2 TEMPORARY FENCING

A. When security fencing or barriers are breached or temporarily removed for the Project, provide temporary security fencing in manner satisfactory to Program Manager and Owner.

B. Provide other security fencing deemed necessary by Design Builder, such as for Design Builder's material and equipment storage areas. Such fencing, when not protecting Owner's or facility manager's property, shall be as deemed appropriate by Design Builder for Design Builder's purposes.

PART 3 - EXECUTION

3.1 ACCESSING OR ENTERING PROPERTY

A. Accessing or Entering Property – General:
   1. Use and occupy only lands and easements furnished by Owner, unless appropriate consent from property owner and occupants is obtained by Design Builder.
   2. The foregoing applies to personnel, construction equipment and machinery, tools, vehicles, materials or equipment to be incorporated into the Work, supplies, temporary facilities, and other items or obstructions.
   3. Limitations, if any, on accessing the Site are indicated in Section 01 55 13 - Vehicular Access and Parking.

3.2 BARRICADES

A. Temporary Barricades and Temporary Warning Lights and Signs – General:
   1. All Work Areas:
      a. Provide temporary barricades, warning lights, and warning signs for both indoor and outdoor Work, in accordance with Laws and Regulations and requirements of owners of affected property and facilities.
      b. Warning Lights and Signage: From 30 minutes before terrestrial sunset to 30 minutes after terrestrial sunrise, provide and maintain not less than one temporary flashing light at each vehicle barricade and at other barriers and barricades as necessary.
      c. Promptly replace temporary barricades that are damaged or are otherwise no longer capable of serving their intended function.
   2. Where the Work is performed on or adjacent to roadway, access road, other area travelled by motor vehicles, railroad, or similar transportation right-of-way, or public place:
      a. Provide temporary barricades, temporary fences, temporary guard rails, temporary lights and warning signs, temporary danger signals, and other precautions for protecting persons, property, vehicles, and the Work.
      b. Provide sufficient temporary barricades to keep vehicles from being driven on or into excavations and the Work under construction.
   3. Temporary Barriers for Areas Not Subject to Vehicular Traffic:
      a. Provide temporary barriers around:
         1) Openings.
         2) Scaffolding.
         3) Temporary stairs and ramps.
         4) Around excavations.

5) Around elevated walkways, slabs, and platforms.
6) Other areas that may present a fall-hazard or hazard to persons and property.

b. Provide appropriate temporary barriers, warning signs and, where necessary, warning lights, at ground level and other low elevations, and at higher elevations. Protect persons and property from fall-hazards and protect persons and property at lower elevations from falling objects.

4. Duration of Temporary Barriers, Barricades, Signs, and Warning Lights:
   a. Design Builder's responsibility for maintaining temporary barriers, barricades, signs, warning lights shall continue until the associated Work is substantially complete in accordance with the Contract Documents, unless other provision for protection are agreed to by the parties.
   b. After Substantial Completion, protect Work and property during periods when Design Builder is on-site: completing the remaining Work, performing correction period work, and performing warranty work.

3.3 TEMPORARY FENCING

A. Installation:
1. Provide temporary security fencing for site security so that integrity of site security is maintained throughout the Project.
2. Install temporary security fencing in accordance with the Contract Documents and fence Supplier's instructions.

B. Maintenance:
1. Maintain temporary security fencing throughout the Project, until removal.
2. Promptly repair damage to temporary security fencing and replace fencing when necessary to preserve Site security.

C. Removal:
1. Remove temporary security fencing when permanent site security fencing is in place and fully functional, or when otherwise acceptable to Program Manager.
2. Remove required temporary security fencing at Site perimeter and other temporary security fencing required by the Contract prior to inspection for Substantial Completion.

3.4 RESPONSIBILITY TO REMEDY DAMAGED PROPERTY

A. Design Builder to Remedy Damage:
1. Design Builder has full responsibility for preserving public and private property and facilities on and adjacent to the Site.
2. Direct or indirect damage done by, or on account of, any act, omission, neglect (including inadvertent acts), or misconduct by Design Builder (including any person or entity for whom contractor is responsible) in performing the Work, shall be promptly remedied by Design Builder, at Design Builder's expense, in accordance with the Contract Documents.
3. If the Contract Documents do not show or indicate the required restoration, or remedy, restore or remedy the damage to condition equal or better than that existing before damage was done.

B. Owner May Remedy:
1. Should Design Builder fail to protect and safeguard property and the Work after requests from Program Manager or Owner, Owner reserves the right to implement measures to protect property and the Work.
2. Cost of such Owner-implemented measures shall be paid by Design Builder. Owner may deduct from payments due Design Builder such amounts as set-offs in accordance with the Contract Documents.
3. Such right, however, does not obligate Owner or Program Manager to continuously monitor or have responsibility for protection of property and the Work, which responsibility is exclusively Design Builder's.

4. In exercising its rights under this provision, Owner will endeavor to give Design Builder sufficient notice to allow Design Builder to remedy the damage or defect within a reasonable time. However, if Owner or Program Manager deems that the situation requires prompt remedy, Owner may act as quickly as Owner deems appropriate, without infringing on or mitigating Owner's rights under this provision and elsewhere in the Contract Documents.

C. Protection of Lawns and Meadows:
1. Protect lawns and meadows from unnecessary damage during performance of the Work.
2. To extent practicable, do not drive vehicles, construction equipment, machinery, or wheeled items such as carts and wheelbarrows, across lawns and meadows.
3. When existing lawn or meadow areas are disturbed, promptly stabilize exposed soil in accordance with Section 01 57 05 - Temporary Controls.
4. Remedy damaged lawns and meadows in accordance with the Contract Documents. If not otherwise addressed in the Contract Documents, restore to preconstruction condition or better with the same or substantively similar species.

3.5 PROTECTION OF UNDERGROUND FACILITIES

A. Underground Facilities – General:
1. Information shown for Underground Facilities is the best available to Owner but is not guaranteed to be correct or complete.
2. Comply with Laws and Regulations regarding notification of utility owners prior to performing the Work, including necessary "call before you dig" notifications.
3. Design Builder shall explore ahead of trenching and excavating Work and shall sufficiently uncover Underground Facilities that will or may interfere with the Work to determine their location, to prevent damage to Underground Facilities, and to prevent service interruption to structures and properties served by Underground Facilities.
4. If Design Builder damages an Underground Facility, Design Builder shall promptly restore the damaged Underground Facility in accordance with requirements of the owner of the damaged facility and the Contract Documents. If the Contract Documents do not address repair or remedy of the damaged facility, restore to not less than preconstruction condition.

B. Protection of Underground Facilities under Roads and Parking Areas:
1. Provide temporary, heavy-duty steel roadway plates to protect existing manholes, handholes, valve boxes, vaults, and other Underground Facilities near to, or visible at, the ground surface.
2. Avoid imparting heavy loads, especially stationary loads (such as with cranes) and transitory loading (such as heavy truck traffic), vibration forces, and impact loads on Underground Facilities that are close to the ground surface and below-grade work areas. Provide temporary bridging or other appropriate protection where traffic must pass over Underground Facilities in close proximity to the ground surface.

C. Temporary Support of Underground Facilities:
1. Where Design Builder exposes or excavates around or under one or more existing Underground Facilities, provide appropriate and adequate temporary supports for the associated Underground Facilities.
2. Do not allow Underground Facilities exposed by Design Builder's operations to remain exposed without temporary support necessary to properly protect the Underground Facility. Where joint of Underground Facility is exposed by excavation, provide temporary support for each exposed joint and other temporary support as necessary.
3. Design of Temporary Supports:
   a. Where necessary or where expressly required by the Contract Documents, retain services of professional engineer to design the temporary supports. Such professional engineer shall be experienced with the type and size of subject Underground Facility, structural engineering, and geotechnical engineering sufficient for the foundations of the temporary supports.

b. Temporary supports are not delegation of professional design responsibility unless expressly so indicated in the Contract Documents.
c. Responsibilities of Design Builder's professional engineer shall include, but are not necessarily limited to, the following:
   1) Advising Design Builder on investigations necessary to obtain information for design of temporary supports. Reviewing and considering results of such investigations in the design of temporary supports.
   2) Visiting the Site to make personal observations as needed.
   3) Identifying appropriate design criteria for temporary supports.
   4) Preparing necessary calculations, design drawings, and design specifications (sealed and signed when required by Contract or Laws or Regulations), appropriately based on the associated soil conditions and subsurface conditions, considering the consequences of failure of the temporary supports and associated potential for damage or failure of the existing subject Underground Facility.
   5) Designing temporary supports with a safety factor of not less than 2.0.
   6) Reviewing and approve or take other appropriate action on submittals of shop drawings and product data for the temporary supports and related materials.
   7) Making periodic visits to the Site during erection of the temporary supports and at appropriate intervals thereafter to inspect the temporary supports during performance of other, adjacent Work.
   8) Issuing to Design Builder written recommendations for repairs and improvements necessary for the proper protection of the associated Underground Facility.
   9) Submitting to Design Builder detailed, written recommendations for backfilling the excavation underneath and adjacent to the Underground Facility and for removing the temporary supports.
d. Design Builder shall comply with the professional engineer's design of the temporary supports.
e. Owner may require and, in such event, Design Builder shall submit, design documents, shop drawings, product data, and reports by Design Builder-hired professional engineer. When such documents are furnished to Owner, the Owner has no obligation to perform any review of such documents and Owner's possession of such documents does not impart on Owner or Program Manager any responsibility for or professional liability associated with design of such temporary supports and consequences of implementing such designs. Owner and Program Manager are not obligated in any way to implement recommendations of Design Builder's professional engineer.

3.6 PROTECTION OF EXISTING SURFACE STRUCTURES

A. Surface Structures – General:
   1. Surface structures are existing buildings, structures, and other facilities at or extending above ground surface, including their foundations and any extension below ground surface. Surface structures include, but are not limited to, buildings, tanks, walls, roads, open drainage routes, exposed piping and utilities, poles, exposed wires and cabling, posts, signs, markers, curbs, walks, fencing, and other facilities visible at or above ground surface.
   2. Protect surface structures as necessary and promptly remedy damage and defects resulting or arising from Design Builder's operations. Unless expressly shown or indicated otherwise in the Contract Documents, protect such items regardless of whether shown or indicated on the Drawings or elsewhere in the Contract Documents.
   3. Protection of Overhead Utilities:
      a. Protect visible, overhead utilities, including electrical power, communications, and piped utilities, and related supports, regardless of whether such items are shown or indicated in the Contract Documents.
      b. When required by the Contract Documents or when acceptable to owner of such utility or facility, temporarily relocate overhead utilities or facilities as necessary perform the Work.

c. Provide temporary barriers, barricades, and warning signs identifying overhead utilities within reach of Design Builder's construction equipment, machinery, or operations.

B. Temporary Removals of Surface Structures:
1. Existing surface facilities, including but not limited to guard rails, handrails, posts, guard cables, signs, poles, markers, curbs, and fencing, that are temporarily removed to facilitate the Work shall be replaced and restored promptly after the associated Work is performed.
2. Replace and restore such items in accordance with the Contract Documents. If not addressed in the Contract Documents, replace and restore such items to preconstruction condition or better.
3. Remedy damage to all items temporarily removed and later replaced and restored.
4. All such temporary relocations, replacement, and restoration is at Design Builder's cost.

C. Protection of Surface Structures:
1. Sustain in their original location and protect from direct and indirect injury all surface structures located within or adjacent to the Site. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure or facility.
2. Before proceeding with the Work of sustaining and supporting such structure or facility, Design Builder shall, upon Program Manager's request, promptly satisfy Program Manager that methods and procedures to be used have been approved by party owning the surface structure or facility.
3. Regardless of approval or acceptance by owner of property, structure, or facility, responsibility for protecting the Work and property is solely Design Builder's.

3.7 PROTECTION OF FLOORS, WALLS, AND ROOFS

A. Protection of Floors, Walls, and Roofs – General:
1. Use proper protective covering when moving equipment, handling materials or other loads, when painting, handling mortar or grout, and when cleaning walls, ceilings, or structure contents.
2. Use metal pans to collect oil and cuttings from piping, conduits, and rod threading machines, and under metal cutting machines.
3. Maintain at the Site and use spill kits and absorbent pads for remedying spills.
4. Do not load concrete floors less than 28 days after concrete placement without Design Professional's written permission.
5. Do not load slabs, floors, walls, or roofs in excess of design loading.
6. Do not load roofs without Design Professional's written permission.
7. Restrict access to roofs, and keep Design Builder's workers and personnel off existing roofs, except as necessary for the Work.
8. If access to roofs is necessary, roofing, parapets, openings, and all other construction on or adjacent to roof shall be protected with suitable plywood, barricades, or other appropriate means.

3.8 PROTECTION OF INSTALLED MATERIALS, EQUIPMENT, AND LANDSCAPING

A. General:
1. Protect existing facilities and installed Work to prevent damage from subsequent operations.
2. Remove protective items when no longer needed, prior to Substantial Completion of the associated Work.
3. Where work will continue in adjacent area(s) after Substantial Completion of a portion of the Work, protect the substantially completed Work until all work in the area is complete.

B. Control traffic (foot traffic, wheeled items such as carts, vehicles, and other traffic) to prevent damage to equipment, materials, and surfaces.

C. Coverings:
1. Provide temporary coverings to protect materials and equipment from damage.

2. Cover: projections, wall corners and jambs, sills, and soffits of openings, in areas used for traffic and for passage of materials and equipment in subsequent work.
3. Fasten protective items without harming the Work. Use tape or adhesives that do not leave residue when removed.

3.9 VIBRATION AND MOVEMENT LIMITS AND MONITORING

A. Conduct all activities on the project in such a manner to prevent damage to adjacent pipes, structures, property and work, and consistently maintain ground vibrations and ground and structure displacements below the maximum levels specified herein.
   1. Blasting will not be permitted.
   2. Provide the services of an Independent Specialist:
      a. To prepare a Monitoring Plan showing the location and type of all settlement monitoring points.
      b. To provide settlement monitoring equipment and engineering seismographs.
         1) Engineering seismographs shall be capable of measuring vibration levels from 0.02 to 10 IN per second, at frequencies from 2 to 200 Hz, and of continually recording readings for a period of 24 HRS.
      c. To monitor vibration and movement throughout the major construction activities for this project.
   3. Provide the services of a surveyor licensed in the Commonwealth of Virginia to perform the baseline survey of structure elevations and perform settlement survey readings.
   4. Monitoring Plan:
      a. Submit Monitoring Plan, settlement and movement monitoring equipment manufacturer's data, and structure examination report prior to performing the work. Identify structures to be monitored during construction.
   5. Structure Examination:
      a. Prior to starting work, the Design Builder, Owner, and Program Manager shall make a joint inspection of the existing structures within 150 FT of the work area to examine and document present conditions.
      b. Take photographs to record any cracks or other evidence of structural distress in the structure.
      c. Perform a baseline survey of structure elevations prior to the start of construction activity.
         1) Establish a system of reference points on or about structures that may be affected by excavation or demolition performed as part of Work.
         2) Provide sufficient points to permit detection of both horizontal and vertical movement.
         3) Accurately reference all readings to one benchmark, sufficiently remote as to be unaffected by any construction activity.
      d. Prepare a report documenting all pre-existing conditions for each structure, verified by the photographs.
         1) Submit in accordance with Section 01 33 00.

B. Movement and Vibration Limits at Existing Structures and Utilities:
   1. Design Professional or Independent Specialist shall establish maximum vibrations that shall not be exceeded as a result of excavation, demolition, pile driving or other activities of the Design Builder. Submit recommended peak particle velocity (PPV) to Program Manager for acceptance for:
      a. Occupied Structures.
      b. Concrete and Utility Structures.
      c. Buried pipelines or other buried utilities.

2. Design Professional or Independent Specialist shall establish maximum movements that shall not be exceeded as a result of excavation, demolition, or other activities of the Design Builder. Submit recommended maximum settlement or heave to Program Manager for acceptance for:
    a. All structures and pavement at the site.
    b. Buried pipelines or other buried utilities.
3. Actions if threshold or limiting values are exceeded:
    a. Stop all work in the vicinity of the exceedance until a meeting takes place between the Design Builder, Design Professional, Owner, Program Manager, and the Design Builder’s Independent Specialist to assess the cause of the exceedance.
    b. Within 24 HRS of notification of the exceedance, submit to the Owner a report indicating the activity causing the exceedance and the steps the Design Builder has taken and will take to prevent further exceedances of the threshold limit.
    c. Do not restart work in the vicinity of the exceedance until the submittal is reviewed and accepted by the Owner.

C. Monitoring Schedule
1. Perform settlement monitoring weekly when excavation, demolition, and construction activities are more than 100 FT from a monitored structure.
2. Perform settlement monitoring daily when any construction activities are within 100 FT of a monitored structure.
3. When excavation, demolition and construction activities are within 20 FT of a monitored structure, settlement monitoring may be conducted several times during the day, as directed by the Design Builder’s Independent Specialist.
4. Provide movement detection survey reports to the Owner within 24 HRS after the survey is made.

END OF SECTION

SECTION 01 75 00
START-UP AND COMMISSIONING PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for start-up and commissioning of equipment, systems, and facilities, including Demonstration and Performance Tests.

B. Scope:
   1. Requirements of this Section are intended to be the minimum requirements for Start-up, Testing, and Commissioning the Work and shall supplement the Design Professional's detailed requirements. The Design Professionals requirements shall not supersede requirements listed herein, unless approved by the Owner.
   2. Design Builder shall initially check out, start-up, and place equipment and systems installed under the Contract into successful operation, in accordance with the material and equipment manufacturers' written instructions, Suppliers' recommendations at the Site, and the Contract Documents.
   3. Successful completion of Demonstration and Performance tests are required prior to receiving Substantial Completion.
   4. Provide the following:
      a. All labor, tools, materials, and equipment required to complete equipment and system checkout and start-up.
      b. Chemicals, lubricants, and other required operating fluids necessary for checkout, start-up, and initial operation of the Work.
      c. Filters and other temporary or consumable items necessary for checkout, start-up, and initial operation of the Work.
      d. Fuel, electricity, water, and other temporary utilities and temporary facilities necessary for checkout and start-up of equipment and systems, unless otherwise specified.
   5. The General Conditions and Section 01 77 19 - Closeout Requirements, address requirements for documenting Substantial Completion.

C. Related Sections include but are not necessarily limited to:
   1. Section 01 78 23 - Operation and Maintenance Data.
   2. Section 01 77 19 - Closeout Requirements.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate checkout, start-up and commissioning with other subcontractors and equipment suppliers, as necessary.
   2. Do not start-up equipment or system(s) for continuous operation until all components of that equipment item or system, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
   3. Subject to the constraints of this Specifications section, Owner will furnish sufficient personnel to assist Design Builder in starting up equipment and system(s), but responsibility for proper operation of the Work is Design Builder's.
   4. Supplier shall be present during checkout, start-up, and initial operation, unless otherwise acceptable to Design Professional and Program Manager or otherwise required by the Contract Documents.
   5. For start-up of heating equipment, air conditioning equipment, and other equipment and systems that provide temperature control, that are dependent upon the time of year, return to

the Site at beginning of next heating or cooling season (as applicable) to recheck and start the appropriate equipment and system(s).

6. Do not start-up equipment and system(s), without submitting acceptable preliminary operations and maintenance manuals by Design Builder in accordance with the Contract Documents.

B. Start-up and Commissioning Plan:
   1. A conceptual Start-up and Commissioning Plan is required during the Design Implementation Stage. This conceptual Plan shall be updated and submitted for review at least 180 days prior to the initial system start-up.
      a. The plan shall be updated a second time and submitted 30 days prior to initial start-up.
   2. Update all information included in the conceptual Plan. In addition, provide detailed checkout and start-up procedures for all individual systems. Separate Plans may be provided for specific systems. At a minimum, include the following with the detailed Start-up and Commissioning Plan:
      a. Detailed processes and procedures for all phases of testing, including templates for review forms for all stages of testing, including verification that all testing requirements have been met.
      b. Detailed start-up sequencing, including procedures for process ramp up and transition from existing solids handling processes.
      c. Analytical methods, calculations, and other techniques to ensure that requirements of testing are met.
      d. Procedures for communicating and responding to unsuccessful test results.
      e. Start-up and commissioning planning meetings required, including number of meetings, timing of meetings, and specific objectives of each meeting.

C. Start-up and Commissioning Meetings:
   1. Design Builder, with appropriate Subcontractors and Suppliers, shall attend and participate in meetings with Owner, Program Manager, and Design Professional to discuss planning, scheduling, and coordination of start-up and commissioning activities as defined in the Start-up and Commissioning Plan.

D. Sequencing:
   1. Comply with Section 01 14 16 - Coordination with Owner’s Operations and the Design Builder’s Maintenance of Plant Operations Plan, regarding staging (phasing) of the Work and allowable shutdowns.

E. Scheduling:
   1. Progress Schedule:
      a. Clearly indicate in the Progress Schedule planned and actual dates for checkout, start-up, and field quality control activities, including all demonstration and performance testing activities addressed in this Specifications section and elsewhere in the Contract Documents. Separately indicate checkout, start-up, and field quality control activities for each equipment item and system.
   2. Restrictions for Scheduling:
      a. Checkout of materials, equipment, and systems by Design Builder that do not involve or require Owner’s personnel may be performed at any time during normal working hours. Where required by the Contract Documents or requested by Program Manager, perform checkout in the presence of Program Manager.
      b. Start-up, including initial operation of materials, equipment, and systems, shall not be initiated on: Monday, Friday, Saturday, Sunday, Owner’s holidays, the day immediately prior to a holiday, or the day immediately following a holiday, unless otherwise acceptable to Owner or Program Manager.
      c. Unless otherwise indicated in the Contract Documents or acceptable to Owner, perform all start-up during normal working hours of the day shift.

d. To the extent practicable, where extended duration start-up or field quality control activities are required by the Contract, avoid having such activities extend into evening, night, weekend, or holiday hours.
e. Owner reserves the right to require a minimum 7 days' notice of rescheduled start-up when Design Builder cannot perform the associated activities as scheduled.

3. Operation and Maintenance Data:
   a. Comply with Section 01 78 23 - Operation and Maintenance Data.
   b. A preliminary copy of all operation and maintenance manuals shall be received by Program Manager prior to the start of the demonstration period.
4. Training:
   a. Comply with Contract Documents.
5. Spare Parts, Tools, and Extra Materials.
   a. Coordinate spare parts requirements with the Owner during the Design Implementation Stage. Provide spare parts, tools, and materials as required by the Design Professional's specifications.
   b. Deliver to Owner all required spare parts, tools, and extra materials prior to commencing the demonstration period, unless earlier delivery is required elsewhere in the Contract Documents.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Do not start-up equipment or systems or place into initial operation until required operating permits are obtained from authorities having jurisdiction.
   2. Where Owner has applied for and obtained initial approvals or permits necessary for operation, Design Builder shall furnish information and assistance to Owner for Owner to secure final approvals from authorities having jurisdiction for required operating permits.

1.4 DEFINITIONS

A. The following defined terms are used in this Specifications Section:
   1. Instrumentation Supplier: Entity retained by Design Builder, Subcontractor, or Supplier to furnish instrumentation or controls that will be part of the completed Work, including manufacturers, manufacturer representatives, wholesalers, retailers, and others, including entities retained to perform systems integration Work.
   2. Project Facility Group (PFG): An established, distinct part of the Project, consisting of an arrangement of items, such as equipment, structures, components, piping, cabling, materials, and incidentals, so related or connected to form an identifiable, unified, functional, operational, safe, and independent system. PFGs will be defined during the Design Implementation Stage.
   3. Pre-Demonstration Period: The period of time, of unspecified duration after initial construction and installation activities during which Design Builder, with assistance from manufacturer's representatives, performs in the following sequence:
      a. Finishing construction work to ensure the Project or each PFG has reached a state of Substantial Completion.
      b. Equipment start-up.
      c. Personnel training.
   4. Demonstration Period: A period of time, of specified duration, following the Pre-Demonstration Period, during which the Design Builder initiates process flow through the facility and starts up and operates the facility, without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components and the control interfaces of the respective equipment and components comprising the facility.
   5. Performance Tests: A period of advanced testing that proves the reliability of the facility as a whole to meet the design intent as evidence of Substantial Completion.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
  1. Final Start-up and Commissioning Plan.
  2. Data collection and reporting log for each required Demonstration Period.

B. Informational Submittals: Submit the following:
  1. Progress Schedules indicating dates for checkout, start-up, and field quality control activates.
  2. Completed checkout and start-up log required in Paragraph 3.2.C of this Specifications section.
  3. Manufacturer's installation check letters (also known as Manufacturer's Field Services Report) required in Paragraph 3.2.C of this Specifications section.
  4. Instrumentation Supplier's Instrumentation Installation Certificate, required in Paragraph 3.2.C of this Specifications section.
  5. Letter verifying completion of all pre-demonstration start-up activities, required in Paragraph 3.2.C of this Specifications section.
  6. Report of data collected during each required Demonstration Period.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 CHECKOUT AND START-UP – GENERAL

A. Facility Start-up Divided into Three Periods:
  1. Pre-Demonstration Period including:
    a. Obtain Program Manager's approval or acceptance (as applicable) of Submittals required prior to checkout and start-up, including all Shop Drawings, Samples, source quality control (shop testing) Submittals, preliminary operation and maintenance manuals, and other Submittals required by the Contract Documents, other than Submittals that cannot be furnished until after start-up.
    b. Complete the Work to a point ready for checkout and start-up, including operation available in all manual, automatic, and other modes.
    c. Checkout and initial field quality control activities that can be performed prior to start-up of the equipment or system.
    d. Start-up of the associated Work.
    e. Field quality control activities for the subject Work as indicated elsewhere in the Specifications and other Contract Documents, other than this section.
    f. Training of operations and maintenance personnel.
  2. Demonstration Period, including:
    a. Demonstration of functional integrity of equipment, system, or PFG. There may be multiple Demonstration Periods.
  3. Performance Tests:
    a. Demonstration of various components of the PFG's ability to meet the design intent. There will be multiple Performance Tests.

3.2 PRE-DEMONSTRATION PERIOD

A. Prior to the Pre-Demonstration Period, complete the Work to the point where it is ready for checkout and start-up.

B. Checkout:
  1. Comply with Design Professional's provisions and equipment manufacturer's requirements concerning installation checks and procedures.

C. Start-up:
1. Comply with requirements for start-up of materials, equipment, and systems indicated in the associated Specification sections, equipment manufacturer's requirements, and elsewhere in the Contract Documents.
2. Prepare the Work so it will operate properly and safely and be ready to demonstrate functional integrity during the Demonstration Period.
3. Perform start-up to extent possible without introducing process flow.
4. Test tanks, pumping and similar equipment requiring a fluid, using clean water. Non-potable water will be provided to Design Builder at no charge by the Owner.
5. Dispose of water used for Equipment Start-up as directed by the Owner.
6. Procedures include but are not necessarily limited to the following:
    a. Test or check and correct deficiencies of:
        1) Power, control, and monitoring circuits for continuity prior to connection to power source.
        2) Voltage of all circuits.
        3) Phase sequence.
        4) Cleanliness of connecting piping systems.
        5) Alignment of connected machinery.
        6) Vacuum and pressure of all closed systems.
        7) Lubrication.
        8) Valve orientation and position status for manual operating mode.
        9) Watertight testing of tanks, cake bins and chutes, valves, gates, and other equipment for integrity using clean water. Watertight testing shall be completed to confirm all listed items are watertight and there are no visible leaks.
        10) Pumping equipment using clean water.
        11) Instrumentation and control signal generation, transmission, reception, and response (open and closed loop testing).
        12) Tagging and identification systems.
        13) Proper connections, alignment, calibration and adjustment.
    b. Calibrate safety equipment.
    c. Manually rotate or move moving parts to ensure freedom of movement.
    d. "Bump-start" electric motors to verify proper rotation.
    e. Perform other tests, checks, and activities required to make the Work ready for Demonstration Period.
    f. Checkout and Start-up Log:
        1) Prepare a log showing each equipment item and system requiring checkout and start-up. Indicate in the log activities to be accomplished during checkout and start-up.
        2) Provide a place for Design Builder to record date and person performing required checkout and start-up. Indicate associated date(s), personnel, and employer of each.
        3) Submit completed checkout and start-up log to Program Manager and obtain Program Manager's acceptance.
7. Obtain Suppliers' certifications of the installed and operational Work, without restrictions, and submit to Program Manager:
    a. Manufacturer's installation check letters (sometimes referred to as Manufacturer's Field Services Report).
    b. Instrumentation Supplier's Instrumentation Installation Certificate.
8. Letter verifying completion of all pre-demonstration start-up activities including receipt of all specified items from Suppliers as final item prior to initiation of Demonstration Period.
9. Personnel Training shall be completed in accordance with the Contract Documents.

3.3 DEMONSTRATION PERIOD

A. Demonstration Period – General:
   1. Demonstrate the operation and performance of mechanical, electrical, instrumentation, and control interfaces of the Work undergoing the Demonstration Period, in accordance with the Contract Documents.
   2. Duration of Demonstration Period: 168 consecutive HRS.
   3. If, during the Demonstration Period, the aggregate time used for repair, alteration, or unscheduled adjustments to any part of the Work that renders the affected Work inoperative or operation outside of recommended ranges exceeds 5 percent of the Demonstration Period, the demonstration of operation and performance will be deemed unacceptable and Design Builder shall provide appropriate adjustments and remedies and re-perform the Demonstration Test, at no additional cost to Owner, until acceptable results are obtained. Re-performance of the Demonstration Period shall comply with the same requirements as the original Demonstration Period.
   4. Perform the demonstration of operation and performance of the Work under full operational conditions.
   5. Owner’s Personnel:
      a. Owner will make available operations personnel to make process decisions affecting facility performance and compliance with applicable operating permits.
      b. Owner's assistance will be available only for process decisions.
      c. Design Builder will perform all other functions associated with the Demonstration Period including but not limited to equipment operation and maintenance until successful completion of the Demonstration Period in accordance with the Contract Documents.
   6. Owner reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, and similar actions and events during the Demonstration Period to verify the operation and performance of the Work in automatic, manual, and other types of operating modes, backup systems, and alternate operating modes.
   7. Demonstration by PFG:
      a. Design Builder may demonstrate by PFG, either individually or a combination of two or more PFG. Design Builder is responsible for properly disposing of any unstabilized solids generated during the Demonstration Period.
   8. Prior to Starting Demonstration Period:
      a. Prepare data collection and reporting log for sampling, analytical data, and data to be obtained by manually recording data from field or panel indicators. Not less than 30 days prior to the start of the Demonstration Period, submit the data collection and reporting log to Program Manager for acceptance.
   9. Timing of Start and End of Demonstration Period:
      a. Schedule the end of the Demonstration Period at a convenient time such as midnight, so the Owner or facility manager can assume operational responsibility on a new day beginning immediately after completion of the Demonstration Period.
      b. Time of beginning and ending Demonstration Period shall be agreed upon by Design Builder, Owner, and Program Manager in advance of initiating Demonstration Period.

B. Baseline Testing: Conduct a series of baseline tests during the Demonstration Period to provide an assessment of the equipment in a new condition. Include the following baseline tests.
   1. Vibration testing: Using an independent firm, complete vibration testing on all rotating and reciprocating equipment with a motor of 50HP or greater. Submit report of findings to the Program Manager.
   2. Natural frequency analysis: Using an independent firm, complete a natural frequency analysis on all rotating and reciprocating equipment with motor of 50 HP or greater after the equipment has been mounted. The firm must employ a registered professional engineer with experience in finite element analysis, rotordynamic analysis, and experimental modal analysis. Submit report of findings to the Program Manager.

3. Infrared thermography testing: Using an independent firm, infrared thermography testing on all rotating and reciprocating equipment with motor of 50 HP or greater. Also test all associated electrical panels, new or modified motor control centers, and new or modified switchgear. Correct all hot spots found during the testing and retest to ensure the issue has been corrected. Submit report of findings to the Program Manager.
4. Baseline testing of pumps: For all pumps with a motor of 5 HP or greater, complete a series of tests to measure flowrate, pressure, and power consumption at various conditions that can be used by the Owner in subsequent years to determine pump condition.

C. Demonstration Period, Evaluation, and Acceptance:
1. Throughout the Demonstration Period, provide knowledgeable personnel to answer Owner's questions, provide final field instruction on select systems (where appropriate) and to respond to problems or failures of the Work.
2. Responsibilities for Sampling and Data Collection:
    a. Use the data collection and reporting log format accepted by Program Manager. Indicate data clearly and legibly.
3. Responsibilities for Data Reporting:
    a. Submit data collected to Program Manager for evaluation of acceptability of results.
4. Data Evaluation:
    a. Program Manager, in consultation with Owner as necessary, will evaluate the data collected during the Demonstration Period and other information obtained during the Demonstration Period for compliance with the Contract Documents.
    b. Owner will advise Design Builder in writing of whether the data and information obtained indicate that the Demonstration Period was successfully completed.

3.4 PERFORMANCE TESTS

A. Performance Tests – General:
1. Following successful completion of the Demonstration Period, demonstrate compliance with Performance Guarantees and compliance with Design Criteria Standards through Performance Tests.
2. Performance Guarantees and Design Criteria Standards will be defined in the Design Builder Guaranteed Maximum Price Amendment.

B. Performance Tests – Reports:
1. Submit results of the Performance Tests to the Owner for Acceptance within 30 days following completion of each Performance Test.
2. Reports shall be certified as a true, complete and correct record of the Performance Tests by the Design Builder and Design Professional.
3. Include a description of each system and subsystem test conducted, the results of the tests, and the level to which the results met or exceeded the applicable Performance Guarantees.
4. Include copies of original data sheets, log sheets, and calculations.
5. Include all laboratory sampling and test results.

C. Concurrence with Certification of Performance Tests:
1. The Owner shall determine within 14 days following receipt of the certified test reports whether it concurs with such certification.
2. If the Owner concurs with the certification, the Performance Test will be accepted and deemed completed on the final date when the testing was actually performed.
3. If the Owner does not concur with the certification, written notice shall be sent to the Design Builder.

D. Corrective Actions:
1. In the event of failure of any Performance Test, the Design Builder shall take all action necessary to make corrections to the failed system to meet the Performance Guarantees and Design Criteria Standards.

2. Submit all corrective actions to the Program Manager for review. Any change to the system performance or design shall follow the Substitution requirements specified in Section 01 33 00.
3. Provide a minimum of 3 days written notice prior to repeating any Performance Test.

END OF SECTION

SECTION 01 77 19
CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for:
   1. Substantial Completion.
   2. Final inspection.
   3. Request for final payment and acceptance of the Work.

1.2 SUBSTANTIAL COMPLETION

A. Substantial Completion – General:
   1. Prior to requesting inspection for Substantial Completion, perform the following for the substantially completed Work:
      a. Materials and equipment for which Substantial Completion is requested shall be fully ready for their intended use, including full operating and monitoring capability in automatic, manual, and other operating modes set forth in the Contract Documents.
      b. Permanent provisions for safety and protection, shown and indicated in the Contract Documents and associated with the substantially completed Work or for personnel accessing and using the substantially completed Work, shall be in place and ready for their intended use.
      c. Complete field quality control Work, including inspections and testing at the Site, indicated in Specifications sections for individual materials and equipment items and related Contract Documents. Submit results of, and obtain Owner and Program Manager's acceptance of, field quality control tests and inspections required by the Contract Documents.
      d. Complete checkout and start-up in accordance with Section 01 75 00 – Start-up and Commissioning Procedures, requirements of the Design Professional's Specifications for the various materials and equipment in the substantially completed Work, and related Contract Documents.
      e. Cleaning for Substantial Completion shall be completed in accordance with –Design Professional and Owner requirements.
      f. Spare parts, tools, and extra materials shall be delivered and accepted in accordance with the Contract Documents and documentation of Owner's acceptance thereof has been submitted to Program Manager in acceptable form.
      g. Training of the facility's operations and maintenance personnel shall be completed in accordance with the Contract Documents.
      h. Submit and obtain Program Manager's acceptance of final operations and maintenance manuals in accordance with Section 01 78 23 - Operation and Maintenance Data.
      i. Obtain and submit to Program Manager all required permits, inspections, and approvals of authorities having jurisdiction for the substantially completed Work to be occupied and used by Owner.
      j. Complete other tasks that the Contract requires be completed prior to Substantial Completion.
      k. Successfully complete all Performance Tests.
   2. Procedures for requesting and documenting Substantial Completion are in the General Conditions.

1.3 FINAL INSPECTION

A. Final Inspection – General:
   1. Prior to requesting final inspection, verify that all the Work is fully complete and ready for final payment.
   2. Procedures for requesting and documenting the final payment are in the General Conditions.

1.4 REQUEST FOR FINAL PAYMENT AND ACCEPTANCE OF THE WORK

A. Procedure:
   1. After successful completion of the final inspection, submit request for final payment in accordance with the Agreement and General Conditions.

B. Request for final payment shall include:
   1. Documents required in the General Conditions.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Requirements for Design Builder-furnished, manufacturers' operation and maintenance (O&M) data, including:
   a. Required operation and maintenance data groupings into maintenance manuals and timing of such Submittals.
   b. Requirements for paper copies of operation and maintenance data and related Electronic Documents.
   c. Content of operation and maintenance data Submittals.
2. Requirements for furnishing program code and configuration files.

B. Scope:
1. Requirements of this Section are intended to be the minimum requirements for Operation and Maintenance Data and shall supplement any requirements by the Design Professional. The Design Professionals requirements shall not supersede requirements listed herein, unless approved by the Owner.
2. Design Builder shall submit operation and maintenance data, and related information, in accordance with this Section and requirements elsewhere in the Contract Documents, as instructional and reference information for use by: (a) Owner's operation and maintenance personnel, and (b) others retained by or working for Owner.
3. In addition to operation and maintenance data expressly required elsewhere in the Contract Documents, also submit operation and maintenance data for:
   a. All equipment and systems, including facility equipment, conveying equipment, fire suppression systems, plumbing equipment, HVAC equipment, electrical equipment, communications equipment, electronic safety and security systems, utility equipment, and process equipment, and other equipment.
   b. Valves, gates, actuators, and related accessories.
   c. Instrumentation and control devices and systems.
   d. Building materials, systems, and finishes that need post-construction troubleshooting, cleaning, or maintenance, such as roofing, doors, windows, louvers, flooring, paint and coatings, other finishes, and other items.

C. Related Requirements:
1. Section 01 33 00 - Submittal Procedures.
2. Section 01 75 00 - Start-up and Commissioning Procedures.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
   a. Submit operation and maintenance data, required by the Contract Documents, grouped into operation and maintenance manual Submittals by process area.
   b. For each required operation and maintenance manual Submittal, furnish preliminary Submittal and final Submittal. Timing of preliminary and final operation and maintenance manual Submittals, and differences between preliminary and final Submittals, are indicated in this Section.

2. Program Code and Configuration Files:
   a. Submit as Electronic Documents, program code for programmable logic controllers, human-machine interfaces, operator interface terminals, and other programmable controllers, and configuration files, in accordance with requirements of this Section.
   b. Program Manager's review of such Electronic Documents will be only to verify required Submittals were furnished. Program Manager is not responsible for verifying completeness or accuracy of program code and configuration file Submittals.

B. Timing of Submittals and Quantity Required:
1. Preliminary Operation and Maintenance Manual Submittals:
   a. Paper Copies: Three copies, exclusive of copies required for Design Builder's use.
   b. Electronic Documents.
   c. Submit to entity indicated in Section 01 33 00 – Submittal Procedures, by the earlier of: 90 days following approval of Shop Drawings and product data Submittals, or 14 days prior to starting training of operation and maintenance personnel, or 14 days prior to field quality control testing at the Site.
   d. Do not perform checkout, start-up, and training without Program Manager's acceptance of preliminary operation and maintenance data Submittals for the associated Work.
2. Final Operation and Maintenance Manual Submittals: Furnish final Submittal prior to Substantial Completion of the associated Work, unless submittal is required prior to an interim Milestone.
   a. Paper Copies: Three copies, exclusive of copies required for Design Builder's use.
   b. Electronic Documents: through e-Builder.
   c. Work will not be eligible for Substantial Completion until associated, required final operation and maintenance data Submittals are accepted by Program Manager.
3. Program code and Configuration Files:
   a. Paper Copies: Not required.
   b. Electronic Documents: transmit as agreed to by Owner and Program Manager. Submit Electronic Documents in both of the following formats:
      1) Portable document format (".pdf") files.
      2) Operable code and configuration files suitable for Owner's use in modifying program code and configuration with Owner's own personnel.
   c. Work will not be eligible for Substantial Completion until associated, required program code and configuration Electronic Documents Submittals are accepted by Program Manager.
   d. If Design Builder (whether or not via Subcontractor or Supplier), revises program code or configuration files between acceptance of Submittal by Program Manager and end of the Contract's correction period and Design Builder's general warranty obligation, furnish updated program code and configuration files to Owner. Before modifying program code and configuration files after Substantial Completion, verify that Owner modifications of program code or configuration files were incorporated into the modified files, subject to the provisions of this Section.

1.3 PAPER COPIES OF O&M MANUALS

A. Binding and Cover:
1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy, as necessary.
2. Binders shall be not less than 1 IN wide and maximum of 3 IN wide. Binders for each copy of each volume shall be same size and color.
3. Binders shall be locking three-ring ("D"-ring) type, or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front and back of each volume.
4. Do not overfill binders.
5. Covers shall be oil-, moisture-, and wear-resistant, including identifying information on cover and spine of each volume.

6. Indicate the following information on cover of each volume:
    a. Title: “OPERATING AND MAINTENANCE INSTRUCTIONS”. For submittal of preliminary operation and maintenance data, include the word, “PRELIMINARY” in the title.
    b. Name or type of material or equipment covered in the manual.
    c. Volume number, if more than one volume is submitted, listed as “Volume __ of __”, with appropriate volume-designating numbers filled in.
    d. Name of Project and, when applicable, Contract name and number.
    e. Name of building or structure, as applicable.
    f. Relevant specification section(s).
    g. Equipment tag numbers.
7. Provide the following information on spine of each volume:
    a. Title: “OPERATING AND MAINTENANCE INSTRUCTIONS”. For submittal of preliminary operation and maintenance data, include the word, “PRELIMINARY” in the title.
    b. Name or type of material or equipment covered in the manual.
    c. Volume number, when more than one volume is submitted, listed as “Volume __ of __”, with appropriate volume-designating numbers filled in.
    d. Project name and building or structure name.
    e. Relevant specification section(s).
    f. Equipment tag numbers.

B. Pages:
1. Print pages in paper copies of operation and maintenance manuals on 30-LB (minimum) paper, 8.5-IN by 11-IN size.
2. Reinforce binding holes in each individual paper sheet with plastic, cloth, or metal. When published, separately bound booklets or pamphlets are part of manuals, reinforcing of pages within booklet or pamphlet is not required.
3. Furnish each page with binding margin not less than 3/4-IN wide.
4. Properly punch each paper page with holes suitable for associated binding. Provide not less than 3/8-IN of paper between outer edge of punched holes and edge of paper. Manuals with improperly punched holes will be returned to Design Builder as unacceptable.
5. In paper copies of manuals, each page in each copy shall be properly bound-through by the binder’s rings or posts. Paper manuals where some pages are not so bound will be returned to Design Builder as unacceptable.

C. Drawings:
1. Bind into operation and maintenance manuals drawings, diagrams, and illustrations up to and including 11-IN by 17-IN size (engineer folded to 8.5 by 11-IN) with reinforcing and punched holes specified for paper pages.
2. Drawings or sheets larger than 11-IN by 17-IN shall be:
    a. Paper Copies: Neatly folded and inserted into clear plastic pockets bound into the manual. Neatly and permanently label each pocket with printed text indicating content and drawing numbers. Include not more than two drawings or sheets per pocket.
    b. Electronic Documents Copies: Included in electronic file at appropriate location.

D. Copy Quality and Document Clarity:
1. Provide original-quality copies. Documents in operation and maintenance manuals shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color. Manuals with copies that are unclear, not completely legible, off-center, skewed, or where text or drawings are cut by binding holes, are unacceptable. Pages that contain approval or date stamps, comments, or other markings that cover text or drawing are unacceptable.
2. Clearly indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished and cross out inapplicable content. Using highlights to so indicate options furnished is unacceptable.

E. Organization:
   1. Indexed tabs between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

1.4 ELECTRONIC DOCUMENTS O&M MANUALS

A. Electronic Documents of Operation and Maintenance Manuals:
   1. Each Electronic Document copy of operation and maintenance data shall include all information included in the corresponding paper copy.
   2. Submit Electronic Documents operation and maintenance data in accordance with Section 01 33 00 - Submittal Procedures.
   3. File Format:
      a. Unless otherwise required by Section 01 33 00 - Submittal Procedures, operation and maintenance data Electronic Documents shall be "portable document format" (PDF) files.
      b. Electronic Documents shall be electronically searchable upon delivery.
      c. Electronic Documents shall not be password-protected and shall not be protected against Owner's copying and printing such files for Owner's use in operating and maintaining the facility.
      d. Electronic Documents shall open to its first page.
      e. Submit each operation and maintenance manual as a single Electronic Document file, unless file size is over-large, in which case divide into as few separate files, each with similar filename, as possible.
      f. Within each Electronic Document, provide bookmarks for the following:
         1) Each chapter and subsection indicated in the corresponding printed copy document's table of contents.
         2) Each figure.
         3) Each table.
         4) Each appendix and attachment.

1.5 CONTENT OF OPERATION AND MAINTENANCE MANUALS

A. Operation and Maintenance Manual Content – General:
   1. Prepare each operation and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-constructed drawings as applicable, bills of materials, technical information, installation and handling requirements, maintenance and repair instructions, and other information required for complete, accurate, and comprehensive data for safe and proper operation, maintenance, and repair of materials and equipment furnished for the Project. Include in manuals specific information required in the Specification Section for the material or equipment, data required by Laws and Regulations, and data required by authorities having jurisdiction.
   2. Provisions of this Article were written for equipment. Where operation and maintenance data are required for building products, such as finishes, openings, thermal and moisture protection, and similar items, comply with this Article to the extent practical and reasonable for the associated item.
   3. Completeness and Accuracy:
      a. Operation and maintenance manuals that include language stating or implying that the manual's content may be insufficient or stating that the manual's content is not guaranteed to be complete and accurate are unacceptable.
      b. Operation and maintenance manuals shall be complete and accurate.
      c. Operation and maintenance manuals shall indicate the specific alternatives and features furnished, and the specific operation and maintenance provisions for the material or equipment furnished.
   4. Indexing System: Coordinate with Program Manager and Owner to develop comprehensive, practical, and consistent indexing system for operation and maintenance data. Program

Manager will review indexing system before preliminary operation and maintenance manual Submittals are furnished.

5. Provide dividers and include manufacturer's information, diagrams, schematics, and equipment cutaways. Avoid submitting catalog excerpts unless they are the only document available showing identification or description of particular component of the equipment. Where published documents, included in operation and maintenance data, pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.
6. Identify each equipment item consistent with names and identification numbers shown or indicated in the Contract Documents, rather than manufacturer's model numbers.
7. Neatly type data not furnished in computer-printed text. Handwriting, except for strikeouts, arrows, and the like, is unacceptable.
8. Include copy of warranty in accordance with the Contract Documents.
9. Include copy of proposed service contract, when applicable.
10. When copyrighted material is used in operation and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

B. Differences Between Preliminary and Final Operation and Maintenance Manuals:
   1. In preliminary operation and maintenance manuals, include flysheet or placeholder for information to be included in final operation and maintenance manual Submittal.
   2. In final operation and maintenance manuals, include information such as the following, as applicable for the associated materials and equipment:
      a. Equipment data that requires collection after start-up, for example: (1) system and equipment balancing reports, including those for HVAC systems; and (2) final settings for electrical switchgear, automatic transfer switches, and circuit breakers: and (3) materials and equipment field testing results.
      b. Equipment start-up reports and Suppliers' field service reports.

C. Initial Documents in Operation and Maintenance Manuals:
   1. Table of Contents:
      a. Provide table of contents in each volume of each operation and maintenance manual.
      b. In table of contents and not less than once in each chapter or section, identify materials and equipment by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is clearly indicated in a table bound at or near beginning of each volume. Using material or equipment model or catalog designations for identifying items is unacceptable.
   2. Equipment Record:
      a. Provide "Equipment Record" section of operation and maintenance manual immediately following the table of contents. "Equipment Record" section is not required for operation and maintenance data for other than equipment (such as building materials and finishes).
      b. Provide "Equipment Record" on forms included as this Section's Attachments 1, 2, and 3.
      c. For instrumentation and control equipment, International Society of Automation (ISA) data sheets are acceptable in lieu of the forms included as this Section's Attachments 1, 2, and 3.
      d. This Section's Attachments 1, 2, and 3 are available from Program Manager as "fillable PDF forms".
      e. Complete in detail each section of "Equipment Record". Merely referencing the associated equipment's operation and maintenance data for nameplate, maintenance, spare parts, lubricants, or other required information, is unacceptable.
      f. For equipment or systems with multiple, separate components (for example, motor and gearbox), fully completed "Equipment Record" is required for each component.

g. Operation and maintenance data Submittals without complete and accurate “Equipment Record” sheets are unacceptable.
3. Supplier’s Field Service Reports:
   a. Include in final operation and maintenance manuals copies of associated Supplier’s field services reports in accordance with Section 01 75 00 – Start-up and Commissioning Procedures.
   b. Include Supplier’s completed field service reports in operation and maintenance manual in section immediately following “Equipment Record” section.

D. Operation and Maintenance Instructions:
1. Safety Considerations:
   a. Submit written descriptions of safety considerations relating to operation and maintenance procedures for materials and equipment.
   b. Describe safety devices and alarms provided with materials and equipment and proper operation and use.
   c. Indicate procedures for proper, safe operating and maintenance of materials and equipment furnished, including manufacturer’s recommended personal protection equipment, apparatus, and devices not furnished under the Contract.
   d. Describe recommended safety-related training for personnel operating and maintaining the subject materials or equipment.
   e. Include in appendix to operation and maintenance manual manufacturers’ relevant “safety data sheets” (SDS), formerly “material safety data sheets” (MSDS).
   f. Program Manager’s review of operation and maintenance data expressly does not extend to adequacy, completeness, and accuracy of SDS or other safety and protection practices and procedures indicated in the operation and maintenance data.
2. Operation:
   a. Include in operation and maintenance data Submittals complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; and regulation and control. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
   b. Include pre-start-up instructions and checklists and complete start-up instructions for each material and equipment item.
   c. Indicate recommended operating instructions for all operating modes and conditions, with associated recommendations for safe operation.
   d. Explain available controls and instrumentation and associated function(s).
   e. Indicate required shutdown checklists and procedures for: normal shutdown, emergency shutdown, and long-term shutdowns.
   f. Troubleshooting instructions.
3. Maintenance – General:
   a. Include in operation and maintenance data complete, written instructions for necessary and recommended maintenance, including mechanical maintenance and electrical/instrumentation and controls maintenance, as applicable.
   b. Include in operation and maintenance data complete instructions for necessary assembly, disassembly, installation, re-installation, storage, and shipping for materials and equipment.
   c. Tools: Include list of required maintenance tools and equipment.
   d. Spare Parts and Extra Materials:
      1) Submit complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.
      2) Submit manufacturer’s recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial 2 years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment,

    including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.
  3) Also refer to this Article's provision, "Bills of Materials", below, for additional requirements regarding ordering replacement parts.

4. Routine and Preventative Maintenance:
   a. Submit complete, detailed, written instructions for routine and preventive maintenance including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
      1) Written explanations with illustrations for each routine and preventive maintenance task such as inspection, adjustment, anchor bolt torque checks, lubrication, calibration, cleaning, replacement of filters, and the like.
      2) Recommended schedule for each routine and preventive maintenance task.
      3) Lubricants:
         a) Provide lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
         b) Table of alternative lubricants.
5. Major Maintenance:
   a. Include detailed, written instructions and illustrations for required periodic (non-routine, non-preventative) maintenance.
   b. Indicate relative level of training and expertise required to perform such maintenance and recommended tools and equipment.
6. Special Maintenance:
   a. Include maintenance instructions for long-term shutdowns and storage.

E. Bills of Materials:
   1. Include in operation and maintenance manuals complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
      a. Manufacturer's name, physical address, telephone number, internet website address.
      b. Manufacturer's local service representative's or local parts supplier's name, physical address, telephone number, internet website address, and e-mail addresses.
      c. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
   2. For each part or piece include the following information:
      a. Parts cross-reference number. Cross-reference number shall be used to identify the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
      b. Part name or description.
      c. Manufacturer's part number.
      d. Quantity of each part used in each assembly.
      e. Current unit price of the part at the time the operation and maintenance manual is submitted. Price list shall be dated.

F. Record Copy of Shop Drawings, Product data, and Other Previously Approved and Accepted Submittals:
   1. Submit original-quality copies of each approved and accepted (as applicable) Shop Drawing, product data Submittal, written results of source quality control activities, and other Submittals, updated to indicate as-installed condition. Do not include prior Submittals that were not approved or were not accepted. Reduced drawings are acceptable only when reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.

G. Electrical Schematics, Diagrams, and Information:
   1. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
   2. Include as-constructed drawings of layouts of electrical panels (such as switchgear and motor control centers) and control panels.

H. NFPA 70 (National Electric Code) Documentation:
   1. Include in operation and maintenance manuals for electrically powered equipment documented calculations of: (1) arc-fault current, equipment available fault current and (2) short-circuit current rating (SCCR), provided as part of equipment Submittals.

1.6 COPIES OF PROGRAM CODE AND CONFIGURATION FILES

A. Copies of Program Code and Configuration Files – General:
   1. Submit as Electronic Documents only. Paper Submittals are not required for program code and configuration files.
   2. File Types: As indicated in this Section’s “Submittals” Article.
   3. Timing: Submit not later than time indicated in this Section’s “Submittals” Article.
   4. In accordance with the Contract Documents, following Substantial Completion, Owner shall have right to: (a) modify program code and configuration files, (b) update software and firmware, (c) revise system security settings, such as passwords, IP addresses, and other security settings, and (d) implement related modifications, without restriction or interference from Design Builder, Subcontractor, Supplier, and others.
   5. Owner agrees to use program code and configuration files only with Owner’s facilities, as may be transferred to Owner’s successors and assigns.
   6. Owner will not be subject to any Supplier-requested non-disclosure agreement that is not part of the Contract Documents.
   7. Program Manager agrees to not distribute program code and configuration files obtained under the Project, except in exchanging such files with Owner or their successors and assigns. Program Manager will not be party to any Supplier-requested non-disclosure agreement.

B. Configuration Files:
   1. Submit copies of system configuration prepared for the Project, such as setpoints for programmable controllers, facility SCADA display configurations, and similar configuration files.
   2. Submit as separate files configuration files for each separate control and monitoring device for which configuration files are furnished. Clearly distinguish the device(s) associated with each file.
   3. Design Builder (including Subcontractors and Suppliers) is not responsible for configurations and control setpoints subsequently changed by Owner or others for whom either is responsible, not in accordance with Supplier’s written recommendations and operation and maintenance instructions.

C. Program Code:
   1. Submit copies of program code for programmable logic controllers (PLC), human-machine interfaces (HMI), operator interface terminals (OIT), and other programmable controllers, subject to the following:
      a. Submit for all PLCs, HMI, OITs, and other programmable controllers furnished as part of the Work, including Original Equipment Manufacturer (OEM) provided controllers and where Owner’s existing devices were modified as part of the Work, regardless of whether such program code is manufacturer’s standard, or developed specifically for the Project, or a combination of manufacturer’s standard program code and Project-specific program code. Design Builder and associated Subcontractors and Suppliers are not responsible for unauthorized program code modifications made by Owner (or third-parties retained by Owner) that result in improper operation of materials, equipment, or

systems or that invalidate applicable warranties and manufacturer's recommended operating instructions.

b. Third-party, licensed, commercially available software (such as, but not limited to, Microsoft operating system software sold at retail, and commercial SCADA system software platforms) is excluded from requirements of this Article. Furnish copies of commercially available, licensed, third-party software, where required, in accordance with the Contract Documents.

2. Submit complete logic listings in format approved by the Owner.
3. Format Requirements:
   a. For ladder diagram logic, include complete cross-referencing of all logic elements. Annotate all elements with clearly understandable tags or descriptive labels.
   b. For function block diagram, label each function block with understandable tags or descriptive labels. Describe purpose and action of each function block.
   c. For sequential function chart, include extensive comments for each step to describe program step function.
   d. For instruction list and structured text, include extensive comments for each program line to describe program line function.
4. Submit complete programmable logic controller listing of all input/output address assignments, tag assignments, and pre-set constant values, with functional point descriptions.
5. Submit complete manufacturer's program code manuals.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. The following, bound after this Section's "End of Section" designation, are part of this Section:
   1. Attachment 1 - Equipment Data and Spare Parts Summary form (one page)
   2. Attachment 2 - Recommended Maintenance Summary form (one page)
   3. Attachment 3 - Lubrication Summary form (one page)

END OF SECTION

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ATTACHMENT 1

Equipment Record

Equipment Data and Spare Parts Summary

Project Name	Specification Section:
Equipment Name	Year Installed:
Project Equipment Tag No(s).	Equipment Location:
Equipment Manufacturer	Project/ Order No.
Address	Phone
Website	E-mail
Local Representative/Service Center	
Address	Phone
Website	E-mail

MECHANICAL NAMEPLATE DATA

Equip.		Serial No.		
Make		Model No.		
ID No.	Frame No.	HP	RPM	Cap.
Size	TDH	Imp. Size	CFM	PSI
Other:				

ELECTRICAL NAMEPLATE DATA

Equip.				Serial No.				
Make				Model No.				
ID No.	Frame No.	HP	V.	Amp.	Hertz	PH	RPM	SF
Duty	Code	Ins. Cl.	Type	NEMA	C Amb.	Temp. Rise	Rating	
Other:								

SPARE PARTS PROVIDED PER CONTRACT

Part No.	Part Name	Quantity

RECOMMENDED SPARE PARTS

Part No.	Part Name	Quantity

ATTACHMENT 2

Equipment Record

Recommended Maintenance Summary

Equipment Description	Project Equip. Tag No(s).	

RECOMMENDED BREAK-IN MAINTENANCE (FIRST OIL CHANGES, ETC.)	INITIAL COMPLETION * FOLLOWING START-UP							
	D	W	M	Q	S	A	RT	Hours

RECOMMENDED PREVENTIVE MAINTENANCE	PM TASK INTERVAL *							
	D	W	M	Q	S	A	RT	Hours

*** D = Daily W = Weekly M = Monthly Q = Quarterly S = Semiannual A = Annual Hours = Run Time Interval**

ATTACHMENT 3

Equipment Record

Lubrication Summary

Equipment Description	Project Equip. Tag No(s).

Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					

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SECTION 01 81 13
ENVISION VERIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. This Section provides an overview of the Envision requirements of the Work by the Design Builder. Envision is a sustainability rating system tailored for infrastructure projects. The Envision rating system evaluates, grades, and gives recognition to projects based on its level of achievement of credits in five categories: Quality of Life (QL), Leadership (LD), Resource Allocation (RA), Natural World (NW), and Climate and Resilience (CR). The Owner will be pursuing approximately 55 credits for the overall program. Identified, Design Builder- involved credits include, but are not limited to, the 15 listed in the Design Builder Envision Action Plan (EAP). Refer to Attachment A: Envision Scorecard Snapshot for the credit levels of achievement (LOA) for the Program.
   2. It is the goal of the Owner, as much as is feasible and practical, to construct a “green” infrastructure project that meets the Institute for Sustainable Infrastructure’s (ISI) Envision Rating System as follows:
      a. Envision Version 3.
      b. Rating Goal: Gold.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. References, resources and information as noted on the Institute for Sustainable Infrastructure website: www.sustainableinfrastructure.org.
   2. An Envision Guidance Manual (Version 3) will be provided to the Design Builder.

B. The Owner has elected to pursue Envision verification for the Project, with a goal of Gold level verification.

1.3 DEFINITIONS

A. Envision:
   1. Envision is a sustainability framework and rating system that evaluates, grades, and gives recognition to infrastructure projects that make exemplary progress and contribute to a more sustainable future. In this regard, Envision assesses not only individual project performance, but how well projects contribute to the efficiency and long-term sustainability of the communities they serve. The Envision rating system is composed of 64 sustainability indicators, called credits, that cover the full dimensions of infrastructure sustainability. Each credit in the Envision system includes an intent statement and metric, levels of achievement, a description, ways to improve performance, evaluation criteria and documentation guidance, and related Envision credits. The credits are organized into five categories and 14 subcategories by subject matter:
      a. Quality of Life – Wellbeing, Mobility, Community.
      b. Leadership – Collaboration, Planning, Economy.
      c. Resource Allocation – Materials, Energy, Water.
      d. Natural World – Siting, Conservation, Ecology.
      e. Climate and Resilience – Emissions, Resilience.

B. Envision Credit Levels of Achievement (LOA):
   1. The credit levels of achievement represent the degree to which the project achieves the credit intent. Envision offers a range of sustainability accomplishment from slightly above

conventional to exceptional (restoring systems). The levels of achievement benchmark the relative impact of project sustainability and encourage stretching the project goals toward higher levels of sustainability. The achievement scale from Improved to Restorative is not linear, incentivizing greater sustainability progress. In most credits, the lower levels must be met in order to achieve higher levels.

a. Conventional – The state of the practice.
b. Improved – Performance that is above conventional. Slightly exceeds regulatory requirements.
c. Enhanced – Sustainable performance that is on the right track. There are indications that superior performance is within reach.
d. Superior – Sustainable performance at a very high level.
e. Conserving – Performance that has achieved essentially zero negative impact.
f. Restorative – Performance that restores natural or social systems. Such performance receives the highest award possible and is celebrated as such. The Restorative level is not applicable to all objectives.

C. Envision Sustainability Professional (ENV SP):

1. Envision Sustainability Professionals (ENV SPs) are trained and credentialed in the use of Envision. They work in the project team to document project sustainability accomplishments. The Program Manager will serve as the Lead ENV SP for the Program. While not required, it is recommended that the Design Builder also have an ENV SP in the coordination role for the Design Builder's responsibilities related to Envision.

D. Recycled Materials (Related To RA1.2 Use Recycled Materials):

1. The percentage of recycled content shall be determined by cost. Refer to Attachment C for guidance and forms.
2. "Post-Consumer" material is defined as waste material generated by residential, commercial, or institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
3. "Post Industrial" (or "Pre Consumer") recycled content is defined as material in a product that is recycled from manufacturing waste. Materials such as rework, regrind, or scrap generated in a process and reclaimed within the same process are excluded.
4. Mechanical, electrical, water equipment, and their components may be excluded from the calculations.

1.4 SUBMITTALS

A. Procedures: Section 01 33 00 – Submittal Procedures:

1. The Design Builder shall submit a copy of this specification section, with addendum updates included, and all referenced and applicable sections, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
2. The Design Builder shall complete activities and provide documentation for Envision credits as noted in Table 2: Design Builder EAP. This includes, but is not limited to, the plans and forms listed in Table 1. Documentation shall be submitted through e-Builder.

TABLE 1: PLANS AND FORMS INCLUDED AS ENVISION SUBMITTALS

	SUBMITTAL	RELATED CREDIT(S)
1	Design Builder EAP – as furnished in Table 2	Multiple credits
2	Project Execution Plan or Safety Plan	QL1.3 Improve Construction Safety
3	Construction Management Plan (CMP) See Attachment B for CMP Guidance	Multiple credits, see CMP Guidance
4	Site and Project Security Plan	QL1.3 Improve Construction Safety
5	Construction Noise Management Plan	QL1.6 Minimize Construction Impacts
6	Reused/Recycled Materials Summary Form See Attachment C for RA1.2 Guidance and Forms	RA1.2 Use Recycled Materials
7	Construction Waste Management Plan (CWMP) See Attachment B for CWMP Guidance	RA1.4 Reduce Construction Waste
8	Construction Waste Diversion Summary Form Spreadsheet See Attachment D for RA1.4 Guidance and Forms	RA1.4 Reduce Construction Waste
9	Spill and leak prevention and response plan	NW2.4 Protect Surface and Groundwater Quality

1.5 DESIGN BUILDER RESPONSIBILITIES

A. The Owner has elected to pursue Envision verification for the Project. The Design Builder shall endeavor to obtain target LOA and suggest methods of achieving higher scores. Identified, Design Builder-involved credits include, but are not limited to, those listed in Table 2: Design Builder EAP. The Design Builder shall provide documentation for credits as identified in the Envision Guidance Manual that are related to the Design Builder's scope of Work. If Design Builder is not able to meet the criteria and documentation requirements, Design Builder shall contact the Owner for direction.

B. Envision Alignment Meeting:
   1. Design Builder's Envision Liaison and team involved in Envision coordination and documentation shall attend an Envision Alignment Meeting (alignment meeting) held by the Owner and Program Manager at the beginning of the design phase. This meeting is intended as time for the Owner and Program Manager to introduce the program's sustainability commitment and overall Envision strategy and respond to questions from the Design Builder about the Design Builder EAP.

C. Design Builder EAP:
   1. Identified Design Builder-involved credits include, but are not limited to, credits listed in the Table 2: Design Builder EAP. The plan provides a description of many, but not all, activities that relate to accomplishing Program's Envision requirements, LOA for each credit, including design activities, construction practices, and necessary documentation for each Envision credit that involves Design Builder actions. The Design Builder EAP will be refined and updated throughout the Program's design and construction phases as the project components evolve.
   2. Design Builder should review and add the following to Table 2 prior to submitting the plan as confirmation of understanding:
      a. Name of Envision Point of Contact, individual(s) responsible for providing required documentation.
      b. Design Builder comments.

D. Envision Project Management and Coordination:
   1. Prior to the Envision alignment meeting, Design Builder shall identify and assign one person on Design Builder's staff to be the Envision Liaison who shall be responsible for Envision compliance and coordination.

a. Envision Point of Contact:
   1) The Design Builder's Envision Liaison shall be familiar with third-party rating systems and implementation of sustainable design. An ENV SP or sustainability professional is preferred.
b. Responsibilities:
   1) Design Builder shall review the Contract for Envision requirements, coordinate work of trades, subcontractors, and suppliers to ensure compliance with the Design Builder EAP; provide guidance related to Envision documentation; and oversee Project Envision Goals.
c. Administrative Requirements:
   1) Design Builder shall be responsive to questions and information/data requests from the Owner and/or the Program Manager regarding Envision credits for which the Design Builder is responsible, provides documentation, or that depend on product selection or product qualities, until ISI has authenticated the Project's Envision verification application even if the Envision verification process extends beyond Final Completion, for a period of time up to 1 year beyond Final Completion.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.1 MEETINGS

A. Include Envision update as a topic in the construction progress meeting agendas. Coordinate with Section 01 31 19 – Project Meetings.

3.2 COMPLETION OF DOCUMENTATION

A. Design Builder shall be responsible for providing required information and documentation for noted credits as outlined in the Design Builder EAP to support the Program Manager's Envision team in completing credit packages per Envision requirements for verification submittal. This includes responding to all applicable comments received from the Owner, Program Manager and ISI during the verification process.

B. Design Builder shall include Envision as an agenda item to regularly record the status of documentation requirements outlined in the Design Builder EAP and report progress to the Owner and Program Manager throughout the design and construction phases.

3.3 DESIGN BUILDER ENVISION ACTION PLAN

A. Activities to meet requirements for pursued Envision credits, as identified in Table 2: Design Builder EAP, shall be Contract requirements and shall be incorporated in full compliance with the Envision Guidance Manual.

B. The Design Builder EAP is based on Envision Guidance Manual language and requirements associated with criteria related to Design Builder activities for credits that the Owner has elected to pursue.

Table 2: Design Builder Envision Action Plan

Note: Items underlined and in blue are also noted in Table 1. Plans and Forms included as Envision Submittals.

CREDIT NO. AND TITLE	TARGET LOA & RELEVANT CRITERIA (PTS)	DESIGN BUILDER RESPONSIBILITIES				DB POC	DB COMMENTS
		DESIGN-RELATED CRITERIA	DESIGN RESPONSIBILITIES *Reference: Envision Guidance Manual*	CONSTRUCTION-RELATED CRITERIA	CONSTRUCTION RESPONSIBILITIES *Reference: Envision Guidance Manual*		
QL1.1 Improve Community Quality of Life	Restorative (26) A+B+C+D+E +F+G	D+E	**Design and provide documentation:** • Document ways that stakeholder engagement/ community input influenced and was incorporated during design. • Document strategies incorporated into design to mitigate negative social impacts.	-	-		
QL1.3 Improve Construction Safety	Conserving (14) A+B+C+D+E	B	**Design and provide documentation:** • Specifications include requirements regarding construction/site health and safety. • Include requirement in project execution for internal documentation that tracks health and safety performance and corrects deficiencies or promotes best practices during construction. • Project Execution Plan	A+B+C+D+E	**Provide documentation:** • Safety commitments. • Safety rewards program (examples available, if needed). • Subcontractor safety requirements. • Documentation showing that senior construction managers are engaged in the project safety program and conduct safety observations and inspections. • Project Execution Plan or similar document. • Health and safety performance tracking. • Injury management system. • Incident Review process. • Examples of incident reporting / "lessons learned." • Safety and security training requirements and programs. • Site-Specific Safety Plan. • Documentation of construction health and/or well-being programs. Documentation may include item's like: • Site inspection checklist. • Jobsite Hazard Assessment forms. • Incident reporting form. • Safety violation notice(s).		
QL1.4 Minimize Noise and Vibration	Conserving (10) A+B+C+D+E	A+B+C+D+E	**Design and provide documentation:** • Conduct noise assessment to establish operational noise baseline. • Design and document strategies to mitigate noise and/or vibrations during operations to not increase noise within the surrounding community beyond existing conditions found in noise assessment. • Document how the project team followed a mitigation hierarchy related to minimizing noise and vibration. • Plans/drawings, specifications related to noise mitigation measures.	-	-		
QL1.5 Minimize Light Pollution	Improved (1) A+B Discuss Conserving (10) A+E	A+B Potential for A+E	**Design and provide documentation:** • Conduct exterior lighting needs assessment. • Design strategies to reduce light pollution. • Determine lighting zone and consider BUG rated lighting for exterior lighting needs. • Document following a mitigation hierarchy. • Plans/drawings, specifications related to exterior lighting.	-	-		

Table 2: Design Builder Envision Action Plan

Note: Items underlined and in blue are also noted in Table 1. Plans and Forms included as Envision Submittals.

CREDIT NO. AND TITLE	TARGET LOA & RELEVANT CRITERIA (PTS)	DESIGN BUILDER RESPONSIBILITIES				DB POC	DB COMMENTS
		DESIGN-RELATED CRITERIA	DESIGN RESPONSIBILITIES *Reference: Envision Guidance Manual*	CONSTRUCTION-RELATED CRITERIA	CONSTRUCTION RESPONSIBILITIES *Reference: Envision Guidance Manual*		
QL1.6 Minimize Construction Impacts	Conserving (8) A+B+C+D+E+F	A+B+C+D+E+F	**Design and provide documentation:** • Specifications include requirements for reducing negative construction impacts related to noise/vibration control, lighting requirements and limitations to reduce light spillage during night-time. • Specifications include requirements that direct construction consideration for safety/wayfinding as well as alternative modes of access to reduce road traffic due to construction vehicles and materials to be brought on-site. • Plans/drawings, specifications related to construction impacts.	A+B+C+D+E+F	Develop a construction management plan that addresses: noise, safety/wayfinding, access/mobility, and lighting during construction; and includes feedback mechanisms and related performance monitoring and reporting. Refer to Attachment B: Construction Management Plan Guidance for more information. **Provide Documentation:** • Construction Management Plan (CMP) • Construction Noise Management Plan • Examples of feedback mechanisms, monitoring and reporting.		
QL2.3 Improve Access and Wayfinding	Enhanced (5) A+B	A+B	**Design and provide documentation:** • Design accommodates incident management for users and emergency personnel. • Design of access routes, safety features, and signage to reduce negative impact on surroundings due to vehicle or pedestrian traffic. • Design of clear signage and wayfinding. • Plans/drawings, specifications.	-	-		
QL3.3 Enhance Views and Local Character	Conserving (11) A+B+C+D+E	A+B+C	**Design and provide documentation:** • Design features that preserve or enhance views and local character, and are informed by the stakeholder consultation process. • Design to existing facility guidelines to preserve or enhance views and local character. Illustrate how the aesthetic quality of the project is important. • Plans/drawings, specifications. • Meeting minutes discussing views/character elements. • Reports outlining views/character elements.	D	**Provide Documentation:** • CMP includes information about protecting any character features or landscape features during construction.		
LD1.1 Provide Effective Leadership and Commitment	Conserving (18) A+B+C+D	A+B+C+D	Sign project commitment to project sustainability. **Provide documentation:** • Meeting minutes and/or reports showing discussion of and/or progress toward sustainability goals. • Examples of the Design Builder's organizational sustainability commitments. Documentation of sustainability commitment may include item's like: • Organizational sustainability Policies. • Sustainability reports. • Sustainability strategy. • Project descriptions. • Awards. • Sustainability training. • Examples of initiatives to improve sustainable performance. • Third-party organizational recognition or commitments. **Include information for all organizations that are a part of the design-build entity.	A+B+C+D	Provide documentation of organizational commitments for any key team members brought on during construction.		

Table 2: Design Builder Envision Action Plan

Note: Items underlined and in blue are also noted in Table 1. Plans and Forms included as Envision Submittals.

CREDIT NO. AND TITLE	TARGET LOA & RELEVANT CRITERIA (PTS)	DESIGN BUILDER RESPONSIBILITIES				DB POC	DB COMMENTS
		DESIGN-RELATED CRITERIA	DESIGN RESPONSIBILITIES *Reference: Envision Guidance Manual*	CONSTRUCTION-RELATED CRITERIA	CONSTRUCTION RESPONSIBILITIES *Reference: Envision Guidance Manual*		
LD1.2 Foster Collaboration and Teamwork	Conserving (18) A+ B+C+D	B+C+D	Work with Owner and project team to implement Envision. Provide documentation of commitment to sustainability and Envision: • Meeting minutes. • Reports. • Assessments.	B+C+D	Work with Owner and project team to implement Envision. Provide documentation of commitment to sustainability and Envision: • Meeting minutes. • Reports. • Assessments.		
LD1.3 Provide For Stakeholder Involvement	Restorative (18) A+B+C+D+E+F	B+C+D+E	Participate in stakeholder engagement activities, as needed. **Provide documentation:** • Showing that stakeholder feedback was evaluated and prioritized, and when and how it impacted project decision making or design elements. • Evidence that stakeholder feedback was treated fairly and equitably. • Stakeholder feedback, if received.	-	Reference QL1.6 Minimize Construction Impacts and related CMP guidance.		
LD1.4 Pursue Byproduct Synergies	Restorative (18) A+B+E	E	**Provide documentation:** Plans/specifications illustrating process for creating beneficial waste streams - biosolids, biogas.	-	-		
LD2.1 Establish A Sustainability Management Plan	Superior (12) A+B+C+D	D	The Sustainability Management Plan (SMP) will be provided by the Program Manager to the DB during DB Envision alignment meeting. The SMP outlines how sustainability and Envision tracking and implementation will be documented during design and construction. Work with Owner and project team to implement Envision.	D	The SMP will be provided by the Program Manager to the DB during DB Envision alignment meeting. The SMP outlines how sustainability and Envision tracking and implementation will be documented during design and construction. Work with Owner and project team to implement Envision.		
LD2.3 Plan For Long-Term Monitoring and Maintenance	Conserving (12) A+B+C+D+E	A+B+C	**Design and provide documentation:** • Plans/specifications showing strategies to reduce maintenance impacts, i.e., better design, durable longer-lasting materials, or ease of access for maintenance and repair with minimal disruption to users and affected communities. • Monitoring and maintenance plan, as incorporated as part of Operation and Maintenance Manuals. • Meet with operations, monitoring, and maintenance staff to explain and discuss the operations and maintenance plan. Provide meeting minutes from these discussions.	-	-		
LD2.4 Plan For End-of-Life	Improved (2) A+B	A+B	Provide input, as requested.	-	-		
LD3.1 Stimulate Economic Prosperity and Development	Superior (12) A+B+C+D	A	**Provide documentation:** • Information on the types of design jobs, number of local workers, and work reports to provide evidence of manhours/number of workers employed.	A	**Provide documentation:** • Information on the types of construction jobs, number of local workers, and work reports to provide evidence of manhours/number of workers employed.		
LD3.2 Develop Local Skills and Capabilities	Improved (2) A to Enhanced (4) A+B	A (+B) Depending on final LOA	• Provide Evidence of training programs associated with the project. • Provide any information related to training targeted at skill gaps in workforce.	A (+B) depending on final LOA	• Provide Evidence of training programs associated with the project. • Provide any information related to training targeted at skill gaps in workforce.		

Table 2: Design Builder Envision Action Plan

Note: Items underlined and in blue are also noted in Table 1. Plans and Forms included as Envision Submittals.

CREDIT NO. AND TITLE	TARGET LOA & RELEVANT CRITERIA (PTS)	DESIGN BUILDER RESPONSIBILITIES				DB POC	DB COMMENTS
		DESIGN-RELATED CRITERIA	DESIGN RESPONSIBILITIES *Reference: Envision Guidance Manual*	CONSTRUCTION-RELATED CRITERIA	CONSTRUCTION RESPONSIBILITIES *Reference: Envision Guidance Manual*		
RA1.1 Support Sustainable Procurement	Project is considering pursuing this credit, LOA to be determined.	B If pursued	• If a sustainable procurement program is put into place for this project, assist in collecting information from suppliers and manufacturers to document their sustainable business practices and the associated materials, supplies and equipment associated with those firms.	B If pursued	• If a sustainable procurement program is put into place for this project, assist in collecting information from suppliers and manufacturers to document their sustainable business practices and the associated materials, supplies and equipment associated with those firms.		
RA1.2 Use Recycled Materials	Improved (4) A	A	**Design and provide documentation:** • Assess what types of materials will be used in project that could contain recycled content and which will. Will any changes be made based on assessment? • Calculate estimated percentage of recycled/reused materials vs. overall materials. Provide calculations estimate by weight, volume, or cost. • Specifications include requirements to document materials containing recycled content. • Provide feedback if the LOA could be increased from Improved (5% of recycled materials including materials with recycled content and/or reused existing structures or materials) to Enhanced = 15% or Superior = 25%. • Specifications showing recycled materials requirements.	A	Implement specified recycled materials requirements. **Provide documentation:** • Cost estimates. • Cut sheets of recycled content materials. • <u>Reused/Recycled Materials Summary Form</u>. (Attachment C), recording the amount of recycled-content or reused materials. It is anticipated that the project will meet the Improved LOA based on types of materials that will be specified. Documentation provided will be used by the Program Manager's Envision team to calculate the overall percentage used in the Program.		
RA1.3 Reduce Operational Waste	Conserving (14) A+B	A	Provide input, as requested.	-	-		
RA1.4 Reduce Construction Waste	Superior (10) A+B During construction at least 75% of waste materials are recycled, reused, and/or salvaged.	A+B	**Design and provide documentation:** • Assess what types of waste will be generated during construction. • Calculate (est) percentage of recycled and reused C&D waste vs. overall C&D waste. Provide calculations estimated by weight, volume, or cost. • Specifications include requirements to meet construction waste diversion target and document construction waste disposal.	A+B	Develop a construction waste management plan that identifies materials to be diverted, plans for sorting / managing materials on-site, and facilities for recycled materials. Fill out and submit forms to support waste diversion activities and provide data for diversion calculation. **Provide documentation:** • <u>Construction waste management plan</u>. • <u>Construction Waste Diversion Summary Form (Attachment D)</u>, recording the amount of waste that is recycled, reused, or salvaged. • Load tickets from landfill, recycling center or salvage facility.		
RA1.5 Balance Earthwork On Site	Improved (2) A	A	**Design and provide documentation:** • Balance earthwork on-site to the extent possible. • Reuse soil on-site as feasible. • Determine cost implications of on-site use and reasonable nearby locations to meet criteria requirements. • Cut and fill calculations, showing how the project balanced cut and fill on-site and calculations of the percentage of excavated materials remaining on-site. • Information on locations/distances for sourcing and/or disposing of fill materials.	A	**Implement and provide documentation:** • Cut and fill calculations. • Information on locations/distances for sourcing and/or disposing of fill materials.		
RA2.1 Reduce Operational Energy Consumption	Improved (6) A+B	A+B	**Provide documentation:** • Calculate estimated annual energy consumption of the project.	-	-		

Table 2: Design Builder Envision Action Plan

Note: Items underlined and in blue are also noted in Table 1. Plans and Forms included as Envision Submittals.

CREDIT NO. AND TITLE	TARGET LOA & RELEVANT CRITERIA (PTS)	DESIGN BUILDER RESPONSIBILITIES				DB POC	DB COMMENTS
		DESIGN-RELATED CRITERIA	DESIGN RESPONSIBILITIES *Reference: Envision Guidance Manual*	CONSTRUCTION-RELATED CRITERIA	CONSTRUCTION RESPONSIBILITIES *Reference: Envision Guidance Manual*		
RA2.2 Reduce Construction Energy Consumption	Enhanced (4) A+B	A+B	**Design and provide documentation:** • Conduct a review to identify and analyze potential options for reducing energy consumption during construction. Provide meeting minutes from discussion. • Specifications include requirements to implement two energy reduction strategies on the construction site and/or construction vehicles, including providing calculations showing that the implemented strategies meet related percentage energy reduction goals, as outlined in the Envision Guidance Manual (RA2.2 Reduce Construction Energy Consumption).	A+B	**Implement and provide documentation:** • Evidence that at least two (2) energy reduction strategies are used on the construction site and/or construction vehicles. • Calculations showing that the implemented strategies meet related percentage energy reduction goals / Completed RA2.2 Credit calculator for implemented strategies. • Information on how strategies are monitored, measured and documented through construction.		
RA2.3 Use Renewable Energy	Restorative (24) A	A	Provide input, as requested.	-	-		
RA2.4 Commission and Monitor Energy Systems	Enhanced (6) A+B	A+B	**Design and provide documentation:** • Design includes energy monitoring equipment and/or software to facilitate performance monitoring during operation. • Plans/specifications outlining energy monitoring equipment/ software. • Specifications outline initial commissioning of energy systems.	-	-		
RA3.1 Preserve Water Resources	Enhanced (5) A+B+C	B+C	**Provide documentation:** • Estimate water use and wastewater generation over the life of the project. • Project features intended to reduce negative impacts of water usage, and/or improve watershed-scale issues.	-	-		
RA3.3 Reduce Construction Water Consumption	Improved (1) A+B	A+B	**Design and provide documentation:** • Conduct a review to identify and analyze potential options for reducing water consumption during construction. Provide meeting minutes from discussion. • Specifications include requirements to implement one potable water reduction strategy on the construction site, including providing calculations showing that the implemented strategies meet related percentage reduction goals, as outlined in the Envision Guidance Manual (RA3.3 Reduce Construction Water Consumption).	A+B	**Implement and provide documentation**: • Evidence that at least one (1) potable water reduction strategy is used on the construction site. • Calculations showing that the implemented strategies meet related percentage reduction goals. • Information on how strategies are monitored, measured and documented through construction.		
RA3.4 Monitor Water Systems	Enhanced (3) A	A	**Design and provide documentation:** • Design includes water monitoring equipment and/or software to facilitate performance monitoring during operation. • Plans/specifications outlining water monitoring equipment/ software. • Documentation showing the percentage of water use that is being monitored.	-	-		

Table 2: Design Builder Envision Action Plan

Note: Items underlined and in blue are also noted in Table 1. Plans and Forms included as Envision Submittals.

CREDIT NO. AND TITLE	TARGET LOA & RELEVANT CRITERIA (PTS)	DESIGN BUILDER RESPONSIBILITIES				DB POC	DB COMMENTS
		DESIGN-RELATED CRITERIA	DESIGN RESPONSIBILITIES *Reference: Envision Guidance Manual*	CONSTRUCTION-RELATED CRITERIA	CONSTRUCTION RESPONSIBILITIES *Reference: Envision Guidance Manual*		
NW2.3 Reduce Pesticide and Fertilizer Impacts	Conserving (9) C	C	**Design and provide documentation:** • Specifications include requirements to direct that fewer, little, or no fertilizers or pesticides will be used on the project site during construction. • Design landscaping with plant species that do not require pesticides or fertilizers. • Plans/specifications showing plantings and plant types. • Information about any integrated and pest management approaches that will be used for the project.	C	Implement project as directed in plans and specifications.		
NW2.4 Protect Surface and Groundwater Quality	Improved (2) A+B	[A]+B	**Design and provide documentation:** • Determine potential impacts to surface water or groundwater quality, including temperature, during construction and operations. • Specifications include requirements for a spill and leak prevention and response plan during construction. • If applicable, specify placement of materials storage piles and handling of potentially polluting runoff.		**Provide documentation:** • Information included in CMP. • Spill and leak prevention and response plan for construction.		
NW3.4 Control Invasive Species	Superior (6) A+B+C	A+C	**Design provide documentation:** • Design landscaping utilizing noninvasive species / landscape/planting plans and specifications, showing incorporation of noninvasive species. • Specifications include requirements to ensure that construction materials and equipment used on-site are free of invasive species and seeds, and provide guidance for handling containment or suppression activities during construction for major infestations of invasive species found on-site. • Specifications include requirements to establish and implement a program that controls minor infestations of invasive species on-site before and throughout construction.	A+C	**Provide documentation:** • Information included in CMP. • Establish and implement a program that controls minor infestations of invasive species on-site before and throughout construction.		
CR1.3 Reduce Air Pollutant Emissions	Improved (2) A+B+C	B	**Provide documentation:** • Documentation of strategies deployed to reduce air pollutant emissions.	-	-		
CR2.3 Evaluate Risk and Resilience	Conserving (26) A+B+C+D+E+F	F	Participate in risk evaluation.	F	Participate in risk evaluation.		
CR2.4 Establish Resilience Goals and Strategies	Conserving (20) A+B+C+D	B+C	Collaborate in developing risk management goals strategies that meet project performance goals and increase project resilience.	B+C	Collaborate in developing risk management goals strategies that meet project performance goals and increase project resilience.		
CR2.5 Maximize Resilience	Enhanced (15) A+B+C	B	**Design and provide documentation:** • Design strategies that increase resilience / document approach to implementing resilience strategies.	B	Implement project as directed in plans and specifications.		

Design Builder Envision Action Plan Confirmation
Due 30 days after Envision Design Builder Alignment Meeting.

I understand that it is the goal of this Project to meet requirements of the Envision Sustainable Infrastructure Framework and pursue Envision verification for the Project, with a goal of Gold-level verification. I have reviewed the credits noted in the Design Builder Envision Action Plan and will provide documentation as needed to meet Envision requirements. This includes information for the initial submittal to ISI, as well as requested follow-up documentation or requests for clarification until the project verification process is completed.

____________________ ____________________ ____________________
Authorized Signature Printed Name Date

This document should be submitted at the beginning of the project for confirmation of project understanding and used throughout the construction process to verify compliance with project requirements.

END OF SECTION

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ATTACHMENT A

ENVISION SCORECARD SNAPSHOT

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ENVISION SCORECARD SNAPSHOT

Credit levels of achievement are based on projections for the ReGen project, but actual levels of achievement may vary depending on available documentation and the verifier's review. Credits included in the Design Builder EAP are highlighted in yellow.

Category	Credit	N/A	None	Improved	Enhanced	Superior	Conserving	Restorative
QUALITY OF LIFE	QL1.1 Improve Community Quality of Life	0	0	2	5	10	20	26
	QL1.2 Enhance Public Health and Safety	0	0	2	7	12	16	20
	QL1.3 Improve Construction Safety	0	0	2	5	10	14	-
	QL1.4 Minimize Noise and Vibration	0	0	1	3	6	10	12
	QL1.5 Minimize Light Pollution	0	0	1	3	6	10	12
	QL1.6 Minimize Construction Impacts	0	0	1	2	4	8	-
	QL2.1 Improve Community Mobility and Access	0	0	1	3	7	11	14
	QL2.2 Encourage Sustainable Transportation	0	0	-	5	8	12	16
	QL2.3 Improve Access and Wayfinding	0	0	1	5	9	14	-
	QL3.1 Advance Equity and Social Justice	0	0	3	6	10	14	18
	QL3.2 Preserve Historic and Cultural Resources	-18	0	-	2	7	12	18
	QL3.3 Enhance Views and Local Character	0	0	1	3	7	11	14
	QL3.4 Enhance Public Space and Amenities	0	0	1	3	7	11	14
	QL0.0 Innovation		2					
POINTS	Max 200 Applicable 182		Low 106			High 121		
LEADERSHIP	LD1.1 Provide Effective Leadership and Collaboration	0	0	2	5	12	18	-
	LD1.2 Foster Collaboration and Teamwork	0	0	2	5	12	18	-
	LD1.3 Provide for Stakeholder Involvement	0	0	3	6	9	14	18
	LD1.4 Pursue Byproduct Synergies	0	0	3	6	12	14	18
	LD2.1 Establish a Sustainability Management Plan	0	0	4	7	12	18	-
	LD2.2 Plan for Sustainable Communities	0	0	4	6	9	12	16
	LD2.3 Plan for Long-Term Monitoring and Maintenance	0	0	2	5	8	12	-
	LD2.4 Plan for End-of-Life	0	0	2	5	8	14	-
	LD3.1 Stimulate Economic Prosperity and Development	0	0	3	6	12	20	-
	LD3.2 Develop Local Skills and Capabilities	0	0	2	4	8	12	16
	LD3.3 Conduct a Life-Cycle Economic Evaluation	0	0	5	7	10	12	14
	LD0.0 Innovation		6					
POINTS	Max 182 Applicable 182		Low 135			High 150		
RESOURCE ALLOCATION	RA1.1 Support Sustainable Procurement	0	0	3	6	9	12	-
	RA1.2 Use Recycled Materials	0	0	4	6	9	16	-
	RA1.3 Reduce Operational Waste	0	0	4	7	10	14	-
	RA1.4 Reduce Construction Waste	0	0	4	7	10	16	-
	RA1.5 Balance Earthwork On Site	0	0	2	4	6	8	-
	RA2.1 Reduce Operational Energy Consumption	0	0	6	12	18	26	-
	RA2.2 Reduce Construction Energy Consumption	0	0	1	4	8	12	-
	RA2.3 Use Renewable Energy	0	0	5	10	15	20	24
	RA2.4 Commission and Monitor Energy Systems	0	0	3	6	12	14	-
	RA3.1 Preserve Water Resources	0	0	3	5	7	9	12
	RA3.2 Reduce Operational Water Consumption	-22	0	4	9	13	17	22
	RA3.3 Reduce Construction Water Consumption	0	0	1	3	5	8	-
	RA3.4 Monitor Water Systems	-12	0	1	3	6	12	-
	RA0.0 Innovation		4					
POINTS	Max 196 Applicable 196		Low 81			High 83		

Category	Credit	N/A	None	Improved	Enhanced	Superior	Conserving	Restorative
NATURAL WORLD	NW1.1 Preserve Sites of High Ecological Value	-22	0	2	6	12	16	22
	NW1.2 Provide Wetland and Surface Water Buffers	-20	0	2	5	10	16	20
	NW1.3 Preserve Prime Farmland	-16	0	-	2	8	12	16
	NW1.4 Preserve Undeveloped Land	0	0	3	8	12	18	24
	NW2.1 Reclaim Brownfields	-22	0	11	13	16	19	22
	NW2.2 Manage Stormwater	0	0	2	4	9	17	24
	NW2.3 Reduce Pesticide and Fertilizer Impacts	0	0	1	2	5	9	12
	NW2.4 Protect Surface and Groundwater Quality	0	0	2	5	9	14	20
	NW3.1 Enhance Functional Habitats	-18	0	2	5	9	15	18
	NW3.2 Enhance Wetland and Surface Water Functions	-20	0	3	7	12	18	20
	NW3.3 Maintain Floodplain Functions	-14	0	1	3	7	11	14
	NW3.4 Control Invasive Species	0	0	1	2	6	9	12
	NW3.5 Protect Soil Health	0	0	-	3	4	6	8
	NW0.0 Innovation		0					
	POINTS Max 232	Applicable 100		Low 35		High 35		
CLIMATE AND RESILIENCE	CR1.1 Reduce Net Embodied Carbon	0	0	5	10	15	20	-
	CR1.2 Reduce Greenhouse Gas Emissions	0	0	8	13	18	22	26
	CR1.3 Reduce Air Pollutant Emissions	0	0	2	4	9	14	18
	CR2.1 Avoid Unsuitable Development	-16	0	3	6	8	12	16
	CR2.2 Assess Climate Change Vulnerability	0	0	8	14	18	20	-
	CR2.3 Evaluate Risk and Resilience	0	0	11	18	24	26	-
	CR2.4 Establish Resilience Goals and Strategies	0	0	-	8	14	20	-
	CR2.5 Maximize Resilience	0	0	11	15	20	26	-
	CR2.6 Improve Infrastructure Integration	0	0	1	5	9	13	18
	CR0.0 Innovation (earn up to 5 points)		2					
	POINTS Max 190	Applicable 174		Low 96		High 127		

TOTAL POINTS	Max	1000	Applicable	834
	Low	453	High	516
		Platinum		Platinum

ATTACHMENT B

CONSTRUCTION MANAGEMENT AND CONSTRUCTION WASTE MANAGEMENT PLANS GUIDANCE

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GUIDANCE FOR

CONSTRUCTION MANAGEMENT PLAN ENVISION REQUIREMENTS

AND CONSTRUCTION WASTE MANAGEMENT PLAN

PART 1 - COMPREHENSIVE CONSTRUCTION MANAGEMENT PLAN ENVISION REQUIREMENTS

1.1 SUMMARY

A. The Design Builder shall develop a comprehensive Construction Management Plan (CMP). Elements of the CM shall address the project's construction impacts, including but not limited to the following:
   1. Noise and/or Vibrations:
      a. Outline the anticipated noise impacts and describe the approach to minimize construction noise and/or vibrations impacts to the extent feasible. Note local construction noise ordinance, and how plans for minimizing construction noise and vibration will meet or exceed local requirements. Include details on the expected sources of significant noise and vibration, how the effects of those sources will be minimized, how noise and vibration will be monitored, and what corrective actions will be taken if specified levels are exceeded.
      b. Provide a Construction Noise Management Plan (CNMP), separate from the CMP. that includes stakeholder engagement and mechanisms for communities to report complaints. Explain how corrective actions applied in response to stakeholder reporting will be recorded and/or documented.
   2. Public Safety and Wayfinding:
      a. Outline how the Design Builder will address safety and wayfinding for pedestrians and vehicles during construction.
   3. Maintaining Access to Public Space and Amenities:
      a. Outline strategies the Design Builder will use to:
         1) Limit disruption and maintain access to public space and amenities during construction within the boundaries of safety.
         2) Limit interruption of service.
      b. Provide evidence of stakeholder understanding and acceptance of construction impacts to public space/amenities, specifically access, during construction.
   4. Construction Lighting:
      a. Outline how the Design Builder will minimize distracting or intrusive lighting during construction.
   5. Public Feedback:
      a. Describe how the Design Builder will support the Program Manager (PM) to work with adjacent properties to understand construction plans as well as monitoring and corrective action programs.
      b. Support the PM on programs to monitor and inform impacted stakeholders on project performance in addressing construction impacts.
   6. Construction Energy Reduction:
      a. Outline potential strategies for reducing energy consumption during construction.
      b. Outline how the Design Builder intends implement a minimum of two energy conservation strategies during construction.
      c. Outline how implementation will meet related percentage energy reduction goals, as outlined in the Envision Guidance Manual (RA2.2 Reduce Construction Energy Consumption).

d. Describe how the energy reduction will be monitored, measured and documented through construction.

7. Construction Water Reduction:
   a. Outline potential strategies for reducing potable water consumption during construction.
   b. Outline how the Design Builder intends to implement a minimum of one potable water reduction strategy during construction.
   c. Outline how implementation will meet related percentage reduction goals, as outlined in the Envision Guidance Manual (RA3.3 Reduce Construction Water Consumption).
   d. Describe how the potable water reduction will be monitored, measured and documented through construction, so that the project team can document a calculation of potable water saved as compared to not implementing the strategy over the construction duration.
8. Spill and Leak Protection:
   a. Confirm and provide evidence that spill and leak prevention and response plans, separate from the CMP, are in place.
   b. Outline placement and management of materials storage piles and handling of potentially polluting runoff, if applicable.
9. Control Invasive Species:
   a. Describe how the Design Builder will prevent the introduction of invasive species, including best practices to ensure that construction materials and equipment used onsite are free of invasive species and seeds.
   b. Outline control, containment or suppression activities that will be used during construction for any major infestations of invasive species that are found on-site.

B. Construction Safety:
   1. Monitoring and Improving health and safety
      a. Describe the Design Builder's commitments to safety and that it is a core concern.
      b. Outline how the Design Builder will implement a proactive safety rewards program to support outstanding safety performance.
      c. Outline programs/requirements to ensure that subcontractors maintain a high level of safety per the contract.
      d. Describe how the Design Builder's senior managers are engaged in the project safety program and conduct safety observations and inspections as part of their standard duties.
   2. Incident Feedback Mechanism:
      a. Outline the Design Builder's investigative process, focusing on root cause and corrective actions vs. disciplinary actions and financial penalties.
      b. Describe Design Builder's proactive injury management system that supports efficient, effective and timely treatment of their employees injured on the job site.
      c. Outline Design Builder's incident review process, including how it involves all levels of management to validate corrective measures to minimize future injuries and incidents on the job site
      d. Provide information describing how the Design Builder develops “lessons learned” reports and how that information is conveyed to other Design Builders and/or projects to implement processes and procedures to minimize similar incidents in the future.
   3. Safety or Security Training:
      a. Outline safety competency training programs for field personnel, including type of training provided and how they specifically target health and safety. Training may include task-specific safety training or general awareness training.
      b. Describe minimum training requirements for health and safety programs such as occupational safety and health, first aid, CPR, emergency response, active shooter training, or equivalent.
      c. Outline security training for personnel, if applicable.

4. Comprehensive Security Plan:
    a. Confirm and provide evidence of a specific site and Project Security Plan (PSP), separate from the CMP. This plan may include, but is not limited to, Design Builder background checks on personnel working on the project, and 24-hour security monitoring on the project (physical/electronic).
5. Health and/or Wellbeing Programs:
    a. Outline the Design Builder's health and/or well-being programs beyond the specific activities associated with project delivery. This may include, but is not limited to, health screenings for workers, nutrition or exercise workshops, and/or free vaccinations.

C. Use Recycled Materials:
1. Confirm understanding of the project’s recycled material goals and compliance with documentation/submittal requirements.
2. Project goal is to use at least 25 percent of recycled materials including materials with recycled content and/or reused existing structures or materials.

PART 2 - CONSTRUCTION WASTE MANAGEMENT PLAN

2.1 SUMMARY

A. The Design Builder shall provide a Construction Waste Management Plan (CWMP), separate from the CMP, including submittal/reporting mechanism to provide evidence of implementation. Refer to Attachment D for forms required.

B. The project has set a target goal for construction waste diversion, for at least 75 percent of waste materials to be recycled, reused, and/or salvaged. Diversion may be a combination of waste-reduction measures and sourcing waste to other facilities for recycling or reuse.

C. The CWMP shall include:
1. The waste diversion target and methodology to reach the target.
2. A general description of each type/category of construction and demolition materials generated, location of receiving agent, and quantity of waste diverted (by category) in weight (tons) or volume (cubic yards/meters).
3. Plan for submitting calculations of total waste reduction measures and percentage of materials diverted to recycling or reuse. The percentage of diverted waste shall be calculated as the ratio of material diverted from landfills against the total waste generated during construction. Calculations may be done by weight (tons) or volume (cubic yards/meters) but must remain consistent.
4. Design Builder shall use the forms outlined in Attachment D for calculations. Forms and corresponding load tickets shall be submitted with monthly submittal.
5. Waste deemed hazardous shall not be included in the total waste calculations and shall be disposed of according to local, state, and federal law.

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ATTACHMENT C

RA1.2 RECYCLED MATERIALS – GUIDANCE AND FORMS

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OVERVIEW

1. Consider which project materials may include recycled materials (both materials with recycled content and/or reuse of existing structures or materials) and/or regional materials.

WORKBOOK INSTRUCTIONS

2. Document inclusion of recycled content or material reuse.

• Use the *Material Content Form* in this workbook to inventory materials, to calculate the inclusion of recycled content and existing materials or structures that have been reused on the site.
• List Product/material description, vendor or manufacturer, quantity and units (tons, cy), total cost/value, and percentage of reuse or recycled content.
• ***Include all materials*** (see notes below for exclusions), even if the percentage of recycled or reused is 0%, so the percentage of recycled/reused can be calculated against total materials.
• Submit form and it will be compiled with other forms to calculate the total recycled/reused materials.
• Calculations for recycled materials do not include plants, soils, or water.
• If product cut sheets are available that provide information about the recycled content, provide as supplemental documentation. If available online, links to the information can be provided.

NOTES

• Mechanical, electrical, water equipment, and their components may be excluded from the calculations.
• Calculations are based on cost or replacement value.
• Materials reused on-site can be considered "reused" under recycled materials and regional because the distance traveled

The Arlington Re-Gen Program is pursuing an Improved level of achievement (LOA) for RA1.2 Use Recycled Materials.
The target goal for materials with recycled content and/or reused existing structures or materials is at least 25%.

RESOURCES

CalRecycle Recycled Content Construction Products Catalog - https://www.calrecycle.ca.gov/condemo/products
EPA Comprehensive Procurement Guideline (CPG) Program - https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program
LEED Recycled content credit - https://www.usgbc.org/credits/new-construction/v20/mrc41-42

Envision RA1.2 Use Recycled Materials

The goal of this credit is to reduce construction waste and divert waste streams from disposal to recycling and reuse. Project teams can improve performance by considering the ability of waste generated during construction to be recycled or beneficially reused, implementing waste management plans to capture waste, and identifying possible recycling centers with appropriate capabilities.

Waste deemed hazardous should not be included in the total waste calculations and should be disposed of according to local, state/provincial, and federal law.

Quantity Total Reused Materials	$ -
Quantity Total Recycled-content Materials	$ -
Total Materials	$ -

Percentage of materials diverted to recycling or reuse	#DIV/0!

Fields will fill in automatically based on totals from corresponding tabs.

Material Content Form

Project	Arlington Re-Gen Comprehensive Biosolids Upgrades - Phase 10
Subcontractor	Subcontractor Name
Component	
Overall Description	
Overall Materials Budget	$0.00
Additional Info.	
Gray cells calculate automatically	

					Reused Materials		Recycled Materials				
					Breakdown Product salvaged, refurbished or reused		Breakdown Recycled Pre-Consumer		Breakdown Recycled Post-Consumer		Product Info. Available
Product	**Vendor or Manufacturer**	**QTY**	**Units**	**Total Cost/ Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Yes/No**
Example - Concrete with fly ash	Concretes R Us	1200	CY	$ 25,000.00	0%	$ -	7%	$ 1,750.00	0%	$ -	No
Example - Concrete reused as aggregate	Existing/onsite	2500	Tons	$ 60,000.00	100%	$ 60,000.00	0%	$ -	0%	$ -	No
				$ -	0%	$ -	0%	$ -	0%	$ -	
				$ -	0%	$ -	0%	$ -	0%	$ -	
				$ -	0%	$ -	0%	$ -	0%	$ -	
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				$ -	0%	$ -	0%	$ -	0%	$ -	
	Line Item Totals			$ -		$ -		$ -		$ -	

RESOURCE ALLOCATION: MATERIALS

RA1.2 Use Recycled Materials

16 POINTS

INTENT

Reduce the use of virgin natural resources and avoid sending useful materials to landfills by specifying reused materials, including structures, and material with recycled content.

METRIC

Percentage of project materials that are reused or recycled. Plants, soil, rock, and water are not included in this credit.

LEVELS OF ACHIEVEMENT

IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
A	A	A	A	Not Available
(4) At Least 5% From Recycled	**(6) At Least 15 % From Recycled**	**(9) At Least 25% From Recycled**	**(16) At Least 50% From Recycled**	
(A) At least 5% (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials.	**(A)** At least 15% (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials.	**(A)** At least 25% (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials.	**(A)** At least 50% (by weight, volume, or cost) of recycled materials including materials with recycled content and/or reused existing structures or materials.	

DESCRIPTION

The purpose of this credit is to reduce the use of virgin natural resources and avoid sending useful materials to landfills. Using recycled, reused, and renewable materials and products, including existing structures and materials on site, reduces demand for virgin materials and the embodied carbon emissions and environmental degradation attributed to their extraction and processing. Using these materials also reduces waste and supports the market for recycled and reused materials. Project teams should consider how salvaging or repurposing existing materials or structures can significantly reduce demand for new construction materials as well as project costs. The reuse of existing materials or elements may also have a significant cultural or aesthetic value, such as street lamps, sidewalk pavers, bridges, and more.

PERFORMANCE IMPROVEMENT

Improved – Conserving: Levels in this credit are distinguished by the percentage of total materials that are reused or recycled. Calculations of recycled materials can be done by weight, volume, or cost, but must remain consistent within the credit. Calculations should compare the total quantity of recycled materials and reused structures with the total quantity of materials on the project. Products that contain a percentage of recycled material should be factored according to the percentage of material that is recycled.

Recycled content is defined in accordance with ISO 14021 as the portion of materials used in a product that have been diverted from the solid waste stream and used in part or whole in place of a new primary material. Material eligible for consideration can also be defined as pre-existing material on site, or from another site, that was previously a product or piece of equipment that is now being repurposed or reused. To be considered "reused," the project team must demonstrate some intention or effort to reclaim, salvage, or repurpose the materials or structures in keeping with the credit intent.

Natural materials such as soil and rock when used as backfill do not count toward this credit but are addressed in RA 1.5 Balance Earthwork On Site. If natural resources on the site are harvested and manufactured in order to take the place of new or primary materials, such as pulverizing stone in order to produce aggregate, project teams are responsible for demonstrating that the actions truly replace a new primary material. Likewise, when claiming the reuse of existing structures or materials, project teams must clearly demonstrate that a conscious decision was made to salvage those materials from demolition and disposal. Materials cannot be counted as recycled if, in standard practice, they would not otherwise have been removed. For example, when repairing a road, project teams cannot claim the entirety of the remaining road as "recycled," as that material would not typically have been removed.

Project teams must always ensure that all project materials meet the necessary quality and performance criteria required for the intended application, whether recycled or not. Materials must also meet all state or local solid waste agency requirements for using recycled materials in construction. Any recycled materials used must not pose unacceptable risks to human health and safety or the environment.

Applicability: This credit is applicable to all projects that include the use or consumption of physical materials in construction or operation.

EVALUATION CRITERIA AND DOCUMENTATION GUIDANCE

A. To what extent has the project team used recycled materials, including materials with recycled content and/or reused existing structures or materials?

1. *Total quantity of materials used on the project by weight, volume, or cost.*
2. *Inventory of specifications for materials containing recycled content. Inventory should include the name of the product, the name of the manufacturer, the weight, volume, or cost of the material, and the percentage of recycled content (either post-industrial or post-consumer recycled content).*
3. *Calculations of percentage of reused or recycled materials by weight, volume, or cost.*

   To calculate materials with recycled content, multiply the material weight, volume, or cost by the percentage of recycled content.

   Mechanical, electrical, water equipment, and their components may be excluded from the calculations. In these instances, the most efficient equipment should be specified.

   Calculations do not include plants, soils, rocks, or water.
4. *Inventory of existing materials or structures that have been reused.*

   Design documents showing the location and weight, volume, or cost of reused structures or materials. In determining weight, volume, or cost, the project team may refer to standard equivalents.

   In order to meet the intent of this credit, the project team must be able to demonstrate an intentional choice to salvage materials or structures that might otherwise have been sent to landfills and/or replaced. In addition, they must demonstrate that such action is within the scope of the project. For example, a project to resurface an airport runway cannot claim the entirety of the surrounding airport as "reused" materials. However, a project that intentionally chooses to refurbish an existing bridge, rather than replace it, may count the retained components of the existing bridge as "reused."

RELATED ENVISION CREDITS

LD1.4 Pursue Byproduct Synergies

NW1.4 Preserve Undeveloped Land

CR1.1 Reduce Net Embodied Carbon

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ATTACHMENT D

RA1.4 REDUCE CONSTRUCTION WASTE – GUIDANCE AND FORMS

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OVERVIEW

1. Draft Construction Waste Management Plan to include identifying:

• Waste streams involved in project's demolition and construction efforts.
  o Note: Soils and rocks are not included in this waste calculation.
  o Note: Waste deemed hazardous shall not be included in the total waste calculations and shall be disposed of according to local, state, and
  federal law.
• Recycling facilities available for project waste streams. These can include, but are not limited to:
  o Paving – concrete or asphalt
  o Milling, concrete slough and grindings
  o Metals – structural steel, steel rebar, metal guardrails, pipes, luminaires, signs, aluminum, various household metals
  o Plastic – waste plastic pipes
  o Wood – various wood construction materials, pallets, packaging
  o Cardboard, paper products – packaging materials, copy paper, paper products
  o Glass
• Demolition materials to be reused in project construction or at another site. These can include, but are not limited to:
  o Concrete – crushed and reused in project construction
  o Asphalt – crushed and recycled into new asphalt
•Collection methods for demolition and construction waste streams.
  o Determine if materials will be separated as they are collected on-site or commingled and separated off-site
  o Locate and label collection waste bins on the project site
  o Provide guidance on waste collection and diversion goals to project team and construction workers on site

2. Document waste diversion efforts

• Document waste brought to recycling facilities and landfill with waste tickets for each delivery. Include manifests, weight tickets, receipts, and invoices, as applicable for recycled and landfilled materials with submittal of spreadsheet.
• Document demolition materials housed and prepped for reuse on site.
• Document waste reduction measures and quantify impact (example – reuse of existing structures that were planned to be demolished and rebuilt).
• Use the Reduce Construction Waste Diversion Summary Form to document all related efforts.

WORKBOOK INSTRUCTIONS

 o Record waste tickets on corresponding "Recycled" and "Landfill" tabs, by date, listing material description, receiving agent, quantity and units (tons, cy)
 o Record information on corresponding "Reused" tab, listing material description, location and/or yype of reuse, quantity and

The Arlington Re-gen Program is pursuing a superior level of achievement (LOA) for RA1.4 Reduce Construction Waste.
The target goal for construction waste diversion is for at least 75% of waste materials to be

Envision RA1.4 Reduce Construction Waste Diversion Summary

The goal of this credit is to reduce construction waste and divert waste streams from disposal to recycling and reuse. Project teams can improve performance by considering the ability of waste generated during construction to be recycled or beneficially reused, implementing waste management plans to capture waste, and identifying possible recycling centers with appropriate capabilities.

Waste deemed hazardous should not be included in the total waste calculations and should be disposed of according to local, state/provincial, and federal law.

Calculations may be done by weight (tons) or volume (cubic yards) but must remain consistent.

Quantity Total Waste to Recycling	0
Quantity Total Waste to Reuse	0
Quantity Total Waste to Landfill	0
Total Waste	0

Fields will fill in automatically based on totals from corresponding tabs.

Percentage of materials diverted to recycling or reuse	#DIV/0!

Waste figures measured in volume can be converted to weight using the conversion factors for construction debris. Tools available to assist in this effort include those provided by the United Nations Environment Programme (UNEP), CalRecycle, or other state/provincial or national authorities.

United Nations Environment Programme (UNEP)
CalRecycle

Waste to Recycling Record

Project	Arlington Re-Gen Comprehensive Biosolids Upgrades - Phase 10
Contractor	
Component	
Overall Description	

Indicate receipt and acceptance of waste by recycling facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices, as applicable, with submittal of spreadsheet.

Insert rows as needed

Date	Material Description	Receiving Agent	QTY	Units
			0	
		Quantity Total Waste to Recycling	0	0

Waste to Reuse Record

Project	Arlington Re-Gen Comprehensive Biosolids Upgrades - Phase 10
Contractor	
Component	
Overall Description	

Insert rows as needed

Date	Material Description	Location and/or Type of Reuse	QTY	Units
			0	
		Quantity Total Waste to Reuse	0	0

Waste to Landfill Record

Project	Arlington Re-Gen Comprehensive Biosolids Upgrades - Phase 10
Contractor	
Component	
Overall Description	

Indicate receipt and acceptance of waste by landfills. Include manifests, weight tickets, receipts, and invoices, as applicable, with submittal of spreadsheet.

Insert rows as needed

Date	Material Description	Receiving Agent	QTY	Units
			0	
		Quantity Total Waste to Landfill	0	0

Receiving Agent Locations

Corresponds with receiving agents listed on each tab - recycled, reused, landfill.
Only list each receiving agent once on this list.

	Receiving Agent/Disposal Facility Name	Type of Material (Recycled, Reused, Landfill)	Street Address	City	State	Zip
1						
2						
3						
4						
5						
6						
7						
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9						
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COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Permit No.	**VA0025143**
Effective Date:	**December 1, 2019**
Expiration Date:	**November 30, 2024**

AUTHORIZATION TO DISCHARGE UNDER THE
VIRGINIA POLLUTANT DISCHARGE ELIMINATION SYSTEM
AND THE VIRGINIA STATE WATER CONTROL LAW

In compliance with the provisions of the Clean Water Act as amended and pursuant to the State Water Control Law and regulations adopted pursuant thereto, the following owner is authorized to discharge in accordance with the information submitted with the permit application, and with this permit cover page, Part I – Effluent Limitations and Monitoring Requirements, Part II – Conditions Applicable To All VPDES Permits, and Part III – Biosolids, as set forth herein.

Owner Name:	Arlington County Board
Facility Name:	Arlington County Water Pollution Control Plant (WPCP)
County:	Arlington
Facility Location:	3402 South Glebe Road, Arlington, VA 22202

The owner is authorized to discharge to the following receiving stream:

Stream Name:	Four Mile Run
River Basin:	Potomac River
River Subbasin:	Potomac River
Section:	6
Class:	II
Special Standards:	b, y

Thomas A. Faha
Director, Northern Regional Office
Department of Environmental Quality

November 25, 2019
Date

A. Effluent Limitations and Monitoring Requirements

1. Outfall 001 – 40 MGD Facility

a. During the period beginning with the permit's effective date and lasting until the expiration date, the permittee is authorized to discharge from Outfall Number 001. Such discharges shall be limited and monitored by the permittee as specified below.

b. This facility has Total Nitrogen and Total Phosphorus calendar year load limits associated with this outfall included in the current Registration List under registration number VAN010021, enforceable under the General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Dischargers and Nutrient Trading in the Chesapeake Watershed in Virginia.

c. There shall be no discharge of floating solids or visible foam in other than trace amounts.

Parameter	Discharge Limitations						Monitoring Requirements	
	Monthly Average[(1)]		Weekly Average[(1)]		Minimum	Maximum[(1)]	Frequency	Sample Type
Flow[(2)] (MGD)	NL		NA		NA	NL	Continuous	TIRE
pH	NA		NA		6.0 S.U.	8.5 S.U.	1/D	Grab
$cBOD_5$	5 mg/L	800 kg/day	8 mg/L	1000 kg/day	NA	NA	1/D	24H-C
Total Suspended Solids, TSS	6.0 mg/L	910 kg/day	9.0 mg/L	1400 kg/day	NA	NA	1/D	24H-C
Dissolved Oxygen	NA		NA		6.0 mg/L	NA	1/D	Grab
Total Kjeldahl Nitrogen, TKN	NL mg/L		NL mg/L		NA	NA	1/W	24H-C
Ammonia, as N (April – October)	1.0 mg/L	150 kg/day	2.7 mg/L	410 kg/day	NA	NA	1/D	24H-C
Ammonia, as N (November – March)	3.5 mg/L		4.2 mg/L		NA	NA	1/W	24H-C
Total Residual Chlorine (after contact tank)	NA		NA		0.5 mg/L	NA	1 / 2 hours	Grab
Total Residual Chlorine (after dechlorination)	0.007 mg/L		0.007 mg/L		NA	NA	1 / 2 hours	Grab
E. coli (Geometric Mean) [(3)]	126 n/100 mL		NA		NA	NA	5D/W	Grab
Nitrate+Nitrite, as N	NL mg/L		NA		NA	NA	1/W	24H-C
Total Nitrogen [(4)]	NL mg/L		NA		NA	NA	1/W	Calculated
Total Nitrogen – Year to Date [(5)]	NL mg/L		NA		NA	NA	1/M	Calculated
Total Nitrogen – Calendar Year [(5)]	3.0 mg/L		NA		NA	NA	1/YR	Calculated
Total Phosphorus	0.18 mg/L	60 lb/day	0.27 mg/L	90 lb/day	NA	NA	1/D	24H-C
Total Recoverable Copper	NA		NA		NA	NL µg/L	1/YR [(6)]	Grab
Chronic Toxicity – *C. dubia* (TU_c) [(7)]	NA		NA		NA	NL	1/YR	24H-C
Chronic Toxicity – *P. promelas* (TU_c) [(7)]	NA		NA		NA	NL	1/YR	24H-C

(1) See Part I.B.
(2) The design flow is 40 MGD.
(3) Samples shall be collected between 10:00 a.m. and 4:00 p.m.
(4) Total Nitrogen = Sum of TKN plus Nitrate+Nitrite.
(5) See Part I.B.4 for nutrient reporting calculations.
(6) Annual sample shall be collected in the month of February or March.
(7) See Part 1.D. for toxicity monitoring requirements.

MGD = Million gallons per day.
NA = Not applicable.
NL = No limit; monitor and report.
S.U. = Standard units.
TIRE = Totalizing, indicating and recording equipment.

1/D = Once every day.
1/W = Once every week.
5D/W = Five days a week.
1 / 2 hrs = Once every two hours.
1/M = Once every month.
1/YR = Once every calendar year.

24H-C = A flow proportional composite sample collected manually or automatically, and discretely or continuously, for the entire discharge of the monitored 24-hour period. Where discrete sampling is employed, the permittee shall collect a minimum of twenty-four (24) aliquots for compositing. Discrete sampling may be flow proportioned either by varying the time interval between each aliquot or the volume of each aliquot. Time composite samples consisting of a minimum of twenty-four (24) grab samples obtained at hourly or smaller intervals may be collected where the permittee demonstrates that the discharge flow rate (gallons per minute) does not vary by 10% or more during the monitored discharge.

Grab = An individual sample collected over a period of time not to exceed 15-minutes.

B. Additional Monitoring Requirements, Quantification Levels and Compliance Reporting

1. Additional Total Residual Chlorine (TRC) Limitations and Monitoring Requirements

   a. The permitee shall monitor the TRC at the outlet of the chlorine contact tank once every two hours by grab sample.

   b. No more than 36 of all TRC samples taken at the outlet of the chlorine contact tank shall be less than 0.5 mg/L for any one calendar month.

   c. No TRC sample collected at the outlet of the chlorine contact tank shall be less than 0.2 mg/L.

   d. If dechlorination facilities exist, the samples above shall be collected prior to dechlorination.

   e. If the permittee violates the monthly geometric mean for *E. coli* (as shown in Part 1.A of this permit) during the permit cycle, the following limits shall apply and supersede the limits in Part I.A of this permit until it can be demonstrated through a revised Chlorine Reduction Study that adequate disinfection will occur using a lower level of chlorine disinfection. The Chlorine Reduction Study shall be reviewed and approved by the Department of Environmental Quality (DEQ).

      1) No more than 36 of all samples for TRC taken after the chlorine contact tank and prior to dechlorination shall be less than 1.0 mg/L TRC for any calendar month.

      2) No TRC sample collected prior to dechlorination shall be less than 0.6 mg/L (instantaneous TRC technological minimum limit).

   f. If disinfection is by a method other than chlorination, *E. coli* shall be limited and monitored by the permittee as specified below and this requirement, if applicable, shall substitute for the TRC and *E. coli* requirements delineated elsewhere in Part I of this permit.

	Discharge Limitations Monthly Average	Monitoring Frequency Requirements	Sample Type
E. coli	126 n/100mL Geometric Mean	1/D	Grab Between 10 AM & 4 PM

2. Quantification Levels

   a. The quantification levels (QL) shall be less than or equal to the following concentrations:

Characteristic	Quantification Level
TSS	1.0 mg/L
$cBOD_5$	2 mg/L
Ammonia-N	0.20 mg/L
TRC	0.10 mg/L
Total Recoverable Copper	7.2 µg/L

   b. The QL is defined as the lowest concentration used to calibrate a measurement system in accordance with the procedures published for the method. It is the responsibility of the permittee to ensure that proper quality assurance/quality control (QA/QC) protocols are followed during the sampling and analytical procedures. QA/QC information shall be documented to confirm that appropriate analytical procedures have been used and the required QLs have been attained. The permittee shall use any method in accordance with Part II A of this permit.

3. Compliance Reporting for parameters in Part I.A.

a. Monthly Average – Compliance with the monthly average limitations and/or reporting requirements for the parameters listed in Part I.B.2.a. of this permit condition shall be determined as follows: All concentration data below the QL used for the analysis (QL must be less than or equal to the QL listed in Part I.B.2.a above) shall be treated as zero. All concentration data equal to or above the QL used for the analysis shall be treated as it is reported. An arithmetic average shall be calculated using all reported data for the month, including the defined zeros. This arithmetic average shall be reported on the Discharge Monitoring Report (DMR) as calculated. If all data are below the QL used for the analysis, then the average shall be reported as "<QL". If reporting for quantity is required on the DMR and the reported monthly average concentration is <QL, then report "<QL" for the quantity. Otherwise use the reported concentration data (including the defined zeros) and flow data for each sample day to determine the daily quantity and report the monthly average of the calculated daily quantities.

b. Weekly Average – Compliance with the weekly average limitations and/or reporting requirements for the parameters listed in Part I.B.2.a. of this permit condition shall be determined as follows: All concentration data below the QL used for the analysis (QL must be less than or equal to the QL listed in a. above) shall be treated as zero. All concentration data equal to or above the QL used for the analysis shall be treated as reported. An arithmetic average shall be calculated using all reported data, including the defined zeros, collected within each complete calendar week and entirely contained within the reporting month. The maximum value of the weekly averages thus determined shall be reported on the DMR. If all data are below the QL used for the analysis, then the weekly average shall be reported as "<QL". If reporting for quantity is required on the DMR and the reported weekly average concentration is <QL, then report "<QL" for the quantity. Otherwise use the reported concentration data (including the defined zeros) and flow data for each sample day to determine the daily quantity and report the maximum weekly average of the calculated daily quantities.

c. Single Datum - Any single datum required shall be reported as "<QL" if it is less than the QL used in the analysis (QL must be less than or equal to the QL listed in Part I.B.2.a above). Otherwise the numerical value shall be reported.

d. Significant Digits - The permittee shall report at least the same number of significant digits as the permit limit for a given parameter. Regardless of the rounding convention used by the permittee (i.e., 5 always rounding up or to the nearest even number), the permittee shall use the convention consistently, and shall ensure that consulting laboratories employed by the permittee use the same convention.

4. Nutrient Reporting Calculations for Part I. A.

a. For each calendar month, the DMR shall show the calendar year-to-date average concentration (mg/L) calculated in accordance with the following formulae:

$MC_{avg}\text{-}YTD = (\sum_{(\text{Jan-current month})} MC_{avg}) \div (\# \text{ of months})$

where:
MC_{avg}-YTD = calendar year-to-date average concentration (mg/L)
MC_{avg} = monthly average concentration (mg/L) as reported on DMR

b. The total nitrogen and phosphorus average concentrations (mg/L) for each calendar year (AC) shall be shown on the December DMR due January 10th of the following year. These values shall be calculated in accordance with the following formulae:

$AC_{avg} = (\sum_{(Jan\text{-}Dec)} MC_{avg}) \div 12$

where:
AC_{avg} = calendar year average concentration (mg/L)
MC_{avg} = monthly average concentration (mg/L) as reported on DMR

c. For Total Phosphorus, all daily concentration data below the quantification level (QL) for the analytical method used should be treated as half the QL. All daily concentration data equal to or above the QL for the analytical method used shall be treated as it is reported.

d. For Total Nitrogen (TN), if none of the daily concentration data for the respective species (i.e., TKN, Nitrates/Nitrites) are equal to or above the QL for the respective analytical methods used, the daily TN concentration value reported shall equal one half of the largest QL used for the respective species. If one of the data is equal to or above the QL, the daily TN concentration value shall be treated as that data point is reported. If more than one of the data is above the QL, the daily TN concentration value shall equal the sum of the data points as reported.

C. Pretreatment Requirements

1. The permittee's pretreatment program has been approved. The program is an enforceable part of this permit. The permittee shall:

a. Continue implementing a pretreatment program that complies with the Clean Water Act, Water Control Law, State regulations, approved program and subsequent approved program elements.

b. Within one year of the effective date of this permit, the permittee shall reevaluate the local limits using current influent, effluent and sludge monitoring data and submit the data and results of the evaluation to the DEQ Regional Office. All SIUs shall be sampled at the end of any categorical process and at the entrance to the treatment works.

c. Submit to the DEQ-NRO an annual report that describes the permittee's program activities over the previous year. The annual report shall be submitted no later than January 31st of each year and shall include:

1) An updated list of the SIUs, as defined in 9VAC25-31-10, noting all of the following:

a) Facility contact information (contact name, mailing address, email address, telephone number);

b) The Standard Industrial Classification (SIC) and North American Industry Classification System (NAIC) codes for all SIUs and categorical industrial users (CIUs);

c) Identification and explanation of any SIUs deleted from the previous year's list;

d) Identification of SIUs subject to Categorical Standards and the applicable standard(s);

e) Applicable sections of Title 40 of the Code of Federal Regulations (CFR);

f) SIUs subject to local limits that are more stringent than Categorical Pretreatment Standards;

g) SIUs subject only to local limits;

h) CIUs that are subject to reduced reporting requirements under 9VAC25-31-840.E.3.; and

i) SIUs that are nonsignificant CIUs.

2) A summary of the compliance status of each SIU with pretreatment standards and permit requirements.

3) A summary of the number and types of SIU sampling and inspections performed by the POTW.

4) All information concerning any interference, upset, VPDES permit or Water Quality Standards violations directly attributable to SIUs/IUs and enforcement actions taken to alleviate said events.

5) A description of all enforcement actions taken against SIUs over the previous twelve (12) months.

6) A summary of any changes to the submitted pretreatment program previously not reported to DEQ-NRO.

7) A summary of the permits issued to SIUs since the last annual report.

8) POTW and self-monitoring results for SIUs determined to be in significant noncompliance during the reporting period.

9) Results of the POTW's influent, effluent and sludge sampling not previously submitted to DEQ-NRO.

10) Copies of newspaper publications of all SIUs in significant noncompliance during the reporting period.

11) Signature of an authorized representative.

d. Submit any changes to the approved pretreatment program to DEQ-NRO and obtain approval before implementation of the changes.

e. Ensure all SIU permits are issued and reissued in a timely manner and that the SIU permits issued or reissued by the POTW are effective and enforceable.

f. Ensure all SIUs are inspected at least annually.

1) Sampling shall include all regulated parameters and shall be representative of the wastewater discharged.

2) Inspection of the SIUs shall cover all areas that could result in wastewater discharge to the treatment works. At a minimum, this would include: manufacturing areas; chemical storage areas; pretreatment facilities; spill prevention and control procedures; hazardous waste generation; and the SIU's self-monitoring procedure and records.

g. Implement the reporting requirements of Part VII of the VPDES Permit Regulation at 9VAC25-31-840.

h. Review the Legal Authority and Enforcement Response Plan (ERP) to ensure they meet state and federal regulatory requirements. The approved Legal Authority and ERP are enforceable parts of this permit and shall be implemented.

i. Ensure that adequate resources are available to implement the approved program.

j. Ensure that all public participation requirements are met. SIUs in significant noncompliance with pretreatment standards and/or requirements for the previous twelve (12) months shall be placed in public notice annually.

2. DEQ may require the POTW to institute changes to the legal authority regarding SIU permits:

   a. If the legal authority does not meet the requirements of the Clean Water Act, State Water Control Law or VPDES Regulations;

   b. If problems such as interferences, pass-through, violations of Water Quality Standards or sludge contamination develop or continue; and/or

   c. If federal, state or local requirements change.

3. Program Streamlining:

   a. The Control Authority may determine that an IU subject to categorical Pretreatment Standards under 9VAC25-31-780 and 40 CFR chapter I, subchapter N is a Non-Significant CIU rather than a SIU on a finding that the IU never discharges more than 100 gallons per day (gpd) of total categorical wastewater (excluding sanitary, non-contact cooling and boiler blowdown wastewater, unless specifically included in the Pretreatment Standard) and the following conditions are met:

      1) The IU, prior to Control Authority's finding, has consistently complied with all applicable categorical Pretreatment Standards and Requirements;

      2) The IU annually submits the certification statement required in 9VAC25-31-840 together with any additional information necessary to support the certification statement; and

      3) The IU never discharges any untreated concentrated wastewater.

   b. Upon finding that an IU, as discussed in 3.a. above, has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the control authority may at any time, on its own initiative or in response to a petition received from an industrial user or POTW, and in accordance with Part VII (9VAC25-31-730 et seq.) of this chapter, determine that such IU is not a SIU, as defined in 9VAC25-31-10.

D. Whole Effluent Toxicity Program Requirements

1. Biological Monitoring

   a. In accordance with the schedule in Part I.D.2. below, the permittee shall conduct annual chronic toxicity tests until the permit term expiration. The permittee shall collect 24-hour flow-proportioned composite samples of final effluent from Outfall 001.

      The chronic tests to use are:

      Chronic 3-Brood Static Renewal Survival and Reproduction Test using *Ceriodaphnia dubia*

      Chronic 7-Day Static Renewal Survival and Growth Test using *Pimephales promelas*

   These chronic tests shall be conducted in such a manner and at sufficient dilutions (minimum of five dilutions) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction or growth. Results which cannot be quantified (i.e., a "less than" NOEC value) are not acceptable and a retest will have to be performed. The NOEC as determined by hypothesis testing shall be converted to TU_c (Chronic Toxic Units) for DMR reporting where TU_c = 100/NOEC. Report the LC_{50} at 48 hours and the IC_{25} with the NOEC's in the test report.

b. The permittee may provide additional samples to address data variability. These data shall be reported. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40 CFR 136.3.

c. The test dilutions shall bracket and include the following endpoint:

A Chronic NOEC $\geq$ 69%; equivalent to a $TU_c \leq 1.44$

d. The test data will be evaluated statistically by DEQ staff to assess the reasonable potential for toxicity of the discharge to surface waters at the conclusion of the test period. The data may be evaluated sooner if requested by the permittee or if toxicity has been noted. Should DEQ determine that a limit is warranted; this permit may be modified, or alternatively revoked and reissued, to incorporate a WET limit and compliance schedule.

e. The permit may be modified or revoked and reissued to include pollutant specific limits in lieu of a WET limit should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limitation shall control the toxicity of the effluent.

f. The results of the test and the test report shall be reported with the DMR for the month following receipt of the testing results. In no case shall this exceed forty-five (45) days from the receipt of the test results.

2. Reporting Schedule

The permittee shall monitor during the specified period; shall report the results on the DMR; and shall supply one copy of the toxicity test report specified in this Whole Effluent Toxicity Program in accordance with the following schedule:

Period	Sampling Period
Annual 1	April 1, 2020 – June 30, 2020
Annual 2	January 1, 2021 – March 31, 2021
Annual 3	October 1, 2022 – December 31, 2022
Annual 4	July 1, 2023 – September 30, 2023

E. Other Requirements and Special Conditions

1. 95% Capacity Reopener

A written notice and a plan of action for ensuring continued compliance with the terms of this permit shall be submitted to the DEQ-Northern Regional Office (DEQ-NRO) when the monthly average flow influent to the sewage treatment plant reaches 95% of the design capacity authorized in this permit for each month of any three consecutive month period. The written notice shall be submitted within 30 days and the plan of action shall be received at the DEQ-NRO no later than 90 days from the third consecutive month for which the flow reached 95% of the design capacity. The plan shall include the necessary steps and a prompt schedule of implementation for controlling any current or reasonably anticipated problem resulting from high influent flows. Failure to submit an adequate plan in a timely manner shall be deemed a violation of this permit.

2. Indirect Dischargers

The permittee shall provide adequate notice to the Department of the following:

a. Any new introduction of pollutants into the treatment works from an indirect discharger which would be subject to Section 301 or 306 of Clean Water Act and the State Water Control Law if it were directly discharging those pollutants; and

b. Any substantial change in the volume or character of pollutants being introduced into the treatment works by a source introducing pollutants into the treatment works at the time of issuance of this permit.

Adequate notice shall include information on (i) the quality and quantity of effluent introduced into the treatment works, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the treatment works.

3. Operation and Maintenance (O&M) Manual Requirement
The permittee shall maintain a current Operations and Maintenance (O&M) Manual for the treatment works that is in accordance with Virginia Pollutant Discharge Elimination System Regulations, 9VAC25-31 and the Sewage Collection and Treatment Regulations, 9VAC25-790.

The O&M Manual and subsequent revisions shall include the manual effective date and meet Part II.K.2 and Part II.K.4 Signatory Requirements of the permit. Any changes in the practices and procedures followed by the permittee shall be documented in the O&M Manual within 90 days of the effective date of the changes. The permittee shall operate the treatment works in accordance with the O&M Manual and shall make the O&M manual available to Department personnel for review during facility inspections. Within 30 days of a request by DEQ, the current O&M Manual shall be submitted to the DEQ-NRO for review and approval.

The O&M Manual shall detail the practices and procedures which will be followed to ensure compliance with the requirements of this permit. This manual shall include, but not necessarily be limited to, the following items, as appropriate:

a. Permitted outfall locations and techniques to be employed in the collection, preservation, and analysis of effluent, storm water and sludge samples;
b. Procedures for measuring and recording the duration and volume of treated wastewater discharged;
c. Discussion of Best Management Practices, if applicable;
d. Procedures for handling, storing, and disposing of all wastes, fluids, and pollutants that will prevent these materials from reaching state waters. List type and quantity of wastes, fluids, and pollutants (e.g. chemicals) stored at this facility;
e. Discussion of treatment works design, treatment works operation, routine preventative maintenance of units within the treatment works, critical spare parts inventory and record keeping;
f. Plan for the management and/or disposal of waste solids and residues;
g. Hours of operation and staffing requirements for the plant to ensure effective operation of the treatment works and maintain permit compliance;
h. List of facility, local and state emergency contacts; and
i. Procedures for reporting and responding to any spills/overflows/ treatment works upsets.

4. CTC and CTO Requirement
The permittee shall, in accordance with the DEQ Sewage Collection and Treatment Regulation (9VAC25-790), obtain a Certificate to Construct (CTC), and a Certificate to Operate (CTO) from the Department. The request for a CTC or CTO shall be submitted by the design engineer and owner to the DEQ Regional Office prior to constructing the wastewater treatment works and operating the treatment works, respectively. Non-compliance with the CTC or CTO shall be deemed a violation of the permit.

5. Licensed Operator Requirement
The permittee shall employ or contract at least one Class I licensed wastewater works operator for this facility. The license shall be issued in accordance with Title 54.1 of the Code of Virginia and Board for Waterworks and Wastewater Works Operators and Onsite Sewage System Professionals Regulations. The permittee shall notify the Department in writing whenever he is not complying, or has grounds for anticipating he will not comply with this requirement. The notification shall include a statement of reasons and a prompt schedule for achieving compliance.

6. Reliability Class
The permitted treatment works shall meet Reliability Class I.

7. Water Quality Criteria Reopener
Should effluent monitoring indicate the need for any water quality-based limitations, this permit may be modified or alternatively revoked and reissued to incorporate appropriate limitations.

8. E3/E4
The annual average concentration limitations for Total Nitrogen and/or Total Phosphorus are suspended during any calendar year in which the facility is considered by DEQ to be a participant in the Virginia Environmental Excellence Program in good standing at either the Exemplary Environmental Enterprise (E3) level or the Extraordinary Environmental Enterprise (E4) level, provided that the following conditions have also been met:

   a. The facility has applied for (or renewed) participation, been accepted, maintained a record of sustained compliance and submitted an annual report according to the program guidelines;
   b. The facility has demonstrated that they have in place a fully implemented environmental management system (EMS) with an alternative compliance method that includes operation of installed nutrient removal technologies to achieve the annual average concentration limitations; and
   c. The E3/E4 designation from DEQ and implementation of the EMS has been in effect for the full calendar year.

   The annual average concentration limitations for Total Nitrogen and/or Total Phosphorus, as applicable, are not suspended in any calendar year following a year in which the facility failed to achieve the annual average concentration limitations as required by b. above.

9. Nutrient Reopener
This permit may be modified or, alternatively, revoked and reissued:

   a. If any approved wasteload allocation procedure, pursuant to Section 303(d) of the Clean Water Act, imposes wasteload allocations, limits or conditions on the facility that are not consistent with the permit requirements;

   b. To incorporate technology-based effluent concentration limitations for nutrients in conjunction with the installation of nutrient control technology, whether by new construction, expansion or upgrade, or

   c. To incorporate alternative nutrient limitations and/or monitoring requirements, should:
      i. the State Water Control Board adopt new nutrient standards for the water body receiving the discharge, including the Chesapeake Bay or its tributaries, or
      ii. a future water quality regulation or statute require new or alternative nutrient control.

10. Total Maximum Daily Load (TMDL) Reopener
This permit shall be modified or alternatively revoked and reissued if any approved wasteload allocation procedure, pursuant to Section 303(d) of the Clean Water Act, imposes wasteload allocations, limits or conditions on the facility that are not consistent with the permit requirements.

11. PCB Pollutant Minimization Plan

   The permittee has completed low-detection level, congener specific monitoring of the effluent for PCBs.

   a. Pollutant Minimization Plan (PMP)

The permittee shall submit to DEQ-NRO for review and approval a Pollutant Minimization Plan (PMP) designed to investigate the location and potential reduction of sources of PCBs in the collection system. The PMP shall be submitted within one (1) year of the effective date of the permit.

The PMP shall detail the practices and procedures which will be followed to investigate the location and potential reduction of sources of PCBs. This PMP shall include, but not necessarily be limited to, the following items, as appropriate:

i. Provide a facility contact for the contents of the PMP and any activities associated with the PMP;

ii. Provide a proposed implementation schedule for minimization activities and prospective milestones;

iii. Propose actions for known or probable sources;

iv. Propose actions to find and control unknown sources;

v. Summarize any previous minimization activities;

vi. Present methods for measuring, demonstrating, and reporting progress;

a) May include an evaluation of the total PCBs and/or PCB congener distribution in the initial source intake water to determine the net contributions of PCBs introduced to the treatment works.

b) May include raw influent testing using either grab or composite samples as well as sampling upstream in the collection system. Screening methods may be utilized to target specific areas of interest.

c) Alternative PCB test methods are acceptable provided analytical sensitivity is sufficient for detection and quantification.

d) May perform further monitoring of the final effluent to determine effectiveness of the reduction efforts and to reestablish a new baseline for PCBs in the final effluent.

vii. Estimate the PCB load reduction provided by treatment; and

viii. Provide information on continuing assessment of progress, which may include establishment of criteria to evaluate whether the location and potential reduction of PCB sources has been addressed, and whether a more routine follow-up awareness, education, and inspection approach is appropriate.

b. Pollutant Minimization Plan (PMP) Annual Report

An Annual Report shall be submitted to DEQ-NRO for review and approval by February 10th for the previous year's PMP activities.

- First Annual Report is due February 10, 2021;
- Second Annual Report is due February 10, 2022;
- Third Annual Report is due February 10, 2023;
- Fourth Annual Report is due February 10, 2024.

The Annual Report shall:

i. Summarize PMP Achievement for investigating the location and potential reduction of sources of PCBs in the collection system during the past calendar year;

ii. Address any revisions needed for the PMP for the coming year;

iii. Address material and process modifications, if applicable;

iv. Summarize measures taken to address known, probable and potential sources; and

v. Discuss incremental and cumulative changes from the baseline loading.

12. Bypass Point Sources
The permittee is not authorized to discharge from any location except Outfall 001 except as provided for in Part II.U of this permit and in accordance with the State Water Control Board's VPDES Permit Regulation.

In addition to the reporting requirements in Part II.I and Part II.U, for each external bypass occurrence, the permittee is required to report the date, the duration of bypass occurrence, and an estimation of the volume of wastewater discharged during the occurrence. Additionally, the permittee shall measure pH and the concentration of BOD, TSS, and TRC discharged from the bypass point. BOD and TSS shall be measured using flow-proportioned composite sampling; grab samples shall be used to measure pH and TRC. The standard operating procedures to be conducted by facility staff during an external bypass event shall be incorporated into the O&M Manual and shall become an enforceable part of the permit.

The permittee shall notify Alexandria Health Department, Arlington Health Department and DEQ of each external bypass event as soon as possible but in no case more than 24 hours after the initial discharge enters Four Mile Run. Written record of notification shall be submitted to DEQ-NRO within five days of each event.

13. Final Effluent Monitoring Alternative
The permittee may develop an effluent specific correlation between $cBOD_5$ and TOC/COD for final effluent compliance monitoring as specified below:

a. The permittee must submit to DEQ for review and approval a plan of study prior to the start of the study. At minimum, the study shall include the following information:
   1. The method of analysis for COD or TOC;
   2. QA/QC procedures for the method;
   3. Time frame for the study;
   4. The number of samples to be analyzed to establish the correlation;
   5. The statistical methods for determining the correlation; and
   6. The method of validating the established correlation.

b. Once the study is completed and a correlation is established, the data, QA/QC information, and correlation calculations are to be submitted to DEQ for review and approval. Upon DEQ's approval of the results, monitoring for COD or TOC will be once per day and sampling will be 24-hour composites. Monitoring for $cBOD_5$ shall be reduced to once per week for the remainder of the permit term. COD or TOC results shall be reported in accordance with Part II.C.

c. The permittee shall validate the established correlation monthly, as outlined in the plan of study, and submit the validation with the monthly DMR. A summary of the validation data shall also be submitted with the permit application at least 180 days prior to the expiration of the current permit. The method of validation in the plan of study shall be an enforceable part of the permit.

d. DEQ may require resumption of $cBOD_5$ daily monitoring should it determine that the correlation is no longer valid. The permittee may discontinue TOC/COD final effluent monitoring and return to $cBOD_5$ monitoring upon notifying DEQ in writing. TOC/COD daily monitoring will cease the first day of the month following the notification.

Part II. Conditions Applicable To All VPDES Permits

A. Monitoring

1. Samples and measurements required by this permit shall be taken at the permit designated or approved location and be representative of the monitored activity.
   a. Monitoring shall be conducted according to procedures approved under Title 40 Code of Federal Regulations Part 136 or alternative methods approved by the U.S. Environmental Protection Agency, unless other procedures have been specified in this permit.
   b. The permittee shall periodically calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals that will insure accuracy of measurements.
   c. Samples taken shall be analyzed in accordance with 1VAC30-45, Certification for Noncommercial Environmental Laboratories, or 1VAC30-46, Accreditation for Commercial Environmental Laboratories.

2. Any pollutant specifically addressed by this permit that is sampled or measured at the permit designated or approved location more frequently than required by this permit shall meet the requirements in A.1.a through c above and the results of this monitoring shall be included in the calculations and reporting required by this permit.

3. Operational or process control samples or measurements shall not be taken at the designated permit sampling or measurement locations. Operational or process control samples or measurements do not need to follow procedures approved under Title 40 Code of Federal Regulations Part 136 or be analyzed in accordance with 1VAC30-45, Certification for Noncommercial Environmental Laboratories, or 1VAC30-46, Accreditation for Commercial Environmental Laboratories.

B. Records

1. Records of monitoring information shall include:
   a. The date, exact place, and time of sampling or measurements;
   b. The individual(s) who performed the sampling or measurements;
   c. The date(s) and time(s) analyses were performed;
   d. The individual(s) who performed the analyses;
   e. The analytical techniques or methods used; and
   f. The results of such analyses.

2. Except for records of monitoring information required by this permit related to the permittee's sewage sludge use and disposal activities, which shall be retained for a period of at least five years, the permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period of retention shall be extended automatically during the course of any unresolved litigation regarding the regulated activity or regarding control standards applicable to the permittee, or as requested by the Board.

C. Reporting Monitoring Results

1. The permittee shall submit the results of the monitoring required by this permit not later than the 10th day of the month after monitoring takes place, unless another reporting schedule is specified elsewhere in this permit. Monitoring results shall be submitted to:

   Department of Environmental Quality - Northern Regional Office (DEQ-NRO)
   13901 Crown Court
   Woodbridge, VA 22193

2. Monitoring results shall be reported on a Discharge Monitoring Report (DMR) or on forms provided, approved or specified by the Department.

3. Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

D. Duty to Provide Information

The permittee shall furnish to the Department, within a reasonable time, any information which the Board may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Board may require the permittee to furnish, upon request, such plans, specifications, and other pertinent information as may be necessary to determine the effect of the wastes from this discharge on the quality of state waters, or such other information as may be necessary to accomplish the purposes of the State Water Control Law. The permittee shall also furnish to the Department upon request, copies of records required to be kept by this permit.

E. Compliance Schedule Reports

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.

F. Unauthorized Discharges

Except in compliance with this permit, or another permit issued by the Board, it shall be unlawful for any person to:

1. Discharge into state waters sewage, industrial wastes, other wastes, or any noxious or deleterious substances; or
2. Otherwise alter the physical, chemical or biological properties of such state waters and make them detrimental to the public health, or to animal or aquatic life, or to the use of such waters for domestic or industrial consumption, or for recreation, or for other uses.

G. Reports of Unauthorized Discharges

Any permittee who discharges or causes or allows a discharge of sewage, industrial waste, other wastes or any noxious or deleterious substance into or upon state waters in violation of Part II.F.; or who discharges or causes or allows a discharge that may reasonably be expected to enter state waters in violation of Part II.F., shall notify the Department of the discharge immediately upon discovery of the discharge, but in no case later than 24 hours after said discovery. A written report of the unauthorized discharge shall be submitted to the Department, within five days of discovery of the discharge. The written report shall contain:

1. A description of the nature and location of the discharge;
2. The cause of the discharge;
3. The date on which the discharge occurred;
4. The length of time that the discharge continued;
5. The volume of the discharge;
6. If the discharge is continuing, how long it is expected to continue;
7. If the discharge is continuing, what the expected total volume of the discharge will be; and
8. Any steps planned or taken to reduce, eliminate and prevent a recurrence of the present discharge or any future discharges not authorized by this permit.

Discharges reportable to the Department under the immediate reporting requirements of other regulations are exempted from this requirement.

H. Reports of Unusual or Extraordinary Discharges

If any unusual or extraordinary discharge including a bypass or upset should occur from a treatment works and the discharge enters or could be expected to enter state waters, the permittee shall promptly notify, in no case later than 24 hours, the Department by telephone after the discovery of the discharge. This notification shall provide all available details of the incident, including any adverse affects on aquatic life and the known number of fish killed. The permittee shall reduce the report to writing and shall submit it to the Department within five days of discovery of the discharge in accordance with Part II.I.2. Unusual and extraordinary discharges include but are not limited to any discharge resulting from:

1. Unusual spillage of materials resulting directly or indirectly from processing operations;
2. Breakdown of processing or accessory equipment;
3. Failure or taking out of service some or all of the treatment works; and
4. Flooding or other acts of nature.

I. Reports of Noncompliance

The permittee shall report any noncompliance which may adversely affect state waters or may endanger public health.

1. An oral report shall be provided within 24 hours from the time the permittee becomes aware of the circumstances. The following shall be included as information which shall be reported within 24 hours under this paragraph:
   a. Any unanticipated bypass; and
   b. Any upset which causes a discharge to surface waters.

2. A written report shall be submitted within 5 days and shall contain:
   a. A description of the noncompliance and its cause;
   b. The period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and
   c. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

   The Board may waive the written report on a case-by-case basis for reports of noncompliance under Part II.I. if the oral report has been received within 24 hours and no adverse impact on state waters has been reported.

3. The permittee shall report all instances of noncompliance not reported under Parts II, I.1.or I.2., in writing, at the time the next monitoring reports are submitted. The reports shall contain the information listed in Part II.I.2.

NOTE: The immediate (within 24 hours) reports required in Parts II, G., H. and I. may be made to the Department's Northern Regional Office at (703) 583-3800 (voice) or (703) 583-3821 (fax) or online at **http://www.deq.virginia.gov/Programs/PollutionResponsePreparedness/MakingaReport.aspx** . For reports outside normal working hours, leave a message and this shall fulfill the immediate reporting requirement. For emergencies, the Virginia Department of Emergency Services maintains a 24-hour telephone service at 1-800-468-8892.

J. Notice of Planned Changes

1. The permittee shall give notice to the Department as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

   a. The permittee plans alteration or addition to any building, structure, facility, or installation from which there is or may be a discharge of pollutants, the construction of which commenced:

      1) After promulgation of standards of performance under Section 306 of Clean Water Act which are applicable to such source; or
      2) After proposal of standards of performance in accordance with Section 306 of Clean Water Act which are applicable to such source, but only if the standards are promulgated in accordance with Section 306 within 120 days of their proposal;

   b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations nor to notification requirements specified elsewhere in this permit; or

   c. The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.

2. The permittee shall give advance notice to the Department of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

K. Signatory Requirements

1. Applications. All permit applications shall be signed as follows:

   a. For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:
      1) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or

      2) The manager of one or more manufacturing, production, or operating facilities, provided the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

b. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

c. For a municipality, state, federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a public agency includes:

1) The chief executive officer of the agency, or
2) A senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency.

2. Reports, etc. All reports required by permits, and other information requested by the Board shall be signed by a person described in Part II.K.1., or by a duly authorized representative of that person. A person is a duly authorized representative only if:

a. The authorization is made in writing by a person described in Part II.K.1.;

b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.); and

c. The written authorization is submitted to the Department.

3. Changes to authorization. If an authorization under Part II.K.2. is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Part II.K.2. shall be submitted to the Department prior to or together with any reports, or information to be signed by an authorized representative.

4. Certification. Any person signing a document under Parts II, K.1. or K.2. shall make the following certification:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

L. Duty to Comply

The permittee shall comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the State Water Control Law and the Clean Water Act, except that noncompliance with certain provisions of this permit may constitute a violation of the State Water Control Law but not the Clean Water Act. Permit noncompliance is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants and with standards for sewage sludge use or disposal established under Section 405(d) of the Clean Water Act within the time provided in the regulations that establish these standards or prohibitions or standards for sewage sludge use or disposal, even if this permit has not yet been modified to incorporate the requirement.

M. Duty to Reapply

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee shall apply for and obtain a new permit. All permittees with a currently effective permit shall submit a new application at least 180 days before the expiration date of the existing permit, unless permission for a later date has been granted by the Board. The Board shall not grant permission for applications to be submitted later than the expiration date of the existing permit.

N. Effect of a Permit

This permit does not convey any property rights in either real or personal property or any exclusive privileges, nor does it authorize any injury to private property or invasion of personal rights, or any infringement of federal, state or local law or regulations.

O. State Law

Nothing in this permit shall be construed to preclude the institution of any legal action under, or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any other state law or regulation or under authority preserved by Section 510 of the Clean Water Act. Except as provided in permit conditions on "bypassing" (Part II.U.), and "upset" (Part II.V.) nothing in this permit shall be construed to relieve the permittee from civil and criminal penalties for noncompliance.

P. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Sections 62.1-44.34:14 through 62.1-44.34:23 of the State Water Control Law.

Q. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes effective plant performance, adequate funding, adequate staffing, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by the permittee only when the operation is necessary to achieve compliance with the conditions of this permit.

R. Disposal of Solids or Sludges

Solids, sludges or other pollutants removed in the course of treatment or management of pollutants shall be disposed of in a manner so as to prevent any pollutant from such materials from entering state waters.

S. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

T. Need to Halt or Reduce Activity not a Defense

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

U. Bypass

1. "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of Parts II, U.2. and U.3.

2. Notice
   a. Anticipated bypass. If the permittee knows in advance of the need for a bypass, prior notice shall be submitted, if possible at least ten days before the date of the bypass.
   b. Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in Part II.I.

3. Prohibition of bypass.
   a. Bypass is prohibited, and the Board may take enforcement action against a permittee for bypass, unless:
      1) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
      2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
      3) The permittee submitted notices as required under Part II.U.2.

   b. The Board may approve an anticipated bypass, after considering its adverse effects, if the Board determines that it will meet the three conditions listed above in Part II.U.3.a.

V. Upset

1. An upset constitutes an affirmative defense to an action brought for noncompliance with technology based permit effluent limitations if the requirements of Part II.V.2. are met. A determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is not a final administrative action subject to judicial review.

2. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

   a. An upset occurred and that the permittee can identify the cause(s) of the upset;
   b. The permitted facility was at the time being properly operated;
   c. The permittee submitted notice of the upset as required in Part II.I.; and
   d. The permittee complied with any remedial measures required under Part II.S.

3. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

W. **Inspection and Entry**

The permittee shall allow the Director, or an authorized representative, upon presentation of credentials and other documents as may be required by law, to:

1. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
4. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act and the State Water Control Law, any substances or parameters at any location.

For purposes of this section, the time for inspection shall be deemed reasonable during regular business hours, and whenever the facility is discharging. Nothing contained herein shall make an inspection unreasonable during an emergency.

X. Permit Actions

Permits may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

Y. Transfer of Permits

1. Permits are not transferable to any person except after notice to the Department. Except as provided in Part II.Y.2., a permit may be transferred by the permittee to a new owner or operator only if the permit has been modified or revoked and reissued, or a minor modification made, to identify the new permittee and incorporate such other requirements as may be necessary under the State Water Control Law and the Clean Water Act.

2. As an alternative to transfers under Part II.Y.1., this permit may be automatically transferred to a new permittee if:
   a. The current permittee notifies the Department at least 30 days in advance of the proposed transfer of the title to the facility or property;
   b. The notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit responsibility, coverage, and liability between them; and
   c. The Board does not notify the existing permittee and the proposed new permittee of its intent to modify or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in Part II.Y.2.b.

Z. Severability

The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

Part III. Biosolids

A. Biosolids Limitations and Monitoring Requirements

During the period beginning with the permit's effective date and lasting until the permit expiration date, the permittee is authorized to manage Class B biosolids in accordance with 9VAC25-31-420 through 720 and 9VAC25-32-303 through 358, the limitations, conditions and requirements set forth in this permit and the approved Biosolids Management Plan.

All biosolids samples shall be collected and analyzed in accordance with Title 40 of the Code of Federal Regulations, Part 503 and 136, and the approved Biosolids Management Plan. Analyses shall be conducted by a VELAP accredited environmental laboratory. The permittee shall ensure that all biosolids generated under authority of this permit and provided to other persons, for the purpose of land application, blending or further treatment, are monitored in accordance with the monitoring requirements as specified below in Part III.A.1.

1. Class B Biosolids

The permittee shall ensure that all Class B Biosolids provided to a person for the purpose of land application or blending are monitored in accordance with the requirements as specified below.

a. Biosolids Annual Production Monitoring (SP1)
The permittee shall report the annual total amount of sludge produced (in dry metric tons) and annual amount of Class B biosolids (in dry metric tons) distributed for land application. Data shall be reported on the Discharge Monitoring Report (DMR) for discharge number SP1.

b. Biosolids Chemical Limitations and Monitoring Requirements (S01)
Pollutants in Class B biosolids that are generated and provided to a land applier under the authority of this permit shall be monitored and limited as specified below. Biosolids shall not be provided for land application if the concentration of any pollutant in the biosolids exceeds the ceiling limitation of that pollutant.

PARAMETERS	PC / CPLR LIMITATIONS	CEILING LIMITATIONS	MONITORING REQUIREMENTS	
	Monthly Average (mg/kg) (1)(2)	Concentration Maximum (mg/kg) (1)(2)	Frequency	Sample Type
Percent Solids (%)	NL	NA	1/2M	Composite
Arsenic, Sludge	41	75	1/2M	Composite
Cadmium, Sludge	39	85	1/2M	Composite
Copper, Sludge	1,500	4,300	1/2M	Composite
Lead, Sludge	300	840	1/2M	Composite
Mercury, Sludge	17	57	1/2M	Composite
Molybdenum, Sludge	NL	75	1/2M	Composite
Nickel, Sludge	420	420	1/2M	Composite
Selenium, Sludge	100	100	1/2M	Composite
Zinc, Sludge	2,800	7,500	1/2M	Composite

NA = Not applicable
NL = No limit, monitor and report
1/2M = Once every two months.
mg/kg = Milligrams per kilograms, dry weight

(1) All parameters are subject to pollutant concentrations (PC), cumulative pollutant loading rates (CPLR), and ceiling limits. PC biosolids contain the constituents identified above at concentrations below the monthly average specified herein. CPLR biosolids contain the constituents identified above at concentrations above the monthly average and each sample must be below the maximum concentration specified.
(2) All limits and criteria are expressed on a dry weight basis

c. Pathogen Reduction and Vector Attraction Reduction (VAR) Requirements

Class B - Biosolids generated and provided to a land applier under this permit shall be treated to meet no less than Class B Pathogen Reduction Alternative and one VAR Option 1 - 8 prior to delivery to a land application site. The biosolids shall be monitored and limited in accordance with the treatment options selected as identified in the table below.

TREATMENT OPTION		CLASS B PATHOGEN REDUCTION & VAR TREATMENT & STANDARDS	MONITORING REQUIREMENTS
PATHOGEN REDUCTION ALTERNATIVE	PROCESS TO SIGNIFICANTLY REDUCE PATHOGENS (PSRP) OPTION		
2	5	PSRP: Sufficient lime is added to the sewage sludge to raise the pH of the sewage sludge to 12 S.U. after two hours of contact (9VAC25-31-710.D.5).	(1)

VAR OPTION	VECTOR ATTRACTION REDUCTION TREATMENT STANDARD	MONITORING REQUIREMENTS
6	Sufficient alkali is added to the sewage sludge to raise the pH of the sewage sludge to 12 or higher, and without the addition of more alkali, maintain the pH at 12 S.U. for two hours and then at 11.5 S.U. or higher for an additional 22 hours. (9VAC25-31-720.B.6.))	(1)(2)

NA = Not applicable

(1) Process monitoring must be sufficient to demonstrate compliance with PSRP and VAR treatment requirements.

(2) If the selected VAR option 1- 8 is not met, the permittee shall provide notification to the land applier at the time the biosolids are delivered that the biosolids did not meet VAR at the WPCP and that the biosolids must be injected below the surface of the land (9VAC25-31-720.B.9) or incorporated into the soil within 6 hours after application (9VAC25-31-720.B.10). The Permittee shall obtain verification from the land applier that injection or incorporation occurred.

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B. Biosolids Management and Reporting Requirements

1. Only biosolids from a source that has been approved by the DEQ, as identified on the DEQ's *Sources of Biosolids, Industrial Sludges, WTP Residuals* list, and treated to meet metals limits in Parts III.A.1.b, pathogen reduction and VAR standards in Parts III.A.1.c, shall be given to any person for the purpose of land application.

2. Biosolids Monitoring Frequency and Reporting Requirements

   a. Monitoring Frequency
   The monitoring frequency is once every two months (1 / 2 Months). The monitoring frequency may be increased during this permit term if DEQ deems it necessary.

   After sewage sludge has been monitored for two years at the monitoring frequency specified in Part III.A.1, the required biosolids monitoring frequency shall be reduced to once a year provided the results of sludge monitoring for all limited pollutants is less than 75% of the monthly average concentration limitation listed in Part III.A.1 in each monitoring event. Should the pollutant concentration in a sludge monitoring event exceed 75% of the monthly average concentration limitation specified for any pollutant in Part III.A.1, the monitoring frequency of once every two months (1 / 2 Months) shall become effective and remain in effect until the permit's expiration date. No other effluent limitations or monitoring requirements are affected by this special condition

   b. Annual Report
   The permittee shall submit an Annual Report not later than February 19th of each year to the DEQ-Northern Regional Office. Each report is for the previous calendar year's activity. If no biosolids were generated and provided to a land applier under this permit during the reporting year, a report shall be submitted stating that no biosolids were generated or delivered during the year. The report shall include at minimum:
   1) Part III.A.1.a Sewage Sludge Annual Production Monitoring;
   2) Biosolids Monitoring Data:
      a) Part III.A.1.b Biosolids – Metals Limitations;
      b) Part III.A.1.c Biosolids - Pathogen Reduction and Vector Attraction Reduction (VAR) Requirements;
      c) Supporting documentation, including laboratory chain of custody forms and certificates of analyses, shall be submitted with the report;
      d) Monthly average shall be reported as the average of the results of all samples collected within a calendar month and analyzed using an approved method, in accordance with Part II.A.1-2. of this permit. For monitoring periods which include multiple months, if one sample is collected during the monitoring period, that result shall be reported as the monthly average. If samples are collected in multiple months during the monitoring period, a monthly average shall be calculated for each month in which samples were collected during the monitoring period and the highest monthly average reported. Individual results and calculations shall be submitted with the report; and
      e) The maximum concentration shall be reported as the highest single result from all samples collected and analyzed during a monitoring period.
   3) A summary of biosolids disposal contracts, if any, currently held with other generators, as well as any other biosolids or sludges currently being handled through subcontracts or other agreements. Include biosolids or sludges given to other generators, contractors or land filled, and biosolids or sludges accepted from other generators for treatment or land application;
   4) Identify other methods used to dispose of or use biosolids or sludge produced during the previous calendar year. Report the annual total amount of biosolids or sludge (in dry metric tons) disposed of or used by each method identified; and
   5) The annual report shall be certified and signed in accordance with Part II.K.

3. Record Keeping

The permittee is required to retain the following information for at least five years:

a. The concentrations of each pollutant in Parts III.A.1.b;
b. A description of how the pathogen reduction requirements in Parts III.A.1.c are met;
c. A description of how the vector attraction reduction requirements in Part III.A.1.c are met;
d. A description of how the management practices specified in the approved Biosolids Management Plan and this permit are met;
e. The reports required in Part II.B.2.;
f. The NANI's required in Part III.B.4; and
g. The following certification statement(s) as applicable:

"I certify, under penalty of law, that the information that will be used to determine compliance with the Class A pathogen requirements in 9VAC25-31-710 A, the Class B pathogen requirements in (insert, B 2, B 3, or B 4 when one of those requirements is met) and the vector attraction reduction requirements in (insert one of the vector attraction reduction requirements in 9VAC25-31-720 B 1 through B 8 when one of those requirements is met) was prepared under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate this information. I am aware that there are significant penalties for false certification including the possibility of fine and imprisonment."

4. Notice and Necessary Information (NANI)

A NANI shall be provided to any person to whom biosolids are provided for the purpose of further treatment, blending or land application. The NANI shall be provided at the time the biosolids are provided if available, but no later than 45 days after the last day of the month in which biosolids were provided. The NANI shall represent the most recent monitoring period.
The NANI shall include at minimum:

a. A statement that Class B pathogen requirements in 9VAC25-31-710.A - B were met and the alternative used;
b. A statement that one of the VAR requirements in 9VAC25-31-720.B.1 through B.8 was met and the alternative used; or
c. A statement that one of the VAR requirements in 9VAC25-31-720.B.1 through B.8 was not met and incorporation or injection was required;
d. The notice(s) provided to the land applier when biosolids provided did not meet VAR and required incorporation or injection;
e. The concentration of total nitrogen (as N on a dry weight basis) of the biosolids; and
f. The following certification statement:

"I certify, under penalty of law, that the information that will be used to determine compliance with the Class B pathogen requirements in 9VAC25-31-710.B or Class A pathogen requirements in 9VAC25-31-710.A and the VAR requirement in (insert one of the VAR requirements in 9VAC25-31-720.B.1 through B.8, if one of those requirements is met) was prepared under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate this information. I am aware that there are significant penalties for false certification, including the possibility of fine and imprisonment".

5. Biosolids Management Plan (BSMP)

a. The permittee shall conduct all biosolids/sewage sludge use or disposal activities in accordance with the Biosolids Management Plan approved with the reissuance of this permit. The permittee shall maintain the BSMP which consists of the following components:

(1) The materials developed and submitted at the time of permit application or permit modification in accordance with 9VAC25-31-100.Q;
(2) The Operations and Maintenance (O&M) Manual (Sections regarding solids handling and biosolids production and management, etc); and
(3) The Odor Control Plan.

b. Odor Control Plan (OCP) Requirement – If an OCP is not on file at DEQ, an OCP shall be submitted to DEQ within 90 days of the effective date of this permit. The OCP shall include at a minimum:
(1) Methods used to minimize odor in producing biosolids;
(2) Methods used to identify malodorous biosolids before delivery to the land applier (at the generating facility);
(3) Methods used to identify and abate malodorous biosolids if delivered to the field, prior to land application; and
(4) Methods used to abate malodor from biosolids if land applied.

c. The BSMP and all of its components are an enforceable part of the permit.

d. Any proposed changes in the biosolids/sewage sludge use or disposal practices or procedures followed by the permittee shall be documented and submitted for DEQ-Northern Regional Office (DEQ-NRO) approval 90 days prior to the effective date of the changes. Upon approval, the revised Biosolids Management Plan becomes an enforceable part of the permit. The permit may be modified or alternatively revoked and reissued to incorporate limitations or conditions necessitated by substantive changes in biosolids/sewage sludge use or disposal practices.

6. Biosolids/Sewage Sludge Reopener

The Board may promptly modify or revoke and reissue this permit if any applicable standard for biosolids/sewage sludge use or disposal promulgated under Section 405(d) of the Clean Water Act is more stringent than any requirements for biosolids/sludge use or disposal in this permit, or controls a pollutant or practice not limited in this permit.

7. Biosolids Use and Disposal

The permittee shall conduct all biosolids use or disposal activities in accordance with the Biosolids Management Plan approved with the issuance of this permit. Any proposed changes in the biosolids use or disposal practices or procedures followed by the permittee shall be documented and submitted for DEQ-Northern Regional Office (DEQ-NRO) approval 90 days prior to the effective date of the changes. Upon approval, the revised Biosolids Management Plan becomes an enforceable part of the permit. The permit may be modified or alternatively revoked and reissued to incorporate limitations or conditions necessitated by substantive changes in biosolids use or disposal practices.

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
NORTHERN REGIONAL OFFICE
13901 Crown Court, Woodbridge, Virginia 22193
(703) 583-3800
www.deq.virginia.gov

Matthew J. Strickler
Secretary of Natural Resources

David K. Paylor
Director

Thomas A. Faha
Regional Director

September 9, 2019

Via Email: wrdodge@arlingtonva.us

Mr. Wilson Dodge
Pretreatment Coordinator
Arlington County Water Pollution Control Plant
3402 Glebe Road
Arlington, VA 22202

READ RECEIPT REQUESTED

RE: Coverage under the Virginia Pollutant Discharge Elimination System (VPDES) General Permit Regulation for Discharges of Stormwater Associated with Industrial Activity – Registration # **VAR051421**

Dear Mr. Dodge:

We have reviewed your Registration Statement received on April 29, 2019, and have determined that stormwater discharges from the above facility are hereby covered under the referenced VPDES general permit. The general permit regulation was effective as of July 1, 2019, and your coverage under this permit is effective as of the date of this transmittal letter. The enclosed copy of the general permit contains the applicable stormwater pollution prevention plan (SWPPP) requirements, sector specific requirements, monitoring requirements, and other conditions of coverage. The general permit requires that you update your Stormwater Pollution Prevention Plan (SWPPP) within 90-days of the date on this transmittal letter to incorporate updates this permit requires into the SWPPP.

Based on the Standard Industrial Classification Code (SIC Code) provided on your registration statement, your facility has been assigned to Sector AE for this reissuance. Sector AE requires no analytical benchmark monitoring.

Your facility monitored stormwater discharges during the 2014 industrial stormwater general permit term in support of the Chesapeake Bay TMDL. Our records indicate that your facility completed the four sampling events as required for each of the following parameters: Total Suspended Solids (TSS), Total Nitrogen (TN), and Total Phosphorus (TP). In accordance with the 2019 permit (Part I.B.8.c.2), your facility is again required to calculate stormwater nutrient loads. Calculations are to be completed using the data collected during the 2014 permit term and those acreages provided on the registration statement for the 2019 permit term. Information to assist with performing the calculations, including a Chesapeake Bay TMDL Calculation Spreadsheet is available at the following:
https://www.deq.virginia.gov/Programs/Water/PermittingCompliance/PollutionDischargeElimination/PermitsFees.aspx#isw

If the calculations indicate the facility loading rate for any of the parameters (e.g. TSS, TN, or TP) is above the loading rates identified in the permit (Part I.B.8.c.1), a Chesapeake Bay TMDL action plan shall be developed and submitted to the DEQ – Northern Regional Office. The Chesapeake Bay TMDL Action Plan Form for submitting your Plan may be found at the same link noted above.

The calculations, and Chesapeake Bay TMDL action plan (Plan) if required, shall be submitted to the DEQ – Northern Regional office within 60 days of the date on this transmittal letter (November 9, 2019) and copies shall also be maintained with the facility's SWPPP. Please note that facilities that submitted a Plan that was approved during the 2014 permit term shall continue to implement the approved Plan during this permit term. There is no requirement to resubmit the Plan on the form provided by the Department. However, you are required to provide updated loading calculations for TSS, TN and TP as described above.

This general permit will expire on June 30, 2024. The permit requires that you submit a new registration statement at least 60 days prior to that date if you wish continued coverage under the general permit, unless permission for a later date has been granted by the Board. Permission cannot be granted to submit the registration statement after the expiration date of the permit.

Should you have any questions, please do not hesitate to contact Susan Mackert at (703) 583-3853 or susan.mackert@deq.virginia.gov.

Respectfully,

Bryant Thomas
Regional Water Permits & Planning Manager

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

General Permit Registration No.: VAR051421
Effective Date: July 1, 2019
Expiration Date: June 30, 2024

VPDES GENERAL PERMIT FOR STORMWATER DISCHARGES
ASSOCIATED WITH INDUSTRIAL ACTIVITY

AUTHORIZATION TO DISCHARGE UNDER THE VIRGINIA POLLUTANT DISCHARGE
ELIMINATION SYSTEM AND THE VIRGINIA STATE WATER CONTROL LAW

In compliance with the provisions of the Clean Water Act, as amended, and pursuant to the State Water Control Law and regulations adopted pursuant thereto, owners of facilities with stormwater discharges associated with industrial activity are authorized to discharge to surface waters within the boundaries of the Commonwealth of Virginia, except those waters specifically named in board regulation that prohibit such discharges.

The authorized discharge shall be in accordance with this cover page, the registration statement, Part I-Effluent Limitations, Monitoring Requirements and Special Conditions, Part II-Conditions Applicable to All VPDES Permits, Part III-Stormwater Pollution Prevention Plan, and Part IV-Sector-Specific Permit Requirements, as set forth in this general permit.

Part I. Effluent Limitations, Monitoring Requirements and Special Conditions

A. Effluent limitations and monitoring requirements.

There are four individual and separate categories of monitoring requirements that a facility may be subject to under this permit: (i) quarterly visual monitoring; (ii) benchmark monitoring of discharges associated with specific industrial activities; (iii) compliance monitoring for discharges subject to numerical effluent limitations; and (iv) monitoring of discharges to impaired waters, both those with an approved TMDL and those without an approved TMDL. The monitoring requirements and numeric effluent limitations applicable to a facility depend on the types of industrial activities generating stormwater runoff from the facility, and for TMDL monitoring, the location of the facility's discharge or discharges. Part IV of the permit (9VAC25-151-90 et seq.) identifies monitoring requirements applicable to specific sectors of industrial activity. The permittee shall review Part I A 1 and Part IV of the permit to determine which monitoring requirements and numeric limitations apply to his facility. Unless otherwise specified, limitations and monitoring requirements under Part I A 1 and Part IV are additive.

Sector-specific monitoring requirements and limitations are applied discharge by discharge at facilities with colocated activities. Where stormwater from the colocated activities are commingled, the monitoring requirements and limitations are additive. Where more than one numeric limitation for a specific parameter applies to a discharge, compliance with the more restrictive limitation is required. Where benchmark, numerical effluent limitations, or TMDL monitoring requirements for a monitoring period overlap, the permittee may use a single sample to satisfy monitoring requirements.

1. Types of monitoring requirements and limitations.
   a. Quarterly visual monitoring. The requirements and procedures for quarterly visual monitoring are applicable to all facilities covered under this permit, regardless of the facility's sector of industrial activity.
      (1) The permittee shall perform and document a quarterly visual examination of a stormwater discharge associated with industrial activity from each outfall, except discharges exempted in Part I A 3 or Part I A 4. The examinations shall be made at least once in each of the following three-month periods: January through March, April through June, July through September, and October through December. The visual examination shall be made during normal working hours, where practicable, and when considerations for safety and feasibility allow. If no storm event resulted in runoff from the facility during a monitoring quarter, the permittee is excused from visual monitoring for that quarter provided that documentation is included with the monitoring records indicating that no runoff occurred. The documentation shall be signed and certified in accordance with Part II K of this permit.
      (2) Samples shall be collected in accordance with Part I A 2. Sample examination shall document observations of color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of stormwater pollution. The visual examination of the sample shall be conducted in a well-lit area. No analytical tests are required to be performed on the samples.
      (3) The visual examination reports shall be maintained on-site with the SWPPP. The report shall include the outfall location, the examination date and time, examination personnel, the nature of the discharge (i.e., runoff or snow melt), visual quality of the stormwater discharge (including observations of color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of stormwater pollution), and probable sources of any observed stormwater contamination.

b. Benchmark monitoring of discharges associated with specific industrial activities.

Table 70-1 identifies the specific industrial sectors subject to the benchmark monitoring requirements of this permit and the industry-specific pollutants of concern. The permittee shall refer to the tables found in the individual sectors in Part IV (9VAC25-151-90 et seq.) for benchmark monitoring concentration values. Colocated industrial activities at the facility that are described in more than one sector in Part IV shall comply with all applicable benchmark monitoring requirements from each sector.

The results of benchmark monitoring are primarily for the permittee to use to determine the overall effectiveness of the SWPPP in controlling the discharge of pollutants to receiving waters. Benchmark concentration values, included in Part IV of this permit, are not effluent limitations. Exceedance of a benchmark concentration does not constitute a violation of this permit and does not indicate that violation of a water quality standard has occurred; however, it does signal that modifications to the SWPPP are necessary, unless justification is provided in a routine facility inspection. In addition, exceedance of benchmark concentrations may identify facilities that would be more appropriately covered under an individual, or alternative general permit where more specific pollution prevention controls could be required.

TABLE 70-1
INDUSTRIAL SECTORS SUBJECT TO BENCHMARK MONITORING

Industry Sector[1]	SIC Code or Activity Code	Benchmark Monitoring Parameters
AE	2611, 2621, 2652-2657, 2671-2679, 2833-2836, 2851, 2861-2869, 2891-2899, 3952, 3211, 3221, 3229, 3231, 3241, 3281, 3291-3299, 3331-3339, 3398, 3399, 3341, 1311, 1321, 1381-1389, 2911, 4512-4581, (TW) Treatment Works, 2011-2015, 2032-2038, 2051-2053, 2061-2068, 2082-2087, 2091-2099, 2111-2141, 2211-2299, 2311-2399, 3131-3199, 2434, 2511-2599, 2711-2796, 3081-3089, 3931, 3942-3949, 3951-3955 (except 3952), 3961, 3965, 3991-3999, 3111, 3711-3799 (except 3731, 3732 see Sector Q), 3571-3579, 3612-3699, 3812-3873	Facilities in Sector AE are not subject to benchmark monitoring requirements.

[1] Table does not include parameters for compliance monitoring under effluent limitations guidelines.

(1) Benchmark monitoring shall be performed for all benchmark parameters specified for the industrial sector or sectors applicable to a facility's discharge. Monitoring shall be performed at least once during each of the first four, and potentially all, monitoring periods after coverage under the permit begins. Monitoring commences with the first full monitoring period after the owner is granted coverage under the permit. Monitoring periods are specified in Part I A 2.

Depending on the results of four consecutive monitoring periods, benchmark monitoring may not be required to be conducted in subsequent monitoring periods (see Part I A 1 b (2)).

(2) Benchmark monitoring waivers for facilities testing below benchmark concentration values. Waivers from benchmark monitoring are available to facilities whose discharges are below benchmark concentration values on an outfall by outfall basis. Sector-specific benchmark monitoring is not required to be conducted in subsequent monitoring periods during the term of this permit provided:

(a) Samples were collected in four consecutive monitoring periods, and the average of the four samples for all parameters at the outfall is below the applicable benchmark concentration value in Part IV. Facilities that were covered under the 2014 industrial stormwater general permit may use sampling data from the last two monitoring periods of that permit and the first two monitoring periods of this permit to satisfy the four consecutive monitoring periods requirement;

(b) The facility is not subject to a numeric effluent limitation established in Part I A 1 c (1) (stormwater effluent limitations), Part I A 1 c (2) (coal pile runoff), or Part IV (Sector Specific Permit Requirements) for any of the parameters at that outfall; and

(c) A waiver request is submitted to and approved by the board. The waiver request shall be sent to the appropriate DEQ regional office, along with the supporting monitoring data for four consecutive monitoring periods, and a certification that, based on current potential pollutant sources and control measures used, discharges from the facility are reasonably expected to be essentially the same (or cleaner) compared to when the benchmark monitoring for the four consecutive monitoring periods was done.

Waiver requests will be evaluated by the board based upon (i) benchmark monitoring results below the benchmark concentration values; (ii) a favorable compliance history (including inspection results); and (iii) no outstanding enforcement actions.

The monitoring waiver may be revoked by the board for cause. The permittee will be notified in writing that the monitoring waiver is revoked, and that the benchmark monitoring requirements are again in force and will remain in effect until the permit's expiration date.

(3) Samples shall be collected and analyzed in accordance with Part I A 2. Monitoring results shall be reported in accordance with Part I A 5 and Part II C and retained in accordance with Part II B.

c. Compliance monitoring for discharges subject to numerical effluent limitations or discharges to impaired waters.

(1) Facilities subject to stormwater effluent limitation guidelines.

(a) Facilities subject to stormwater effluent limitation guidelines (see Table 70-2) are required to monitor such discharges to evaluate compliance with numerical effluent limitations. Industry-specific numerical limitations and compliance monitoring requirements are described in Part IV of the permit (9VAC25-151-90 et seq.). Permittees with colocated industrial activities at the facility that are described in more than one sector in Part IV shall comply on a discharge-by-discharge basis with all applicable effluent limitations from each sector.

(b) Permittees shall monitor the discharges for the presence of the pollutant subject to the effluent limitation at least once during each of the monitoring periods after coverage under the permit begins. Monitoring commences with the first full monitoring period after the owner is granted coverage under the permit. Monitoring periods are specified in Part I A 2. The substantially identical outfall monitoring provisions (Part I A 2 f) are not available for numeric effluent limits monitoring.

(c) Samples shall be collected and analyzed in accordance with Part I A 2. Monitoring results shall be reported in accordance with Part I A 5 and Part II C, and retained in accordance with Part II B.

TABLE 70-2 STORMWATER-SPECIFIC EFFLUENT LIMITATION GUIDELINES
Effluent Limitation Guidelines Are Not Applicable to Sector AE

(2) Facilities subject to coal pile runoff monitoring.

(a) Facilities with discharges of stormwater from coal storage piles shall comply with the limitations and monitoring requirements of Table 70-3 for all discharges containing the coal pile runoff, regardless of the facility's sector of industrial activity.

(b) Permittees shall monitor such stormwater discharges at least once during each of the monitoring periods after coverage under the permit begins. Monitoring commences with the first full monitoring period after the owner is granted coverage under the permit. Monitoring periods are specified in Part I A 2. The substantially identical outfall monitoring provisions (Part I A 2 f) are not available for coal pile numeric effluent limits monitoring.

(c) The coal pile runoff shall not be diluted with other stormwater or other flows in order to meet this limitation.

(d) If a facility is designed, constructed and operated to treat the volume of coal pile runoff that is associated with a 10-year, 24-hour rainfall event, any untreated overflow of coal pile runoff from the treatment unit is not subject to the 50 mg/L limitation for total suspended solids.

(e) Samples shall be collected and analyzed in accordance with Part I A 2. Monitoring results shall be reported in accordance with Part I A 5 and Part II C, and retained in accordance with Part II B.

TABLE 70-3 NUMERIC LIMITATIONS FOR COAL PILE RUNOFF			
Parameter	Limit	Monitoring Frequency	Sample Type
Total Suspended Solids (TSS)	50 mg/l, max.	1/6 months	Grab
pH	6.0 min. - 9.0 max.	1/6 months	Grab

(3) Facilities discharging to an impaired water with an approved TMDL wasteload allocation. Owners of facilities that are a source of the specified pollutant of concern to waters for which a TMDL wasteload allocation has been approved prior to the term of this permit will be notified as such by the department when they are approved for coverage under the general permit.

(a) Upon written notification from the department, facilities subject to TMDL wasteload allocations shall be required to monitor such discharges to evaluate compliance with the TMDL requirements.

(b) Permittees shall monitor the discharges for the pollutant subject to the TMDL wasteload allocation once every six months after coverage under the permit begins, unless otherwise determined by the department for polychlorinated biphenyls (PCBs). Monitoring commences with the first full monitoring period after the owner is granted coverage under the permit. Monitoring periods are specified in Part I A 2.
(c) Samples shall be collected and analyzed in accordance with Part I A 2. Monitoring results shall be reported in accordance with Part I A 5 and Part II C, and retained in accordance with Part II B.
(d) If the pollutant subject to the TMDL wasteload allocation is below the quantitation level in all of the samples from the first four monitoring periods (i.e., the first two years of coverage under the permit), the permittee may request to the board in writing that further sampling be discontinued, unless the TMDL has specific instructions to the contrary (in which case those instructions shall be followed). The laboratory certificate of analysis shall be submitted with the request. If approved, documentation of this shall be kept with the SWPPP.

If the pollutant subject to the TMDL wasteload allocation is above the quantitation level in any of the samples from the first four monitoring periods, the permittee shall continue the scheduled TMDL monitoring throughout the term of the permit.

(4) Facilities discharging to an impaired water without an approved TMDL wasteload allocation.
Owners of facilities that discharge to waters listed as impaired in the 2016 Final 305(b)/303(d) Water Quality Assessment Integrated Report, and for which a TMDL wasteload allocation has not been approved prior to the term of this permit, will be notified as such by the department when they are approved for coverage under the general permit.
(a) Upon written notification from the department, facilities discharging to an impaired water without an approved TMDL wasteload allocation shall be required to monitor such discharges for the pollutants that caused the impairment.
(b) Permittees shall monitor the discharges for all pollutants for which the waterbody is impaired, and for which a standard analytical method exists, at least once during each of the monitoring periods after coverage under the permit begins. Monitoring commences with the first full monitoring period after the owner is granted coverage under the permit. Monitoring periods are specified in Part I A 2.
(c) If the pollutant for which the waterbody is impaired is suspended solids, turbidity, or sediment, or sedimentation, monitor for total suspended solids (TSS). If the pollutant for which the waterbody is impaired is expressed in the form of an indicator or surrogate pollutant, monitor for that indicator or surrogate pollutant. No monitoring is required when a waterbody's biological communities are impaired but no pollutant, including indicator or surrogate pollutants, is specified as causing the impairment, or when a waterbody's impairment is related to hydrologic modifications, impaired hydrology, or temperature.

Samples shall be collected and analyzed in accordance with Part I A 2. Monitoring results shall be reported in accordance with Part I A 5 and Part II C, and retained in accordance with Part II B.

(d) If the pollutant for which the water is impaired is below the quantitation level in the discharges from the facility, or it is above the quantitation level but its presence is caused solely by natural background sources, the permittee may request to the board in writing that further impaired water monitoring be discontinued. The laboratory certificate of analysis shall be submitted with the request. If approved, documentation of this shall be kept with the SWPPP.

To support a determination that the pollutant's presence is caused solely by natural background sources, the following documentation shall be submitted with the request and kept with the SWPPP: (i) an explanation of why it is believed that the presence of the impairment pollutant in the facility's discharge is not related to the activities at the facility; and (ii) data or studies that tie the presence of the impairment pollutant in the facility's discharge to natural background sources in the watershed. Natural background pollutants include those substances that are naturally occurring in soils or groundwater. Natural background pollutants do not include legacy pollutants from earlier activity at the facility's site, or pollutants in run-on from neighboring sources that are not naturally occurring.

2. Monitoring instructions.
   a. Collection and analysis of samples. Sampling requirements shall be assessed on an outfall by outfall basis. Samples shall be collected and analyzed in accordance with the requirements of Part II A.
   b. When and how to sample. A minimum of one grab sample shall be taken from the discharge associated with industrial activity resulting from a storm event that results in a discharge from the site (defined as a "measurable storm event"), providing the interval from the preceding measurable storm event is at least 72 hours. The 72-hour storm interval is waived if the permittee is able to document that less than a 72-hour interval is representative for local storm events during the sampling period. In the case of snowmelt, the monitoring shall be performed at a time when a measurable discharge occurs at the site. For discharges from a stormwater management structure, the monitoring shall be performed at a time when a measurable discharge occurs from the structure.

      The grab sample shall be taken during the first 30 minutes of the discharge. If it is not practicable to take the sample during the first 30 minutes, the sample may be taken during the first three hours of the discharge, provided that the permittee explains why a grab sample during the first 30 minutes was impracticable. This information shall be submitted in the department's electronic discharge monitoring report (e-DMR) system, and maintained with the SWPPP. If the sampled discharge commingles with process or nonprocess water, the permittee shall attempt to sample the stormwater discharge before it mixes with the nonstormwater.

   c. Storm event data. For each monitoring event (except snowmelt monitoring), along with the monitoring results, the permittee shall identify the date and duration (in hours) of the storm events sampled; rainfall total (in inches) of the storm event that generated the sampled runoff; and the duration between the storm event sampled and the end of the previous measurable storm event. For snowmelt monitoring, the permittee shall identify the date of the sampling event.
   d. Monitoring periods.
      (1) Quarterly visual monitoring. The quarterly visual examinations shall be made at least once in each of the following three-month periods each year of permit coverage: January through March, April through June, July through September, and October through December.
      (2) Benchmark monitoring, effluent limitation monitoring, and impaired waters monitoring (for waters both with and without an approved TMDL). Monitoring shall be conducted at least once in each of the following semiannual periods each year of permit coverage: January through June, and July through December.
   e. Documentation explaining a facility's inability to obtain a sample (including dates and times the outfalls were viewed or sampling was attempted), of no rain event, or of deviation from the "measurable" storm event requirements shall be maintained with the SWPPP. Acceptable documentation includes National Climatic Data Center (NCDC) weather station data, local weather station data, facility rainfall logs, and other appropriate supporting data.

f. Representative outfalls - substantially identical discharges. If the facility has two or more outfalls that discharge substantially identical effluents, based on similarities of the industrial activities, significant materials, size of drainage areas, and stormwater management practices occurring within the drainage areas of the outfalls, frequency of discharges, and stormwater management practices occurring within the drainage areas of the outfalls, the permittee may conduct monitoring on the effluent of just one of the outfalls and report that the observations also apply to the substantially identical outfall or outfalls. The substantially identical outfall monitoring provisions apply to quarterly visual monitoring, benchmark monitoring, and impaired waters monitoring (both those with and without an approved TMDL). The substantially identical outfall monitoring provisions are not available for numeric effluent limits monitoring.

The permittee shall include the following information in the SWPPP:
(1) The locations of the outfalls;
(2) An evaluation, including available monitoring data, indicating the outfalls are expected to discharge substantially identical effluents, including evaluation of monitoring data where available; and
(3) An estimate of the size of each outfall's drainage area in acres.

3. Adverse climatic conditions waiver. When adverse weather conditions prevent the collection of samples, a substitute sample may be taken during a qualifying storm event in the next monitoring period. Adverse weather conditions are those that are dangerous or create inaccessibility for personnel, and may include such things as local flooding, high winds, electrical storms, or situations that otherwise make sampling impracticable, such as drought or extended frozen conditions. Unless specifically stated otherwise, this waiver may be applied to any monitoring required under this permit. Narrative documentation of conditions necessitating the use of the waiver shall be kept with the SWPPP.

4. Inactive and unstaffed sites (including temporarily inactive sites).
   a. A waiver of the quarterly visual monitoring, routine facility inspections, and monitoring requirements (including benchmark, effluent limitation, and impaired waters monitoring) may be granted by the board at a facility that is both inactive and unstaffed, as long as the facility remains inactive and unstaffed and there are no industrial materials or activities exposed to stormwater. The owner of such a facility is only required to conduct an annual routine site inspection in accordance with the requirements in Part III B 5.
   b. An inactive and unstaffed sites waiver request shall be submitted to the board for approval and shall include the name of the facility; the facility's VPDES general permit registration number; a contact person, phone number and email address; the reason for the request; and the date the facility became or will become inactive and unstaffed. The waiver request shall be signed and certified in accordance with Part II K. If this waiver is granted, a copy of the request and the board's written approval of the waiver shall be maintained with the SWPPP.
   c. If circumstances change and industrial materials or activities become exposed to stormwater, or the facility becomes either active or staffed, the permittee shall notify the department within 30 days, and all quarterly visual monitoring, routine facility inspections, and monitoring requirements shall be resumed immediately.
   d. The board retains the right to revoke this waiver when it is determined that the discharge is causing, has a reasonable potential to cause, or contributes to a water quality standards violation.
   e. Inactive and unstaffed facilities covered under Sector G (Metal Mining) and Sector H (Coal Mines and Coal Mining-Related Facilities) are not required to meet the "no industrial materials or activities exposed to stormwater" standard to be eligible for this waiver, consistent with the conditional exemption requirements established in Part IV Sector G and Part IV Sector H.

5. Reporting monitoring results.
   a. Reporting to the department. The permittee shall follow the reporting requirements and deadlines below for the types of monitoring that apply to the facility:

TABLE 70-4 MONITORING REPORTING REQUIREMENTS	
Quarterly Visual Monitoring	Retain results with SWPPP - do not submit unless requested to do so by the department.

   Permittees shall submit results for each outfall associated with industrial activity according to the requirements of Part II C.
   b. Significant digits. The permittee shall report at least the same number of significant digits as a numeric effluent limitation or TMDL wasteload allocation for a given parameter; otherwise, at least two significant digits shall be reported for a given parameter. Regardless of the rounding convention used by the permittee (i.e., five always rounding up or to the nearest even number), the permittee shall use the convention consistently and shall ensure that consulting laboratories employed by the permittee use the same convention.

6. Corrective actions.
   a. Data exceeding benchmark concentration values.
      (1) If the benchmark monitoring result exceeds the benchmark concentration value for that parameter, the permittee shall review the SWPPP and modify it as necessary to address any deficiencies that caused the exceedance. Revisions to the SWPPP shall be completed within 60 days after an exceedance is discovered. When control measures need to be modified or added (distinct from regular preventive maintenance of existing control measures described in Part III C), implementation shall be completed before the next anticipated storm event if possible, but no later than 60 days after the exceedance is discovered, or as otherwise provided or approved by the department. In cases where construction is necessary to implement control measures, the permittee shall include a schedule in the SWPPP that provides for the completion of the control measures as expeditiously as practicable, but no later than three years after the exceedance is discovered. Where a construction compliance schedule is included in the SWPPP, the SWPPP shall include appropriate nonstructural and temporary controls to be implemented in the affected portions of the facility prior to completion of the permanent control measure. Any control measure modifications shall be documented and dated, and retained with the SWPPP, along with the amount of time taken to modify the applicable control measures or implement additional control measures.
      (2) Natural background pollutant levels. If the concentration of a pollutant exceeds a benchmark concentration value, and the permittee determines that exceedance of the benchmark is attributable solely to the presence of that pollutant in the natural background, corrective action is not required provided that:
         (a) The concentration of the benchmark monitoring result is less than or equal to the concentration of that pollutant in the natural background;
         (b) The permittee documents and maintains with the SWPPP the supporting rationale for concluding that benchmark exceedances are in fact attributable solely to natural background pollutant levels. The supporting rationale shall include any data previously collected by the facility or others (including literature studies) that describe the levels of natural background pollutants in the facility's stormwater discharges; and

(c) The permittee notifies the department on the benchmark monitoring DMR that the benchmark exceedances are attributable solely to natural background pollutant levels.

Natural background pollutants include those substances that are naturally occurring in soils or groundwater. Natural background pollutants do not include legacy pollutants from earlier activity on the facility's site, or pollutants in run-on from neighboring sources that are not naturally occurring.

b. Corrective actions. The permittee shall take corrective action whenever:
(1) Routine facility inspections, inspections by local, state or federal officials, or any other process, observation or event result in a determination that modifications to the stormwater control measures are necessary to meet the permit requirements;
(2) There is any exceedance of an effluent limitation (including coal pile runoff), TMDL wasteload allocation, or a reduction required by a local ordinance established by a municipality to meet Chesapeake Bay TMDL requirements; or
(3) The department determines, or the permittee becomes aware, that the stormwater control measures are not stringent enough for the discharge to meet applicable water quality standards.

The permittee shall review the SWPPP and modify it as necessary to address any deficiencies. Revisions to the SWPPP shall be completed within 60 days following the discovery of the deficiency. When control measures need to be modified or added (distinct from regular preventive maintenance of existing control measures described in Part III C), implementation shall be completed before the next anticipated storm event if possible, but no later than 60 days after the deficiency is discovered, or as otherwise provided or approved by the department. In cases where construction is necessary to implement control measures, the permittee shall include a schedule in the SWPPP that provides for the completion of the control measures as expeditiously as practicable, but no later than three years after the deficiency is discovered. Where a construction compliance schedule is included in the SWPPP, the SWPPP shall include appropriate nonstructural and temporary controls to be implemented in the affected portion of the facility prior to completion of the permanent control measure. The amount of time taken to modify a control measure or implement additional control measures shall be documented in the SWPPP.

Any corrective actions taken shall be documented and retained with the SWPPP. Reports of corrective actions shall be signed in accordance with Part II K.

c. Follow-up reporting. If at any time monitoring results indicate that discharges from the facility exceed an effluent limitation or a TMDL wasteload allocation, or the department determines that discharges from the facility are causing or contributing to an exceedance of a water quality standard, immediate steps shall be taken to eliminate the exceedances in accordance with the above Part I A 6 b (Corrective actions). Within 30 calendar days of implementing the relevant corrective action, an exceedance report shall be submitted to the department. The following information shall be included in the report:
(1) General permit registration number;
(2) Facility name and address;
(3) Receiving water for each outfall exceeding an effluent limitation of TMDL wasteload allocation;
(4) Monitoring data from the event being reported;
(5) A narrative description of the situation;
(6) A description of actions taken since the event was discovered and steps taken to minimize to the extent feasible pollutants in the discharge; and
(7) A local facility contact name, email address, and phone number.

B. Special conditions.

1. Authorized nonstormwater discharges. Except as provided in this section or in Part IV (9VAC25-151-90 et seq.), all discharges covered by this permit shall be composed entirely of stormwater. The following nonstormwater discharges are authorized by this permit:
    a. Discharges from emergency firefighting activities;
    b. Fire hydrant flushings, managed in a manner to avoid an instream impact;
    c. Potable water, including water line flushings, managed in a manner to avoid an instream impact;
    d. Uncontaminated condensate from air conditioners, coolers, and other compressors and from the outside storage of refrigerated gases or liquids;
    e. Irrigation drainage;
    f. Landscape watering provided all pesticides, herbicides, and fertilizer have been applied in accordance with the approved labeling;
    g. Routine external building washdown that does not use detergents or hazardous cleaning products;
    h. Pavement wash waters where no detergents or hazardous cleaning products are used and no spills or leaks of toxic or hazardous materials have occurred (unless all spilled material has been removed). Pavement wash waters shall be managed in a manner to avoid an instream impact;
    i. Uncontaminated groundwater or spring water;
    j. Foundation or footing drains where flows are not contaminated with process materials; and
    k. Incidental windblown mist from cooling towers that collects on rooftops or adjacent portions of the facility, but not intentional discharges from the cooling tower (e.g., "piped" cooling tower blowdown or drains).

    All other nonstormwater discharges are not authorized and shall either be eliminated or covered under a separate VPDES permit.

2. Releases of hazardous substances or oil in excess of reportable quantities. The discharge of hazardous substances or oil in the stormwater discharges from the facility shall be prevented or minimized in accordance with the SWPPP for the facility. This permit does not authorize the discharge of hazardous substances or oil resulting from an on-site spill. This permit does not relieve the permittee of the reporting requirements of 40 CFR Part 110, 40 CFR Part 117, and 40 CFR Part 302 or § 62.1-44.34:19 of the Code of Virginia.

    Where a release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity established under either 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302 occurs during a 24-hour period:
    a. The permittee is required to notify the department in accordance with the requirements of Part II G as soon as he has knowledge of the discharge;
    b. Where a release enters an MS4, the permittee shall also notify the owner of the MS4; and
    c. The SWPPP required under Part III shall be reviewed to identify measures to prevent the reoccurrence of such releases and to respond to such releases, and the SWPPP shall be modified where appropriate.

3. Colocated industrial activity. If the facility has industrial activities occurring on-site which are described by any of the activities in Part IV of the permit (9VAC25-151-90 et seq.), those industrial activities are considered to be colocated industrial activities. Stormwater discharges from colocated industrial activities are authorized by this permit, provided that the permittee complies with any and all additional SWPPP and monitoring requirements from Part IV applicable to that particular colocated industrial activity. The permittee shall be responsible for additional SWPPP and monitoring requirements applicable to the colocated industrial activity by examining the narrative descriptions of all discharges covered under this section.

4. The stormwater discharges authorized by this permit may be combined with other sources of stormwater which are not required to be covered under a VPDES permit, so long as the combined discharge is in compliance with this permit.

5. There shall be no discharge of waste, garbage, or floating debris in other than trace amounts.

6. Approval for coverage under this general permit does not relieve the permittee of the responsibility to comply with any other applicable federal, state, or local statute, ordinance, or regulation.

7. Discharges to waters subject to TMDL wasteload allocations. Owners of facilities that are a source of the specified pollutant of concern to waters for which a TMDL wasteload allocation has been approved prior to the term of this permit shall incorporate measures and controls into the SWPPP required by Part III that are consistent with the assumptions and requirements of the TMDL. The department will provide written notification to the owner that a facility is subject to the TMDL requirements. The facility's SWPPP shall specifically address any conditions or requirements included in the TMDL that are applicable to discharges from the facility. If the TMDL establishes a specific numeric wasteload allocation that applies to discharges from the facility, the owner shall perform any required monitoring in accordance with Part I A 1 c (3), and implement control measures designed to meet that allocation.

8. Discharges to waters subject to the Chesapeake Bay TMDL.
   a. Owners of facilities in the Chesapeake Bay watershed shall monitor their discharges for total suspended solids (TSS), total nitrogen (TN), and total phosphorus (TP) to characterize the contributions from their facility's specific industrial sector for these parameters. Total nitrogen is the sum of total Kjeldahl nitrogen (TKN) and nitrite + nitrate and shall be derived from the results of those tests. After the facility is granted coverage under the permit, samples shall be collected during each of the first four monitoring periods (i.e., the first two years of permit coverage). Monitoring periods are specified in Part I A 2. Samples shall be collected and analyzed in accordance with Part I A 2. Monitoring results shall be reported in accordance with Part I A 5 and Part II C, and retained in accordance with Part II B.
   b. Facilities that were covered under the 2014 industrial stormwater general permit shall comply with the following:
      (1) Facilities that submitted a Chesapeake Bay TMDL action plan that was approved by the board during the 2014 industrial stormwater general permit term shall continue to implement the approved Chesapeake Bay TMDL action plan during this permit term. An annual report shall be submitted to the department by June 30 of each year describing the progress in meeting the required reductions unless this reporting requirement is waived by the department in accordance with Part I B 8 g. Monitoring in accordance with Part I B 8 a is not required for these facilities during this permit term.

(2) Facilities that completed four samples for TSS, TN, and TP during the 2014 industrial stormwater general permit term shall utilize the procedures in Part I B 8 c (2) to calculate their facility stormwater loads. The permittee shall submit a copy of the calculations and Chesapeake Bay TMDL action plan if required under Part I B 8 f to the department within 60 days of coverage under this general permit.

(3) Facilities that did not complete four samples for TSS, TN, and TP during the 2014 industrial stormwater general permit term shall be subject to completing the monitoring requirements in Part I B 8 a beginning with the first full monitoring period after receiving permit coverage. Calculations and a Chesapeake Bay TMDL action plan if required under Part I B 8 f shall be submitted no later than 90 days following the completion of the fourth monitoring period to the DEQ regional office serving the area where the industrial facility is located on a form provided by the department and maintained with the facility's SWPPP.

(4) Facilities that monitored for TSS, TN, or TP may use the applicable sampling data collected during the 2014 industrial stormwater general permit term to satisfy all or part of the four monitoring periods requirement in accordance with Part I B 8 a.

c. Chesapeake Bay TMDL wasteload allocations and Chesapeake Bay TMDL action plans.

(1) EPA's Chesapeake Bay TMDL (December 29, 2010) includes wasteload allocations for VPDES permitted industrial stormwater facilities as part of the regulated stormwater aggregate load. EPA used data submitted by Virginia with the Phase I Chesapeake Bay TMDL Watershed Implementation Plan, including the number of industrial stormwater permits per county and the number of urban acres regulated by industrial stormwater permits, as part of their development of the aggregate load. Aggregate loads for industrial stormwater facilities were appropriate because actual facility loading data were not available to develop individual facility wasteload allocations.

Virginia estimated the loadings from industrial stormwater facilities using actual and estimated facility acreage information and TP, TN, and TSS loading rates from the Northern Virginia Planning District Commission (NVPDC) Guidebook for Screening Urban Nonpoint Pollution Management Strategies (Annandale, VA November 1979), prepared for the Metropolitan Washington Council of Governments. The loading rates used were as follows:

TP - High (80%) imperviousness industrial; 1.5 lb/ac/yr
TN - High (80%) imperviousness industrial; 12.3 lb/ac/yr
TSS - High (80%) imperviousness industrial; 440 lb/ac/yr

The actual facility area information and the TP, TN, and TSS data collected for this permit will be used by the board to quantify the nutrient and sediment loads from VPDES permitted industrial stormwater facilities.

(2) Calculation of facility loads. The permittee shall analyze the nutrient and sediment data collected in accordance with Part I B 8 a and 8 b to determine if pollution reductions are required for this permit term. The permittee shall average the data collected at the facility for each of the pollutants of concern (POC) (e.g., TP, TN, and TSS) and compare the results to the loading rates for TP, TN, and TSS presented in Part I B 8 c (1).

The following formula may be used to determine the loading rate:
$L = 0.226 \times P \times Pj \times (0.05 + (0.9 \times Ia)) \times C$

where:
L = the POC loading rate (lb/acre/year)
P = the annual rainfall (inches/year) - The permittee may use either actual annual average rainfall data for the facility location (in inches/year), the Virginia annual average rainfall of 44.3 inches/year, or another method approved by the board.
Pj = the fraction of annual events that produce runoff - The permittee shall use 0.9 unless the board approves another rate.
Ia = the impervious fraction of the facility impervious area of industrial activity to the facility industrial activity area
C = the POC average concentration of all facility samples (mg/L) - Facilities with multiple outfalls shall calculate a weighted average concentration for each outfall using the drainage area of each outfall.

For total phosphorus and total suspended solids, all daily concentration data below the quantitation level (QL) for the analytical method used shall be treated as half the QL. All daily concentration data equal to or above the QL for the analytical method used shall be treated as it is reported.

For total nitrogen, if none of the daily concentration data for the respective species (i.e., TKN, nitrate, or nitrite) are equal to or above the QL for the respective analytical methods used, the daily TN concentration value reported shall equal one half of the largest QL used for the respective species. If one of the data is equal to or above the QL, the daily TN concentration value shall be treated as that data point is reported. If more than one of the data is above the QL, the daily TN concentration value shall equal the sum of the data points as reported.

d. The permittee shall submit a copy of the calculations to the department within 90 days from the end of the last monitoring period that satisfies the monitoring requirement in Part I B 8 a. Calculations shall be submitted to the DEQ regional office serving the area where the industrial facility is located, on a form provided by the department, and maintained with the facility's SWPPP.
e. Any modification to the facility's industrial acreage or impervious industrial acreage shall require the facility to recalculate facility loading rates. This may require the facility to modify the facility's Chesapeake Bay TMDL action plan or submit a Chesapeake Bay TMDL action plan as appropriate. Any recalculation of facility loading rates or modifications to a Chesapeake Bay TMDL action plan shall be submitted to the department within 90 days of the date on which the permittee completes a site modification. If previous monitoring is no longer representative of the modified facility, monitoring in accordance with Part I B 8 a shall commence within 90 days of the modification and the revised calculations and Chesapeake Bay TMDL action plan if required under Part I B 8 f shall be submitted no later than 90 days following completion of the fourth monitoring period.
f. Chesapeake Bay TMDL action plan requirements. If the calculated facility loading rate for TP, TN, or TSS is above the loading rates for TP, TN, or TSS presented in Part I B 8 c (1), then the permittee shall develop and submit a Chesapeake Bay TMDL action plan to the department.

   The Chesapeake Bay TMDL action plan shall be submitted on a form provided by the department to the regional office serving the area where the industrial facility is located within 90 days following the completion of the fourth monitoring period. A copy of the current Chesapeake Bay TMDL action plan and all facility loading rate calculations shall be maintained with the facility's SWPPP. The Chesapeake Bay TMDL action plan shall include:

(1) A determination of the total pollutant load reductions for TP, TN, and TSS (as appropriate) necessary to reduce the annual loads from industrial activities. This shall be determined by multiplying the industrial average times the difference between the TMDL loading rates listed in Part I B 8 c (1) and the actual facility loading rates calculated in accordance with Part I B 8 c (2). The reduction applies to the total difference calculated for each pollutant of concern;
(2) The means and methods, such as management practices and retrofit programs, that will be utilized to meet the required reductions determined in Part I B 8 f (1) and a schedule to achieve those reductions by June 30, 2024. The schedule should include annual milestones to demonstrate the ongoing progress in meeting those reductions; and
(3) The permittee may consider utilization of any pollutant trading or offset program in accordance with §§ 62.1-44.19:20 through 62.1-44.19:23 of the Code of Virginia, governing trading and offsetting, to meet the required reductions.

g. A permittee required to develop and implement a Chesapeake Bay TMDL Action Plan shall submit an annual report to the department by June 30 of each year describing the progress in meeting the required reductions.

h. Chesapeake Bay TMDL action plan annual reporting waiver. Upon implementation of the facility's Chesapeake Bay TMDL action plan, permittees may submit a waiver for the annual reporting requirements. The waiver request shall be submitted for board approval to the DEQ regional office serving the area where the industrial facility is located on a form provided by the department. Annual reporting requirements will be in effect until the permittee receives notice from the department that the waiver has been approved. A copy of the waiver approval shall be maintained with the SWPPP. The waiver may be revoked for cause by the board. A waiver request may be approved by the board once the permittee demonstrates that they have achieved all of the required pollutant reductions calculated under Part I B 8 f (1). Pollutant reductions may be achieved using a combination of the following alternatives:
(1) Reductions provided by one or more of the BMPs from the Virginia Stormwater BMP Clearinghouse listed in 9VAC25-870-65, approved BMPs found on the Virginia Stormwater Clearinghouse website, or BMPs approved by the Chesapeake Bay Program. Any BMPs implemented to provide the required pollutant reductions shall be incorporated in the SWPPP and be permanently maintained by the permittee;
(2) Implementation of site-specific BMPs followed by a minimum of four stormwater samples collected in accordance with sampling requirements in Part I B 8 a that demonstrate pollutant loadings have been reduced below those calculated under Part I B 8 c. Any BMPs implemented to provide the required pollutant reductions shall be incorporated in the SWPPP and be permanently maintained by the permittee; or
(3) Acquisition of nonpoint source credits certified by the board as perpetual in accordance with § 62.1-44.19:20 of the Code of Virginia.

9. Discharges through a regulated MS4 to waters subject to the Chesapeake Bay TMDL. In addition to the requirements of this permit, any facility with industrial activity stormwater discharges through a regulated MS4 that is notified by the MS4 operator that the locality has adopted ordinances to meet the Chesapeake Bay TMDL shall incorporate measures and controls into its SWPPP to comply with applicable local TMDL ordinance requirements.

10. Expansion of facilities that discharge to waters subject to the Chesapeake Bay TMDL. Virginia's Phase I Chesapeake Bay TMDL Watershed Implementation Plan (November 29, 2010), states that the wasteloads from any expansion of an existing permitted facility discharging stormwater in the Chesapeake Bay watershed cannot exceed the nutrient and sediment loadings that were discharged from the expanded portion of the land prior to the land being developed for the expanded industrial activity.

a. For any industrial activity area expansions (i.e., construction activities, including clearing, grading, and excavation activities) that commence on or after July 1, 2019, (the effective date of this permit), the permittee shall document in the SWPPP the information and calculations used to determine the nutrient and sediment loadings discharged from the expanded land area prior to the land being developed, and the measures and controls that were employed to meet the no net increase of stormwater nutrient and sediment load as a result of the expansion of the industrial activity. Any land disturbance that is exempt from permitting under the VPDES construction stormwater general permit regulation (9VAC25-880) is exempt from this requirement.
b. The permittee may use the VSMP water quality design criteria to meet the requirements of Part I B 10 a. Under this criteria, the total phosphorus load shall not exceed the greater of (i) the total phosphorus load that was discharged from the expanded portion of the land prior to the land being developed for the industrial activity or (ii) 0.41 pounds per acre per year. Compliance with the water quality design criteria may be determined utilizing the Virginia Runoff Reduction Method or another equivalent methodology approved by the board. Design specifications and pollutant removal efficiencies for specific BMPs can be found on the Virginia Stormwater BMP Clearinghouse website.
c. The permittee may consider utilization of any pollutant trading or offset program in accordance with §§ 62.1-44.19:20 through 62.1-44.19:23 of the Code of Virginia, governing trading and offsetting, to meet the no net increase requirement.

10. Water quality protection. The discharges authorized by this permit shall be controlled as necessary to meet applicable water quality standards. The board expects that compliance with the conditions in this permit will control discharges as necessary to meet applicable water quality standards.

11. Adding or deleting stormwater outfalls. The permittee may add new or delete existing stormwater outfalls at the facility as necessary and appropriate. The permittee shall update the SWPPP and notify the department of all outfall changes within 30 days of the change. The permittee shall submit a copy of the updated SWPPP site map with this notification.

12. Antidegradation requirements for new or increased discharges to high quality waters. Facilities that add new outfalls, or increase their discharges from existing outfalls that discharge directly to high quality waters designated under Virginia's water quality standards antidegradation policy under 9VAC25-260-30 A 2 may be notified by the department that additional control measures, or other permit conditions are necessary to comply with the applicable antidegradation requirements, or may be notified that an individual permit is required in accordance with 9VAC25-31-170 B 3.

13. Termination of permit coverage.
    a. The owner may terminate coverage under this general permit by filing a complete notice of termination with the department. The notice of termination may be filed after one or more of the following conditions have been met:
        (1) Operations have ceased at the facility and there are no longer discharges of stormwater associated with industrial activity from the facility;
        (2) A new owner has assumed responsibility for the facility. A notice of termination does not have to be submitted if a VPDES Change of Ownership Agreement Form has been submitted;
        (3) All stormwater discharges associated with industrial activity have been covered by an individual VPDES permit; or
        (4) Termination of coverage is being requested for another reason, provided the board agrees that coverage under this general permit is no longer needed.

b. The notice of termination shall contain the following information:
   (1) Owner's name, mailing address, telephone number, and email address (if available);
   (2) Facility name and location;
   (3) VPDES industrial stormwater general permit registration number;
   (4) The basis for submitting the notice of termination, including:
      (a) A statement indicating that a new owner has assumed responsibility for the facility;
      (b) A statement indicating that operations have ceased at the facility, and there are no longer discharges of stormwater associated with industrial activity from the facility;
      (c) A statement indicating that all stormwater discharges associated with industrial activity have been covered by an individual VPDES permit; or
      (d) A statement indicating that termination of coverage is being requested for another reason and a description of the reason; and
   (5) The following certification: "I certify under penalty of law that all stormwater discharges associated with industrial activity from the identified facility that are authorized by this VPDES general permit have been eliminated, or covered under a VPDES individual permit, or that I am no longer the owner of the industrial activity, or permit coverage should be terminated for another reason listed above. I understand that by submitting this notice of termination, that I am no longer authorized to discharge stormwater associated with industrial activity in accordance with the general permit, and that discharging pollutants in stormwater associated with industrial activity to surface waters is unlawful where the discharge is not authorized by a VPDES permit. I also understand that the submittal of this notice of termination does not release an owner from liability for any violations of this permit or the Clean Water Act."
c. The notice of termination shall be signed in accordance with Part II K.
d. The notice of termination shall be submitted to the DEQ regional office serving the area where the industrial facility is located.

Part II. Conditions Applicable To All VPDES Permits

A. Monitoring.

1. Samples and measurements taken as required by this permit shall be representative of the monitored activity.
2. Monitoring shall be conducted according to procedures approved under 40 CFR Part 136 or alternative methods approved by the U.S. Environmental Protection Agency, unless other procedures have been specified in this permit.
3. The permittee shall periodically calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals that will ensure accuracy of measurements.
4. Samples taken as required by this permit shall be analyzed in accordance with 1VAC30-45, (Certification for Noncommercial Environmental Laboratories), or 1VAC30-46 (Accreditation for Commercial Environmental Laboratories).

B. Records.

1. Records of monitoring information shall include:
   a. The date, exact place, and time of sampling or measurements;
   b. The individuals who performed the sampling or measurements;
   c. The dates and times analyses were performed;
   d. The individuals who performed the analyses;
   e. The analytical techniques or methods used; and
   f. The results of such analyses.
2. The permittee shall retain copies of the SWPPP, including any modifications made during the term of this permit, records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the registration statement for this permit, for a period of at least three years from the date that coverage under this permit expires or is terminated. This period of retention shall be extended automatically during the course of any unresolved litigation regarding the regulated activity or regarding control standards applicable to the permittee, or as requested by the board.

C. Reporting Monitoring Results.

1. The permittee shall submit the results of the monitoring required by this permit not later than the 10th day of the month after monitoring takes place, unless another reporting schedule is specified elsewhere in this permit. Monitoring results shall be submitted to the department's regional office.
2. Monitoring results shall be reported in the department's electronic discharge monitoring report (e-DMR) system. All reports and forms submitted in compliance with this permit shall be submitted electronically by the permittee in accordance with 9VAC25-31-1020.
3. If the permittee monitors any pollutant specifically addressed by this permit more frequently than required by this permit using test procedures approved under 40 CFR Part 136 or using other test procedures approved by the U.S. Environmental Protection Agency or using procedures specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in e-DMR or reporting form specified by the department.
4. Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

D. Duty to Provide Information.

The permittee shall furnish to the Department, within a reasonable time, any information which the board may request to determine whether cause exists for modifying, revoking and reissuing, or terminating coverage under this permit or to determine compliance with this permit. The board may require the permittee to furnish, upon request, such plans, specifications, and other pertinent information as may be necessary to determine the effect of the wastes from the discharge on the quality of state waters, or such other information as may be necessary to accomplish the purposes of the State Water Control Law. The permittee shall also furnish to the department upon request, copies of records required to be kept by this permit.

E. Compliance Schedule Reports.

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.

F. Unauthorized Discharges.

Except in compliance with this permit, or another permit issued by the Board, it shall be unlawful for any person to:

1. Discharge into state waters sewage, industrial wastes, other wastes, or any noxious or deleterious substances; or
2. Otherwise alter the physical, chemical or biological properties of such state waters and make them detrimental to the public health, or to animal or aquatic life, or to the use of such waters for domestic or industrial consumption, or for recreation, or for other uses.

G. Reports of Unauthorized Discharges.

Any permittee who discharges or causes or allows a discharge of sewage, industrial waste, other wastes or any noxious or deleterious substance into or upon state waters in violation of Part II F; or who discharges or causes or allows a discharge that may reasonably be expected to enter state waters in violation of Part II F, shall notify the department of the discharge immediately upon discovery of the discharge, but in no case later than 24 hours after said discovery. A written report of the unauthorized discharge shall be submitted to the department within five days of discovery of the discharge. The written report shall contain:

1. A description of the nature and location of the discharge;
2. The cause of the discharge;
3. The date on which the discharge occurred;
4. The length of time that the discharge continued;
5. The volume of the discharge;
6. If the discharge is continuing, how long it is expected to continue;
7. If the discharge is continuing, what the expected total volume of the discharge will be; and
8. Any steps planned or taken to reduce, eliminate and prevent a recurrence of the present discharge or any future discharges not authorized by this permit.

Discharges reportable to the department under the immediate reporting requirements of other regulations are exempted from this requirement.

H. Reports of Unusual or Extraordinary Discharges.

If any unusual or extraordinary discharge including a bypass or upset should occur from a treatment works and the discharge enters or could be expected to enter state waters, the permittee shall promptly notify, in no case later than 24 hours, the department by telephone after the discovery of the discharge. This notification shall provide all available details of the incident, including any adverse affects on aquatic life and the known number of fish killed. The permittee shall reduce the report to writing and shall submit it to the department within five days of discovery of the discharge in accordance with Part II I 1 b. Unusual and extraordinary discharges include any discharge resulting from:

1. Unusual spillage of materials resulting directly or indirectly from processing operations;
2. Breakdown of processing or accessory equipment;
3. Failure or taking out of service some or all of the treatment works; and
4. Flooding or other acts of nature.

I. Reports of Noncompliance.

1. The permittee shall report any noncompliance that may adversely affect state waters or may endanger public health.
   a. An oral report shall be provided within 24 hours from the time the permittee becomes aware of the circumstances. The following shall be included as information which shall be reported within 24 hours under Part II I:
      (1) Any unanticipated bypass; and
      (2) Any upset which causes a discharge to surface waters.
   b. A written report shall be submitted within five days and shall contain:
      (1) A description of the noncompliance and its cause;
      (2) The period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and
      (3) Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

   The board may waive the written report on a case-by-case basis for reports of noncompliance under Part II I if the oral report has been received within 24 hours and no adverse impact on state waters has been reported.

2. The permittee shall report all instances of noncompliance not reported under Part II I 1 in writing, at the time the next monitoring reports are submitted. The reports shall contain the information listed in Part II I 1.
3. The immediate (within 24 hours) reports required in Part II G, H. and I. may be made to the department's Northern Regional Office at (703) 583-3800 (voice) or online at http://www.deq.virginia.gov/Programs/PollutionResponsePreparedness/MakingaReport.aspx. For reports outside normal working hours, a message may be left and this shall fulfill the immediate reporting requirement. For emergencies, the Virginia Department of Emergency Management maintains a 24-hour telephone service at 1-800-468-8892.

J. Notice of Planned Changes.

1. The permittee shall give notice to the department as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:
   a. The permittee plans alteration or addition to any building, structure, facility, or installation from which there is or may be a discharge of pollutants, the construction of which commenced:

(1) After promulgation of standards of performance under § 306 of Clean Water Act which are applicable to such source; or
(2) After proposal of standards of performance in accordance with § 306 of Clean Water Act which are applicable to such source, but only if the standards are promulgated in accordance with § 306 within 120 days of their proposal;

b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations nor to notification requirements specified elsewhere in this permit; or
c. The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.

2. The permittee shall give advance notice to the Department of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

K. Signatory Requirements.

1. Registration Statements. All registration statements shall be signed as follows:
   a. For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation; or (ii) the manager of one or more manufacturing, production, or operating facilities, provided the manager is authorized to make management decisions that govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit registration requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;
   b. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or
   c. For a municipality, state, federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a public agency includes (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency.
2. Reports, etc. All reports required by permits, and other information requested by the board shall be signed by a person described in Part II K 1 or by a duly authorized representative of that person. A person is a duly authorized representative only if:
   a. The authorization is made in writing by a person described in Part II K 1;
   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. A duly authorized representative may thus be either a named individual or any individual occupying a named position; and
   c. The written authorization is submitted to the department.
3. Changes to authorization. If an authorization under Part II K 2 is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Part II K 2 shall be submitted to the department prior to or together with any reports, or information to be signed by an authorized representative.

4. Certification. Any person signing a document under Part II K 1 or 2 shall make the following certification:

   "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

L. Duty to Comply.

The permittee shall comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the State Water Control Law and the Clean Water Act, except that noncompliance with certain provisions of this permit may constitute a violation of the State Water Control Law but not the Clean Water Act. Permit noncompliance is grounds for enforcement action; for permit coverage termination or denial of a permit coverage renewal.

The permittee shall comply with effluent standards or prohibitions established under § 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards even if this permit has not yet been modified to incorporate the requirement.

M. Duty to Reapply.

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee shall submit a new registration statement at least 60 days before the expiration date of the existing permit, unless permission for a later date has been granted by the board. The board shall not grant permission for registration statements to be submitted later than the expiration date of the existing permit.

N. Effect of a Permit.

This permit does not convey any property rights in either real or personal property or any exclusive privileges, nor does it authorize any injury to private property or invasion of personal rights, or any infringement of federal, state or local law or regulations.

O. State Law.

Nothing in this permit shall be construed to preclude the institution of any legal action under, or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any other state law or regulation or under authority preserved by § 510 of the Clean Water Act. Except as provided in permit conditions on "bypassing" (Part II U), and "upset" (Part II V) nothing in this permit shall be construed to relieve the permittee from civil and criminal penalties for noncompliance.

P. Oil and Hazardous Substance Liability.

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under §§ 62.1-44.34:14 through 62.1-44.34:23 of the State Water Control Law.

Q. Proper Operation and Maintenance.

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes effective plant performance, adequate funding, adequate staffing, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by the permittee only when the operation is necessary to achieve compliance with the conditions of this permit.

R. Disposal of Solids or Sludges.

Solids, sludges or other pollutants removed in the course of treatment or management of pollutants shall be disposed of in a manner so as to prevent any pollutant from such materials from entering state waters.

S. Duty to Mitigate.

The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

T. Need to Halt or Reduce Activity not a Defense.

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

U. Bypass

1. "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of Part II U 2 and 3.
2. Notice
   a. Anticipated bypass. If the permittee knows in advance of the need for a bypass, prior notice shall be submitted, if possible at least 10 days before the date of the bypass.
   b. Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in Part II I.
3. Prohibition of bypass.
   a. Bypass is prohibited, and the board may take enforcement action against a permittee for bypass, unless:
      (1) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
      (2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
      (3) The permittee submitted notices as required under Part II U 2.
   b. The board may approve an anticipated bypass, after considering its adverse effects, if the board determines that it will meet the three conditions listed above in Part II U 3 a.

V. Upset.

1. An upset constitutes an affirmative defense to an action brought for noncompliance with technology based permit effluent limitations if the requirements of Part II V 2 are met. A determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is not a final administrative action subject to judicial review.
2. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:
   a. An upset occurred and that the permittee can identify the causes of the upset;
   b. The permitted facility was at the time being properly operated;
   c. The permittee submitted notice of the upset as required in Part II I; and
   d. The permittee complied with any remedial measures required under Part II S.
3. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

W. Inspection and Entry.

The permittee shall allow the director, or an authorized representative, including an authorized contractor acting as a representative of the administrator, upon presentation of credentials and other documents as may be required by law, to:

1. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
4. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act and the State Water Control Law, any substances or parameters at any location.

For purposes of this section, the time for inspection shall be deemed reasonable during regular business hours, and whenever the facility is discharging. Nothing contained herein shall make an inspection unreasonable during an emergency.

X. Permit Actions.

Permit coverages may be terminated for cause. The filing of a request by the permittee for a permit termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

Y. Transfer of Permits.

1. Permits are not transferable to any person except after notice to the department.
2. Coverage under this permit may be automatically transferred to a new permittee if:
   a. The current permittee notifies the department within 30 days of the transfer of the title to the facility or property; unless permission for a later date has been granted by the board;
   b. The notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit responsibility, coverage, and liability between them; and
   c. The board does not notify the existing permittee and the proposed new permittee of its intent to deny the new permittee coverage under the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in Part II Y 2 b.

Z. Severability.

The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

Part III. Stormwater Pollution Prevention Plan

A stormwater pollution prevention plan (SWPPP) shall be developed and implemented for the facility covered by this permit. The SWPPP is intended to document the selection, design, and installation of control measures, including BMPs, to minimize the pollutants in all stormwater discharges from the facility, and to meet applicable effluent limitations and water quality standards.

The SWPPP requirements of this general permit may be fulfilled, in part, by incorporating by reference other plans or documents such as a spill prevention control and countermeasure (SPCC) plan developed for the facility under § 311 of the Clean Water Act, or best management practices (BMP) programs otherwise required for the facility, provided that the incorporated plan meets or exceeds the plan requirements of Part III B (Contents of the SWPPP). All plans incorporated by reference into the SWPPP become enforceable under this permit. If a plan incorporated by reference does not contain all of the required elements of the SWPPP of Part III B, the permittee shall develop the missing SWPPP elements and include them in the required plan.

A. Deadlines for SWPPP preparation and compliance.

1. Facilities that were covered under the 2014 Industrial Stormwater General Permit. Owners of facilities that were covered under the 2014 Industrial Stormwater General Permit who are continuing coverage under this general permit shall update and implement any revisions to the SWPPP within 90 days of the board granting coverage under this permit.
2. New facilities, facilities previously covered by an expiring individual permit, and existing facilities not currently covered by a VPDES permit. Owners of new facilities, facilities previously covered by an expiring individual permit, and existing facilities not currently covered by a VPDES permit who elect to be covered under this general permit shall prepare and implement the SWPPP prior to submitting the registration statement.
3. New owners of existing facilities. Where the owner of an existing facility that is covered by this permit changes, the new owner of the facility shall update and implement any revisions to the SWPPP within 60 days of the ownership change.
4. Extensions. Upon a showing of good cause, the director may establish a later date in writing for the preparation and compliance with the SWPPP.

B. Contents of the SWPPP.

The contents of the SWPPP shall comply with the requirements listed below and those in the appropriate sectors of Part IV (9VAC25-151-90 et seq.). These requirements are cumulative. If a facility has colocated industrial activities that are covered in more than one sector of Part IV, that facility's SWPPP shall comply with the requirements listed in all applicable sectors. The following requirements are applicable to all SWPPPs developed under this general permit. The SWPPP shall include, at a minimum, the following items:

1. Pollution prevention team. The SWPPP shall identify the staff individuals by name or title who comprise the facility's stormwater pollution prevention team. The pollution prevention team is responsible for assisting the facility or plant manager in developing, implementing, maintaining, revising and ensuring compliance with the facility's SWPPP. Specific responsibilities of each staff individual on the team shall be identified and listed.
2. Site description. The SWPPP shall include the following:
   a. A description of the industrial activities at the facility.
   b. A site map identifying the following:
      (1) The boundaries of the property and the size of the property in acres;
      (2) The location and extent of significant structures and impervious surfaces;

(3) Locations of all stormwater conveyances, including ditches, pipes, swales, and inlets, and the directions of stormwater flow using arrows to indicate which direction stormwater will flow;
(4) Locations of all stormwater control measures, including BMPs;
(5) Locations of all surface water bodies, including wetlands;
(6) Locations of potential pollutant sources identified under Part III B 3;
(7) Locations where significant spills or leaks identified under Part III B 3 c have occurred;
(8) Locations of stormwater outfalls.
  (a) An approximate outline of the area draining to each outfall;
  (b) The drainage area of each outfall in acres;
  (c) The longitude and latitude of each outfall;
  (d) The location of any MS4 conveyance receiving discharge from the facility; and
  (e) Each outfall shall be identified with a unique numerical identification code. For example: Outfall Number 001, Outfall Number 002, etc.;
(9) Location and description of all nonstormwater discharges;
(10) Location of any storage piles containing salt;
(11) Locations and sources of suspected run-on to the site from an adjacent property if the run-on is suspected of containing significant quantities of pollutants; and
(12) Locations of all stormwater monitoring points.

c. Receiving waters and wetlands. The name of all surface waters receiving discharges from the site, including intermittent streams, dry sloughs, and arroyos. Provide a description of wetland sites that may receive discharges from the facility. If the facility discharges through an MS4, identify the MS4 operator, and the receiving water to which the MS4 discharges.

3. Summary of potential pollutant sources. The SWPPP shall identify each separate area at the facility where industrial materials or activities are exposed to stormwater. Industrial materials or activities include material handling equipment or activities, industrial machinery, raw materials, industrial production and processes, intermediate products, byproducts, final products, and waste products. Material handling activities include the storage, loading and unloading, transportation, disposal, or conveyance of any raw material, intermediate product, final product or waste product. For each separate area identified, the description shall include:
   a. Activities in the area. A list of the industrial activities exposed to stormwater.
   b. Pollutants. A list of the pollutants, pollutant constituents, or industrial chemicals associated with each industrial activity that could potentially be exposed to stormwater. The pollutant list shall include all significant materials handled, treated, stored or disposed that have been exposed to stormwater in the three years prior to the date this SWPPP was prepared or amended. The list shall include any hazardous substances or oil at the facility.
   c. Spills and leaks. The SWPPP shall clearly identify areas where potential spills and leaks that can contribute pollutants to stormwater discharges can occur and their corresponding outfalls. The SWPPP shall include a list of significant spills and leaks of toxic or hazardous pollutants that actually occurred at exposed areas, or that drained to a stormwater conveyance during the three-year period prior to the date this SWPPP was prepared or amended. The list shall be updated within 60 days of the incident if significant spills or leaks occur in exposed areas of the facility during the term of the permit.
   d. Sampling data. The SWPPP shall include stormwater discharge sampling data collected during the previous three years.

4. Stormwater controls.
   a. Control measures shall be implemented for all the areas identified in Part III B 3 to prevent or control pollutants in stormwater discharges from the facility. Regulated stormwater discharges from the facility include stormwater run-on that commingles with stormwater discharges associated with industrial activity at the facility. The SWPPP shall describe the type, location and implementation of all control measures for each area where industrial materials or activities are exposed to stormwater.
   Selection of control measures shall take into consideration:

(1) That preventing stormwater from coming into contact with polluting materials is generally more effective, and less costly, than trying to remove pollutants from stormwater;
(2) Control measures generally shall be used in combination with each other for most effective water quality protection;
(3) Assessing the type and quantity of pollutants, including their potential to impact receiving water quality, is critical to designing effective control measures;
(4) That minimizing impervious areas at the facility can reduce runoff and improve groundwater recharge and stream base flows in local streams (however, care must be taken to avoid groundwater contamination);
(5) Flow attenuation by use of open vegetated swales and natural depressions can reduce instream impacts of erosive flows;
(6) Conservation or restoration of riparian buffers will help protect streams from stormwater runoff and improve water quality; and
(7) Treatment interceptors (e.g., swirl separators and sand filters) may be appropriate in some instances to minimize the discharge of pollutants.

b. Nonnumeric technology-based effluent limits. The permittee shall implement the following types of control measures to prevent and control pollutants in the stormwater discharges from the facility, unless it can be demonstrated and documented that such controls are not relevant to the discharges.
(1) Good housekeeping. The permittee shall keep clean all exposed areas of the facility that are potential sources of pollutants to stormwater discharges. The permittee shall perform the following good housekeeping measures to minimize pollutant discharges:
(a) The SWPPP shall include a schedule for regular pickup and disposal of waste materials, along with routine inspections for leaks and conditions of drums, tanks, and containers;
(b) As feasible, the facility shall sweep or vacuum;
(c) Store materials in containers constructed of appropriate materials;
(d) Manage all waste containers to prevent a discharge of pollutants;
(e) Minimize the potential for waste, garbage, and floatable debris to be discharged by keeping areas exposed to stormwater free of such materials or by intercepting such materials prior to discharge; and
(f) Facilities that handle pre-production plastic or plastic waste shall implement BMPs to eliminate stormwater discharges of plastics.
(2) Eliminating and minimizing exposure. To the extent practicable, manufacturing, processing, and material storage areas (including loading and unloading, storage, disposal, cleaning, maintenance, and fueling operations) shall be located inside, or protected by a storm-resistant covering to prevent exposure to rain, snow, snowmelt, and runoff. Eliminating exposure at all industrial areas may make the facility eligible for the "Conditional Exclusion for No Exposure" provision of 9VAC25-31-120 E, thereby eliminating the need to have a permit. Unless infeasible, facilities shall implement the following:
(a) Use grading, berming, or curbing to prevent runoff of contaminated flows and divert run-on away from potential sources of pollutants;
(b) Locate materials, equipment, and activities so that potential leaks and spills are contained, or able to be contained, or diverted before discharge;
(c) Clean up spills and leaks immediately, upon discovery of the spills or leaks, using dry methods (e.g., absorbents) to prevent the discharge of pollutants;
(d) Store leaking vehicles and equipment indoors or, if stored outdoors, use drip pans and adsorbents;
(e) Utilize appropriate spill or overflow protections equipment;
(f) Perform all vehicle maintenance or equipment cleaning operations indoors, under cover, or in bermed areas that prevent runoff and run-on and also capture any overspray; and

   (g) Drain fluids from equipment and vehicles that will be decommissioned, and for any equipment and vehicles that remain unused for extended periods of time, inspect at least monthly for leaks.

(3) Preventive maintenance. The permittee shall have a preventive maintenance program that includes regular inspection, testing, maintenance and repairing of all industrial equipment and systems to avoid situations that could result in leaks, spills and other releases of pollutants in stormwater discharged from the facility. This program is in addition to the specific control measure maintenance required under Part III C (Maintenance).

(4) Spill prevention and response procedures. The SWPPP shall describe the procedures that will be followed for preventing and responding to spills and leaks, including:
   (a) Preventive measures, such as barriers between material storage and traffic areas, secondary containment provisions, and procedures for material storage and handling;
   (b) Response procedures, including notification of appropriate facility personnel, emergency agencies, and regulatory agencies, and procedures for stopping, containing and cleaning up spills. Measures for cleaning up hazardous material spills or leaks shall be consistent with applicable Resource Conservation and Recovery Act regulations at 40 CFR Part 264 and 40 CFR Part 265. Employees who may cause, detect or respond to a spill or leak shall be trained in these procedures and have necessary spill response equipment available. If possible, one of these individuals shall be a member of the Pollution Prevention Team;
   (c) Procedures for plainly labeling containers (e.g., "used oil," "spent solvents," "fertilizers and pesticides," etc.) that could be susceptible to spillage or leakage to encourage proper handling and facilitate rapid response if spills or leaks occur; and
   (d) Contact information for individuals and agencies that must be notified in the event of a spill shall be included in the SWPPP, and in other locations where it will be readily available.

(5) Salt storage piles or piles containing salt. Storage piles of salt or piles containing salt used for deicing or other commercial or industrial purposes shall be enclosed or covered to prevent exposure to precipitation. The permittee shall implement appropriate measures (e.g., good housekeeping, diversions, containment) to minimize exposure resulting from adding to or removing materials from the pile. All salt storage piles shall be located on an impervious surface. All runoff from the pile, and runoff that comes in contact with salt, including under drain systems, shall be collected and contained within a bermed basin lined with concrete or other impermeable materials, or within an underground storage tank or tanks, or within an above ground storage tank or tanks, or disposed of through a sanitary sewer (with the permission of the owner of the treatment facility). A combination of any or all of these methods may be used. In no case shall salt contaminated stormwater be allowed to discharge directly to the ground or to surface waters.

(6) Employee training. The permittee shall implement a stormwater employee training program for the facility. The SWPPP shall include a schedule for all types of necessary training, and shall document all training sessions and the employees who received the training. Training shall be provided at least annually for all employees who work in areas where industrial materials or activities are exposed to stormwater, and for employees who are responsible for implementing activities identified in the SWPPP (e.g., inspectors, maintenance personnel, etc.). The training shall cover the components and goals of the SWPPP, and include such topics as spill response, good housekeeping, material management practices, control measure operation and maintenance, etc. The SWPPP shall include a summary of any training performed.

(7) Sediment and erosion control. The SWPPP shall identify areas at the facility that, due to topography, land disturbance (e.g., construction, landscaping, site grading), or other factors, have a potential for soil erosion. The permittee shall identify and implement structural, vegetative, and stabilization control measures to prevent or control on-site and off-site erosion and sedimentation. Flow velocity dissipation devices shall be placed at discharge locations and along the length of any outfall channel if the flows would otherwise create erosive conditions.

(8) Management of runoff. The SWPPP shall describe the stormwater runoff management practices (i.e., permanent structural control measures) for the facility. These types of control measures shall be used to divert, infiltrate, reuse, or otherwise reduce pollutants in stormwater discharges from the site.

Structural control measures may require a separate permit under § 404 of the Clean Water Act and the Virginia Water Protection Permit Program Regulation (9VAC25-210) before installation begins.

(9) Dust suppression and vehicle tracking of industrial materials. The permittee shall implement control measures to minimize the generation of dust and off-site tracking of raw, final, or waste materials. Stormwater collected on-site may be used for the purposes of dust suppression or for spraying stockpiles. Potable water, well water, and uncontaminated reuse water may also be used for this purpose. There shall be no direct discharge to surface waters from dust suppression activities or as a result of spraying stockpiles.

5. Routine facility inspections. Personnel who possess the knowledge and skills to assess conditions and activities that could impact stormwater quality at the facility and who can also evaluate the effectiveness of control measures shall regularly inspect all areas of the facility where industrial materials or activities are exposed to stormwater, areas where spills or leaks have occurred in the past three years, discharge points, and control measures. At least one member of the pollution prevention team shall participate in the routine facility inspections.

   The inspection frequency shall be specified in the SWPPP based upon a consideration of the level of industrial activity at the facility, but shall be at a minimum of once per calendar quarter unless more frequent intervals are specified elsewhere in the permit or written approval is received from the department for less frequent intervals. Inspections shall be performed during operating hours. At least once each calendar year, the routine facility inspection shall be conducted during a period when a stormwater discharge is occurring.

   The requirement for routine facility inspections is waived for facilities that have maintained an active VEEP E3/E4 status. Certain sectors in Part IV have additional inspection requirements. If the VEEP E3/E4 waiver language is not included for the sector specific inspections, these additional inspection requirements may not be waived.

   Any deficiencies in the implementation of the SWPPP that are found shall be corrected as soon as practicable, but not later than within 60 days of the inspection, unless permission for a later date is granted in writing by the director. The results of the inspections shall be documented in the SWPPP and shall include at a minimum:

   a. The inspection date;
   b. The names of the inspectors;
   c. Weather information and a description of any discharges occurring at the time of the inspection;
   d. Any previously unidentified discharges of pollutants from the site;
   e. Any control measures needing maintenance or repairs;
   f. Any failed control measures that need replacement;

g. Any incidents of noncompliance observed; and
h. Any additional control measures needed to comply with the permit requirements.

C. Maintenance.

The SWPPP shall include a description of procedures and a regular schedule for preventive maintenance of all control measures, and shall include a description of the back-up practices that are in place should a runoff event occur while a control measure is off-line. The effectiveness of nonstructural control measures shall also be maintained by appropriate means (e.g., spill response supplies available and personnel trained, etc.).

All control measures identified in the SWPPP shall be maintained in effective operating condition and shall be observed at least annually when a stormwater discharge is occurring to ensure that they are functioning correctly. Where discharge locations are inaccessible, nearby downstream locations shall be observed. The observations shall be documented in the SWPPP.

If routine facility inspections required by Part III B 5 identify control measures that are not operating effectively, repairs or maintenance shall be performed before the next anticipated storm event. If maintenance prior to the next anticipated storm event is not possible, maintenance shall be scheduled and accomplished as soon as practicable. In the interim, back-up measures shall be employed and documented in the SWPPP until repairs or maintenance is complete. Documentation shall be kept with the SWPPP of maintenance and repairs of control measures, including the dates of regular maintenance, dates of discovery of areas in need of repair or replacement, dates for repairs, dates that the control measures returned to full function, and the justification for any extended maintenance or repair schedules.

D. Nonstormwater discharges.

1. Discharges of certain sources of nonstormwater listed in Part I B 1 are allowable discharges under this permit. All other nonstormwater discharges are not authorized and shall be either eliminated or covered under a separate VPDES permit.
2. Annual outfall evaluation for unauthorized discharges.
   a. The SWPPP shall include documentation that all stormwater outfalls associated with industrial activity have been evaluated annually for the presence of unauthorized discharges. The documentation shall include:
      (1) The date of the evaluation;
      (2) A description of the evaluation criteria used;
      (3) A list of the outfalls or on-site drainage points that were directly observed during the evaluation;
      (4) A description of the results of the evaluation for the presence of unauthorized discharges; and
      (5) The actions taken to eliminate unauthorized discharges if any were identified.
   b. The permittee may request in writing to the department that the facility be allowed to conduct annual outfall evaluations at 20% of the outfalls. If approved, the permittee shall evaluate at least 20% of the facility outfalls each year on a rotating basis such that all facility outfalls will be evaluated during the period of coverage under this permit.

E. Signature and SWPPP review.

1. Signature and location. The SWPPP, including revisions to the SWPPP to document any corrective actions taken as required by Part I A 6, shall be signed in accordance with Part II K, dated, and retained on-site at the facility covered by this permit in accordance with Part II B 2. All other changes to the SWPPP, and other permit compliance documentation, shall be signed and dated by the person preparing the change or documentation. For inactive and unstaffed facilities, the plan may be kept at the nearest office of the permittee.
2. Availability. The permittee shall retain a copy of the current SWPPP required by this permit at the facility, and it shall be immediately available to the department, EPA, or the operator of an MS4 receiving discharges from the site at the time of an on-site inspection or upon request.
3. Required modifications. The permittee shall modify the SWPPP whenever necessary to address all corrective actions required by Part I A 6 a (Data exceeding benchmark concentration values) or Part I A 6 b (Corrective actions). Changes to the SWPPP shall be made in accordance with the corrective action deadlines in Part I A 6 a and Part I A 6 b, and shall be signed and dated in accordance with Part III E 1.

   The director may notify the permittee at any time that the SWPPP, control measures, or other components of the facility's stormwater program do not meet one or more of the requirements of this permit. The notification shall identify specific provisions of the permit that are not being met, and may include required modifications to the stormwater program, additional monitoring requirements, and special reporting requirements. The permittee shall make any required changes to the SWPPP within 60 days of receipt of such notification, unless permission for a later date is granted in writing by the director, and shall submit a written certification to the director that the requested changes have been made.

F. Maintaining an updated SWPPP.

1. The permittee shall review and amend the SWPPP as appropriate whenever:
   a. There is construction or a change in design, operation, or maintenance at the facility that has a significant effect on the discharge, or the potential for the discharge, of pollutants from the facility;
   b. Routine inspections or compliance evaluations determine that there are deficiencies in the control measures, including BMPs;
   c. Inspections by local, state, or federal officials determine that modifications to the SWPPP are necessary;
   d. There is a significant spill, leak, or other release at the facility;
   e. There is an unauthorized discharge from the facility; or
   f. The department notifies the permittee that a TMDL has been developed and applies to the permitted facility, consistent with Part I B.
2. SWPPP modifications shall be made within 60 calendar days after discovery, observation or event requiring a SWPPP modification. Implementation of new or modified control measures (distinct from regular preventive maintenance of existing control measures described in Part III C) shall be initiated before the next storm event if possible, but no later than 60 days after discovery, or as otherwise provided or approved by the director. The amount of time taken to modify a control measure or implement additional control measures shall be documented in the SWPPP.
3. If the SWPPP modification is based on a significant spill, leak, release, or unauthorized discharge, include a description and date of the incident, the circumstances leading to the incident, actions taken in response to the incident, and measures to prevent the recurrence of such releases. Unauthorized discharges are subject to the reporting requirements of Part II G of this permit.

Part IV. Sector Specific Permit Requirements

The permittee must only comply with the additional requirements of Part IV (9VAC25-151-90 et seq.) that apply to the sectors of industrial activity located at the facility. These sector specific requirements are in addition to the requirements specified in Parts I, II and III of this permit. All numeric effluent limitations and benchmark monitoring concentration values reflect two significant digits, unless otherwise noted.

9VAC25-151-380. Sector AE – Facilities with no analytical benchmark monitoring requirements.

A. Discharges covered under this section. The requirements listed under this section apply to stormwater discharges associated with industrial activity from facilities with SIC Codes 2611, 2621, 2652-2657, 2833-2836, 2851, 2861-2869, 2891-2899, 3952, 3211, 3221, 3229, 3231, 3241, 3281, 3291-3299, 3331-3339, 3398, 3399, 3341, 1311, 1321, 1381-1389, 2911, 4512-4581, Treatment Works (TW), 2011-2015, 2032-2038, 2051-2053, 2061-2068, 2082-2087, 2091-2099, 2111-2141, 2211-2299, 2311-2399, 3131-3199, 2434, 2511-2599, 2711-2796, 3081-3089, 3931, 3942-3949, 3951-3955 (except 3952), 3961, 3965, 3991-3999, 3111, 3711-3799 (except 3731 and 3732 as identified in Sector Q), 3571-3579, 3612-3699, and 3812-3873.

B. No additional sector-specific requirements apply to this sector.

ARLINGTON COUNTY

ENVIRONMENTAL SERVICES DEPARTMENT

WATER POLLUTION CONTROL BUREAU

STANDARD OPERATING PROCEDURES

Contractor Safety Standard

Effective Date: April 1, 2016

New/Last Revision: ____

Safety Specialist Date:

Water Pollution Control Bureau

Approved By: ____

Thomas A. Broderick, Bureau Chief Date:

Water Pollution Control Bureau (WPCB)

APPLICABILITY

WPCB facilities, a bureau of the Department of Environmental Services. This is a site specific document written for use by the Water Pollution Control Bureau only.

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I. PURPOSE

The purpose of this standard is to provide minimum guidelines and procedures that will be followed by all Contractors who perform work or contracted services at the Water Pollution Control Bureau (WPCB) facility and remote WPCB locations (herein after the WPCB facilities). The guidelines outlined in this standard are to ensure the protection and safety of service Contractors, construction Contractors, sub–Contractors, WPCB employees, county employees, citizens (i.e. any personnel on WPCB property), property, equipment, and anyone who might be affected by the service contracted or construction work being performed at the WPCB. The Contractor Safety Standard shall be provided to all service and construction Contractors in order to communicate and outline known hazards at the WPCB facilities and to provide information that outlines the WPCB's Safety and Environmental procedures in order to comply with the following standards: Occupational Safety and Health Administration/Virginia Occupational Safety and Health (OSHA/VOSH) Title 29 CFR 1910, Standards for General Industry; Title 29 CFR 1926, Standards for the Construction Industry; Federal, State and Local laws; applicable national consensus standards; and Arlington County policies and procedures.

II. SCOPE

This standard applies to all Contractors performing work and/or services at the WPCB facilities. This includes Contractors who through a written contract are performing work or services at the WPCB facilities, as well as Contractors working on construction projects (upgrade or expansion) at the WPCB, such as the Master Plan 2001 upgrade and expansion project. Contractors bear sole responsibility for the safety of his or her employees. The Contractor must take all steps necessary to establish, administer, and enforce safety rules that meet or exceed the minimum laws, standards and procedures outlined in Section I of this standard. Contractors are also responsible for ensuring that all of their sub–Contractors comply with the requirements outlined within this standard.

III. GENERAL OVERVIEW OF THE CONTRACTOR SAFETY STANDARD

A. HEALTH AND HUMAN FACTOR CONSIDERATION

Contractors must recognize the fact that their employees, as well as sub–Contractors, often resist following safety and health laws due to scheduling requirements, inconvenience, and discomfort sometimes associated with wearing Personal Protective Equipment, and the requirements for specialized equipment. All service Contractors are responsible for meeting the intent of this standard for the work in which they were hired to perform in conformance to Section 1 of this standard. Hazardous conditions or practices not covered in an OSHA or VOSH standard may be covered under Section 5(a)(1) or 5(a)(2) (General Duty clause) of the Occupational Safety and Health Act of 1970, which states, "Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

B. MINIMUM STANDARD REQUIREMENTS

Listed below are the minimal requirements that will be followed by Contractors in conjunction with; Construction safety plans, where applicable, VOSH laws, County policies and procedures, State and Federal laws, as well as applicable National Consensus guidelines. All of the above will be followed in order to ensure that everyone (i.e. Contractors, sub–Contractors, facility employees, visitors, citizens on site, equipment, and property are protected from hazards). The main sections of the standard are listed below: 1) Written Contractor Program; (2) General Requirements; (3) Relationship with WPCB; (4) Designation of Competent Person(s); (5) Workplace Inspections; (6) Basic Safety Rules; (7) Safety permits and procedures; (8) Training requirements; (9) Facility Operations; (10) Housekeeping and Sanitation; (11); Maintenance and Inspection; (12) Storage; (13) Medical Services and First Aid; (14) Reporting Accidents and Incidents; (15) Environmental Issues; (16) Periodic review and Standard evaluation; and (17) Appendices #1–6: (Appendix #1 – General review of OSHA standards applicable to Contractors; Appendix #2 – Contractor Safety Checklist; Appendix #3 – Pre Job Contractor Safety Planning Checklist; Appendix #4 – Instructions for use of Appendix #3 & 4 – Checklists; Appendix #5 – Contact Telephone Numbers; and Appendix #6 – Facility Map of the WPCB).

IV. DEFINITIONS

Accident – An unplanned or unforseen event that may or may not result in physical harm and/or property or equipment damage; any unplanned event which interrupts the normal progress of an activity and is proceeded by an unsafe act, unsafe condition or some combination thereof. An accident may be seen as resulting from a failure to identify a hazard or from some inadequacy in an existing system of hazard controls.

Annually – Time period not to exceed 365 days.

ANSI – American National Standards Institute.

Approved – Sanctioned, endorsed, accredited, certified or accepted as satisfactory by a duly constituted and nationally recognized authority or agency.

Authorized – A person approved or assigned by the employer to perform a specific type of duty or duties or to be at a specific location or locations at the jobsite.

Certified or Licensed – A person possessing a license or certification issued by a reputable authority attesting that the person has been trained and/or tested and is qualified to perform specific tasks or operate specific equipment.

Competent Person – This person must be capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate or correct hazards.

Contractor – One who contracts to do work for another. This term is applicable to any person who enters into a contract, but is commonly reserved to designate one who, for a fixed price, undertakes to procure the performance of works or services on a large scale, or the furnishing of goods in large quantities, whether for the public, a company, or an individual. A Contractor is a person who, in pursuit of any independent business, undertakes to do a specific piece of work for another, using his/her own means and methods without submitting to their control in respect to all its details, and who renders service in the course of an independent occupation representing the will of his/her employer only as to the result of the work, and not as to the means of which it is accomplished.

Contractor Employee(s) – A person(s) employed by a Contractor.

Construction – Construction work means work for the creation of a structure, alteration, and/or repair including painting and decorating.

Construction Manager – The Construction Manager is responsible for the implementation of the construction project including all aspects of Contractor management and construction protocols.

Construction Program Management Company – The Construction Program Management Company is the person(s) or company contracted to represent WPCB and manage the facility upgrade and expansion projects conducted at the WPCB facilities and remote locations. They oversee the overall performance of the project including, but not limited to, budget, schedules, designer and Contractor management, work quality, safety and program communications.

Designated – Means selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

Designee – A designated or authorized person that has been given the responsibility for acting in another person's place in order to ensure that a task is performed.

D.O.T. – Department of Transportation (Federal agency).

Employee – The person taking direction from the employer. An individual who has an agreement to work for an employer and is compensated by that employer for his/her time and/or effort.

Employer – Employer for the purpose of this standard means Arlington County, Contractors or sub-Contractors working at the WPCB.

EMS – Emergency Management System.

Engineer Program Coordinator – The Water Pollution Control Bureau Engineer Program Coordinator is responsible for the coordination, contract administration and negotiations for facility upgrades and/or expansions.

General Contractor – General Contractor fits the description of a Contractor but has responsibility for the entire job or project.

Hazard Analysis /Evaluation – A review or evaluation by a person trained in hazard recognition to evaluate a work area. A Hazard Analysis is performed to identify hazardous conditions and gather data for the purpose of the elimination or control of the hazard.

Hazardous Atmosphere – An atmosphere that is poisonous, corrosive, oxidizing, irritating or otherwise harmful. The atmosphere is likely to cause injury or death.

Hazardous Substance – Any substance that has the potential of causing injury by reason of being explosive, flammable, toxic, corrosive, oxidizing, irritating or otherwise harmful to a person.

Imminent Danger – An impending or threatening situation that is dangerous with an outcome that could be expected to cause serious injury or death to persons in the immediate future unless corrective measures are taken.

Incident – An occurrence, happening or energy transfer that results from either positive or negative influencing events. An incident may be classified as an accident, mishap, or near miss, depending on the negative or positive outcome.

IDLH (Immediately Dangerous to Life and Health) – Any atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

Lift Stations – Pumping or flow metering stations that are located away or off-site from the main WPCB facility.

NIOSH – National Institute for Occupational Safety and Health.

OSHA – Occupational Safety and Health Administration.

PFAS – Personal Fall Protection System.

PPE – Personal Protective Equipment.

Qualified – A person by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training and experience has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work or the project.

SDS – Safety Data Sheets.

Sub-Contractor(s) – A person(s) who meets the definition of a Contractor but is only responsible for a portion of the job.

Training – Prior to beginning work at the WPCB, all Contractors must be trained regarding all aspects of Contractor protection and applicable safety and health requirements according to Titles 29 CFR 1910 or 29 CFR4 1926, and applicable national consensus standards relevant to the type of work being performed. (Note the section of this Contractor Safety Standards entitled “Training”).

VOSH – Virginia Department of Labor and Industry (Virginia Occupational Safety and Health Compliance Program).

WPCB – Water Pollution Control Bureau (i.e. facility, lift stations and other remote locations belonging to WPCB facility). .

V. RESPONSIBILITIES

The following responsibilities are assigned to make sure that both management and employees are involved in the Contractor safety process. Managers and employees are encouraged to become familiar with their responsibilities, as they will be held accountable for this standard as well as for reporting Contractors who fail to comply with this standard.

A. RESPONSIBILITIES OF THE BUREAU CHIEF

1. Take the necessary actions to ensure that a Contractor Safety Standard is established and maintained for the Bureau. Support managers and supervisors with resolving problem areas as they pertain to this standard.

2. Make sure that training regarding this Standard is established for all employees to include Contractor hazards and the contents of this standard. Additional training will be provided for those who are required to work directly with Contractors.

3. Support managers and supervisors through the budgetary and staffing process such that the contents of this standard are implemented and maintained in order to ensure the health and safety of Water Pollution Control Bureau employees as well as Contractor employees while contracted services are being performed at the WPCB facility.

4. Shall require that managers, supervisors and crew leaders, or their designees(s) implement, adhere to, enforce, and comply with this policy, and report unsafe acts and conditions to the appropriate authorities including the Safety Specialist and WPCB Bureau Chief.

5. Make best efforts to ensure that all contract documents for contracted or construction services contain the necessary information concerning safety, health, and environmental requirements that comply with all aspects of this standard.

6. Make best efforts to ensure that violations of this standard are addressed in a timely manner when Contractors or their employees fail to adhere to policies, laws, and standards outlined within this document.

7. Make best efforts to coordinate with the Arlington County Purchasing agent to ensure that the appropriate contract language is included in contract documentation to ensure Contractor compliance.

8. Makes best efforts to implement, adhere to, enforce, and comply with this standard, and take the necessary acts to address all unsafe acts, conditions, and violations of this standard.

B. RESPONSIBILITIES OF SAFETY SPECIALIST

1. Assist WPCB management to ensure that a written Contractor Safety Standard is implemented and periodically maintained.

2. Provide support and safety expertise to designated WPCB project employees assigned to Contractor or construction projects to ensure the health and safety of all employees at all WPCB locations.

3. Periodically ensure that the Contractor Safety Standard complies with applicable Arlington County policies, County, State, and Federal laws, as well as applicable National Consensus Guidelines.

4. Develop training that includes all aspects of the Contractor Safety Standard. Awareness training will be provided to all WPCB employees and additional training provided for those required to work with Contractors as a part of their job function. The Safety Specialist will coordinate, with the appropriate WPCB person who is in responsible charge of the Contractor in order to ensure that Contractors are aware

and adhere to appropriate safety training requirements outlined within this standard. Contractor employee safety training is the sole responsibility of the Contractor and must be conducted prior to work beginning at the WPCB facility.

5. Ensure that a hazard analysis of work areas is performed upon request to ensure that known facility hazards are identified prior to the beginning of Contractor service or work. Communication of this information will be via the person in responsible charge of the Contractor.

6. Ensure that the Contractor Safety Checklist completed by service and construction Contractors is reviewed and that necessary steps are taken to ensure compliance with the WPCB Contractor Safety Standard.

7. Ensure that the Contractor Safety Standard is monitored and that a periodic Standard review is conducted to ensure compliance.

8. Periodically monitor for any changes of County, State, or Federal laws, and applicable national consensus standards that might require subsequent changes to this Contractor Safety Standard. Make sure that any updates or changes are made in a timely manner after the periodic review, and communicated to the appropriate employees.

9. Shall inform the Bureau Chief in a timely manner of any violations of this policy of which the Safety Specialist has been made aware.

10. Shall include a review of this policy in all training provided to employees in the New Employee Orientation training.

C. RESPONSIBILITIES OF THE OPERATIONS/MAINTENANCE MANAGERS

1. Ensure that WPCB employees performing job duties requiring them to work with Contractors as a part of their job are identified to the Safety Specialist.

2. Ensure that employees within their sections adhere to all aspects of the Contractor Safety Standard.

3. Ensure that all safety concerns surrounding Contractors are promptly resolved or referred to the Safety Specialist or designee for review and resolution.

4. Ensure that any accidents, exposures, or concerns that are communicated to them by employees are reported immediately or within 24 hours to the Safety Specialist or designee, so that the appropriate steps such as inspections or hazard analysis can be conducted immediately in order to resolve concerns. In the event that the Safety Specialist is not available, the designee will up channel the report to the WPCB Chief, and brief the Safety Specialist as soon as possible.

5. Shall be responsible for taking all action necessary to implement and enforce this policy.

6. Shall budget adequate funding for the implementation and maintenance of this policy.

D. RESPONSIBILITIES OF SUPERVISORS

1. Make sure that employees comply with all aspects of this standard.

2. Ensure that any changes in the work place due to contracted services that might pose a health or safety hazard to Contractors or employees are reported to the

appropriate Manager, Safety Specialist, or designee immediately for proper evaluation and resolution.

3. Report problem areas immediately to the appropriate Manager, Safety Specialist, or designee for prompt inspection or resolution prior to allowing employee(s) to enter areas where Contractors are working.

4. Ensure that employees comply with all signs, barricades, or warnings implemented by Contractors to ensure site safety.

5. Monitor and periodically access Contractors to ensure compliance with this standard and report any violations to the appropriate Manager, Safety Specialist, or designee immediately.

6. Monitor and periodically assess the safe use of Contractor equipment by Contractor employees while they are working in areas that are under their supervision.

7. Ensure that WPCB employees do not provide WPCB equipment to Contractors for use under any circumstances, other than emergency equipment such as eyewash facilities, AEDs, and first aid supplies - and only in the event of an emergency.

8. Ensure that Contractors return work areas to a safe condition upon completion of contracted services before leaving the WPCB work site.

E. RESPONSIBILITY OF WPCB RELIABILITY ENGINEER, PLANNERS/OR DESIGNEE/ENGINEERING PROGRAM COORDINATOR/PROGRAM MANAGERS OR OTHER WPCB EMPLOYEES REQUIRING CONTRACTED SERVICES

1. Ensure that all work is planned, looking at the safety-related aspects of the job. Ensure that the hazards associated with the work that is to be performed are outlined and communicated to the Contractor before the work is started.

2. Ensure that Contractors working on jobs are aware that they have responsibility for complying with all aspects of this standard.

3. Ensure that any changes in the work place due to contracted services that might pose a safety hazard to Contractors or employees are reported to the appropriate Manager, Safety Specialist, or designee immediately for proper evaluation and resolution.

4. Report problem areas immediately to the Manager, Safety Specialist, or designee for prompt inspection or resolution prior to allowing employees to enter areas where Contractors are working.

5. Ensure that facility employees comply with all signs, barricades, or warnings implemented by Contractors to ensure site safety during contracted services or construction.

6. Monitor and periodically assess Contractors to ensure that they are not violating this standard, and report any violations to the appropriate Manager, Safety Specialist, designee, or WPCB point of contact immediately. In the event that the Safety Specialist is not available, the designee will up channel the report of all accidents, exposures or concerns to the WPCB Chief, and brief the Safety Specialist as soon as possible.

7. Monitor and periodically assess the safe use of Contractor equipment by Contractor employees while they are working in areas on projects that they oversee.

8. Ensure that WPCB personnel do not provide WPCB equipment to Contractors for use under any circumstances other than emergency eyewash facilities, AED’s, and first aid supplies - and only in the event of an emergency.

9. Ensure that Contractors maintain housekeeping in such a way as to not pose hazards to facility employees and others.

10. Ensure that Contractors return work area to a safe condition upon completion of work before leaving the WPCB work site.

11. Ensure that safety-related paperwork generated by the Contractor is turned in to the safety office in a timely manner for record keeping purposes.

12. Report all instances, which you have been made aware of, concerning the Contractor(s) failure to comply with this standard immediately to the appropriate Construction Management, Safety Specialist, or designee for prompt inspection or resolution.

13. Make best efforts to ensure that issues concerning safety and health are addressed in a timely manner between the WPCB Safety Specialist and the designated construction safety employees.

F. RESPONSIBILITIES OF ENGINEER PROGRAM COORDINATOR OR DESIGNEE

1. Make best efforts to coordinate contract administration, negotiations, and communications regarding the contract to facility employees to ensure the safety of all employees throughout the construction project.

2. Make best efforts to ensure that all construction contract language and documents contain the necessary information concerning safety, health, and environmental requirements that comply with all aspects of this standard.

G. RESPONSIBILITIES OF ALL EMPLOYEES

1. Adhere to all signs, warnings, and barricades implemented by the Contractor to ensure facility safety.

2. Ensure that any changes in the facility that occur as a result of, or during work being performed by Contractors that might pose a hazard to anyone is reported to his/her Supervisor immediately for proper evaluation and resolution.

3. Report all observations of Contractor unsafe acts or conditions immediately to his/her Supervisor for prompt resolution.

4. Report any observations of Contractor unsafe use of equipment, equipment malfunction, need for equipment repair, damage, or replacement needs to the supervisor for proper resolution.

5. Do not under any circumstances provide Contractors tools or equipment belonging to the WPCB other than emergency equipment such as eyewash facilities, AED's, and first aid supplies - and only in the event of an emergency. Report any request for these items immediately to the WPCB Supervisor.

6. Attend scheduled Contractor training as required by WPCB management.

VI. REQUIREMENTS

A. MINIMUM REQUIREMENTS

1.) Written Contractor Safety Standard – The WPCB will implement, maintain, review, and update a written Contractor Safety Standard that provides guidance designed to protect workers from known hazards that have been identified in the workplace. Companies who perform contracted work and/or services within the WPCB facility or offsite locations will adhere to the contents of this Standard, as well as all applicable national consensus standards listed in Section I of this standard.

2.) Contractor General Requirements – Contractors shall be subject to the OSHA/VOSH provisions outlined in the Contractor Safety Standard which has been prepared for the protection and safety of WPCB employees, other Contractors, property, and anyone who may be affected by work being performed. Contractor work can potentially affect the safety of all employees and property, and for this reason the Contractor Safety Standard shall be provided to all Contractors working at the WPCB. Due to the wide variety of services that Contractors and construction companies could provide while working at the WPCB, it is not feasible to outline every applicable law, standard, and work practice in this document. Contractors bear sole responsibility for the safety of their employees. Contractors must take all steps necessary to establish, administer, and enforce health and safety rules and regulations that meet or exceed the following regulatory requirements: VOSH (Virginia Occupational Safety and Health); OSHA (Occupational Safety and Health Administrator); DEQ (Virginia Department of Environmental Quality); Virginia Workers' Compensation Commission; all Local, State, and Federal laws; and applicable national consensus Safety and Environmental standards. Contractors are expected to take all steps necessary to establish, administer, and enforce safety rules that meet or exceed the regulatory requirements listed above. Hazardous conditions or practices not outlined in a specific VOSH or PSHA standard may be covered under section 5(a)(1), 5(a)(2) (i.e., the General Duty clause of the Occupational Safety and Health Act of 1970 which states that, "Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.") Contractors bear sole responsibility for communication and safety-related information and requirements to sub-Contractors working under their direction. Contractors shall ensure that their sub-Contractors comply with the requirements outlined herein.

3.) Relationship with WPCB – All agencies, firms, or companies conducting work at the WPCB facility must comply with the requirements of this standard. Contractors shall adhere to all safety requirements outlined in purchasing documentation. The agency, firm, or company shall maintain appropriate insurance - including general liability, auto liability, and Worker's Compensation insurance. Verification of insurance shall be sent to the Arlington County Purchasing Agent prior to the start of work. The Arlington County purchasing agent can be reached at 703-228-3410.

4.) Designation of Competent Person – The designation of a competent person will be required when the job consists of work that meets the definition of construction as outlined in 29 CFR 1926. The selection of a Competent Person will be made in accordance with the requirements outlined in 29 CFR 1926.32. The competent person must have the ability and authority to address and remedy hazards that are identified in a timely manner.

5.) Workplace inspections – An assessment of all areas and types of equipment currently being utilized for contracted services is ongoing and may be conducted while the Contractor is working on site. The duration of inspections will depend upon the type of work being performed, the hazards associated with the work, and the amount of time that the Contractor will be working at the WPCB. Inspections may be conducted upon request when non–compliance to this standard is demonstrated, or upon request by any affected employee. The purpose of this assessment will be to identify possible Contractor hazards that might exist in the workplace. The hazard analysis must be conducted by a person trained to recognize hazards and must be documented. The hazard analysis must adequately access the potential for the use of Administrative or Engineering controls and must be conducted prior to recommendations being made for the use of Contractor protection. Contractors must be notified of deficiencies immediately.

6.) Basic Safety Rules – An employee of a contractor may be temporarily or permanently removed from the WPCB for the following reasons:

- Possession or use of alcoholic beverages or related drugs not prescribed by a physician
- Being under the influence of prescribed or non-prescribed medications that could influence behavior or equipment operation
- Not using appropriate PFAS (Personal Fall Protection System)
- Failure to wear the appropriate PPE. The following PPE (Personal Protective Equipment) is required at all times on the WPCB site:
    - Hard Hat
    - Safety Toe Footwear

  - Safety Glasses with Side Shields

Note: In addition Construction Contractor employees will also be required to wear:

    - Long Pants
    - Shirts that cover the shoulders

  - Reflective Vest

A hazard assessment may indicate the need for additional PPE. All designated PPE must be worn by Contractors and their employees.

- Fighting or horseplay
- Possession of explosives, firearms, ammunition, or other weapons
- Deliberate violation of safety or security rules
- Ignoring “Danger,” “Caution,” or other safety-related signs or barricades
- Unauthorized removal or destruction of a safety barricade, guardrails, warning signs, fall protection, or other warning devices intended to protect WPCB employees, property, or others on the WPCB site.
- Illegal dumping, handling or disposal of hazardous chemicals or materials
- Destruction or removal, without written permission of any property belonging to WPCB, WPCB employees, or other Contractors or their employees
- Intimidating, threatening, harassing, impeding, or interfering with an inspector, police officer, security officer, WPCB employee, VOSH Compliance Officer, state or federal employee, or designated representative of any of these agencies
- Using emergency exits other than for emergencies
- Misuse of fire prevention and protection equipment
- Not maintaining an orderly and clean work area
- Violating any Arlington County policy, Local, State, or Federal safety and environmental law
- Operation of equipment or vehicles without mandated State license, endorsements, or equipment-specific training
- Failure to notify Miss Utility of Virginia and keeping tickets current. Miss Utility of Virginia can be reached at 1–800-552-7001.

7.) Safety Permits and Procedures – There are no operations that Contractors or sub–Contractors might perform that could represent a hazard to their employees, WPCB employees, and others at the facility. Approval must be obtained through the WPCB Safety Specialist or designee, Shift Supervisor, EMS Administrator, Contract Administrator, WPCB Planners, or other WPCB designated points of contact before the following work is to begin:

- Working on fire protection/detection systems
- All hot work including, but not limited to burning, welding, cutting, or soldering requires a hot permit
- Working on electrical, steam, chilled water systems, chemical systems and piping, chemical storage containers
- Working on or near energized systems
- Working on or moving emergency equipment (fire extinguishers, first aid kits, etc.) provided by WPCB
- Installing a temporary electrical service or system
- Working with hazardous chemicals (including solvents, paints, pesticides, and herbicides)
- Generating Hazardous Waste (such as waste oil)
- Using powder-actuated tools
- Using a gas, diesel, or LP (propane) powered engine indoors
- Operating a powered vehicle or self–propelled work platform
- Excavating/trenching
- Using radioactive source or conducting field radiography (x–ray)
- Working with asbestos–containing materials
- Working with lead–containing materials
- Working with Silica containing materials
- Working on security systems
- Working with compressed air/gases

- Using a laser
- Working on a fume hood
- Working on a solvent storage cabinet
- Working on heating, ventilation, or air conditioning systems
- Working on a roof
- Lifting or hoisting with cranes, derricks, hoists or helicopter (Note - construction project may require a “Critical Lift Plan” before work begins)
- Performing blasting operations
- Confined Space Entry
- Working in close proximity to basins, tanks, and any other space containing large amounts of liquid
- Any work that involves a discharge or potential discharge to the storm sewer system (i.e., hydrant flushing, coil cleaning, etc.)

8.) <u>Training Requirements</u> – All contractors, sub–Contractors and their employees must be trained, according to OSHA and VOSH requirements, in general safety relative to the jobs that they are expected to perform while working at the WPCB. This training must be conducted and documented prior to employees beginning work at the WPCB facility. Training regarding specific hazards must be provided to anyone working at the WPCB facility prior to the beginning of work on site. Anyone required to operate specialized equipment must be certified to do so. Specialized equipment includes, but is not limited to, all heavy equipment such as cranes, scrapers, bulldozers, track machines, front end loaders, Bobcats, fork trucks, stinger cranes, and backhoes. A copy of the training certification must be current and available upon request by WPCB management or designee. Contractors working during a construction project at the WPCB must conduct the above safety training as well as any additional instruction that is defined in the training portion of the Contractor specifications or documentations. The use of any machinery, tool or equipment by a person who has not been trained in accordance with applicable requirements of the VOSH (Virginia Occupational Safety and Health) or OSHA (Occupational Safety and Health Administration) is prohibited.

9.) <u>Facility Operations</u> – Care must be observed to not disrupt facility operations or cause conditions that could violate the WPCB Department of Environmental Quality Virginia Pollution Discharge Elimination System permit. The following rules apply for working on any system that impacts the operation of the facility:

- Only trained WPCB Operations employees may shut down, start up, or adjust equipment and facilities that impact the operation of the facility.
- Contractors must notify the WPCB supervisor or designated persons and must coordinate with appropriate WPCB Operations employees in advance of the need for shutdowns and startups of any facility system.
- Lock Out and Tag Out of facility systems must be coordinated with the WPCB supervisor or designated Operations employees
- The attachment and disconnection of Backflow Prevention devices must be authorized and coordinated with the WPCB Supervisor or designated Operations employees
- Contractors must notify the WPCB Supervisor or designee of suspected or actual hazardous materials or substances observed or discovered in the course and scope of their work

10.) Housekeeping and Sanitation – Contractors must maintain good housekeeping while working on WPCB facilities at all times. Poor housekeeping at a jobsite may lead to increased potential for safety hazards and an increased incidence of accidents and chemical spills. Contractors are expected to comply with 29 CFR 1926.25, and must:

- Keep all work areas neat, clean, orderly, and free of excess trash and debris
- Keep form and scrap lumber with protruding nails and all other debris clear from work areas
- Combustible scrap and debris shall be removed on a regular basis to prevent safety and fire hazards from occurring
- Containers shall be provided for collection and separation of all refuse. If the Contractor is utilizing the Arlington Water Pollution Control Plant waste conveyance system per the Contract, the Contractor shall provide appropriate separate waste containers to segregate the refuse into the following categories: metals, glass, plastic, clean paper, and other non–hazardous materials. No hazardous materials will be disposed of via the Arlington Water Pollution Control Plant waste conveyance system by the Contractor.
- Containers that comply with OSHA/VOSH standards shall be provided and used for flammable or harmful substances. Containers must be properly labeled.
- Wastes shall be disposed of at frequent intervals to prevent safety and fire hazards from occurring

- Lay down/Staging areas shall be orderly and free from tripping hazards
- Impeding access to walkways, stairs, driveways, or roadways can only be done with the permission of the Safety Specialist and the WPCB Bureau Chief or designee. Fire exits cannot be impeded or blocked under any circumstances.
- The Contractor shall provide adequate water and sanitation facilities for Contractor employees during major construction. These provisions will be outlined in the construction contract. Service Contractors will be permitted to utilize water and sanitation facilities within WPCB facilities.

11.) Maintenance and Inspection – All Contractor employees required to wear or use safety equipment must conduct visual inspections prior to the wear or use of the equipment. The purpose of this inspection is to identify the need for repairs of faults/damage that could hamper or impair the use of the equipment or cause accidents. The employee is responsible to report maintenance and repair concerns to their supervisor immediately. Equipment must be immediately replaced with the same make, model and size, or equivalent equipment. The employee will not wear or use equipment that they identify during the inspection process as needing repair or being unsafe.

12.) Storage of equipment – Contractor equipment must be stored in such a way as to ensure that it remains clean and ready for use when needed. It should also be stored in such a way as to not cause an unsafe condition and to ensure that no one else is able to use or misuse the equipment. Lay down areas must be kept neat and items that must be stacked and stored must be stored at a minimum of 12” off the ground.

13.) Medical Services and First Aid – All Contractors performing work at the WPCB are to ensure that Medical and First Aid Services are available to their employees in the event that their employee(s) are involved in an accident. All aspects of Section 17, Appendix 1 – Item 17.11 must be followed.

14.) Reporting Accident and Incidents – Contractors must report all accidents and incidents that have caused, or have the potential to cause injury, illness, property loss or damage to the appropriate WPCB personnel immediately or within 24 hours according to Section 17, Appendix 1 – Item 17.28.

15.) Environmental Issues – All applicable Environmental regulations and standards must be followed while work is being performed at the WPCB facilities. All spills must be reported immediately to the WPCB Supervisor, EMS Administrator, Safety Specialist, or WPCB designee. Clean up and disposal of hazardous waste must be coordinated with one of the WPCB employees listed above.

16.) <u>Periodic Standard Review and Evaluation</u> – The Safety Specialist or WPCB designee will review the requirements of this standard periodically and when changes occur that might impact the current Standard. Any changes in the Standard will be identified and communicated to all employees who are impacted by this Standard within the Bureau.

B. APPENDICES TO STANDARD (1–6)

VII. WORKPLACE HAZARD ASSESSMENT

A workplace hazard assessment is a qualitative evaluation of potential hazards in all elements of a system (i.e. employees, equipment, and facilities). For the purpose of this standard an assessment will be conducted with a focus on potential Contractor hazards. The results of these assessments will be used to recommend Administrative and Engineering Controls first. In the event that these controls will not adequately reduce facility hazards, recommendations by Contractors for their staff will be required to supply and enforce the use of PPE that provides adequate protection against the hazards to which their employees will be exposed.

VIII. HAZARD PREVENTION AND CONTROL

Every effort will be made to prevent and control Contractor hazards by the use of Administrative and Engineering controls. Guidance from other VOSH standards including, but not limited to, Hazard Communication, Confined Space, the Control of Hazardous Energy, and various equipment standards will also be used to assist in this process. However the controls utilized must minimize and reduce identified hazards to acceptable levels as noted in OSHA/VOSHA, NIOSH, ACGIH and other applicable national consensus standards. The WPCB will inform the Contractor of known hazards in work areas without the hazards generated by the performance of the task(s). The Contractor will determine the additional hazards in work areas based on the performance of the task(s).

IX. RECORDKEEPING

Recordkeeping for all aspects of the Contractor Safety Standard shall be maintained by the Safety Specialist or WPCB designee. Records will include the following:

- Completed – Contractor Safety Checklist by companies
- Completed – Contractor Safety Planning Checklist
- Completed – Contractors Confined Space Permits

- Documentation of all onsite Contractor accidents

- List of Contractors, subs, consultants, etc., who are anticipated to be working onsite (needs to be submitted prior to Contractor proceeding with work)
- Safety Data Sheets for chemicals used by Contractors (needs to be submitted prior to proceeding with work

These records will be maintained in accordance with OSHA/VOSHA recordkeeping requirements.

The above-noted information must be provided to the Safety Specialist or WPCB designee prior to or immediately after completion of the work element.

X. SOURCES INFORMATION FOR STANDARD

- Local, State, and Federal Environmental Regulations
- Local, State, and Federal Occupational Safety laws including OSHA/VOSH –
- Title 29 CFR 1910 and 1926
- Applicable national consensus standards

SECTION 17 APPENDIX 1 SAFETY STANDARD SUMMARY

17.1 – Flammable and Combustible Liquids

- Flammable and combustible liquids shall only be stored in accordance with OSHA 29 CFR 1910.106. Flammable and combustible liquids must be stored in approved and labeled containers.
- Flammable and combustible liquids must only be stored in appropriate quantities for the job site use.
- Plastic gasoline cans are not allowed on site.
- Containers must meet all qualifications listed in OSHA 29 CFR 1910.106.
- Conspicuous and legible signs prohibiting smoking shall be posted in service and refueling areas as well as where large amounts of flammable materials are stored.
- Flammable liquids shall be dispensed through grounded and bonded containers.
- Flammable and combustible liquids must have appropriate containment.
- Flammable and combustible liquids cannot be stored near doors that would be used for emergency exits or in egress areas.

- Storage locations shall have at least one approved portable fire extinguisher that is appropriate for the materials that are being stored and any other flammable materials or ignition sources that are present in the storage area.

17.2 – Liquefied Petroleum Gas (LP Gas)

- Storage of LP Gas within buildings is prohibited.

- Each system shall have containers, valves, connectors, manifold valve assemblies, and regulators of an approved type.

- All cylinders shall meet DOT (Department of Transportation) specifications.

- Every container and vaporizer shall be provided with one or more approved safety relief valves or devices.

- Containers shall be placed upright on firm foundations or otherwise firmly secured.

- Portable heaters shall be equipped with an approved automatic device to shut off the flow of gas in the event of flame failure.

- Storage locations shall have at least one approved portable fire extinguisher.

17.3 – Compressed Air Tools

Must comply with 29 CFR 1910.179

- Pneumatic power tools shall be secured to the hose or whip in a positive manner to prevent accidental disconnection.

- Safety clips or retainers shall be securely installed and maintained on pneumatic impact tools to prevent attachments from being accidentally expelled.

- The manufacturer's safe operating pressure for all fittings shall not be exceeded.

- All hoses exceeding 1/2- inch diameter shall have a safety device at the source of supply or branch line to reduce pressure in case of hose failure.

- Damaged hoses shall not be used and must be removed from service immediately.

17.4 – Compressed Air

- Compressed air used for cleaning purposes must be less than 30 P.S.I.

- Compressed air for cleaning will only be used with effective chip guarding and personal protective equipment.

- Compressed air is NOT to be used on any individual for cleaning, dusting off clothing, or any other purpose.

17.5 – Compressed Gas Cylinders

Compressed gases can pose a severe hazard. Contractors must take the following measures for their protection and the protection of others:

- Valve protection caps must be in place when compressed gas cylinders are transported, moved, or stored.
- Close cylinder valves and replace valve protection caps when work is complete and when cylinders are empty or moved.
- Secure compressed gas cylinders in an upright position in a welding cart or to a solid object (using chains, straps, or a rigid retaining bar).
- Secure compressed gas cylinders on an approved carrier in an upright position while being transported. Cylinders shall only be moved with suitable hand truck, forklift truck, cylinder pallet system or by vehicles that are in compliance with D.O.T., OSHA/VOSH standards. The cylinders must be secured to the device or vehicle in such a way as to guard against dropping or permitting containers to violently strike against each other or other surfaces. Personnel who handle containers must be trained in the safe handling and storage of compressed gasses in containers.
- Keep cylinders at a safe distance or shielded from welding or cutting operations.
- Do not place cylinders where they can contact an electrical circuit. Do not hang welding leads or electrical cords from cylinders.
- Keep oxygen and flammable gas regulators in proper working order and a wrench in position on the acetylene valve when in use.

- Oxygen and flammable gas cylinders in storage must be separated by 20 feet or a 5 foot high fireproof barrier having a fire-resistance rating of at least one-half hour Cylinder storage is addressed in 1910.253 (b)(2)(iv) for General Industry and 1926.253 (b)(4) for Construction. Keep cylinders a safe distance from any heat, flame, and/or spark producing activities.

- If a leak develops in a cylinder and it cannot be immediately corrected, move the cylinder to a safe location outdoors Away from sources of ignition, fuel, and oxidizers and slowly empty. This must be done a safe distance away from flammable or combustible materials, confined spaces, and ignition sources. Contractor shall follow all manufacturer recommended procedures for handling leaking cylinders.

- Use only approved spark igniters to light torches. Matches or cigarette lighters are strictly prohibited.

- Cylinders must not be taken into or stored in confined spaces, including gang boxes and office/storage trailers.

- Store hoses and regulators according to OSHA, VOSH, and applicable National Consensus Guidelines.

- Contractor shall properly store and secure all cylinders according to OSHA, VOSH, and applicable National Consensus Guidelines in order to prevent unauthorized personnel from accessing the cylinders. In addition, the partially filled or empty cylinders that will not be utilized within 24 hours must be removed from the job site.

17.6 – Control of Fugitive Emissions

The Contractor shall take all reasonable precautions necessary to control fugitive emissions from the job site. Fugitive emissions include, but are not limited to: nuisance dust, chemical odors, vapors, gases, and hazardous materials (such as lead dust or asbestos).

Where the product(s) or material(s) to be used by the Contractor has a permissible exposure limit (PEL) established by OSHA or VDLI, the Contractor shall take all reasonable steps to maintain exposures below the PEL. Contractor employees, WPCB employees and the public must be protected from exposure to product or material. Where products or materials may cause exposure, the Contractor shall monitor, or shall contract to have monitored, work area exposure conditions. Monitoring shall occur, at a minimum, prior to, during, and after the start of work and whenever there is a change in procedure, process, or chemical or material used. If exposures cannot be maintained below the PEL, the Contractor shall restrict access to all areas where exposures exceed the PEL to authorized employees only who have been provided the required PPE for the operation. Safety Specialist or designee shall be notified if the potential exists for the PEL to be exceeded.

17.7 – Pest Control

The Contractor shall not use any insecticide/pesticide products on WPCB facilities unless such activities are part of contracted work, workers are specifically trained and licensed to use/apply the product and prior approval for use has been obtained from the WPCB EMS administrator, Safety Specialist/designee, and the Operations Manager/designee (all three are required). The Pest Control Contractor shall provide a copy of the SDS for any chemicals to be used for Pest Control at the WPCB. Care shall be taken by the Contractor to ensure that no persons are exposed to insecticide/pesticide products while pest control work is being performed at WPCB facilities. Contractors must notify the WPCB designated contact person, designee or the Shift Supervisor immediately when his/her employees see evidence of cockroaches, rats, mice, ants or other pests during the course of their work. Contractors must ensure that they perform their on-site operations in a manner that minimizes the potential for pest and insect infestation including, but not limited to, potential, maintaining housekeeping on the project site, utilizing rodent-proof trash receptacles and securing door/window/wall penetrations and other access points. In addition, the Contractor shall take all necessary measures to prevent the insecticide/pesticide from entering the process streams in the WPCB facilities unless the process stream is the prior determined target for the application of the insecticide/pesticide. Also, the Contractor shall take all necessary measures to prevent the insecticide/pesticide from entering the storm drainage system and the receiving waters.

17.7 – Herbicides

The Contractor shall not use any herbicide products on WPCB facilities unless such activities are part of contracted work, workers are specifically trained and licensed to use/apply the product, and prior approval for use of the product has been obtained from the WPCB EMS administrator, Safety Specialist/designee, and the Operations manager/designee (all three are required). The Herbicide Control Contractor shall provide a copy of the SDS for any chemicals to be used for plant control at the WPCB. Care shall be taken by the Contractor to ensure that no persons are exposed to herbicide products while plant control work is being performed at WPCB facilities. In addition, the Contractor shall take all necessary measures to prevent the herbicide from entering the process streams in the WPCB facilities unless the process stream is the prior determined target for the application of the herbicide. Also, the Contractor shall take all necessary measures to prevent the herbicide from entering the storm drainage system and the receiving waters.

17.8 – Air Emissions

Contractors must ensure compliance with all applicable local, state, and federal air emissions regulations pertaining to the operations of their on-site equipment.

17.9 – Combustion Units

Combustion units include, but are not limited to, boilers, heaters, emergency generators and kilns. All Contractors must immediately report the following to the WPCB designated contact person, designee or the Shift Supervisor.

- Any installation, maintenance or repairs to a combustion unit that could result in a change in maximum heat input valve or overall emissions (e.g. burner replacement or fuel conversions)

- Any conditions discovered which could have resulted in an increase on air pollutant emissions.

- Prior to beginning work on any combustion unit, the Contractor must notify the WPCB designated contact person

17.10 – CFC-Containing Unit

CFC containing units include those containing any ozone depleting refrigerants including, but not limited to, Chloro-fluorocarbons (CFC), Hydro chloro-fluorocarbons (HCFC) and Halon. Contractors shall immediately notify the WPCB designated contact person, designee or the Shift Supervisor whenever they become aware of any unintentional or intentional release of CFC's above de-minims levels as established by EPA regulations. The intentional release of CFC's and Halon is prohibited.

Contractors must immediately notify and provide documentation to the WPCB designated contact person, designee or the Shift Supervisor whenever:

A leak rate equals or exceeds the limits established in 40 CFR part 82, OSHA, VOSH, General Consensus Guidelines, or other applicable laws and/or regulations.

Contractors must provide the following documentation to the WPCB designated contact person, designee or the Safety Specialist:

- EPA certifications for any re-claimers to which CFC products evacuated from WPCB systems are to be sent.

- Certifications for any CFC recycle/recovery equipment to be use for WPCB.

- Technician Certifications

- Service records for all units containing greater than 50 pounds of refrigerant. Records must include the date and type of service and the type and quantity of refrigerant added.

17.11 – Medical Services and First Aid

- A person(s) employed by the Contractor who is trained to render First Aid and CPR must be on site or, in the absence of an infirmary or onsite medical employees, a clinic or hospital in near proximity to the facility must be designated for treatment of injuries sustained by Contractor employees.

- Adequate first aid supplies, based on information contained within American National Standard (ANSI) Z308.1.1998 “Minimum Requirements for Workplace First-aid Kits”, are to be provided by the Contractor for their employees.

- Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. WPCB has emergency showers located throughout the facility that the Contractor is permitted to use in emergencies. The Contractor and the WPCB shall verify, together at the same time, that the emergency showers and eyewashes are properly operational prior to beginning work.

- WPCB has 6 AED’s, Phillips Heart Start defibrillators, located on site. Contractors must contact the WPCB Shift Supervisor or Safety Specialist/designee immediately if ones of these units is needed or activated.

17.12 – Hand and Power Tools

- Electric power operated tools shall either be approved double-insulated, or be properly grounded, and used with ground fault circuit interrupters when used in damp or wet areas.

- Only authorized and properly trained employees shall use power tools.

- Powder actuated tools must only be used by trained operators and warning signs posted in all areas affected by the noise of the nail gun.

- Wrenches shall not be used when the jaws are sprung to the point slippage occurs.

- Impact tools shall be kept free of mushroomed heads.

- The wooden handles of tools shall be kept free of splinters or cracks and shall be kept tight in the tool.

17.13 – Confined Spaces

ALL CONFINED SPACES IN THE WPCB FACILITY ARE 'PERMIT REQUIRED'

The Contractor has responsibility to implement and maintain its own Confined Space Entry Program, including a written program, and a provision for emergency rescue. The Contractor can designate rescue to be done by the Arlington County Fire and Rescue Department prior to beginning work. The Arlington County Fire and Rescue Department can be contacted by dialing 911 and requesting Technical Rescue. The Contractor shall perform confined space entry in accordance with the OSHA 29 CFR 1926.20 and/or 1910.146 as applicable and Virginia Department of Labor and Industry (VDLI) requirements. The Contractor's written program shall be made available to the WPCB Safety Specialist or the WPCB designated contact person or designee for review upon request.

When the WPCB arranges to have a Contractor perform work that involves entry into a 'Permit-Required' confined space, the WPCB designated contact person or designee will:

- Inform the Contractor that the workplace contains 'Permit Required' confined spaces and that entrance into permit spaces are allowable only through compliance with the above mentioned regulations.

- Apprise the Contractor of the elements, including the hazard(s) identified and the reason for why the space is a confined space and a permit is required for entry.

- Apprise the Contractor of any precautions or procedures that WPCB has implemented for the protection of WPCB employees in or near 'Permit Required' spaces where Contractor employees will be working.

- Debrief the Contractor at the conclusion at the conclusion of the entry operations regarding the permit space program followed and any hazards confronted or created in permit spaces during entry operations.

- The Contractor must provide a copy of the permit for the entry into the space to WPCB designated contact person or designee who will forward the copy to the Safety Specialist.

Each Contractor who is retained to perform work that will require permit space operations shall:

- Coordinate entry operations with the WPCB designated contact person or designee whether or not both the Contractor and WPCB employees will be working in or near the permit spaces.

- Inform the DES Safety Specialist/designee in writing of the permit space program the Contractor will follow and provide a copy of the Confined Space Entry program for review at least one month prior to performing any Confined Space Entries.

- Inform DES Safety Specialist/designee of any hazards confronted or created in permit spaces during operations.

- Inform the WPCB Safety Specialist/designee in writing of the rescue services/team they will be using during entry (if Arlington County Fire and Rescue are to be used outline how they will be contacted immediately for notification of an emergency. i.e. cell phone or other method). Notification of the Safety Specialist or WPCB point of contact shall also be made in conjunction with the 911 call.

- Provide a copy of the canceled permit(s) to the WPCB Safety Specialist or the WPCB point of contact at the conclusion of entry operations.

17.14 – Ladders

- The use of ladders with broken or missing rungs, steps, broken or split side rails or with other faulty or defective construction is prohibited.

- When ladders with such defects are discovered they shall immediately be withdrawn from service.

- Portable ladders shall be placed on a substantial base at a 4 to 1 pitch, have clear access at top and bottom, extend a minimum of 36 inches above the landing, or where practical, be provided with grab rails and be secured against movement while in use.

No portable metal ladders will be permitted for any type of work.

- Weight limits of ladders shall not be exceeded.

- Job-made ladders shall be constructed for their intended use. Cleats shall be uniformly spaced, 12 inches, top-to-top.

- Except where either permanent or temporary stairways or suitable ramps or runways are provided, ladders shall be used to give safe access to all elevations.

- All users of ladders shall be properly trained and documented by the Contractor.

- Ladders shall be inspected periodically by the Contractor and removed promptly should any defects be found.

17.15 – Powder–Actuated Tools

Powder-actuated tools can pose many hazards; therefore their use will not be permitted in WPCB facility buildings without approval of the WPCB Safety Specialist or designee. In addition:

- Contractor employees who operate, load, maintain, etc. powder-actuated tools must be properly trained in their use as specified by the manufacturer.

- Each powder-actuated tool must be stored in its own locked container when not being used.

- A sign of at least 7 inches by 10 inches with bold face type reading "POWDER-ACTUATED TOOL IN USE" must be conspicuously posted in the area where the tool is being used and at all entrances immediately adjacent to the work area.

- Powder-actuated tools must be left unloaded until they are ready to be used.

17.16 – Scaffolds

- Contractors shall comply with 29 CFR 1926, Subpart L on scaffolding and 29 CFR 1910.28.
- Access to scaffolds shall be restricted to authorized employees only, especially after work hours.

17.17 – Railings

- A standard railing used to protect employees from falls shall consist of top rail, intermediate rail, toe board, and posts, and have a vertical height of 42 inches from upper surface of top rail to the floor, platform etc.
- The top of a railing shall be smooth-surfaced, with strength to withstand at least 200 pounds. The intermediate rail shall be approximately halfway between the top rail and floor.
- A stair railing shall be of construction similar to a standard railing, but the vertical height shall be no more than 34 inches, or less than 30 inches from upper surface of top rail to surface of tread in line with face or riser at forward edge of tread.

17.18 – Fall Protection

Contractors are responsible to comply at a minimum with the following regulations pertaining to fall protection in the workplace as it applies to their work at WPCB facilities:

- 29 CFR 1926 Subpart M – Fall Protection
- 29 CFR 1910.23 – Guarding Floors, Wall Openings and

Holes

- Reasonable fall protection shall be provided to protect employees from accidental falls associated with floors, platforms, scaffolds, guardrails, physical barriers, elevated work locations, trenches and excavations.

- Fall protection devices must be rate for industrial use and must be used according to the manufacturer recommendations.

- Standard guardrails must be provided for work locations 6 feet or more above the adjacent level per 29 CFR 1926.500 and personal fall protection as required.

- All employees working at unguarded locations above 6 feet in construction (10 feet on scaffolds) must be protected by properly wearing approved fall protection equipment including safety harnesses and life lines as specified in 29 CFR 1926.500.

- Protection for floor openings, wall openings and holes are to include railing and toe boards as outlined in 29 CFR 1910.23.

- All employees required to wear approved fall protection devices must be properly trained concerning the need for and purpose of the protection. They must also be instructed in the proper use, care, and storage of the equipment and shall demonstrate that they know, understand and can use the fall protection devices properly.

- Contractors must maintain guardrails, mid rails, and toe boards located at WPCB facilities unless removal is approved by the WPCB Safety Specialist or WPCB designee as part of a contract. An inspection to ensure the proper replacement of any of these items removed for service or work must be conducted upon completion of the job and before the Contractor leaves the facility. Employees working in or entering areas where the removal of guardrails, mid rails and toe boards have occurred must be protected at all times. Communications such as signs and barricades must be used.

- Contractors must cover all open holes, trenches, or excavations into which WPCB employees or others may fall and/or have guardrails, mid rails, toe boards installed around them.

- Open trenches and areas must be protected such that people cannot accidentally walk into the trench.

- Materials used for barricades or railings must be substantial and act as a barrier such as to restrict a person from access to an area. Materials such as wood, pipe, angle iron and concrete jersey barriers should be used. Snow fencing or the equivalent and tape are not acceptable. ‘Caution’ and ‘Danger’ tape are only used to communicate hazards and are not substantial enough to act as a barrier or prevent access.

- Contractor’s must provide all employees with exposure to fall hazards personal fall protection equipment or other hazard control measures listed within the fall protection standard and ensure their proper use.

- Contractors must ensure that fall related hazards are thoroughly communicated to Contractor employees, sub-Contractors and anyone who might be exposed. The communication must be adequate for the hazard.

17.19 – Hot Work (Welding, Brazing, Cutting)

Contractors performing hot work shall maintain a ‘Hot Work Permit’ program and employee training program that meets the requirements in 29 CFR 1926.352, 1910.251, ANSI Z49.1-88 and NFPA 51B. Examples of hot work include, but are not limited to:

- Use of open flames.
- Compressed gasses or supplied fuel burning.
- Brazing, cutting, grinding, soldering, thawing pipe, torch applied roofing, and welding.

Contractors must obtain a permit for hot work activities from the designated WPCB contact person for each separate work activity and ensure that all conditions of the permit are met at all times. The permit must be submitted to the WPCB Safety Specialist or WPCB designee prior to the start of any welding/cutting/brazing work. (See Section VI-A, #7, Pages 18 and 19 of this standard).

The Contractor Must:

- Request the initial permit and receive the permit before beginning the Hot Work.
- Post a copy of the Hot Work permit at entrances to the Hot Work area.
- Provide a copy of all canceled permits to the WPCB designee or Safety Specialist upon completion of the work.
- Remove combustible materials from the area before beginning work or if this is not possible, protect combustible materials so that they will not be ignited
- Take the necessary actions to protect oxygen/acetylene hoses from conditions that could cause damage to them.

- Install anti-flash back (safety/check) valves in both the oxygen/acetylene hoses at the regulator.

- Shield adjacent areas with welding partitions.

- Have a “Fire watch”, i.e. a second person standing by, at the location of the hot work, with an approved fire extinguisher for welding and burning operations and that is appropriate for the material in the area in accordance with OSHA/VDLI regulations and permit requirements. This person should remain in the area for a minimum of 30 minutes after the hot work is completed to ensure the site id cold.

17.20 – Cranes and Rigging

Each crane, rigging, or hoist bought onto WPCB facilities must have an annual inspection performed by a certified testing agency. All documentation, including certifications, log book, must be provided to the Safety Specialist/WPCB designee before operations begin on the site and when new and offsite equipment is brought onsite.

All operators must be fully trained, certified and have a license if applicable, for the operation of the equipment they will be using on WPCB facilities. Training records shall be provided upon request.

Employees who are not appropriately trained or licensed for using equipment (cranes, hoists, and rigging equipment) that is to be utilized no WPCB facilities are prohibited from operating or using this equipment.

All critical lifts must be planned and documented with a ‘Critical lift’ plan outlining the means and methods to protect employees, property and operations from accidents.

The operator is responsible for the proper placement of the crane in relationship to the load to be handled and the landing area so as to obtain the best rated lift capacity.

The operator is not to override crane safety devices and is responsible for maintaining appropriate clearances around the crane.

Employees operating cranes shall:

- Comply with the manufacturer's specifications and limitations for hoists.
- Never move suspended loads directly over employees.
- Have current information concerning rated load capacities, recommended operating speeds, and special hazard warnings or instructions posted on cars and platforms.

17.21 – Hazard Communication

The Contractor is responsible for developing, implementing and maintaining a Hazard Communication Plan that complies with 29 CFR 1910.1200.

The Contractor shall maintain, on site, Material Safety Data Sheets (SDS's) for all chemicals used or stored on the job site as required by VDLI/OSHA regulations. The Contractor shall provide copies of SDS's to the WPCB Safety Specialist or designee upon request. All Contractors shall:

- Ensure that all containers that are brought onto WPCB facilities for the storage of hazardous chemicals are labeled and inspected in accordance with all applicable regulations.
- Contact the WPCB EMS Administrator, Safety Specialist or designee, to ensure that manifesting, storage, the proposed disposal method and disposal site meet regulatory

compliance when there are instances that hazardous waste disposal manifests are required by regulations

- The contractor shall notify the Environmental Management System administrator, Safety Specialist, and Household Hazardous Materials coordinator of incidents of the discovery or generation of hazardous materials and also inform the above noted personnel at least 30 days in advance of the shipping date for the disposal of solid materials.

- The Contractor shall supply a legible copy of the properly filled out and partially completed waste manifest (having signatures of the generator and transporter) to the EMS Administrator or WPCB designee within 24 hours of when the material was removed from WPCB facilities.

- The Contractor shall supply a legible copy of the completed waste manifest (having signatures of the generator, all transporters, and the TSD (treatment, storage, and disposal) facility) upon receipt of the material at the TSD facility to the EMS Administrator or WPCB designee within 24 hours of receipt.

- The Contractor shall supply a legible copy of the completed waste manifest (having signatures of the generator, all transporters and the TSD (treatment, storage and disposal) facility) upon proper disposal of the material at the TSD facility to the EMS Administrator or WPCB designee within 24 hours of receipt.

- The Contractor shall properly and safely dispose of all hazardous chemicals that it brings onto WPCB facilities.

- The Contractor may request and review Material Safety Data Sheets for any chemical encountered on WPCB facilities during the performance of facility work. Requests should be made through the Safety Specialist at (703) 228-6834 or the WPCB Shift Supervisor at (703) 585-6851. The WPCB chemical list is available upon request through the Safety Specialist at (703) 228-6834

17.21 – Other Hazardous Materials

Sludges (non-stabilized biosolids), wastewater, and plant process liquids are a hazardous material and appropriate PPE should be worn when handling these materials. Discharging any materials into nearby streams or storm sewers is prohibited unless pre-approved by the EMS Administrator, WPCB Supervisor, Manager and the Bureau Chief.

The Contractor shall post at all entry access ways warnings if lasers are either being or intended to be used.

17.22 – Excavations and Trenches

The Contractor shall coordinate excavating and trenching work with the WPCB Shift Supervisor, designee or Safety Specialist.

The design of sloping and benching systems, support systems, shield systems or other protective systems shall conform to, at a minimum, to the OSHA requirements detailed in 29 CFR 1926 Subpart P and VDLI requirements. The Contractor shall submit a copy of the completed review to the designated WPCB Engineer or Safety Specialist prior to the start of work. When this design requires review and approval by a registered professional engineer, the Contractor will be required to procure those services at the Contractor’s cost.

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The Contractor shall notify the WPCB designated person of the name of the individual that is to serve as the Contractor’s ‘Competent person’ as defined by OSHA/VDLI regulations. The Contractor’s designated ‘Competent person’ shall maintain a written log of the daily inspections made of excavations, adjacent areas, and protective systems. A copy of these written logs shall be made available to the WPCB Safety Specialist or WPCB designee upon request.

Substantial physical barricades to prevent persons from falling into an open trench shall be maintained around the perimeter of trenches. This is especially important for trenches that must remain open overnight. Snow fencing or the equivalent, tape, and plastic caution tape/ribbon are not acceptable.

All areas of 29 CFR 1926 Subpart P and VDLI regulation must be followed.

Anyone proposing to excavate, dig, bore, tunnel, blast or disturb the earth in any manner which may damage buried utilities is required to call Miss Utility of Virginia at 1-800-552-7001 48 hours (2 working days) before starting the proposed work. All Miss Utility Tickets must be cleared before work begins, to check for cleared tickets call 1-800-552-3120. Just waiting 48 does not necessarily mean you may start excavations, you must make phone contact to ensure ticket is clear before beginning work.

17.23 – Lockout/Tagout

The Contractor is responsible for its own Lockout/Tagout program. This program must be in full compliance with OSHA 29 CFR 1910.147 and VDLI regulations. The Contractor shall submit a copy of its Lockout/Tagout Program to the WPCB designee for review by the Safety Specialist or designee before the start of any work where 29 CFR 1910.147 is applicable. OSHA lockout/tagout procedure requires at a minimum:

- Use of locks and/or tags on energy isolating devices.
- Special lockout/tagout procedures for jobs requiring multiple lockout/tagout devices.
- Contractors must provide their own lockout/tagout devices.
- All Contractor employees, (authorized, affected, and other employees), must be trained by the Contractor (or other acceptable training source) concerning lockout/tagout procedures.

Locks, and/or tags must not be removed by anyone other than the employee applying them except under approved emergency situations and the appropriate notification and documentation must be followed to ensure the safety of contractor and WPCB employees.

- Testing and positioning of machines or equipment will be performed only under special procedures per OSHA 29 CFE 1910.147(f).

- WPCB employees will shut down and start up all systems unless otherwise specifically directed by WPCB management.

- The Contractor will maintain a log of machines and equipment that are locked out and/or tagged out during the performance of the work at the WPCB facilities. The log shall identify the equipment that was worked on, the dates the work began and ended, why work was being done and the name of the individual performing the work. The Contractor will submit this log to the WPCB Safety Specialist or designee on a daily basis when lockout/tagout work is being performed.

17.24 – General Electrical Safety

- Electrical systems and equipment that use or control electrical power can only be worked on by qualified electricians.

- Do not operate electrical tools or equipment in wet areas where potentially flammable dusts, vapors, or liquids are present, unless specifically approved for the location. Intrinsically safe tools are required in areas where the potential for a hazardous atmosphere exist due to raw sewage or sludge.

- Ensure that a qualified electrician checks the circuit and equipment and corrects the problem before resetting the breaker when a circuit breaker or other protective device trips.

- The Contractor shall erect barriers and post warning signs to ensure non-authorized personnel stay clear of electrical work areas.

- The Contractor must report hazards (lack of protective guards or covers, damaged equipment etc.) to the WPCB Shift Supervisor, Safety Specialist or the WPCB designee immediately.

- Do not leave electrical boxes, switch gear, cabinets, or other electrical rooms open when not directly attended. Insulate energized parts when covers have been removed or doors are ajar. Use of cardboard, plywood, or other flammable materials to cover energized circuits is prohibited.

- Contractors must establish and maintain an effective electrical safety-related work practices program. References for such a program include OSHA standards 29 CFR 1910.331 to 1910.333 – Electrical Safety Related Work practices and CFR 1926 Subpart K Electrical.

- All electrical work shall be in compliance with the most recent (NFPA) National Fire Protection Association, NEC (National Electrical Code) and NFPA 70-E guidelines.

- Unqualified persons i.e. WPCB or Contractors shall not be allowed to work or operate equipment within 10 feet of energized overhead power lines or crossing clearance from electrical distribution lines and 50 feet from transmission lines. Special permission in writing must be obtained from the power company for all work that involves 50 feet or less working clearance from overhead lines. The written documentation must be provided to the appropriate WPCB point of contact or designee prior to the beginning of work.

- Extension cords used with portable electric tools shall be the 3-wire type, shall be protected from damage. Extension cords shall be inspected and maintained in accordance with the Contractor's Assured Grounding Program. Worn or frayed cords shall not be used. Cords used in damp or wet areas must be GFCI protected.

- Bulbs on temporary lights shall be equipped with guards or deeply recessed in the reflector. Temporary lights shall not be suspended by their electrical cords unless designed for suspension.

- Receptacles for attachment plugs shall be of the approved concealed contact type. Where different voltages, frequencies, or types of current are supplied, receptacles shall be of such designs that attachment plugs are not interchangeable.

- Each disconnecting means of motors and appliances and each service feeder or branch circuit at the point where it originates shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident.

- Cable passing through work areas shall be covered or elevated to protect it from damage which would create a hazard to employees.

- Boxes for disconnecting means shall be securely and rigidly fastened to the surface upon which they are mounted and fitted with covers.

- All extension cords and cord & plug connected equipment shall be protected by an assigned equipment grounding conductor program.

- Workers, other licensed electricians, shall not use jackhammers, bars, or other hand tools in close proximity to energized lines.

Personal Protective Equipment

17.25 – Personal Protective Equipment

- A hazard assessment must be conducted by the Contractor to determine the appropriate Personal Protective Equipment for contract employees performing work at the WPCB facility. Personal Protective Equipment shall be worn in all operations where there is an exposure to hazardous conditions or where the need is indicated for using such equipment to reduce the hazard to the employee. The minimum requirement for Personal Protective Equipment at all WPCB facilities is:

  - Safety Glasses
  - Steel Toed Boots/Shoes
  - Reflective Vest
  - Hard Hat

- Additional Personal Protective Equipment may be required based on the work that Contractors are on site to perform. The selection and use of additional Personal Protective equipment is the responsibility of the Contractor.

- Employees working over or near non-aerated (process or non-process) water, where the danger of drowning exists, shall be provided with U.S. Coast Guard approved life jackets or buoyant work vests. Employees working over or near aerated (process or non-process) water, where the danger of drowning exists, shall be provided with harnesses and lanyards of such length that they cannot fall into the water.

17.25.1 – Eye and Face Protection

- Eye and face protection shall be provided when machines or operations present potential eye or face injury.

- Eye and face protective equipment shall meet requirements of ANSI Z87.1–1991. “Practice for Occupational and Educational Eye and Face Protection.”

- Employees involved in welding operations shall be furnished with filter lenses or plates of at least the proper shade number for the type of welding being performed.

- Employees exposed to laser beams shall be furnished suitable laser safety goggles that will protect for the specific wavelength of the laser and shall have adequate optical density for the laser being used.

17.25.2 – Foot Protection

- All Contractors working at the WPCB must wear the appropriate foot protection that meets or exceeds the requirements of ANSI Z41-1991. Steel toe boots/shoes that totally cover the foot are required as a minimum.

17.25.3 – Head Protection

- Head protective equipment (hard hats only) shall be worn in all WPCB facility areas unless it is determined to be unsafe. Hard hats shall meet the highest performance requirements of ANSI Z89.1–2003 “American Standards for Industrial Head Protection”. Then use of Bump caps at WPCB facilities is prohibited.

17.25.4 – Hearing Protection

- Feasible engineering or administrative controls shall be utilized to protect employees against sound levels in excess of those shown in Table D-2 OSHA Standard 1926.52.

- When engineering or administrative controls fail to reduce sound levels within the limits of table D-2, hearing protective devices shall be provided and used.

- Hearing protection is required at constant noise levels above 85 decibels. Exposure to impulsive or impact noise should not exceed above 140 dB peak sound pressure level.

- Hearing protection that meets the NRR (Noise Reduction Rating) that protects the employee from the noise that the contract employees might be exposed to while working at the WPCB facility is required.

- Hearing protection is required anywhere in the WPCB where signs are posted indicating that hearing protection is a requirement.

- A hearing conservation program shall be administered and maintained in all cases where the sound levels exceed the values shown in safety and health regulations,

17.25.5 – Respiratory Protection

- When engineering or administrative controls are not effective in controlling toxic and other substances that could cause injury or illness to the respiratory system, appropriate respiratory protection shall be selected, provided and use enforced.

- Respiratory protective devices approved by the Mine Safety and Health Administration/National Institute for Occupational Safety and Health for the specific contaminant to which the employee is exposed shall be used.

- Respiratory protective devices provided to Contractor employees by their supervisors shall be appropriate for the hazardous materials involved and the extent and nature of the work requirements and conditions.

- Contractor must not provide Air Purifying Respirations to employees who are working in IDLH or Oxygen Deficient atmospheres. The appropriate Supplied Air respirator must be provided.

- Employees required to use respiratory protective devices shall be medically cleared, fit tested and thoroughly trained in the use of respiratory protection in accordance with OSHA Standards. The use of negative pressure respiratory equipment with tight fitting face pieces is prohibited with facial hair.

- Contractors shall have a written respirator program that meets or exceeds the requirements of 29 CFR 1926.103. This program shall be made available to the WPCB Safety Specialist or designee upon request.

17.26 – Motor Vehicles and Mechanized Equipment

- All Contractors and their employees must observe posted speed limits, give pedestrians the right of way, and yield to emergency vehicles. Unless otherwise posted the speed limit on WPCB Glebe Road facility shall be 10 miles an hour. Note: several areas on both sides of the WPCB facility have 5 M.P.H posted with an instruction to sound the horn. Caution should be observed when entering or exiting the WPCB tunnel that is below S. Glebe Road.

- All vehicles in use shall be checked at the beginning of each shift to ensure that all parts, equipment and accessories that affect safe operation are in proper operating condition and free from defects. All defects will be corrected before vehicle is placed in service.

- No person shall use any motor vehicle, earth moving or compacting equipment having an obstructed view to the rear unless.
    - The vehicle has a reverse signal alarm distinguishable from the surrounding noise level.
    - The vehicle id backed up only when an observer signals that it is safe to do so.
- Heavy machinery, equipment, or parts thereof which are suspended or held aloft shall be substantially blocked to prevent falling or shifting before employees are permitted to work under or between them.
- Park only in areas approved for Contractor use.
- Contractors must ensure that their drivers are legally licensed and trained for the vehicle or equipment that they are required to operate.

17.27 – Work Zones

Contractor must follow the Standard on Uniform Traffic Control Devices (MUTCD) and the Virginia Work Area Protection Standard.

Flaggers must be trained and keep their Flagger Certification Card on them at all times.

17.28 – Accident, Incident, Injury, or Illness

All life threatening work related accidents, incidents, injuries and illnesses must be immediately reported to the appropriate emergency agency (i.e., Local Emergency 9-1-1 for WPCB Emergency, Fire and Rescue), The Contractor must also report all accidents to the WPCB Shift Supervisor, must WPCB Safety Specialist or the WPCB designee immediately or within 24 hours of the incident. A type written report detailing the incident and outlining methods to keep it from occurring must be submitted within 48 hours of the accident. The Contractor is responsible for notifying VDLI for any incidents that are reportable to that agency.

17.28 – Lead–Containing Building Materials

The location of lead materials, where present, will be detailed in the construction documents for that project.

Contractors that will disturb lead-containing building materials during the course of work shall take all necessary precautions to protect Contractor employees, WPCB employees and the public from exposure to lead dust or contamination. These measures shall conform, at a minimum, to the OSHA requirements detailed in 29 CFR 1926.62 and applicable VDLI, and federal regulations related to health, safety, transportation and disposal. Proper disposal of lead materials must be coordinated with the WPCB Safety Specialist, or WPCB designee. A copy of applicable manifest documents shall be provided to the WPCB for recordkeeping purposes.

- The Contractor shall contact the WPCB EMS Administrator, Safety Specialist or designee to ensure that manifesting, storage, the proposed disposal method and disposal site meet regulatory compliance when there are instances that hazardous waste disposal manifest(s) are required by regulations.

- The Contractor shall supply a legible copy of the properly filled out and partially completed waste manifest (having signatures of the generator and transporter) to the EMS Administrator or WPCB designee within 24 hours of when the material was removed from WPCB facilities.

- The Contractor shall supply a legible copy of the completed waste manifest (having signatures of the generator, all transporters and the TSD (treatment, storage and disposal) facility) upon receipt of the material at the TSD facility to the EMS Administrator or WPCB designee within 24 hours of receipt.

- The Contractor shall supply a legible copy of the completed waste manifest (having signatures of the generator, all transporters and the TSD (treatment, storage and disposal) facility) upon proper disposal of the material at the TSD facility to the EMS Administrator or WPCB designee within 24 hours of receipt.

17.30 – Asbestos and Suspect Asbestos Containing Building Materials

Asbestos materials may not be used or installed in WPCB Facilities.

The Contractor has the responsibility to provide their own asbestos awareness program which shall include, but not be limited to, the information contained in the construction documents and the OSHA asbestos related regulations (29 CFR 1926.1101). Verification that the training has been conducted shall be sent to the Architect/Engineer of record for the project, the WPCB Safety Specialist or WPCB designee. Proper disposal of asbestos containing materials must be coordinated with the WPCB Supervisor, EMS Administrator, HHM Coordinator, Safety Specialist, or WPCB designee. A copy of applicable manifest documents shall be provided to the WPCB for recordkeeping purposes.

- The Contractor shall contact the WPCB EMS Administrator, Safety Specialist or designee to ensure that manifesting, storage, the proposed disposal method and disposal site meet regulatory compliance when there are instances that hazardous waste disposal manifest(s) are required by regulations.

- The Contractor shall supply a legible copy of the properly filled out and partially completed waste manifest (having signatures of the generator and transporter) to the EMS

Administrator or WPCB designee within 24 hours of when the material was removed from WPCB facilities.

- The Contractor shall supply a legible copy of the completed waste manifest (having signatures of the generator, all transporters and the TSD (treatment, storage and disposal) facility) upon receipt of the material at the TSD facility to the EMS Administrator or WPCB designee within 24 hours of receipt.

- The Contractor shall supply a legible copy of the completed waste manifest (having signatures of the generator, all transporters and the TSD (treatment, storage and disposal) facility) upon proper disposal of the material at the TSD facility to the EMS Administrator or WPCB designee within 24 hours of receipt.

17.31 – Inspections

Work site inspections should be conducted by the Contractor to ensure that work is proceeding in a safe manner. Contractors that are on site for long term projects will thoroughly inspect their work areas at least once a week at a minimum.

Work site inspection will also be conducted by the WPCB Shift Supervisor, WPCB Safety Specialist or a WPCB designee. These inspections are conducted solely for the benefit of WPCB, and shall not relieve the Contractor of responsibility for enforcement of, and compliance with, VDLI and the OSHA, environmental or other applicable regulations.

In the event that work site conditions exist that potentially impact the safety of WPCB employees or the public, WPCB shall issue a verbal or written warning to the Contractor and shall notify the Contractor's main office. If the unsafe conditions cannot be immediately corrected and represent imminent danger to Contractor employees or have the potential to harm WPCB employees or the public, WPCB will:

- Detail the VDLI and/or OSHA violations that were noted, and explain the potential impact upon WPCB employees and the public.

- Require that the Contractor either cease that portion of work, or implement measures to isolate the hazardous condition until the unsafe condition can be mitigated.

- Issue a formal written report of the violation(s) to the Contractor, and their main office.

Reports of deficiencies may be factored into the evaluation of the contract by WPCB. Repeat safety violations of a similar nature and/or a single serious, willful safety violation by a Contractor will require a detailed investigation and a written report that will outline root causes and corrective action within 48 hours of the incident. This report must be sent to the WPCB Bureau Chief, Safety Specialist and the Contractor's home office. In addition, the employee who was responsible for the safety infraction must be barred from working at WPCB unless the Contractor requests in writing and received written permission from the WPCB Bureau Chief, after Safety Specialist review, that the employee can continue to work.

Environmental Requirements

17.32 – Hazardous Waste Management

The Contractor must provide the EMS Administrator, WPCB Safety Specialist or designee with a list of actual and potential hazardous waste(s) to be generated during a project. Hazardous waste generated by a Contractor as part of its work is the responsibility of the Contractor. Contractors must ensure that their hazardous waste is properly identified, stored, transported and disposed of in accordance with all applicable local, state, and federal laws. The Contractor must provide the WPCB designated employee with the appropriate manifest or paperwork to validate disposal. Contractor employees must be properly trained to handle hazardous waste safely and in compliance with all applicable local, state and federal laws. For projects where temporary on-site storage is necessary, the Contractor must ensure, at a minimum, proper labeling of containers and tanks, adequate secondary containment, segregation of incompatible materials and documentation of weekly inspections of these storage areas. Contractors must maintain an adequate emergency plan and spill equipment to address spills, fire, etc. In addition, all hazardous waste containers shall be kept securely closed at all times.

The Contractor is responsible for completing all disposal documents, which may include, but are not limited to, waste profiles, waste analytical samples and hazardous waste manifests. Copies of these documents will be provided to the WPCB Safety Specialist or WPCB designee at the end of the project or when requested for the inclusion in WPCB's project file.

Manifests will be provided to the WPCB Safety Specialist or WPCB designee as follows:

- The Contractor shall supply a legible copy of the properly filled out and partially completed waste manifest (having signatures of the generator and transporter) to the EMS Administrator or WPCB designee within 24 hours of when the material was removed from WPCB facilities.

- The Contractor shall supply a legible copy of the completed waste manifest (having signatures of the generator, all transporters and the TSD (treatment, storage and disposal) facility) upon receipt of the material at the TSD facility to the EMS Administrator or WPCB designee within 24 hours of receipt.

- The Contractor shall supply a legible copy of the completed waste manifest (having signatures of the generator, all transporters and the TSD (treatment, storage and disposal) facility) upon proper disposal of the material at the TSD facility to the EMS Administrator or WPCB designee within 24 hours of receipt.

For projects where WPCB is deemed responsible for hazardous waste generated, the Contractor will ensure that hazardous wastes are managed in accordance with local, state and federal laws. The Contractor must ensure that the WPCB is designated as the generator on all manifests and land disposal restriction forms for which the county is the generator. The Contractor shall provide the WPCB Safety Specialist or designee with copies of all waste analyses and related documentation.

The Contractor shall immediately cease work in the affected area when previously unidentified material that is reasonably believed to be radioactive, volatile, corrosive, flammable, explosive, biomedical, infectious, toxic, hazardous, asbestos containing or oil based are found. The condition must be reported immediately to the WPCB Supervisor or WPCB designee. At no time shall such material be disposed of in any manner that is inconsistent with the local, state, federal and other applicable environmental regulations. The Contractor agrees to cooperate with WPCB and any consultants engaged by WPCB to perform services with respect to the analysis, detection, removal, containment, treatment and disposal of such regulated materials.

17.33 – Transport of Hazardous Materials

Hazardous materials must not be transported via public or private roads at the WPCB in a manner that could result in an unsafe condition for employees or the environment. All transportation of hazardous materials while on or off WPCB facilities shall be conducted in accordance with USDOT Hazardous Materials Regulations for proper packaging, marking/labeling, handling, documentation, etc. Contractors must ensure, that appropriate shipping documentation accompanies shipments of hazardous materials and that a 24-hour emergency contact is available to address transportation related emergencies in accordance with USDOT regulations.

17.34 – Spill Prevention and Response

Water Pollution Control Bureau Spill Prevention Control and Countermeasures (SPCC) Program establishes facility procedures for prevention, detection and reporting of spills and/or releases of oil or hazardous materials. Contractors must adhere to SPCC protocols, including the following when working at WPCB facilities:

17.34.1 – Spill Prevention

- The Contractor shall have available equipment (e.g., secondary containment pallets, absorbent pads, absorbent booms, or other absorbent agents) that are suitable and sufficient to control a potential spill/release based on the inventory of oil, hazardous chemicals, and other materials that will be brought and/or stored on-site.

- The Contractor is responsible for immediately identifying conveyances to the environment (e.g., sumps, storm/floor drains, etc.) and adequately minimizing spill potential to these areas.

- The Contractor is responsible for the proper storage of all flammable and combustible chemicals that are brought and/or stored on site to complete work of this contract. Such storage may require the use of safety containers, safety cabinets, and/or secondary containment. The Contractor shall also ensure that any incompatible chemicals are safely segregated. The Contractor is responsible for maintaining and securing all chemical containers and all chemical storage areas. This requires selecting locations and methods to minimize exposure to rainfall, surface water, and the ground surface or subsurface. Enclosures, shelters, and secondary containment should be used where appropriate.

- The Contractor must use appropriate protective procedures such as double containment, inspections, employee training, overflow protection, and other measures as part of activities involving the use, storage, or handling of petroleum products or hazardous materials on WPCB facilities.

- The Contractor must ensure that their employees are adequately trained in spill response/notification procedures outlined below.

17.34.2 – Spill Response

“Incidental” spills meet all the following criteria: 1) employees are familiar with the hazards associated with the spill material; 2) containment/response does not pose potential health and safety hazards (i.e.; fire, explosion, and chemical exposure); 3) a small quantity (less than 10 gallons) of material is spilled/released which **DOES NOT** reach the environment or pose potential health hazards; and 4) spilled/released material can be readily absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate area or by maintenance personal.

"Non-Incidental" spills include 1) major spill/release (e.g. greater than 10 gallons) that does not reach the environment or 2) any amount of spilled material that escapes to the environment (including drains, sumps, soil, etc.)

Water Pollution Control Bureau SPCC Program also establishes reporting requirements in event of a spill or release of oil or hazardous materials. The Contractor is responsible for the proper management of their spills including internal/external notifications, must pay for all costs as well as, proper mitigation steps and clean-up to the satisfaction of the WPCB EMS Administrator. Schedule delays, cost overruns, etc. caused by a spill are the responsibility of the Contractor. In the event of a spill or release, the Contractor must follow all of the reporting requirements of the SPCC Program as specified below:

(1) The Contractor shall determine if the spill/release in incidental or non-incidental.

(2) For ***incidental*** spills/releases:

- The Contractor shall attempt to stop or contain the spill/release at the source provided that doing so does not endanger anyone.
- The Contractor shall prevent discharge of materials to the environmental receptors including drains, sumps, soil etc.
- The Contractor shall immediately notify the WPCB EMS Administrator, WPCB Supervisor, Safety Specialist or WPCB designee of all incidental spills/releases.
- The Contractor is responsible for the proper collection, storage of waste materials in compliance with EPA and DEQ regulations and in cooperation with the Contract Coordinator.

(3) For ***non-incidental*** spills/releases: The Contractor shall immediately report the spill/release to the Arlington County Fire Department if the spill is too large to contain. The Contractor must immediately notify the WPCB Shift Supervisor at (703) 585-6851, the WPCB EMS Administrator at (703) 228-6881, or the WPCB Safety Specialist at (703) 228-6834-office, (703) 864-5380 cell.

The Contractor must also contact the Virginia Department of Environmental Quality at (703) 583-3864 or (703) 583-3800.

Water Pollution Control Bureau

Arlington County Department of Environmental Services

Appendix #2

Contractor Safety Program Checklist

I hereby acknowledge that I have received and completed a copy of the WPCB Department of Environmental Services Water Pollution Control Bureau Contractor Safety Program Checklist.

Name: ____

Title: ____

Company (name, address and phone number): ______________________

____

____

____

Sign name ____

Print Name ____

Date: ____

Return this signed copy to: Safety Specialist

Department of Environmental Services

Water Pollution Control Bureau

Room 306

3402 S. Glebe Road

Arlington Virginia, 22202

Return the signed document to the Safety Specialist or WPCB designee prior to the start of work.

CONTRACTOR SAFETY PROGRAM CHECKLIST

Please complete and return this checklist to the Safety Specialist or designee before beginning work. Copies of all Permits i.e. Permit Required Confined Space and Hot Work must be posted while work is in progress and provided to the Safety Specialist or designee upon completion of the work. Write N/A next to any item that does not apply to the work your company is performing. Questions:

WRITTEN SAFETY PROGRAM

1. Do you have a written safety program Yes No

2. Does it contain the following components: Yes No
   a. Management Yes No
   b. Record keeping Yes No
   c. Analysis Yes No
   d. Education/Training Yes No
   e. Inspections & Internal Audits Yes No
   f. Accident Investigations Yes No
   g. Periodic Review & Revision Yes No

GENERAL WORKSITE

1. Required posters – VOSH Yes No

2. Virginia Workers' Compensation Notice Yes No

3. Written substance abuse policy Yes No

4. Sanitation – adequate toilets and wash areas Yes No

5. Housekeeping
    a. Provisions to keep work areas clean and orderly Yes No
    b. Clean up and discard materials daily Yes No

6. First Aid and Medical Attention
    a. First aid kits provided Yes No
    b. Emergency medical procedures & phone numbers Yes No
    c. System to contract WPCB Safety Specialist or Yes No

designee when an injury or emergency occurs

7. Fire Prevention & Protection

8. Established procedures Yes No
    a. Will Fire Extinguishers be provided Yes No
    b. Storage for flammable and combustible liquids Yes No
    c. Storage of compressed gas cylinders Yes No
    d. Welding fire watch Yes No

9. Signs and Barricades
    a. Type used _
    b. Plan to address vehicle traffic Yes No
    c. Method of preventing non-construction personnel on the job-site Yes No
    d. Trenches Yes No

GENERAL CONTRACTOR AND SUBCONTRACTOR RELATIONSHIP

1. Are sub-Contractors required to follow any particular established guidelines

a. What are they ____

b. VOSH, OSHA.ANSI, DOT, etc. Yes No

2. Are Sub-Contractors required to have a written safety program Yes No

3. Are Sub-Contractors required to provide documentation of training Yes No

4. Who is responsible for ensuring Sub-Contractors follow established safety requirements _____

PERSONAL PROTECTIVE EQUIPMENT (PPE)

1. Has a Job Hazard Analysis been performed to determine

what PPE is required Yes No

a. Is it in writing Yes No

2. What type of PPE will this project require

a. Eye, head, and foot Yes No

b. Hearing protection Yes No

c. Respiratory protection Yes No

d. Fall protection Yes No

e. Others ____

3. Will eye wash and/or a shower be available Yes No

a. Type of materials used which could require the use of an

eye wash or shower ___

4. Welding curtains Yes No

JOB SITE EQUIPMENT

1. Heavy and Mechanized Equipment (front-end loaders, scrappers, etc.)
   a. Experienced (Trained and certified) operators Yes No
   b. Back-up alarms or horns Yes No
   c. Equipped and operated according to OSHA, VOSHA and Yes No

ANSI standards

2. Material Handling Equipment
   a. Types used (powered industrial trucks, chain hoists, conveyors)

Circle all that apply.

Others: _____________

   b. Cranes used Yes No
   c. Trained and certified operators Yes No
   d. Established safety procedures Yes No
   e. Will lift plans be provided Yes No
   f. Equipped and operated according to OSHA, VOSHA, ANSI Yes No

and applicable standards

ELECTRICAL

1. Do you specify compliance with VOSH, OSHA and WPCB Codes Yes No

for all contract electrical work

2. Portable tools and equipment grounded or double insulated Yes No

3. Ground-fault circuit interrupters installed Yes No

4. Electrical cords and cables free of splices or taps Yes No

5. Plan for location and work around electrical power lines and cables
(overhead, underground, under floors and in walls) Yes No

6. Lock-out/Tag-out program Yes No

ELEVATED SURFACES – FLOOR & WALL OPENINGS

1. Scaffolding or propelled mobile ladder stands used Yes No
   a. Erected and used according to OSHA requirements Yes No

2. Handrail, mid rails, and toe boards installed according to OSHA requirements Yes No

3. Floor openings guarded by a cover, guardrail or equivalent on all sides Yes No

CONFINED SPACES

1. Have job-site confined spaces been identified Yes No
   a. Will your work create confined spaces Yes No

2. Written program developed Yes No

3. Do you have a Permit System Yes No

4. Do you have air monitoring equipment & other safety equipment Yes No

CHEMICALS

1. Will you be bringing chemicals onto the work site Yes No

2. Do you have SDS's for the chemicals you plan to use Yes No

3. Provided SDS's to Safety Specialist or designee Yes No

Additional information or comments:

Water Pollution Control Bureau

Arlington County Department of Environmental Services

Appendix #3

Pre– Job Contractor Safety Planning Checklist

Company Name: ____

Contractor performing work: ____

Date of Pre-Job Conference: ________________________________

Date work to start: ________________________________

Location of work: ____

Describe work being performed: ____

____

____

____

Identification of Hazards in work area:

Fall Protection concerns: ____

Hazard Communications – Chemical(s) ____________________________________

Permit Required Confined Space(s) Location: ______________________________

Hazards in space ____

Lock Out / Tag Out ____

Material Handling and Rigging ____

Personal Protective Equipment ____

Welding and Hot Work Permits ____

Work Zones and Traffic Control ____

Other: ____

____

____

____

Signature of Contractor Representative: ___________________________________

Date: __________________

Signature of WPCB Representative: ____

Date: ___________________

Water Pollution Control Bureau

Arlington County Department of Environmental Services

Appendix #4

Instructions for the Use of the 'Contractor Safety Checklist' and the Pre–Job Contractor Safety Planning Checklist'

The 'Contractor Safety Checklist' should be sent or given to all Contractors performing work at WPCB facilities.

The 'Contractor Safety Planning Checklist' should be sued to plan and provide information to Contractors about WPCB facility hazards.

1.) The WPCB point of contact securing the contracted services must ensure that the Contractor receives, completes and returns a copy of the 'Contractor Safety Checklist'. The checklist must be completed and signed before work begins.

2.) The completed 'Contractor Safety Checklist' form must be forwarded to the Safety Specialist upon receipt for review.

3.) The Safety Specialist must review the document to ensure that the Contractor safety program meets minimum Safety requirements.

4.) The Safety Specialist notifies the WPCB point of contact indicating that the Contractor Safety program meets the WPCB Contractor Safety Standard.

5.) The WPCB point of contact will then complete the 'Contractor Safety Planning Checklist' form as a part of planning the job.

6.) The WPCB point of contact will contact the WPCB Safety Specialist for support should they have any questions identifying hazards.

7.) The WPCB point of contact will contact the Contractor to advise them of hazards that they could encounter while performing the proposed task or service. They will discuss special Personal Protective Equipment or equipment requirements so that the Contractor can prepare for the job before coming on site.

8.) The WPCB point of contact will go over the information with the Contractor on the date of service and secure the Contractor's signature.

9.) The WPCB point of contact will send the completed form to the Safety Specialist as documentation for file.

Water Pollution Control Bureau

Arlington County Department of Environmental Services

Appendix #5

CONTACT TELEPHONE NUMBERS

Safety Specialist

Department of Environmental Services

Water Pollution Control Bureau

3402 S. Glebe Road

Room 306

Arlington, Virginia 22202

(703) 228-6875 Office

(703) 864-5380 Cell Phone

Operation Shift Supervisor(s)

Water Pollution Control Bureau

3402 S. Glebe Road

Arlington, Virginia 22202

(703) 585-6851 Cell Phone

This cell phone number will put you in touch with the on duty Supervisor 24 hour 365 days a week for the Department of Environmental Services Water Pollution Control Bureau

Engineering Program Coordinator

Water Pollution Control Bureau

Arlington County Department of Environmental Services

3402 S. Glebe Road

Arlington, Virginia 22202

(703) 228-3732 Office

(703) 927-2636 Cell Phone

(703) 228-6875 Fax

EMS Administrator

3402 S. Glebe Road

Room 331

Arlington, Virginia 22202

(703) 228-6881 Office

Reliability Engineer/Planning Supervisor

3111 South Fern Street

Arlington, Virginia 22202

(703) 228-6827 Office

PLANNERS:

3111 South Fern Street

Arlington, Virginia 22202

(703) 228-6825

(703) 228-6859

(703) 228-6860

Water Pollution Control Bureau

Arlington County Department of Environmental Services

Appendix #6

WPCB Facility Map

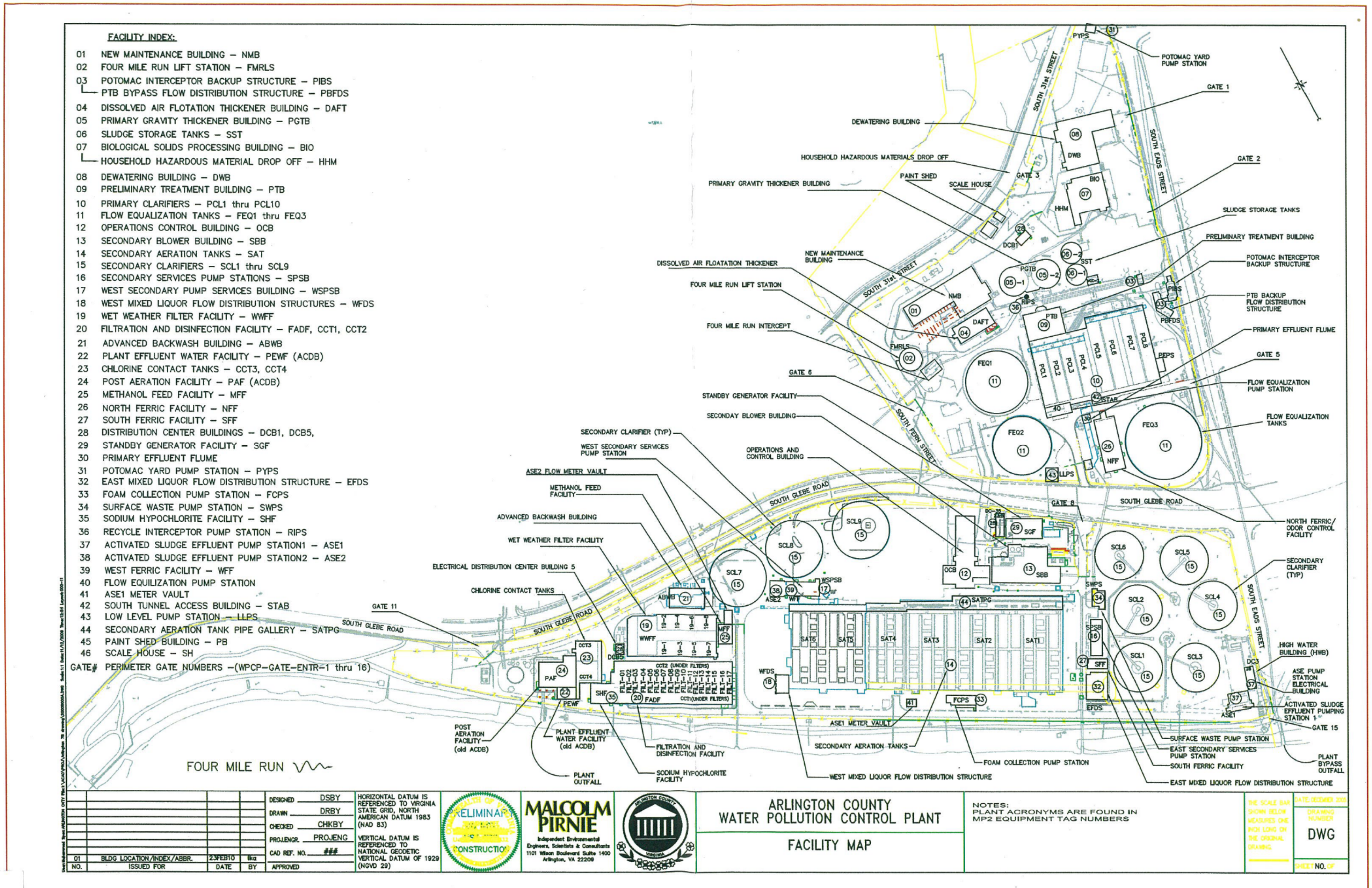

EXHIBIT C

ARLINGTON COUNTY DES FACILITIES DESIGN AND CONSTRUCTION GENERAL CONDITIONS

TABLE OF CONTENTS

A. INTRODUCTION TO TERMS

1) The term "Agreement" means the completed and signed Form of Contract Agreement.

2) The term “Award Date” means the date of execution of the Agreement by the Purchasing Agent.

3) The term “Business Day” shall refer to any day that the County is open for general business.

4) The term “Calendar Day” means any day of twenty-four hours measured from midnight to the next midnight. Included are weekends and holidays. When the term “Day” is used it shall be assumed to refer to a Calendar Day unless otherwise specified.

5) The term “Change Order” means a written order to the Contractor, signed by the Project Officer and the Contractor, which authorizes a change in the Work, and/or adjustment to the Contract Amount and/or an adjustment to the Time for Completion. A Change Order once signed by all the parties is incorporated into and becomes part of the Contract.

6) The term "Commencement Date" means the date on which the Time for Completion will commence for the Contractor to begin to perform his obligations under the Contract Documents as provided in the Notice to Proceed.

7) The term “Construction Change Directive” means a written order issued by the County directing a change in the Work prior to agreement on adjustment, if any, in the Contract Amount or Contract Time, or both.

8) The term "Contract Documents" means the Agreement and all the documents and Exhibits and/or Attachments identified therein which shall include the Drawings and the Specifications, and all modifications including amendments and subsequent Change Orders thereto properly incorporated in the Contract.

9) The terms "County" and "Contractor" shall mean the respective parties to the Contract. They shall be treated throughout the Contract Documents as though each were of the singular number and masculine gender. Only one Contractor is recognized as a party to this Contract.

10) The term “Critical Path Method or CPM” means a step-by-step project management technique for process planning that defines critical and non-critical tasks with the goal of preventing time-frame problems and process bottlenecks. An activity on the critical path cannot be started until its predecessor activity has been completed.is delayed then the entire project is delayed.

11) The term “Delay” means an event or condition that results in a work activity starting or being completed later than originally planned.

12) The term "Drawings" means all drawings pertaining to the Contract, including the Contract Drawings and Construction Notes which show and describe the locations, character, dimensions, and details of the Work to be performed under the contract.

13) The term “Field Order” is a written order to the Contractor, authorized by the Project Officer, which acknowledges a change in the Work that does not adjust the Contract Amount and does not adjust the Time for Completion.

14) The term “Final Acceptance” shall mean the date on which the County issues the final payment for the Work.

15) The term “Final Completion” shall mean the condition when the County agrees that all the Work has been fully completed in accordance with the Contract Documents and is acceptable. The date of the Final Completion of the Work under the Contract is the date on which Final Completion is accomplished.

16) The term “Float” shall represent the amount of time that a task in a project network or sequence can be delayed without causing a delay to: subsequent tasks ("free Float") or project completion date ("total Float"). Float shall belong to the County and shall be used for the successful completion of the Project within the Time for Completion.

17) The term “Limits of Disturbance (LOD)" shall represent the area within which land disturbing activities take place. Land disturbing activities include all actions that expose bare soil during construction.

18) The term “Limits of Work (LOW)" shall represent the area within which construction activities take place, including but not limited to the Limits of Disturbance area.

19) The term “Notice to Proceed” shall mean a written notice issued by the County to the Contractor stating the Commencement Date. The Notice to Proceed will specify the Time for Completion of the Contract.

20) The term “Project” means the entire proposed construction to be executed as stipulated in the Contract Documents

21) The term "Project Officer" means the County Project Officer assigned by the Director of the County Department responsible for the project, or the Director’s designee. When a designee to act on behalf of the Project Officer is used by the County, the name of the designee and the duties and authority of such designee will be identified in the Contract Documents or in a written notice to the Contractor from the Project Officer responsible for the project. The designee may be a professional architect or engineer or other person employed by the County to perform construction services administration, design services, or project oversight.

22) The term “Punch List” means unfinished items of the construction of the Project, which unfinished items of construction are minor or insubstantial details of construction, mechanical adjustment or decoration remaining to be performed, the non-completion of which would not materially affect use of the Project, and which are capable of being completed within the time specified for Final Completion after Substantial Completion has been achieved.

23) The term “Request for Information” (RFI) means a request originated by the Contractor requesting clarification or additional information from the Project Officer and/or Architect/Engineer concerning information in the construction documents where the Contractor believes there is insufficient information or a conflict in the documents. RFI’s shall be submitted by the Contractor sufficiently in advance of the Work to provide time for assessment and response without delay of the Work. Reponses to RFI’s shall not be construed as authorization for a Change Order.

24) The term “Schedule of Values” means a listing of the Contractor’s total contract value by Construction Specifications Institute (CSI) divisions, including Division 1, Contractor’s General Conditions.

25) The term “Site” refers to that portion of the property on which the Work is to be performed or which has otherwise been set aside for use by the Contractor.

26) The terms "Special Conditions" mean the written statements modifying or supplementing the Technical Specifications or General Conditions for requirements or conditions peculiar to the Contract.

27) The term "Specifications" means and shall include the Technical Specifications, the Special Conditions and all written agreements and instructions pertaining to the performance of the Work.

28) When used, the term “Stipulated Price Item” means and includes an item of Work, unanticipated or of unknown quantity at the time of issuance of the solicitation for a Bid and determined to be executed, based on the actual field conditions during the progress of Work under the Contract. The Unit Price for the “Stipulated Price Item”, as identified in the “Stipulated Price Items” section of the Bid Form, is predetermined by the County as the current reasonably workable rate for the Item inclusive of all necessary labor, equipment, materials, overheads (provision and installation), and the contractor’s profit.

29) The term "Subcontractor", shall include only those having a direct contract with the Contractor, and it shall include those who furnish material worked to a special design according to the plans and specifications for this Work but shall not include those who merely furnish material not so worked.

30) The term “Substantial Completion” shall mean the condition when the County agrees that the Work, or a specific portion thereof, is sufficiently complete, in accordance with the Contract Documents, so that it can be utilized by the County

for the purposes for which it was intended. The date of Substantial Completion of the Work under the Contract is the milestone date on which Substantial Completion condition is accomplished.

31) The term "Technical Specifications" means that part of the Contract Documents that describe the quality of materials, method of installation, standard of workmanship, and the administrative and procedural requirements for the performance of the Work under the contract.

32) The term “Time for Completion” shall mean the time period set forth in the Agreement.

33) The term "Work" shall mean the services performed under this Contract including, but not limited to, furnishing labor, and furnishing and installing materials and equipment required to complete the Project specified in the Contract Documents.

B. DRAWINGS, SPECIFICATIONS, RELATED DATA AND RECORDS KEEPING

1. INTENT OF THE DRAWINGS AND SPECIFICATIONS

   a. It is understood that, except as otherwise specifically stated in the Contract Documents, the Contractor shall provide and pay for all materials, labor, tools, equipment, water, water haulage, light power, transportation, superintendence, temporary construction of all kinds, and other services and facilities of every nature whatsoever that are necessary to execute and deliver the Work, complete and usable within the scope of the Contract with all parts in working order, and all connections properly made.

   b. The general character and scope of the Work are illustrated by the Drawings and listed in the Specifications. Any additional drawings and or other instructions deemed necessary by the Project Officer or designee will be furnished to the Contractor when required for the Work and shall be incorporated into the Contract Documents.

   c. Where “as shown”, “as indicated”, “as detailed”, or words of similar import are used, it shall be understood that direction, requirements, permission, or review of Project Officer or designee is intended unless stated otherwise. As used herein, “provide” shall be understood to mean “provide complete in place”, that is, “furnish and install.”

   d. Unless otherwise specifically noted, the word "similar" where it occurs in the Drawings, shall be interpreted in its general sense and not as meaning identical, and all details shall be worked out in relation to their locations and their connection with other parts of the Work.

   e. Materials or work described in words which, so applied, have a well-known technical, construction industry, or trade meaning, shall be held to refer to the recognized technical or trade meaning.

   f. The Contract Documents are complementary, and what is called for by any one document shall be as binding as if called for by all documents. In case of conflicting variance between the Contract Documents, the Order of Precedence stated in the Agreement shall govern. Figured dimensions on the plans shall be used; drawings shall not be scaled.

   g. Unless otherwise specifically noted, construction tolerances shall be to the numerical precision presented in the Contract Drawings.

2. DISCREPANCIES AND ERRORS

   If the Contractor discovers any discrepancies between the Drawings and Specifications and the site conditions or any errors or omissions in the Drawings or Specifications, the Contractor shall at once, but in no event later than three calendar days after discovery of the discrepancy or error, report them in writing to the Project Officer or designee. If the Contractor proceeds with any work that may be affected by such discrepancies, errors, or omissions, after their discovery, but before a clarification is provided, such work shall be at the Contractor's risk and expense. Issues affecting critical path activities shall be made known to the Project Officer or designee within one business day after discovery.

3. DIFFERING SITE CONDITIONS

The Contractor shall immediately, and before the conditions are further disturbed, give notice to the Project Officer of subsurface or latent physical conditions at the Site which differ materially from those indicated in this Contract, or previously unknown physical conditions discovered at the Site of an unusual nature and which differ materially from those ordinarily expected to be encountered at the Site. Such notice shall be followed by a written notice provided within 48 hours of discovery.

The Project Officer will investigate the site conditions promptly after receiving the notice. If the conditions do materially differ to the extent that an increase or decrease would result in the Contractor's cost of the Work, or the time required for performing any part of the Work under the contract, an equitable adjustment may be made under this clause and the Contract modified in writing accordingly.

No request by the Contractor for an adjustment to the Contract under this clause shall be allowed, unless the Contractor has given the written notice required. If the Contractor proceeds with any work that may be affected by such differing site conditions before giving notice to the Project Officer as set forth herein, such work shall be at the Contractor's sole risk and expense.

No request by the Contractor for an adjustment to the contract for differing site conditions shall be allowed if made after Final Payment under the Contract.

4. COPIES FURNISHED

Except as provided for otherwise, copies of the Drawings and Specifications reasonably necessary for the execution of the Work will be furnished to the Contractor. One electronic copy of the Contract Drawings and Specifications will be provided by the Project Officer or designee to the Contractor.

5. USE OF CADD FILES

The Contractor may request Electronic CADD files related to the Work or the Project. The CADD files will be provided by the County only if the Contractor completes the Arlington County Electronic CADD Drawing Release Form, which form is then incorporated by reference into this Contract. Use of CADD files is at the Contractor's own risk and in no way alleviates Contractor's responsibility for the Work to conform to the Plans and Specifications.

6. DOCUMENTS ON THE JOBSITE

The Contractor shall keep on the Site of the Project a copy of the Drawings and Specifications updated to include all authorized revisions and RFI responses, and shall at all times give the County and its authorized representatives access thereto. The Contractor shall mark up the Drawings on a daily basis in red. The As-Built Drawings shall be submitted to the County at Substantial Completion as the Final As-Built Drawings.

7. OWNERSHIP OF DRAWINGS AND SPECIFICATIONS

All Drawings and Specifications and copies thereof furnished by the County are the property of the County and shall not be used on other projects. All copies of the Drawings and Specifications except the signed Contract sets shall be returned to the Project Officer or designee at Final Completion.

8. SUBMITTALS

a. The term "submittals", as used herein, shall include fabrications, erection and setting drawings, manufacturers' standard drawings, schedules, descriptive literature, catalogs, brochures, performance and test data, wiring and control diagrams, and other descriptive data pertaining to the materials and equipment as required to demonstrate compliance with the Contract requirements.

b. Unless other specified in the Specifications the Contractor shall submit for the review of the Project Officer or designee a listing of all submittals required by the Specifications or requested by the Project Officer or designee within fifteen (15) calendar days after receipt of the Notice to Proceed. This listing shall include due dates for each required submittal, coordinated with the project schedule such that adequate time is allotted for review and potential resubmittals, fabrication and delivery without causing delay. The Contractor bears all risk for delay associated with submittals not received in a timely manner.

c. Submittals shall be submitted in such number of copies as established in the Specifications. Each submission shall be accompanied by a letter of transmittal, listing the contents of the submission and identifying each item by reference to specification section or drawing. All submittals shall be clearly labeled with the name of the project and such information as may be necessary to enable their complete review by the Project Officer or designee. Catalog plates and other similar material that cannot be so labeled conveniently shall be bound in suitable covers bearing the identifying data.

d. Submittals shall be accompanied by all required certifications and other such supporting material, and shall be submitted in sequence or groups that all related items can be checked together. When submittals cannot be checked because a submission is not complete, or because submittals on related items have not been received by the Project Officer or designee, then such submittals will be returned without action or will be held, not checked, until the missing material is received. Incomplete or defective submittals shall not be considered to have been submitted. Failure to deliver submittals within the specified time will not be grounds for additional time or compensation.

e. Submittals shall have been reviewed by the Contractor and coordinated with all other related or affected work before they are submitted for review and acceptance and shall bear the Contractor's certification that the Contractor has checked and approved them as complying with all relevant information in the Contract Documents. Submittals submitted without such certification and coordination will be returned to the Contractor without action and will not be considered as a formal submission.

f. If shop drawings show variations from the Drawings and Specifications because of standard shop practice or other reasons, the Contractor shall make specific mention of such variation in the Contractor's letter of transmittal in order that, if acceptable, suitable action may be taken for proper adjustment; otherwise the Contractor will not be relieved of the responsibility for executing the work in accordance with the Drawings and Specifications even though shop drawings have been accepted.

g. The Project Officer or designee shall review the shop drawings with reasonable promptness. Review and/or acceptance of shop drawings will be general for conformance with the design concept of the Project and compliance with the information given in the Contract Documents, and will not include quantities, detailed dimensions, nor adjustments of dimensions to actual field conditions. Acceptance shall not be construed as permitting any departure from Contract requirements, as authorization of any increase in price nor as relieving the Contractor of the responsibility for any error in details, dimensions or otherwise that may exist. Review is not intended to relieve the contractor of full responsibility for the accuracy and completeness of the plans and calculations, or for the complete compliance with the contract documents. Contractor is solely responsible for the means and methods of the construction, including temporary items proposed for use.

9. SAMPLES

The Contractor shall submit to the Project Officer or designee, all samples required by the Specifications or requested by the Project Officer or designee. Samples shall be submitted in single units only, unless the Contractor desires additional units for the Contractor's own use. Each sample shall bear a label indicating what the material represented, the name of the producer and the title of the Project. Acceptance of a sample shall be only for conformance with the design concept of the Project and compliance with the information given in the Contract Documents, and only for the characteristics or use named in such acceptance. Such acceptance shall not be construed to change or modify any Contract requirements or the Contract Price. Materials and equipment incorporated in the Work shall match the accepted samples. The Contractor shall be responsible for researching the availability of the specified product in the dimensions and colors specified at no additional cost to the County. Failure of the Contractor to identify specified products that are not commercially produced within the time required for submittal transmittal in order to meet the project schedule shall not be entitled to additional time or compensation.

10. TESTS

Any specified tests of materials and finished articles shall be made by bureaus, laboratories or agencies approved by the Project Officer or designee and the certified reports of such tests shall be submitted to the Project Officer or designee. All tests shall be in compliance with the Specifications. All costs in connection with the testing and test failures shall be borne by the Contractor. Failure of any material to pass the specified tests or any test performed by the Project Officer or designee, will be sufficient cause for refusal to consider, under this Contract, any further materials of the same brand or make of that material. Samples of various materials delivered on the Site or in place may be taken by the Project Officer or designee for testing. Samples failing to meet the Contract requirements will automatically void previous acceptance of the items tested. The Contractor will not be compensated for additional time and/or cost incurred in finding an acceptable replacement or the removal and replacement of the defective item.

11. MATERIALS AND EQUIPMENT LIST

a. Unless otherwise specified in the Specifications, within thirty (30) days of the Commencement Date the Contractor shall submit to the Project Officer or designee a complete list of materials and equipment proposed for use in connection with the Project. Partial lists submitted from time to time will not be considered unless specifically approved by the Project Officer or designee.

b. After any material or piece of equipment has been approved through submittal process, no change in brand or make will be permitted unless satisfactory written evidence is presented to prove that the manufacturer cannot make scheduled delivery of the accepted material, or that material delivered has been rejected and the substitution of a suitable material is an urgent necessity, or that other conditions have become apparent which indicate that acceptance of such other material is in the best interest of the County. The Contractor is solely responsible for the cost and time required to obtain and install a suitable replacement.

12. STANDARDS, SUBSTITUTIONS

a. Any material specified by reference to the number, symbol or title of a specific standard, such as a Commercial Standard, a Federal Specification, a Trade Association Standard, or other similar standard, shall comply with the requirements in the latest revision of the standards or specification and any amendment or supplement, except as limited to type, class or grade, or as modified in such reference. The standard referred to, except as modified in the Specifications, shall have full force and effect as though printed in the Specifications.

b. Reference in the Specifications or on the Drawings to any article, device, product, material, fixture, form or type of construction by name, make or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as eliminating from competition other products of equal or better quality by other approved manufacturers. Otherwise, applications for acceptance of substitutions for the specified items will be considered only upon request of the Contractor, not of individuals, trades or suppliers, and only for a specific purpose; no blanket acceptance will be granted. No acceptance of a substitution shall be valid unless it is in written form and signed by the Project Officer or designee.

c. If any proposed substitution will affect a correlated function, adjacent construction or the work of other contractors, then the necessary changes and modifications to the affected work shall be considered as an essential part of the proposed substitution, to be accomplished by the Contractor without additional expense to the County or an extension of the contract time, if and when accepted. Detail drawings and other information necessary to show and explain the proposed modifications shall be submitted with the request for acceptance of the substitution.

13. SURVEYS AND CONTROLS

Unless otherwise specified, the Contractor shall establish all baselines for the location of the principal component parts of the Work, establish a suitable number of benchmarks adjacent to the Work, and develop all detail surveys necessary for construction by a professional land surveyor licensed in the Commonwealth of Virginia. The Contractor shall carefully preserve benchmarks, reference points and stakes, and in the case of destruction thereof by the Contractor or due to the Contractor's negligence or the negligence of any subcontractor or supplier, the Contractor shall be responsible for expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the loss or disturbance of such benchmarks, reference points and stakes. The Contractor shall within 30 days of NTP perform a full site survey to verify all control points shown on the drawings against existing conditions within the Site limits. Any discrepancies found during this effort shall be made known immediately to the Project Officer. Failure to perform this survey and provide proof and acceptance of Project datum, control points, and existing benchmarks will not give rise to any extensions to contract time or amount. The cost of all necessary surveying services shall be considered incidental to the work and, unless otherwise specified, shall be included in the cost of the Work.

14. AS-BUILT DRAWINGS

As-Built Drawings shall be the responsibility of the Contractor. The Contractor shall maintain and mark up one set of prints of the applicable Contract Drawings to portray as-built construction. The prints shall be neatly and clearly marked in red to show all variations between the Work actually provided and that indicated on the Contract Drawings, and all utilities encountered in the Work. All drafting shall conform to good drafting practice and shall include such supplementary notes, legends and details as may be necessary for legibility and clear portrayal of the as-built construction. These drawings shall be marked promptly upon any approved change to the Work or discovery of any undocumented utility or obstruction and shall be submitted to the Project Officer or designee in sufficient time to be approved no later than thirty (30) calendar days after the Substantial Completion Date. The final As-Built Drawings approved by the Project Officer or designee shall be submitted in paper copy and .pdf format electronic files prior to Final Completion. Unless otherwise required under the Contract Documents, incorporation of red-lined changes into CADD format shall be the responsibility of the Architect and/or Engineer of Record, with the exception being any documents prepared by the Contractor in CADD, the record version of which shall also be provided to the County in CADD format by the Contractor. Final payments will be held until the complete set of red-line drawings are submitted to and approved by the Project Officer.

15. <u>WEB BASED RECORDS DOCUMENTATION</u>

Unless instructed otherwise, the Contractor shall use the web based construction management tool, e-Builder for, but not limited to, submittals, record keeping and document storage of all construction files including, invoices, pay applications, RFIs, approved shop drawings, change orders, construction progress meeting minutes, warranties, equipment specifications and brochures, record drawings, automated alerts and reminders for all functions, and Operation and Maintenance (O&M) Manuals.

C. COUNTY, COUNTY PROJECT OFFICER, AND CONTRACTOR RELATIONS

1. STATUS OF COUNTY PROJECT OFFICER OR DESIGNEE

The Project Officer or designee shall be the County's representative during the construction period. All Contractor instructions or requests shall be issued from or submitted through the Project Officer or designee. The Project Officer or designee shall have authority to suspend the Work whenever such suspension may be necessary in the responsible opinion of the Project Officer or designee to ensure the proper execution of the Contract. The Project Officer or designee shall also have authority to reject all work and materials that do not conform to the Contract and to decide questions that arise in the execution of the Work. The County Project Officer or designee will, within a reasonable time, make decisions on all matters relating to the execution and progress of the Work.

2. LIMITATION ON COUNTY’S RESPONSIBILITIES

The County shall not supervise, direct, or have control or authority over, nor be responsible for: The Contractor’s means, methods, techniques, sequences or procedures of construction; the safety precautions and programs related to safety, or the Contractor’s failure to perform or furnish the Work in accordance with the Contract Documents.

3. DISPUTES

a. All disputes or claims arising under this Contract or its interpretation, whether involving law or fact or both, or extra work, and all claims for alleged breach of Contract shall be submitted in writing to the Project Officer or designee as set forth in these General Conditions. Such claims must set forth in detail the amount of the claim, and shall state the facts surrounding it in sufficient detail to identify it together with its character and scope.

b. Claims denied by the Project Officer shall be processed in accordance with the procedures outlined in Sections 7-107, Contractual Disputes and 7-108, Legal Actions of the Arlington County Purchasing Resolution and the Dispute Resolution paragraph in the Agreement.

c. The Contractor shall not cause a delay in the work pending a decision of the Project Officer or designee, County Manager, County Board, or court, except by prior written approval of the Project Officer or designee.

4. INSPECTION OF WORK

The Project Officer or designee and representatives of any public authority having jurisdiction shall, at all times, have access to the Work while in progress. The Contractor shall provide suitable facilities for such access and for proper observation of the Work and shall conduct all special tests required by the Specifications, the Project Officer or designee's instructions, and any laws, ordinances or the regulations of any public authority applicable to the work. Nothing in this section shall abrogate or otherwise limits or relieves the Contractor’s independent duty to inspect the Work.

5. INSPECTION OF MATERIALS

All articles, materials, and supplies purchased by the Contractor for the Work are subject to inspection upon delivery to the Site and during manufacturing or fabrication The County reserves the right to return for full credit, at the risk and expense of the Contractor, all or part of the articles, materials, or supplies furnished contrary to Specifications and instructions. Nothing in this section shall abrogate or otherwise limit or relieve the Contractor's independent duty to inspect materials.

6. EXAMINATION OF COMPLETED WORK

If the Project Officer or designee requests it, the Contractor, at any time before acceptance of the Work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the Specifications. Should the work thus exposed or examined prove acceptable, then the uncovering or removing, and the replacing of the covering or making good of the parts removed shall be paid for as extra work, but should the work so exposed or examined prove unacceptable, then the uncovering, removing and replacing shall be at the Contractor's expense.

7. RIGHT TO SUSPEND WORK

The County shall have the authority to suspend the Work, in whole or in part, for such periods and such reasons as the County may deem necessary or desirable. Any such suspension shall be in writing to the Contractor and the Contractor shall obey such order immediately and not resume the Work until so ordered in writing by the County. No such suspension of the Work shall be the basis for a claim by the Contractor for any increase in the Contract Amount provided that the suspension is for a reasonable time under the circumstances then existing. If the suspension of Work is caused by the County's belief that non-conforming work is being installed, and subsequent investigation proves that the Work was non-conforming, the Contractor shall not be awarded additional time or costs.

8. RIGHT TO CARRY OUT THE WORK

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a 10-day period after receipt of written notice from the County or such shorter time as may be reasonable under the circumstances, to commence and continue correction of such default or neglect with diligence and promptness, the County may, without prejudice to other remedies the County may have, correct such deficiencies. In such case an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the reasonable cost of correcting such deficiencies, including the County's expenses, and any additional architect or engineering costs necessary by Contractor's default, neglect or failure. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the County upon demand.

9. CONTRACTOR MANAGEMENT PERSONNEL

The Contractor shall keep a competent superintendent and any necessary assistants on the Site at all times during progress of the Work and such persons shall be satisfactory to the Project Officer or designee. The superintendent or project manager shall not be changed except with the Project Officer or designee's consent. If the Project Officer determines that the superintendent or project manager is no longer satisfactory, then the superintendent or project manager must be replaced within 15 days of the Project Officer's written notice with a replacement superintendent or project manager with equal or superior qualifications and subject to Project Officer approval.

The superintendent and project manager shall represent the Contractor and all directions given to such persons shall be as binding as if given to the Contractor. The Contractor shall at all times enforce strict discipline and good order among the workers performing under this Contract, and shall not employ on the Work any person not reasonably proficient in the Work assigned. Persons permitted to perform Work under Contractor, or any subcontractor, or sub-subcontractor, shall meet all employment eligibility, safety training, security or drug/alcohol testing requirements required by law or by the County. Any person not complying with all such requirements shall be immediately removed from the Site.

The Contractor shall have a qualified and experienced person who can clearly communicate technical matters regarding the subject project. This person shall be available via phone to respond to emergency situations on the project 24 hours a day.

10. <u>DRUG-FREE POLICY</u>

The Contractor is responsible for ensuring that the Site remains a drug-free site. Contractor will require that employees undergo random drug/alcohol screening on a quarterly interval. Any employee who fails the test must be removed from the Site immediately. Random screening shall be performed by a third party licensed to do so in the Commonwealth of Virginia. The Contractor shall provide its random testing policy and schedule to the Project Officer within 30 days of Notice to Proceed. The Contractor will include this provision in every subcontract relating to this Contract. Any infraction by an employee of the Drug-Free policy shall be reported to the Project Officer within 24 hours.

11. <u>LANDS BY COUNTY</u>

The County shall provide access to the lands shown on the Drawings upon which the Work under the Contract is to be performed and to be used for rights of way and for access. In case all the lands, rights-of-way or easements have not been obtained as herein contemplated before construction begins, then the Contractor shall begin its work on such lands and rights-of-way that the County has acquired access to. No additional time or compensation shall be awarded to the Contractor for modifying work location and sequence provided other locations are available for work.

Contractor shall verify the acquisition of all off-site easements and Rights-of-Way prior to the start of off-site construction. Restore all off-site easements to the conditions existing prior to the start of work.

The Contractor shall confine all activities at the Site associated with construction activities, to include storage of equipment and or materials, access to the work, formwork, etc. to within the designated Limits of Disturbance (LOD).

12. LANDS BY CONTRACTOR

If the Contractor requires additional land or lands for temporary construction facilities and for storage of materials and equipment other than the areas available on the Site or right-of-way, or as otherwise furnished by the County, then the Contractor shall provide such other lands and access thereto entirely at the Contractor's own expense and without liability to the County. The Contractor shall not enter upon private property for any purpose without prior written permission of all of the persons and entities who own the property. The Contractor shall provide copies of all agreements to the County and shall include language in the agreement indemnifying and holding the County harmless for any damages, repairs, restoration or fees associated with the use of the property. Upon termination of the agreement, the Contractor shall provide to the County a fully executed release from the property owner.

13. PROTECTION OF WORK AND PROPERTY

a. The Contractor shall continuously maintain and protect all of its Work from damage and shall protect the County's property from damage or loss arising in connection with this Contract until Substantial Completion. After Substantial Completion, the maintenance or protection of any incomplete or remedial Work identified on the punch list that requires maintenance or protection in order to allow for the final completion and acceptance of such Work shall be the responsibility of the Contractor until Final Completion. The Contractor shall make good any such damage or loss, except such as may be caused by agents or employees of the County. Failure to adequately protect the Work shall not be grounds for additional compensation for any maintenance and/or repairs to such Work.

b. The Contractor shall not place upon the Work, or any part thereof, any loads which are not consistent with the design strength of that portion of the Work.

c. The Contractor shall be responsible for the preservation of all public and private property, trees, monuments, etc., along and adjacent to the street and/or right-of-way, and shall use every precaution to prevent damage to pipes, conduits and other underground structures, curbs, pavements, etc., except those to be removed or abandoned in place and shall protect carefully from disturbance or damage all monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and shall not remove them until directed. Any damage which occurs by reason of the operations under this Contract, whether shown or not on the approved construction plans, shall be completely repaired or replaced to the County’s satisfaction by the Contractor at the Contractor's expense. The Contractor shall be responsible for all damages caused by their construction activities.

d. Prior to commencing construction activity at the Site, the Contractor shall videotape the Site and an additional fifty (50) feet outside the perimeter of the Site. Contractor shall submit a copy of high resolution digital recording on a DVD or flash drive to the County. The recording shall be stable, continuous, and contain all items within the limits of Work. Submission of the DVD to the County shall be a condition precedent to any obligation of the County to consider an

Application for Payment. The DVD shall be the property of the County, and the County shall be permitted to reproduce such DVD's and use the same for any purpose without limitation or claim of ownership or compensation from any party. Contractor shall incorporate the cost of the preconstruction survey in the bid amount or the unit prices of the bid items, as applicable. No additional payment will be made by the County.

e. The Contractor shall shore, brace, underpin, secure, and protect, as may be necessary, all foundations and other parts of existing structures adjacent to, adjoining, and in the vicinity of the Site that may be affected in any way by excavations or other operations connected with the work required under this Contract. The Contractor shall be responsible for giving any and all required notices to owners or occupants of any adjoining or adjacent property or other relevant parties before commencement of any work. Contractor shall provide all engineering (signed and sealed) for items listed in this section per the Specifications. The Contractor shall indemnify and hold the County harmless from any damages on account of settlements or loss of all damages for which the County may become liable in consequence of such injury or damage to adjoining and adjacent structures and their premises.

f. In an emergency affecting the safety of life or of the Work, or of adjoining property, the Contractor, without special instruction or authorization from the Project Officer or designee, or the County, is hereby permitted to act, at the Contractor's discretion, to prevent such threatened loss or injury, and the Contractor shall so act without appeal, if so instructed or authorized.

g. The Contractor shall contact "Miss Utility" at 811 for marking the locations of existing underground utilities (i.e., Water, sewer, gas, telephone, electric, and cable tv) at least 72 hours prior to any excavation or construction. The Contractor is required to identify and protect all other utility lines found in the work Site area belonging to other owners that are not members of "Miss Utility". Private water and/or sewer laterals will not be marked by "Miss Utility" or the County. The Contractor shall locate and protect these services during construction.

14. <u>SEPARATE CONTRACTS</u>

a. The County reserves the right to let other contracts in connection with this Project. The Contractor shall afford other contractors reasonable access to the Project including storage of their materials and the execution of their work, and shall properly connect and coordinate its work with the work of other such contractors.

b. If any part of the Contractor's work depends, for proper execution or results, upon the work of any other contractor, the Contractor shall inspect and promptly report to the Project Officer or designee any defects in such work that renders it unsuitable for such proper execution and results. The Contractor's failure to so inspect and report shall constitute an acceptance of the other contractor's work as fit and proper for the reception of the Contractor's work, except as to defects which may develop in other contractor's work after its execution.

c. If the Contractor or any of the Contractor's subcontractors or employees cause loss or damage to any separate contractor on the Work, the Contractor agrees to settle or make every effort to settle or compromise with such separate contractor. If such separate contractor sues the County on account of any loss so sustained, the County shall notify the Contractor, who shall indemnify and save the County harmless against any expense, claim or judgment arising therefrom, including reasonable attorney's fees.

d. In case of a dispute arising between two or more separate contractors engaged on adjacent work as to the respective rights of each under their respective contracts, the Project Officer shall determine the rights of the parties.

15. SUBCONTRACTS

a. Unless otherwise specified, the Contractor shall, within fifteen (15) calendar days after the execution of the Contract by the County, provide to the Project Officer or designee, in writing, the names of all subcontractors proposed for the principal parts of the Work and for such others as requested by the Project Officer or designee, and shall not employ any subcontractors that the Project Officer or designee may object to as incompetent or unfit after an appropriate determination of the subcontractor's ability. No proposed subcontractor will be disapproved except for cause.

b. The Contractor shall make no substitutions for any subcontractor previously selected/approved unless first submitted to the County for approval.

c. The Contractor shall be as fully responsible to the County for the acts and omissions of the Contractor's subcontractors as the Contractor is for the acts and omissions of persons directly employed by the Contractor.

d. The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the Work to bind subcontractors to the Contractor by the terms of the General Conditions of the Contract, Special Provisions and other Contract Documents comprising the Contract insofar as such documents are applicable to the work of subcontractors.

e. Nothing contained in the Contract shall be construed to create any contractual relation between any subcontractor and the County, nor shall it establish any obligation on the part of the County to pay to, or see to the payment of any sums to any subcontractor. The County will not discuss, negotiate or otherwise engage in any contractual disputes with any subcontractor.

f. If requested by the County, the Contractor shall replace any subcontractor at no cost to the County within 30 days of the Project Officers written notice or as otherwise specified. No additional time or compensation will be provided in the event a subcontractor is removed due to non-compliance of the requirements outlined within the Contract.

16. ELIMINATED ITEMS

If any item(s) in the Contract are determined to be unnecessary for the proper completion of the Work contracted, the Project Officer or designee may, upon written notice to the Contractor, eliminate such item(s) from the Contract. Payment will not be made for such item(s) so eliminated; except that the Contractor will be compensated for the actual cost of any work performed and the net cost of materials purchased before the item(s) was eliminated from the Contract, including freight and tax costs, as evidenced by invoice. No additional compensation will be made for overhead or anticipated profit. The County will receive the full unit price credit for work eliminated prior to production or installation.

17. COUNTY ORDINANCES

The Contractor shall comply with all applicable County ordinances, including but not limited to: the *Noise Control, Erosion & Sediment Control, Storm Water Management, and Chesapeake Bay Preservation ordinances (Chapters 15, 57, 60, and 61 of the County Code).*

D. MATERIALS AND WORKMANSHIP

1. MATERIALS FURNISHED BY THE CONTRACTOR

Unless otherwise specified, all materials and equipment incorporated in the Work under the Contract shall be new. All work shall be accomplished by persons qualified in the respective trades.

2. IBC AND VUSBC REQUIREMENTS

The Contractor certifies that all material supplied or used under this Contract meets all current International Building Code (IBC) requirements and the requirements of the Virginia Uniform Statewide Building Code (VUSBC); and further certifies that, if the material delivered or used in the performance of the work is found to be deficient in any of the applicable state or national code requirements, all costs necessary to bring the material into compliance with the requirements shall be borne by the Contractor. The County shall be entitled to offset such costs against any sums owed by the County to the Contractor under this Contract.

3. ADA COMPLIANCE

The Contractor shall ensure that all Work performed under this Agreement is completed in accordance with the Contract Documents, including Work intended to meet the accessibility requirements of the Americans with Disabilities Act (ADA).

The Contractor is not required to ascertain whether the Contract Documents meet ADA design standards and guidelines. However, should the Contractor discover any non-conformity with such requirements, the Contractor shall immediately inform the County and its design consultant, if applicable, to allow for corrective action.

The Contractor shall defend and hold the County harmless from any expense or liability arising from the Contractor's non-compliance in meeting its obligations herein. The Contractor shall be responsible for all costs related to permitting delays, redesign, corrective Work, and litigation relating to such non-compliance.

4. MANUFACTURER'S DIRECTIONS

Manufactured articles, material, and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned in accordance with the manufacturer's directions as accepted by the Project Officer or designee, unless herein specified to the contrary.

5. WARRANTY

All material provided to the County shall be fully guaranteed by the Contractor against manufacturing defects within the period of the manufacturer's standard warranty. Such defects shall be corrected by the Contractor at no expense to the County. The Contractor shall provide all manufacturers' warranties to the Project Officer by the date of Final Completion.

All Work is guaranteed by the Contractor against defects resulting from the use of inferior or faulty materials. The Contractor warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects or inferior or faulty workmanship, or work not in accordance with the Contract Documents for one (1) year from the date of Substantial Completion or as set forth in the Specifications of the work by the County in addition to and irrespective of any manufacturer's or supplier's warranty.

No date other than Substantial Completion or as set forth in the Specifications shall govern the effective date of the Warranty, unless that date is agreed upon by the County and the Contractor in advance and in a signed writing.

The Contractor shall promptly correct any defective work or materials after receipt of a written notice from the County to do so. If the Contractor fails to proceed promptly or use its best efforts and due diligence to complete such compliance as quickly as possible, the County may have the materials or work corrected and the Contractor and its Sureties shall be liable for all expenses and costs incurred by the County.

Nothing contained in this section shall be construed to establish a period of limitations with respect to other obligations the Contractor may have under this Contract.

6. INSPECTION AND ACCEPTANCE OF MATERIALS

Inspection and acceptance by the County will be at the work site in Arlington County, Virginia and within ten (10) calendar days of delivery unless otherwise provided for in the Contract Documents. The County will not inspect, accept, or pay for any materials stored or delivered off-site by the Contractor, except as provided by the Payment for Stored Materials clause of these General Conditions and other requirements of the Contract Documents. The County's right of inspection shall not be deemed to relieve the Contractor of its obligation to ensure that all articles, materials and supplies are consistent with Specifications and instructions and are fit for their intended use. The County reserves the right to conduct any tests or inspections it may deem appropriate before acceptance. The Contractor shall be responsible for maintaining all materials and supplies in the condition in which they were accepted until they are used in the work.

The Contractor is to coordinate its work and request inspections in such a manner as to minimize the cost to the County without impacting the overall schedule of the Project within reason. All costs associated with re-inspection shall be borne by the Contractor.

7. CONTRACTOR'S TITLE TO MATERIALS

No materials or supplies for the work shall be purchased by the Contractor or any subcontractor subject to any chattel mortgage or under a conditional sale or other agreement by which an interest is retained by the seller. The Contractor warrants that it has good title to, and that it will require all subcontractors to warrant that they have good title to, all materials and supplies for which the Contractor invoices for payment. The County may request proof of title or payment prior to acceptance of the Contractors invoice.

8. TITLE TO MATERIALS AND WORK COVERED BY PARTIAL PAYMENTS

All material and work covered by partial payments made by the County will become the property solely of the County at the time the partial payment is made. However, risk of loss or damage to all items shall be the responsibility of the Contractor until Final

Acceptance by the County. This provision will not be construed as relieving the Contractor from having sole responsibility for all materials and work upon which payments have been made and for the restoration of any damaged work or replacement or repair at the County's option of any damaged materials. This provision will not be construed as a waiver of the County's right to require fulfillment of all terms of the Agreement, including full rights under the terms of the Warranty provisions of the Agreement, nor shall payment indicate acceptance of the materials or work.

9. CONNECTING WORK

The Contractor shall do all cutting, patching, or digging of the Contractor's work that may be required to make its several parts come together properly and fit it to receive or be received by work of other contractors as shown upon or reasonably implied by the Drawings and Specifications for the completed Project and shall make good after them as the Project Officer or designee may direct. This work will be performed in a workmanlike manner utilizing proper care and equipment to achieve proper line and grade. The Contractor shall not endanger any work by cutting, patching, or digging, or otherwise, and shall not cut or alter the work of any other contract except with the prior written consent of the Project Officer or designee.

10. REJECTED WORK AND MATERIALS

a. Any of the Work or materials, goods, or equipment which do not conform to the requirements of the Contract Documents, or are not equal to samples accepted by the Project Officer or designee, or are in any way unsatisfactory or unsuited to the purpose for which they are intended, shall be rejected and replaced immediately so as not to cause delay to the Project or work by others. Any defective work, whether the result of poor workmanship, use of defective materials, damage through carelessness or any other cause, shall be removed and the work shall be re-executed by the Contractor at the Contractor's expense. The fact that the Project Officer or designee may have previously overlooked such defective work shall not constitute acceptance of any part of it.

b. If the Contractor fails to proceed at once with the replacement of rejected material and/or the correction of defective workmanship when notified to do so by the Project Officer or designee, the County may, by contract or otherwise, replace such material or correct such workmanship and charge the cost to the Contractor. This clause applies during the Contract and during any warranty or guarantee period.

c. The Contractor shall be responsible for managing, addressing within a timely manner, and formally closing out all notices of non-compliance issued by the inspector of record, Arlington County Inspection Services, or the Design Team. The Contractor shall be solely liable for any costs or time associated with the corrective action to address any notices of non-compliance. The Contractor must work directly with the entity issuing the notice of non-compliance.

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d. If the Project Officer or designee deems it expedient not to require correction of work which has been damaged or not done in accordance with the Contract, an appropriate adjustment to the Contract Price may be made.

11. PROHIBITION AGAINST ASBESTOS CONTAINING MATERIALS

No goods or equipment provided to the County or construction material installed shall contain asbestos. If a Contractor or supplier provides or installs any goods, equipment, supplies, or materials that contain asbestos in violation of this prohibition, the Contractor shall be responsible for all costs related to the immediate removal and legal disposal of the goods, equipment or materials containing asbestos and replacement with County-approved alternate. The Contractor shall be responsible for all goods, equipment, supplies or materials installed or provided by any of its employees, agents or subcontractors in connection with the work under this contract. The Contractor shall also reimburse to the County all costs of such goods, equipment, supplies or materials installed if not corrected by the Contractor.

E. LEGAL RESPONSIBILITY AND PUBLIC SAFETY

1. SITE INVESTIGATION AND CONDITIONS AFFECTING THE WORK

The Contractor acknowledges that it has taken steps reasonably necessary to ascertain the nature and locations of the work of the Contract, and that it has investigated and satisfied itself as to the general and local conditions and factors which can affect the Work or its cost, including but not limited to:

a. conditions bearing upon transportation, disposal, handling, and storage of materials;
b. the availability of labor, water, electric power, and roads;
c. uncertainties of weather, river stages, tides, or similar physical conditions at the Site;
d. the information and conditions of the ground; and
e. the character of equipment and facilities needed before and during work performance.

The Contractor, by executing the Contract, represents that it has reviewed and understands the Contract Documents and has notified the County of and obtained clarification of any discrepancies which have become apparent during the bidding period. During the Contract, the Contractor must promptly notify the County in writing of any apparent errors, inconsistencies, omissions, ambiguities, construction impracticalities or code violations discovered as a result of the Contractor's review of the Contract Documents including any differences between actual and indicated dimensions, locations and descriptions, and must give the County timely notice in writing of same and of any corrections, clarifications, additional Drawings or Specifications, or other information required to define the Work in greater detail or to permit the proper progress of the Work. The Contractor must provide similar notice with respect to any variance between its review of the Site and physical data and Site conditions observed. If the Contractor performs any Work involving an apparent error, inconsistency, ambiguity, construction impracticality, omission or code violation in the Contract Documents of which the Contractor is aware, or which could reasonably have been discovered, without prompt written notice to the County and request for correction, clarification or additional information, as appropriate, the Contractor does so at its own risk and expense and all related claims are specifically waived.

The Contractor also acknowledges that it has satisfied itself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the Site, including all exploratory work done by the County, as well as from the Drawings and Specifications made a part of this Contract. Unless otherwise specified, all existing structures, materials and obstructions that interfere with the new construction shall be removed and disposed of as part of this Contract. Any failure of the Contractor to take the actions described and acknowledged in this paragraph will not relieve the Contractor from responsibility for estimating properly the difficulty and cost of successfully performing the Work without additional expense to the County.

The locations of existing utilities, including underground utilities, which may affect the Work, are indicated on the Drawings or in the Specifications insofar as their existence and location were known at the time of preparation of the drawings. However, nothing in these Drawings or Specifications shall be construed as a guarantee that such utilities are in the location indicated or that they actually exist, or that other utilities are not within the area of the operations. The Contractor shall make all necessary investigations to determine the existence and locations of such utilities. Should uncharted or incorrectly charted utilities be encountered during performance of the Work, notify the Project Officer or designee immediately for instructions. The Contractor will be held responsible for any damage to and maintenance and protection of existing utilities and structures, of both public and private ownership. However, if it is determined that such existing utility lines or structures require relocation or reconstruction or any other work beyond normal protection, then such additional work will be ordered under the terms of the clause entitled “Changes in Work.” At all times, cooperate with the County and utility companies to keep utility services and facilities in operation.

The County assumes no responsibility for any conclusions or interpretations made by the Contractor based on the information made available by the County. The County assumes no responsibility for any understanding reached or representation made concerning conditions which can affect the Work by any of its officers or agents before the execution of this Contract, unless that understanding or representation is expressly stated in this Contract.

2. PUBLIC CONVENIENCE

The Contractor shall at all times so conduct its Work as to ensure the least possible obstruction to traffic (vehicular, bicycle and pedestrian) and inconvenience to the general public, County employees, and the residents in the vicinity of the Work. Traffic shall be maintained in accordance with the approved Maintenance of Traffic (MOT) plan. No road, street or sidewalk shall be closed to the public except with the permission of the Project Officer or designee and or proper governmental authority. Fire hydrants on or adjacent to the Work shall be kept accessible to firefighting equipment at all times. Temporary provisions shall be made by the Contractor and included in the cost of the Work to ensure the use of sidewalks, trails, and transit facilities compliant with all applicable ADA and other regulations, as well as the proper functioning of all gutters, drainage inlets, drainage ditches, and irrigation ditches, which shall not be obstructed except as approved by the Project Officer or designee.

The Contractor is responsible for securing its work area for safety and security. The Contractor shall confine its construction and presence to the Limits of Work, unless otherwise approved by the County Project Officer.

3. SAFETY AND ACCIDENT PREVENTION

The Contractor shall comply with, and ensure that the Contractor's employees and subcontractors comply with, all current applicable local, state and federal policies, regulations and standards relating to safety and health, including, by way of illustration and not limitation, the U.S. Department of Labor’s Occupational Safety and Hazard Administration (OSHA) Construction Industry Regulations, the standards of the Virginia

Occupational Safety and Health program of the Department of Labor and Industry for General Industry and for the Construction Industry, the Federal Environmental Protection Agency Standards and the applicable standards of the Virginia Department of Environmental Quality.

The Contractor shall provide, or cause to be provided, all technical expertise, qualified personnel, equipment, tools and material to safely accomplish the Work specified to be performed by the Contractor and subcontractor(s).

The Contractor shall identify to the County Project Officer at least one on-site person who is the Contractor's competent, qualified, and authorized safety officer on the worksite and who is, by training or experience, familiar with and trained in policies, regulations and standards applicable to the work being performed. The competent, qualified and authorized person must be capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees, shall be capable of ensuring that applicable safety regulations are complied with, and shall have the authority and responsibility to take prompt corrective measures, which may include removal of the Contractor's personnel from the work site.

The Contractor shall provide to the County, within 7 days of issuance of the Notice to Proceed, a copy of the Contractor's written safety policies and safety procedures applicable to the scope of work. Failure to provide this information within may result in cancellation of the Contract.

The Contractor shall exercise proper precaution at all times for the protection of persons and property and shall be responsible for all injury to persons and damage to property either on or off the Site, which occur as a result of the Contractor's prosecution of the Work.

The Contractor shall take or cause to be taken such additional safety and health measures as the County may determine to be reasonably necessary. Machinery, equipment, and all hazards shall be guarded in accordance with the safety provisions of the current version of "Manual of Accident Prevention" published by the Associated General Contractors of America, Inc., to the extent that such provisions are not in conflict with applicable local laws. The Contractor is directed to the "Rules and Regulations Governing Construction, Demolition and All Excavation" and adopted by the Safety Codes Commission of Virginia, 1966, or latest edition, covering requirements for shoring, bracing, and sheet piling of trench excavations.

4. <u>HAZARDOUS MATERIALS</u>

Arlington County is subject to the Hazard Communication Standard, 29 CFR §1910.1200 (Standard). The Contractor agrees that it will provide or cause to be provided Safety Data Sheets (SDS) required under the Standard for all hazardous materials supplied to the County or used in the performance of the work. Such SDS shall be delivered to the County no later than the time of actual delivery of any hazardous materials to the County or use of such material in the performance of work under the Contract by the Contractor or its subcontractors, whichever occurs first. Container labeling meeting the requirements of the Standard shall be appropriately affixed to the shipping or internal containers. The

County reserves the right to refuse shipments of hazardous materials not appropriately labeled, or when SDS have not been received prior to or at the time of receipt of the shipment for use by the County or for use by the Contractor in the performance of the Contract, or whenever the material is delivered in a manner inconsistent with any applicable law or regulation. Any expenses incurred due to the refusal or rejection of SDS are the responsibility of the Contractor. The Contractor shall comply with all federal, state, and local laws governing the storage, transportation, and use of toxic and hazardous materials. The Contractor shall maintain on-site an up to date SDS binder for all material used and delivered to the Project. The County Project Officer or his designee shall be allowed access to the SDS book at all times.

5. HAZARDOUS WASTE

Hazardous Waste Generator/Hazardous Waste Disposal: The County Board of Arlington County, Virginia and the Contractor shall be listed as Co-generators. The Contractor shall assume all the duties pertaining to the Waste Generator, including signing the Waste Shipment Record ("WSR") and manifest. The Contractor shall supply the County Project Officer with the executed original Owner's Copy of the WSR, as required by applicable regulatory agencies within 35 days from the time the waste was accepted by the initial waste transporter, and prior to request for final payment. A separate WSR shall be submitted for each shipment to the disposal site.

Delayed Waste Shipment Records: The Contractor shall report in writing to the EPA Region III office within 45 days if an executed copy of the WSR is not received from the operator of the disposal site. The report to the EPA regional office shall include a copy of the original WSR and a cover letter signed by the Contractor stating the efforts taken to locate the hazardous waste shipment and the results of those efforts.

Temporary Hazardous Waste Storage Prohibited: The Contractor shall not temporarily store hazardous waste unless pre-approved by the County in writing. If so approved, hazardous waste stored off-site in a temporary facility shall be monitored and records shall be kept on the number of containers, size, and weight. The Contractor shall inform the County when the hazardous waste is to be transported to the final disposal site. The County has the right to inspect the temporary site at any time. The Contractor shall submit copies of all relevant manifests, Waste Shipment Record(s), and landfill receipts to the County Project Officer prior to the request for final payment. All paperwork shall be signed by the Contractor and disposal site operator as required.

6. ASBESTOS

Whenever and wherever during the course of performing any work under this Contract the Contractor discovers the presence of asbestos or suspects that asbestos is present, the Contractor shall stop work immediately, secure the area, notify the County Project Officer immediately and await positive identification of the suspect material. During the downtime in such a case, the Contractor shall not disturb any surrounding surfaces but shall protect the area with suitable dust covers. Work shall not proceed without an Asbestos-Related Work Authorization executed by the County Asbestos Program Manager.

7. CROSSING UTILITIES

When construction crosses highways, railroads, streets, waterways, or utilities under the jurisdiction of State, County, City, or other public agency, public utility, or private entity, the Contractor shall secure written permission where necessary from the proper authority before executing such new construction. A copy of such written permission must be filed with the County before any work is started. The Contractor shall be required to furnish a release from the proper authority before Final Acceptance of the Work.

8. OVERHEAD HIGH VOLTAGE LINES SAFETY ACT

If any work required herein will be performed within ten feet of an overhead high voltage line, the provisions of Virginia Statute 59.1-406, et. seq., "Overhead High Voltage Line Safety Act" (Act) shall apply. The "person or contractor responsible for the work to be done", as that term is used in the Act, will be interpreted to mean the Contractor. The Contractor shall notify the owner or operator of the high voltage line in the manner prescribed in Section 59.1-411 of the Act in sufficient time prior to the time work is to be commenced to avoid any delays in the work. The County will not pay for lost time, profits, or permit any extension of the work for any delays caused by the failure of the Contractor to make such arrangements in a timely manner. All costs for the work shall be paid by the Contractor. The County shall reimburse the Contractor for the actual reasonable cost paid to the owner or operator of the high voltage line by the Contractor on presentation to the County by the Contractor of original invoices from the owner or operator of the high voltage line in the same manner as for other Contractor invoices submitted for work performed. Retention, if applicable to the Contract, shall not be withheld from the payment to the Contractor by the County for this work. No processing, administrative, or other charges above the actual amount charged by the owner or operator of the high voltage line shall be paid to the Contractor by the County.

9. SANITARY PROVISIONS

The Contractor shall provide and maintain such sanitary accommodations for the use of the Contractor's employees and those of its subcontractors as may be necessary to comply with the requirements and regulations of OSHA and of the local and State departments of health.

10. SITE CLEAN-UP AND WASTE DISPOSAL

The Contractor shall frequently remove and properly dispose of all refuse, rubbish, scrap materials, and debris from the Site resulting from the Contractor's operations during the performance of this contract. The Contractor shall ensure the work Site presents a neat and orderly appearance at all times. The Contractor shall isolate any and all dumpsters, trash cans and recycling bins provided for the Project from public use until Final Acceptance.

Unless otherwise stated, the Contract Amount and any unit prices shall include all costs and fees for removal and disposal of all waste and debris, whether disposed of at a County site or at any other location.

The Contractor shall remove all surplus material, false work, temporary structures including foundations thereof, and debris resulting from the Contractor's operations at work completion and before Final Acceptance. The County shall reserve the right to remove the surplus material, false work, temporary structures including foundations and debris. The County will restore the Site to a neat, orderly condition if the Contractor fails to do so. The County shall be entitled to offset such cost against any sums owed by the County to the Contractor under this Contract.

11. STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

When the Project includes an approved SWPPP, the Contractor shall strictly abide by this plan which includes: a Pollution Prevention (P2) Plan, an Erosion and Sediment Control (E&S) Plan, and a Stormwater Management Plan. If the Contractor proposes to deviate from this approved plan, it shall be the Contractor's responsibility to coordinate and obtain approval from the County Project Officer prior to implementing any changes.

No separate payment shall be made by the County for SWPPP implementation, with the exception of E&S items as specified on the E&S plans or listed as pay items. The Contractor shall not be entitled to any additional payment for changes to the SWPPP which are the result of the Contractor's work schedule or resource allocation, weather delays, or other factors not controlled by the County.

F. PROGRESS AND COMPLETION OF THE WORK

1. NOTICE TO PROCEED
The Contractor shall be given written Notice to Proceed with the Work. Such Notice to Proceed shall state the date on which the Work is to be commenced, and every calendar day thereafter shall be counted in computing the actual Time for Completion.

2. TIME FOR COMPLETION
It is hereby understood and mutually agreed by and between the Contractor and the County that the Commencement Date, the rate of progress, and the Time for Completion of the Work to be done hereunder are essential conditions of the Contract. The Contractor agrees that the Work shall be started promptly upon receipt of a written Notice to Proceed in accordance with the accepted schedule. The Work shall be prosecuted regularly, diligently, and uninterruptedly at a rate of progress that will ensure full completion of the Project within the Time for Completion specified in the Contract Documents.

3. SCHEDULE OF COMPLETION
Unless otherwise specified, the Contractor shall within 10 business days after the Award Date, or prior to the pre-construction meeting, whichever occurs first, submit schedules which show the order in which the Contractor proposes to carry on the Work, with dates for starting and completing the various activities of the Work. The Contractor shall submit an updated schedule monthly with the request for partial payment. Review and acceptance by the County of the Contractor's schedule of completion shall in no way relieve the Contractor of its responsibility to complete the Work within the contract time. If the Work falls behind the schedule, the County may require the Contractor to prepare and submit, at no extra cost to the County, a recovery schedule indicating by what means the Contractor intends to regain compliance with the schedule. The recovery schedule must be submitted to the County for review by the date indicated in the County's written demand.

4. CONDITIONS FOR COMPLETION
   a. SUBSTANTIAL COMPLETION: The Work will be considered Substantially Complete when all of the following conditions have been met and accepted by the Project Officer, and a Certificate of Substantial Completion has been issued:

      1. The Contractor has provided formal notice that the Work is substantially complete, and the Project Officer has agreed that the condition of the Work warrants a Substantial Completion inspection;

      2. The Contractor has provided a Punch List and that list has been reviewed and approved by the Project Officer. Failure to include an item on the Punch List does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents;

      3. Final test reports as required by the Contract and certificates of inspection and approval required for use and occupancy;

4. Fire Marshal's report, if applicable;

5. Approval forms and transfer documents for all utilities;

6. All life safety systems, including fire alarms, visual and audios alarms, fire detectors and fire alarm annunciator system, sprinkler systems, and all mechanical and electrical systems are complete and working in an automatic mode, and the County has been adequately trained in the operation of the systems;

7. The HVAC system Testing and Balancing Report and build air quality test results as required for LEED certification have been accepted by the Project Officer;

8. Operation and Maintenance Manuals have been submitted for review;

9. All documents and verification of training required in accordance with any Commissioning Plan;

10. Mark-ups of construction drawings showing the As-Built or "Record" condition have been submitted for review and approval by the Project Officer;

12. Entrances and egress pathways have been constructed and can remain clear of construction activities;

13. A Certificate of Occupancy has been issued for the space by the County's Inspection Services Division;

14. All Commissioning has performed and completed to the satisfaction of the Project Officer; and

15. Schedule to complete the Punch List and value of Work not yet complete.

b. Upon the Contractor providing notice that the Work is substantially complete, the Project Officer or designee will invite all relevant parties to perform an inspection of the Work, and any noted deficiencies or incomplete items not indicated on the Contractor's punch list will be added. All punch list items, whether generated by the Contractor or any other party on behalf of the County, shall be completed within thirty (30) days of the date of Substantial Completion, unless otherwise agreed to by the County due to seasonal or other extenuating circumstances.

c. FINAL COMPLETION: The Work will be considered Finally Complete when all of the following conditions have been met and accepted and a Final Completion Notice has been issued by the Project Officer:

1. The Contractor has provided formal notice that the Work is complete, and the Project Officer has agreed that the condition of the Work warrants a Final Completion inspection;

2. All construction deficiencies and punch list items have been closed and all construction deficiencies corrected and accepted by the Project Officer;

3. All spare parts and attic stock have been delivered, stored in an orderly manner in a space designated by the Project Officer and a complete inventory list has been verified and accepted by the Project Officer;

4. All warranties and manufacturer certificates and contact information for parties providing warranties have been delivered and accepted by the Project Officer;

5. All final Operating and Maintenance manuals have been delivered and approved and accepted by the Project Officer;

6. All final As-Built Drawings in .pdf format on a CD delivered and accepted by the Project Officer;

7. All commissioning has been completed and any open construction items in the commissioning agent's report have be closed and accepted by the Project Officer; and

8. All LEED documents and submittals, if applicable, to be provided by the Contractor or subcontractors have been submitted and accepted by the Project Officer.

5. USE OF COMPLETED PORTIONS

The County shall have the right to take possession of and use any completed or partially completed portions of the Work, notwithstanding that the time for completing the entire Work or such portions may not have expired; but taking such possession and use shall not be deemed an acceptance of any work not done in accordance with the Contract Documents. If the Contractor claims that such prior use increases the cost or delays, the completion of remaining work, or causes refinishing of completed work, the Contractor may submit a claim for compensation or extension of time, or both.

G. MEASUREMENT AND PAYMENT

1. PAYMENTS TO CONTRACTOR

The County will make partial payments, less retainage, to the Contractor monthly on the basis of the Contractor's written estimate of the work performed during the preceding calendar month as approved by the Project Officer or designee.

The Contractor's application for payment shall indicate the amount of work completed to date in a format consistent with the accepted bid and as indicated below:

a. Lump Sum: For lump sum contracts, the Contractor shall provide to the Project Officer a Schedule of Values, and the application for payment will reflect the Schedule of Values and the amount of work completed in those units.

For contracts that include multiple lump sum line items, the application for payment shall reflect the percentage of work completed for each lump sum item. If requested by the Project Officer, the Contractor shall provide a Schedule of Values for each lump sum line item in the contract.

b. Unit Price: The schedule of unit prices in the accepted bid shall be used as the basis for preparing the estimates, and each partial payment shall represent the total value of all units of work completed, computed at the unit prices stated in the Contract, less the aggregate of previous payments.

At the discretion of the Project Officer, payments may alternatively be based on actual quantities and site measurements taken in the field by County staff using the Contract Unit Prices.

If Stipulated Price Items are included in the contract, Work on such Stipulated Price Items shall be carried out only upon written order by the Project Officer. The payment for a Stipulated Price Item shall be made by the County to the Contractor at the related unit price specified in the 'Stipulated Price Items' section of the Bid Form on the same basis as the payment for any other regular Bid Item.

In addition to the amount of work completed to date, the application for payment shall indicate the aggregate of all previous payments for each line item, the retainage previously withheld, and the total payment requested this period.

The Contractor's application for payment will not be reviewed or processed unless an updated schedule is attached. The pay application shall also contain a certification by the Contractor that due and payable amounts have been paid by the Contractor, including payments to subcontractors, for work which previous payment was received by the Contractor from the County.

2. PAYMENT FOR STORED MATERIALS

When requested in writing by the Contractor, payment allowances may be made for material secured for use on the Project and secured at the Site. Such payments will only be made for materials scheduled for incorporation into the work within sixty (60) days.

Payment for materials stored off-site may be considered at the discretion of the Project Officer. Any such request shall be made in writing, and the Contractor shall provide photographs of materials stored off-site, bills of sale, and proof of insurance on the premises at which off-site materials are stored with the application for payment. Payment for stored materials may also be subject to additional requirements contained elsewhere in the Contract Documents.

3. PAYMENTS WITHHELD

The Project Officer or designee may withhold or, on account of subsequently discovered evidence, nullify the whole or a part of any certificate for payment to the extent necessary to protect the County from loss on account of defective work not remedied or withhold payment for violation of any contract term or condition not remedied after sufficient notice given to the Contractor.

Any such withholding shall not result in any liability to the Contractor for damages.

4. COUNTY ORDERED CHANGES IN WORK

The County, without invalidating the Contract, may order extra Work or make changes by addition, deletion or revision in the Work, with the total Contract Amount being adjusted accordingly if applicable. All such work shall be executed under the conditions of the original Contract, except that modification of the Time for Completion caused thereby shall be made at the time of approving such change.

a. Changes in the Work which do not involve extra cost and are not inconsistent with the purpose of the Project can be directed by means of a Field Order. Otherwise, except in an emergency endangering life or property, no extra Work or change shall be made unless in pursuance of a written Construction Change Directive or Change Order and no claim for an addition to the Contract Amount or Contract Time shall be valid unless so ordered.

b. The Contractor shall review any County requested or directed change and shall respond in writing within 14 days after receipt of the proposed change stating the effect of the proposed change upon Contractor’s work, including any increase or decrease in Contract time and price. The Contractor shall furnish the County an itemized breakdown of the quantities and prices used in computing the proposed change. The Contractor shall also furnish any sketches, drawings, and or pictures to properly explain the change or impact to the Project Officer. It is the sole responsibility of the Contractor to provide adequate change order backup to satisfy the Project Officer.

c. The value of any such extra work or change shall be proposed by the Contractor in one or more of the following ways: (a) by estimate in a lump sum; (b) by cost and fixed fee; (c) by unit price additions or deletions of quantities stated in the unit price contract; or (d) by any other method permitted under the Arlington County Purchasing Resolution. The Project Officer will determine the method appropriate based on the nature of the changes.

d. If none of the aforementioned methods is agreed upon the Contractor shall proceed with the work without delay under force account, provided the Contractor receives a Construction Change Directive. In such case, the Contractor shall keep and present in such form as the Project Officer or designee may direct, a correct account of the cost, together with vouchers. The Project Officer or designee shall be permitted to verify such records on a daily basis and may require such additional records as are necessary to determine the cost of the change to the Work. The Project Officer or designee shall certify to the amount due to the Contractor, including a reasonable lump sum allowance for overhead and profit. A complete accounting of the extra cost shall be made within 14 days after completion of the work involved in the claim. Refer to Paragraph G.5, *Force Account Work*, below for a description of allowable costs when work is performed under force account.

e. A cost proposal for a change in the Work shall provide a complete breakdown itemizing the estimated quantities and costs of labor, materials, and equipment (base cost) required in addition to any markup used. The allowable percentage markups for overhead and profit for a non-force account change to the Work performed by the Contractor's own forces or performed by the Subcontractor shall be negotiated based on the nature, size, and complexity of the Work involved but shall not exceed the percentages for each category listed below.

1) Subcontractor's markup for overhead and profit for the work it performs in a change to the Work shall be a maximum of fifteen (15%).

2) Contractor's markup for overhead and profit on the Subcontractor's base cost in a change to the Work shall be a maximum of ten percent (10%).

3) Contractor's markup for overhead and profit (including bonds and insurance) for work it performs in a change to the Work shall be a maximum of fifteen percent 15%.

4) The markup for overhead and profit of a sub-subcontractor at any tier on a change to the Work it performs shall be a maximum of fifteen percent (15%). The Contractor and all intervening tiers of subcontractors' markup on such sub-subcontractor's base cost in the change to the Work shall not exceed a total of ten percent (10%).

f. Base Cost is defined as the total of labor, material, and equipment costs, it does not include markup for overhead and profit. The labor costs include only the costs of employees directly constructing or installing the change in the Work and exclude the costs of employees coordinating or managing the work.

g. The allowable percentage markups for overhead and profit stated above shall compensate the Contractor, subcontractor, and sub-subcontractor for all other costs associated with or relating to the change to the Work including by way of illustration and not limitation, general conditions, supervision, field engineering, coordination, insurance, bond(s), use of small tools, incidental job costs, and all other general and administrative home and field office expenses.

h. Allowable costs for changes in the Work shall not include home office expenses including payroll costs for the Contractor's officers, executives, administrators, project managers, estimators, clerks timekeepers, and other administrative personnel employed by the Contractor, whether at the Site or in the Contractor's principal or branch office for general administration of the Work. These costs are deemed overhead included in the percentage markups in Subsection (e) above.

i. If the change to the Work also changes the Time for Completion by adding days to perform the Work, an itemized accounting of the following Site direct overhead expenses for the change to the time may be considered as allowable costs for compensation in addition to the base cost indicated above:

1) site superintendent's pro-rata salary
2) temporary site office trailer expense
3) temporary site utilities including basic telephone service, electricity, heat, water, and sanitary/toilet facilities.

All other direct and indirect overhead expenses are considered covered by and included in Subsection (e) markups above. In no case shall subcontractor extended overhead be submitted or considered. The County does not have a direct contractual relationship with any subcontractor or supplier and therefore will not direct, discuss or negotiate with subcontractors employed by the Contractor.

j. If Contractor requests an extension to the Time for Completion due to changes in the Work it must provide to the Project Officer adequate documentation substantiating its entitlement for the time extension. The documentation must demonstrate an anticipated actual increase in the time required to complete the Work beyond that allowed by the Contract as adjusted by prior changes to the Work, not just an increase or decrease in the time needed to complete a portion of the total Work. In the event a Critical Path Method (CPM) schedule is required by the Contract, no extension to the Time for Completion shall be granted unless the additional or change to the Work increases the length of the critical path beyond the Time for Completion as demonstrated on the approved CPM schedule or bar chart schedule. Any Float belongs to Arlington County. A written statement in addition to a CPM analysis shall be prepared explaining how no other sequence of work activities could have been performed to decrease the impact or eliminate the impact altogether. If requested by the Project Officer the Contractor must provide alternate documentation detailing the claim to the County's satisfaction.

k. Any change that will increase the Contract Amount more than 10% will require notice to sureties and require that Performance and Payment Bonds be increased by the Contractor. The increased Performance and Payment Bonds must be sent to the County's Office of the Purchasing Agent within 15 calendar days of the County's approval of such change.

5. FORCE ACCOUNT WORK

A Force Account may be used at the County's discretion and only when either 1) agreement on the valuation of a change cannot be made using the methods described in the preceding paragraph, *County Ordered Changes in the Work*, or 2) the County cannot firmly establish an applicable and acceptable estimate for the cost of the work because the level of effort necessary to perform and complete the work cannot be reasonably estimated or anticipated but can only be determined by performing the work. Because of the significant burden on the County to monitor and control the work, Force Account work is not a preferred method, and it shall be the responsibility of the Contractor to provide all necessary documentation and justification of costs. The rates for labor, equipment and materials to be used in cases of work performed on a force account basis will be compensated as documented below. No costs other than those explicitly listed below shall be allowed:

a. Labor: Before any Force Account work begins, the Contractor shall submit for approval to the Project Officer the proposed hourly rates and associated labor costs (benefits and payroll burden) for all laborers and forepersons to be engaged in the work. The number of laborers and forepersons engaged in the work will be subject to regulation by the Project Officer and shall not exceed the number that the Project officer deems most practical and economical for the work. For all labor and forepersons in direct charge of the force account work, excluding general superintendence, compensation will be as follows:

1) Certified Pay Rate: The Contractor will receive the actual rate of wage or scale as set forth in his most recent payroll for each classification of laborers, and forepersons who are in direct charge of the specific operation. The time allowed for payment will be the number of hours such workers are actually engaged in the work. If overtime work is authorized by the County, payment will be at the normal overtime rate set forth in the Contractor's most recent payroll.

2) Benefits: The Contractor will be entitled to receive the actual cost for any fringe benefits that are regularly provided to the classes of laborers and forepersons engaged in the work and that are not included in the certified pay rate.

3) Payroll Burden: The Contractor will be entitled to receive the actual cost for all costs associated with required payroll taxes and payroll benefits not covered in 2) above, including:
   - Social Security Tax
   - Medicare Tax

- Unemployment Tax
- Worker's Compensation Insurance
- Contractor's Public Liability Insurance
- Contractor's Property Damage Liability Insurance

4) If the Contractor is unable to provide the necessary documentation for Benefits and Payroll Burden as identified above, the Contractor will be entitled to an additive of 20% of the Certified Hourly Pay Rate as full and final compensation for Benefits and Payroll Burdens

5) Overhead and Profit: The Contractor will be entitled to an additive of 10% on all properly documented and approved costs established in paragraphs 1), 2), 3), and 4) above for all administrative, overhead, and profit associated with labor costs.

6) Subsistence and lodging allowances may be allowed by the Project Officer at the actual and documented costs for lodging and meals if the following conditions are met and the applicable rates and authorization for such costs are established prior to beginning the work. No additives for overhead, administrative, profit, or any other costs will be permitted for subsistence and lodging.

    i. The specific Force Account work is outside the scope of the original contract, requires mobilization of a separate crew not intended to be used on the original contract, and the Contractor's base location is more than 50 miles from the Site, or

    ii. Forces which have been working on the Contract will be used for the Force Account work and have been routinely staying overnight during the life of the Project, and the Force Account Work will warrant an extension of the contract time, and the distance from the Contractor's base location to the Site is more than 50 miles

b. Materials: The Contractor will receive the actual cost of materials accepted by the Project Officer that are delivered and used for the work including taxes, transportation, and handling charges paid by the Contractor, not including labor and equipment rentals as herein set forth, to which 15 percent (15%) of the cost will be added for administration and profit. The Contractor shall make every reasonable effort to take advantage of trade discounts offered by material suppliers. Any discount received shall pass through to the County. Salvageable temporary construction materials will be retained by the County, or their appropriate salvage value shall be credited to the County, at the County's discretion.

c. Equipment: For all equipment other than small tools, the Contractor will be entitled to rental rates as established herein, and agreed to in writing before the work is begun. Transportation costs directly attributable to Force Account work will be as stated below. Small tools will be considered any equipment which has a new cost of $1000 or less, and will not be eligible for any compensation. The Contractor shall provide the Project Officer a list of all equipment to be used in the work. For each piece of equipment, the list shall include the serial number; date of manufacture; location from which equipment will be transported; and, for rental equipment, the rental rate and name of the company from which it is rented. The number and types of equipment engaged in the work will be subject to regulation by the Project Officer as deemed to be the most practical and economical for the work. No compensation will be allowed for equipment which is inoperable due to mechanical failure. Compensation for equipment shall be as follows:

1) Hourly Base Equipment Rental Rates (Owned Equipment) – For equipment authorized for use in the Force Account work that is owned by the Contractor, the Contractor shall be entitled to an Hourly Base Rental Rate as detailed in the following paragraphs. The Hourly Base Rental Rate for Contractor owned equipment will not exceed 1/176 of the monthly rates of the schedule shown in the *Rental Rate Blue Book* modified in accordance with the *Rental Rate Blue Book* rate adjustment tables that are current at the time the force account is authorized. The rates for equipment not listed in the *Rental Rate Blue Book* schedule shall not exceed the hourly rate being paid for such equipment by the Contractor at the time of the force account authorization. In the absence of such rates, prevailing rates being paid in the area where the authorized work is to be performed shall be used.

2) Hourly Base Equipment Rental Rates (Rented Equipment) – If the Contractor does not possess or have readily available equipment necessary for performing the force account work and such equipment is rented from a source other than a company that is an affiliate of the Contractor, payment will be based on actual invoice rates when the rates are reasonably in line with established rental rates for the equipment in question and are approved by the Project Officer.

3) Hourly Operating Rates – Hourly Operating Rates shall be as established in the Blue Book estimated operating cost per hour. This operating cost will be full compensation for fuel, lubricants, repairs, servicing (greasing, fueling, and oiling), small tools, and any and all incidentals. If rental rates for the equipment being used in the work are not listed in the Blue Book or otherwise readily available, the Hourly Operating Cost will be 15% of the established Hourly Base Rental Rate. If invoices for Rental Equipment include the furnishing of fuel, lubricants, repair, and servicing, then the Contractor will not be entitled to any Hourly Operating costs for that equipment.

4) Equipment Usage - Equipment usage will be measured by time in hours of actual time engaged in the performance of the work. The Contractor shall be entitled to the applicable Hourly Base Equipment Rental Rate and Hourly Operating Rate for all approved Equipment Usage.

5) Equipment Standby – Standby time is defined as the period of time equipment authorized for Force Account work by the Project Officer is available on-site for the work but is idle for reasons not the fault of the Contractor or normally associated with the efficient and necessary use of that equipment in the overall operation of the work at hand. Hourly rates for Contractor owned equipment on standby, will be at 50 percent (50%) of the rate paid for equipment performing work. Operating costs will not be allowed for equipment on Standby. When equipment is performing work less than 40 hours for any given week and is on standby, payment for standby time will be allowed for up to 40 hours, minus hours performing work. Payment for Standby will be allowed only for working days. Payment for Standby will not be made for the time that equipment is on the Project in excess of 24 hours prior to its actual performance in the force account work.

6) Transporting Costs – When it is necessary to obtain equipment exclusively for Force Account work from sources beyond the Project limits and the Project Officer authorizes the transporting of such equipment to the Site, the cost of transporting the equipment will be allowed as an expense. Where the transport requires the use for a hauling unit, the allowable expense will consist only of the actual cost incurred for the use of the hauling equipment, or the applicable Blue Book cost, whichever is less. When equipment is transferred under its own power, the allowable Transporting cost shall be 50% of the Hourly Base Equipment Rental Rate.

7) Overhead and Profit – The Contractor shall be entitled to an additive of 10% on all appropriate and approved Equipment Rental, Operating, and Transporting costs as defined above.

d. Subcontracting: The Contractor shall receive the cost of work performed by a subcontractor as determined in (a), (b), and (c) above. In addition, the Contractor will be allowed an allowance per the schedule below for administrative costs and profit.

Total Cost of Subcontract Work:	Rate Schedule
$0 - $10,000	10%
> $10,000	$1,000 + 5 % above $10,000

e. Other Costs: The Contractor shall not be entitled to any costs associated with Force Account Work other than those specifically identified in this section.

f. Statements: Payments will not be made for work performed on a force account basis until the Contractor has furnished the Project Officer duplicate itemized statements of all costs of such work detailed as follows:

1. Payroll indicating name, classification, date, daily hours, total hours, rate, and extension of each laborer, foreperson

2. Designation, dates, daily hours, total hours, rental rate, and extension for each unit of equipment
3. Quantities of materials, prices, and extensions
4. Transportation of materials
5. Statements shall be accompanied and supported by invoices for all materials used and transportation charges. However, if materials used on the Force Account work are not specifically purchased for such work but are taken from the Contractor's stock, then in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from his stock; that the quantity claimed was actually used; and that the price, transportation, and handling claimed represented his actual cost.

6. CLAIMS FOR EXTRA COST

If the Contractor claims that any event will give rise to a claim for an increase in the Contract Amount or that any instructions from the Project Officer, by drawings or otherwise, will incur him extra cost under the Contract, then, except in emergencies endangering life or property, it shall give the Project Officer written notice thereof no later than three (3) days of the event or instruction. The Contractor thereafter must provide to the Project Officer a full cost proposal within 14 days detailing the amount of additional compensation claimed, together with the basis therefore and documentation supporting the claimed amount. No such claims shall be valid unless so made. If the Project Officer agrees that such event or instructions involve extra cost to the Contractor, any additional compensation will be determined by one of the methods provided in the Changes in Work paragraph of these General Conditions as selected by the Project Officer. All pricing and supporting documentation requirements of the Changes in the Work clause shall apply to claims for extra cost deemed valid under this paragraph.

7. DAMAGES FOR DELAY; EXTENSION OF TIME OTHER THAN FOR WEATHER

a. Excusable Non-Compensable Delays: If and to the extent that the Contractor is delayed at any time in the progress of the Work by a Force Majeure event or other causes outside of the County's control or the Contractor's control and which the Contractor could not have reasonably foreseen, the Contractor may request an extension of the Time for Completion. To be considered for an extension of the Time for Completion, the Contractor shall give the Project Officer timely written notice at the inception of the delay. The Contractor thereafter must provide to the Project Officer a full claim within 14 calendar days of the cessation of the delay and demonstrate that the delay affected the critical path of the accepted schedule and any Float has been consumed. If the Project Officer agrees with the existence and impact of the delays, the Project Officer shall extend the Time for Completion for the length of time that the Time for Completion was actually delayed thereby. The Contractor shall not be due compensation or damages of any kind as a result of such delay. Delays caused by weather are addressed in Section G.8.

b. Excusable Compensable Delays: If and to the extent that the Contractor is unreasonably delayed at any time in the progress of the Work by any act or omission of the County, its agents or employees, due to causes within the County's control, the

Contractor may request an extension of the Time for Completion and/or additional compensation. The Contractor shall give notice to the Project Officer immediately at the time of the occurrence giving rise to the delay and shall give written notice no later than five (5) calendar days after the inception of the delay. The Contractor's written notice shall specify the nature of the delay claimed, the cause of the delay, and the impact of the delay on the Contractor's schedule. Thereafter the Contactor shall provide to the Project Officer a full claim within 14 calendar days of the cessation of the delay. The claim must detail the amount of additional contract time or compensation claimed, together with the basis therefor along with itemized documentation supporting the claim. The itemized documentation must demonstrate that the claimed delay directly affected the critical path of the accepted schedule and any Float has been consumed and the time and/or costs incurred by the Contractor are directly attributable to the delay in the work claimed. The Contractor shall be entitled to additional compensation only if the delay was caused solely by acts or omission of the County, its agents or employees, or due to causes within their control.

If the Contractor is entitled to compensation, an itemized accounting of the following direct site overhead expenses will be considered as allowable costs to be used in determining the compensation due the Contractor: the site superintendent(s) (as identified at the inception of the work) pro rata salary, temporary site facilities, temporary site office expense, and temporary site utilities including basic telephone service, electricity, heat, water, and sanitary/toilets. A fifteen percent (15%) markup of these expenses will be allowed to compensate the Contractor for home office and other direct or indirect overhead.

Furthermore, compensation for the delay shall be calculated from the contractual Time for Completion, as adjusted by Change Order, and shall not be calculated based on any early completion planned or scheduled by the Contractor

c. Non-Excusable Non-Compensable Delays: The Contractor shall not be entitled to an extension of the Time for Completion or to any additional compensation for delays if and to the extent they are caused by acts, omissions, fault, or negligence of the Contractor or its subcontractors, agents, or employees or due to foreseeable causes within their control, including, but not limited to, delays resulting from defective work, including workmanship and/or materials, from rejected work which must be corrected before dependent work can proceed, from defective work or rejected work for which corrective action must be determined before like work can proceed, from incomplete, incorrect, or unacceptable Submittals or samples, or from the failure to furnish enough properly skilled workers, proper materials or necessary equipment to diligently perform the work in a timely manner in accordance with the Project schedule.

d. No extension of time or additional compensation shall be given for a delay if the Contractor failed to give notice in the manner and within the time prescribed herein. Furthermore, no extension of time or additional compensation shall be given for any delay unless a full claim is made to the Project Offer within 14 days of the end of the delay.

Failure to give written notice or failure to present a timely claim shall constitute a waiver of any claim for extension or additional compensation based upon that cause.

e. If the Contractor submits a claim for damages pursuant to this Section, the Contractor shall be liable to the County for a percentage of all costs incurred by the County in investigating, analyzing, negotiating and litigating the claim, which percentage shall be equal to the percentage of the Contractor's total delay claim that is determined through litigation to be false or to have no basis in law or fact (Virginia Code §2.2-4335).

f. Any change in the Time for Completion or additional compensation shall be accomplished only by the issuance of a Change Order.

8. TIME EXTENSIONS FOR WEATHER

The Contractor's sole relief on any claims for delay which is caused by abnormal weather shall be an extension of the Time for Completion provided the Contractor gave the Project Officer written notice no later than five (5) calendar days after the onset of such delay and provided the weather affected the Critical Path. A fully-documented claim for a time extension under this Section must be submitted no later than thirty (30) calendar days after the cessation of the delay. It shall be the Contractor's responsibility to provide the necessary documentation to satisfy the Project Officer that the weather conditions claimed were encountered, which may include daily reports by the Contractor, copies of notification of weather days to the Project Officer, NOAA backup, and pictures from each day claimed.

The Time for Completion will not be extended due to inclement weather conditions which are normal, as defined below, for Arlington County. The Time for Completion includes an allowance for workdays (based on five (5) day workweek) which according to historical data may not be suitable for construction work. The Contractor may request extension to the Time for Completion if it can demonstrate unusual and disruptive weather conditions per the requirements below:

a. That one or more of the Weather Conditions listed below was encountered; and,
b. The occurrence of the Weather Condition(s) resulted in an inability to prosecute work which would have otherwise been performed on the day(s) the Weather Condition(s) occurred; and,
c. The work which was not able to be completed was on the Critical Path and could not be completed ***only*** due to the Weather Condition(s) claimed.

The Project Officer will determine the Contractor's entitlement to an extension of the Time for Completion. A time extension of no more than one (1) day will be granted for one (1) day of lost work which satisfies the requirements above, regardless of the number of Weather Conditions encountered. The Contractor's sole relief shall be an extension of the Time for Completion and no claim for an increase in Contract Amount will be allowed.

The Weather Conditions listed below will be the only basis for consideration by the County, based upon the requirements listed above, as an extension of the Time for Completion due to inclement weather or weather-related site conditions.

Weather Condition #1: Unusually Heavy Precipitation - Figure 1 illustrates the anticipated monthly inclement weather due to precipitation (Rain Days). If the number of days with precipitation in excess of 0.10", as recorded at Washington Reagan National Airport, exceeds the anticipated Rain Days, the Contractor will be entitled to an extension of one (1) day on the Time for Completion for every day in excess of the Rain Days illustrated in Figure 1. The anticipated value of Rain Days for partial months at the beginning and end of the Contract shall be evaluated on a pro-rated basis.

FIGURE 1

Average days with precipitation of 0.1" or more

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
7	6	7	6	8	6	7	6	6	5	6	6

Weather days are not exclusive to the individual months that they represent in Figure 1. If weather days are not used in a previous month(s) they can be used to offset weather delays in subsequent months. This will be reviewed on a case by case basis and is subject to reconciliation at the end of the Project.

Condition #2: Temperature – The Contractor may be entitled to an additional day for every day that the recorded high temperature at Washington Reagan National Airport is 32 degrees Fahrenheit or less, that has not already been incurred under Weather Condition #1 above. This condition does not apply to vertical construction as defined by the Arlington County Vertical Construction Standards.

9. RELEASE OF LIENS

The County, before making final payment, shall require the Contractor to furnish a complete release of all liens arising out of this Contract. The Contractor may, if any subcontractor refuses to furnish a release or receipt in full, furnish a bond satisfactory to the County, to indemnify him against any lien. If any lien remains unsatisfied after all payments have been made, the Contractor shall refund to the County all money that the latter may be compelled to pay in discharging such lien. However, the County may make payments in part or in full to the Contractor without requiring the releases or receipts, and the payments so made shall not impair the obligations of any Surety or Sureties on any bond or bonds furnished under this Contract.

10. FINAL PAYMENT

After the Contractor has completed all work and corrections to the satisfaction of the Project Officer or designee and delivered all maintenance and operating instructions, schedules, quantities, bonds, certificates of inspection, maintenance records, As-Built Drawings, and other items required as final payment submittal documents, the Contractor may make application for final payment following the procedure for progress payments. The Final Application for Payment shall be accompanied by all documents required in the Contract, including a complete and signed and notarized copy of the Final Payment Release Form as follows:

RELEASE AND REQUEST FOR FINAL PAYMENT

CONTRACT NUMBER:____________ CONTRACTOR NAME:______________________

FINAL PAYMENT AMOUNT: ____

The Contractor hereby requests final payment in the amount indicated on the above referenced Contract. The Contractor agrees that its acceptance of final payment releases and forever discharges Arlington County and its officers, employees, servants and agents from any and all actions, claims, demands and liability of whatever nature now existing or which may hereafter arise as a result of or in connection with the above referenced Contract.

The Contractor certifies that all of the debts for labor, materials, and equipment incurred in connection with the above referenced Contract have been fully paid.

AUTHORIZED SIGNATURE DATE: ____

The date of Final Acceptance is the date on which the County issues the final payment for the work performed.

COMMONWEALTH OF VIRGINIA

COUNTY OF ARLINGTON

On this the _____ day of _______________, 20___, before me, personally appeared _________________________________, who acknowledged himself/herself to be _________________________________ in the above instrument, and that he/she, as such _________________________________, being authorized so to do, executed the foregoing instrument for the purposes therein contained, by signing his/her name by himself/herself as ___________________________________.

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

____
Notary Public

My Commission Expires:_________________

EXHIBIT D

VIRGINIA DEPARTMENT OF LABOR AND INDUSTRY WAGE DETERMINATION DECISION

COMMONWEALTH of VIRGINIA
DEPARTMENT OF LABOR AND INDUSTRY

Gary G. Pan
COMMISSIONER

Main Street Centre
600 East Main Street, Suite 207
Richmond, Virginia 23219
PHONE (804) 371-2327
FAX (804) 371-6524

Virginia Department of Labor and Industry Wage Determination Decision

Project Name	Biosolids Upgrade
County Project Code	24-DES-ITBPW-473
DOLI Project Number	ARLC-23-0006 UPDATE
County or Independent City	Arlington County
Publication Date	01/19/2024
Construction Type	Heavy

Wage Determinations	Wage	Fringe
Carpenter	$22.74	$7.82
Cement Mason/Concrete Finisher	$30.00	$12.99
Electrician	$53.00	$21.35
Form Worker	$33.21	$13.87
Ironworker	$30.32	$18.86
Laborer: Common or General	$18.02	$1.32
Laborer: Landscape	$23.00	$2.32
Laborer: Pipelayer	$29.86	$8.85
Mason - Stone	$43.16	$20.28
Operator: Backhoe/Excavator/Trackhoe	$26.86	$5.98
Operator: Bobcat/Skid Steer/Skid Loader	$21.37	$3.83
Operator: Bulldozer	$24.42	
Pipefitter	$50.27	$23.32

Wage Determinations	Wage	Fringe
Power Equipment Operator: Crane	$34.16	$11.50
Power Equipment Operator: Loader	$34.80	$11.60
Truck Driver: Dump Truck	$16.44	$2.83

Additional Notes

All wage rates to be used on a contract will be set at the time the contract is awarded. While DOLI maintains a list of wage determinations online for reference purposes, only the wage determinations made in an official Wage Determination Decision, sent by DOLI to the contracting agency, can be used to ascertain the exact rates to be paid for a specific contract.

All rates are determined by DOLI and any appeals of specific classifications may be made through the Wage Determination Appeal form available at http://www.doli.virginia.gov/wp-content/uploads/2021/04/Appeal-for-Wage-Determination-Clarification.pdf
Any additional classifications may be requested through the Additional Wage Classification form available at http://www.doli.virginia.gov/wp-content/uploads/2021/04/Request-for-Additional-Wage-Classification.pdf

Understand your duties as a contractor under Virginia law by referencing our Contractor Responsibilities information sheet available at http://www.doli.virginia.gov/wp-content/uploads/2021/04/PREVAILING-WAGE-CONTRACTOR-RESPONSIBILITIES.pdf

Your employees have specific rights, which can be found on our List of Employee Rights information sheet available at http://www.doli.virginia.gov/wp-content/uploads/2021/04/PREVAILING-WAGE-EMPLOYEE-RIGHTS.pdf

Any further questions should be directed to PrevailingWage@doli.virginia.gov

EXHIBIT E

GUARANTEED MAXIMUM PRICE

THIS GUARANTEED MAXIMUM PRICE AMENDMENT ("Amendment") is entered into by and between the County Board of Arlington County, Virginia (the "County") and ________________________ (the "Contractor"), pursuant to Agreement No. 20-227-RFP (the "Agreement"), dated _________ between the County and the Contractor, for ____to establish a Guaranteed Maximum Price (GMP) as set forth below.

1. GUARANTEED MAXIMUM PRICE

Subject to additions and deductions which may be made only in accordance with the Agreement, the Contractor represents, warrants and guarantees to the County that the total maximum cost to be paid by the County for Contractor's complete performance under the Agreement, including, but not limited to, Final Completion of all Work, and all fees, compensation and reimbursements to Contractor, shall not exceed the total amount of __________________________________dollars ($_____________) ("Guaranteed Maximum Price" or "GMP"). Costs which would cause the Guaranteed Maximum Price (as may be adjusted pursuant to the Contract Documents) to be exceeded shall be paid by the Contractor without reimbursement by the County.

2. GUARANTEED MAXIMUM PRICE COMPONENTS

The Guaranteed Maximum Price is comprised of the maximum amount payable by the County for:

A. the Cost of the Work, as defined in the Contract Documents, for full and complete performance of the Work in strict accordance with the Contract Documents, in the amount of __________________ dollars ($_________);

B. a Design-Build Fee for the Contractor, as defined in the Contract Documents, in the amount of __________________ dollars ($_________);

C. the General Conditions Fee, as defined in the Contract Documents, in the amount of __________________ dollars ($_________); and

The Contractor may reallocate funds between the Cost of Work and General Conditions Fee categories in order to complete construction of the Project within the GMP. The Guaranteed Maximum Price is further broken down into line items and categories as specified in Attachment ____ to this Amendment.

3. BASIS FOR THE GMP

The GMP is based on the GMP Drawings and Specifications developed as part of solicitation No. **22-DES-RFPPW-672**, and the Contractor covenants and agrees that, except for such increases to the GMP as expressly authorized in this Contract, it will deliver a fully complete Project that is a logical development of the RFP Plans and constructed in strict accordance with the IFC Set for an amount that does not exceed the GMP. The GMP is for the performance of the Work in accordance with the Contract Documents and the following Attachments to this Amendment:

A. Attachment A: List of the Drawings and Specification, addenda, and General, Supplementary, and other Conditions of the Contract on which the GMP is based.

B. Exhibit B: A list of Unit Prices as well as a statement of their basis.

C. Attachment C: Assumptions and Clarifications made by the Contractor in the preparation of the GMP Proposal to supplement the information contained in the Drawings & Specifications.

D. Attachment D: The proposed GMP, including a statement of the detailed cost estimate for the Cost of Work organized by trade categories, General Condition Fee, and Design-Build Fee that comprise the GMP.

E. Attachment E: An agreed upon schedule that the Contractor has negotiated with the Designers, and all Subcontractors. The schedule shall include, but not limited to the Substantial and Final Completion Dates, upon which the proposed GMP is based. All other project schedule requirements shall be followed as defined in the County issued RFP and Agreement.

4. CONTRACTOR CERTIFICATION

The Contractor and the County acknowledge that the Drawings and Specifications are not complete and, as of the date hereof, that such Drawings and Specifications have reached the level of approximately _______ of the total design effort. The Contractor, however, hereby acknowledges and declares that the Contract Documents are sufficiently complete to have enabled the Contractor to determine the Cost of the Work therein in order to enter into the GMP Amendment and to enable the Contractor to agree to construct the Work outlined therein in accordance with applicable leases, statutes, building codes and regulations without any increase to the GMP or extension of Contract Time, except if and to the extent otherwise expressly provided in the Agreement. The Contractor further acknowledges that it has visited the Site, examined all conditions affecting the Work, performed and agrees with all studies the Contractor was required to be performed under this agreement, is fully familiar with all of the conditions thereon and affecting the same, and has carefully examined all drawings and specifications.

5. DESIGN INTENT; INFERABLE WORK

The GMP Drawings and Specifications include various clarifications and assumptions that are intended to further define the Scope of Work that will be required to complete design. The Contractor has included within the Guaranteed Maximum Price sufficient amounts to cover aspects of the Work that are not shown on the GMP Drawings and Specifications.

6. COST OVERRUNS

Subject to additions or deductions, which may be made in accordance with the Contract, the Contractor shall be solely liable and responsible for and shall pay any and all costs, fees and other expenditures in excess of the Guaranteed Maximum Price for and/or relating to the Work, without entitlement to reimbursement from the County. The Contractor shall not be entitled to any fee, payment, compensation or reimbursement under this Agreement or relating to the Work or Project other than as expressly provided in the Agreement.

7. CONTINGENCY

Separate and outside of the GMP, the Contingency is a sum of money unassociated with any specific work to allow the Contractor to accommodate market changes and/or unforeseen conditions in order to complete the Project. For example, market changes and/or unforeseen conditions include:

- Market changes – extraordinary changes in pricing of certain equipment, components or commodities which causes an increase in pricing. Procedures for defining market changes and procedures for quantifying the amount of the potential increase shall be defined in this GMP Amendment, including what equipment, components, or commodities will be considered for adjustments based on market changes.

- Unforeseen conditions – certain conditions and events identified in the County General Conditions that could not be foreseen at the time of GMP.

The County shall approve all uses of Contingency. Any County authorized use of Contingency will result in a modification to the GMP per the terms of the Contract via the Change Order process. Any unused Contingency will be returned to the County with no shared savings.

8. ALLOWANCE

Separate from the GMP, a list of allowance items, including unit prices, as well as a statement of their basis has been provided in Attachment ___. The allowance is for the sole use of the County for scope changes and adjustments or agreed to scope items that the County controls. The allowance budget shall be outside of the Guaranteed Maximum Price. Any County authorized use of allowance will result in a modification to the Guaranteed Maximum Price per the terms of the Contract via the Change Order process. The Contractor is not guaranteed any work as related to the allowance items, and any unused allowance will be returned to the County with no shared savings.

EXHIBIT F

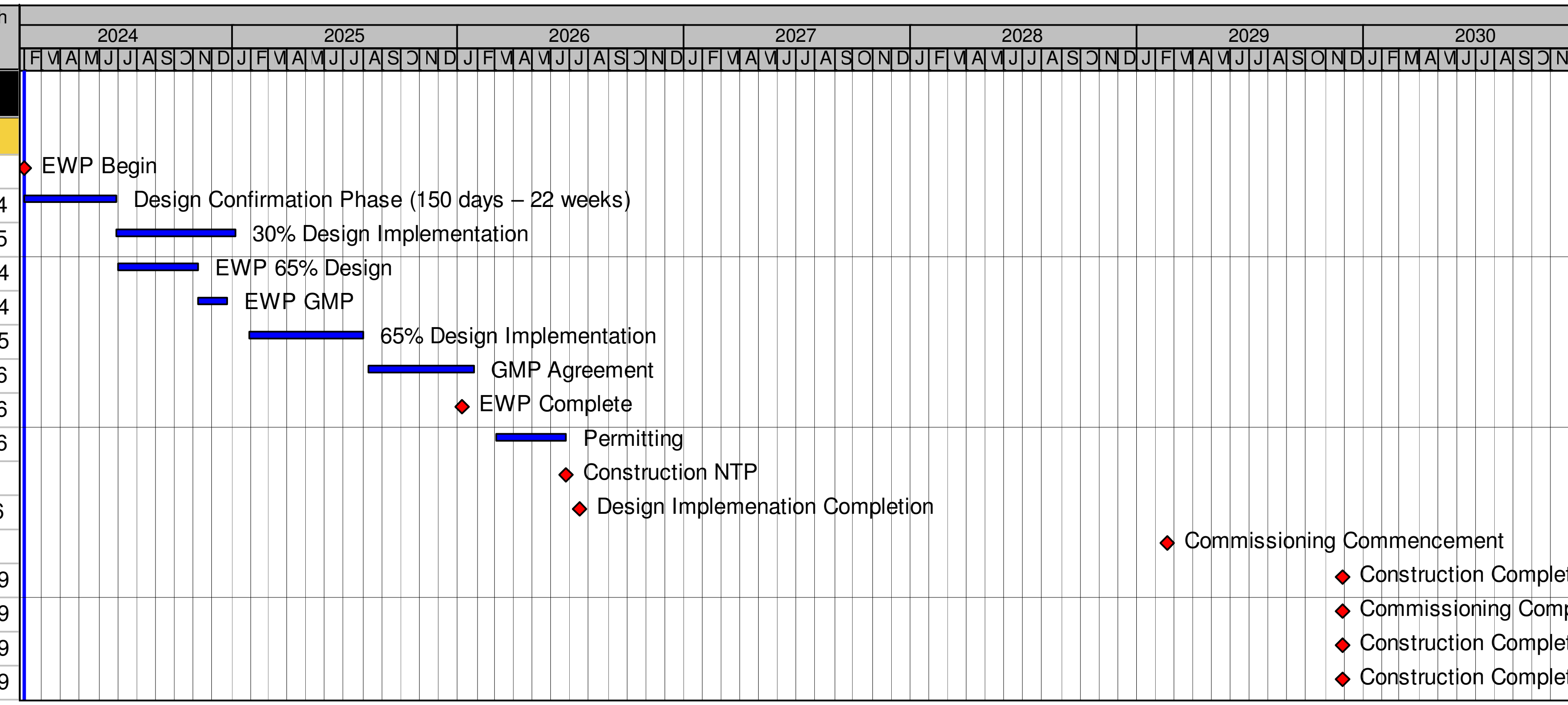
DRAWINGS, SPECIFICATIONS, AND CONSTRUCTION NOTES

<u>EXHIBIT G</u>

NEGOTIATED PROJECT SCHEDULE

ARLINGTON COUNTY BIOSOLIDS UPGRADES, PROPOSAL SCHEDULE

Activity ID	Activity Description	Duration	Early Start	Early Finish
Summary				
S1050	EWP Begin	0	01-Feb-24	
S1010	Design Confirmation Phase (150 days – 22 weeks)	150	01-Feb-24	29-Jun-24
S1020	30% Design Implementation	130	28-Jun-24	06-Jan-25
S1030	EWP 65% Design	92	01-Jul-24	07-Nov-24
S1040	EWP GMP	30	08-Nov-24	24-Dec-24
S1070	65% Design Implementation	130	29-Jan-25	01-Aug-25
S1080	GMP Agreement	115	11-Aug-25	27-Jan-26
S1060	EWP Complete	0		08-Jan-26
S1130	Permitting	80	05-Mar-26	25-Jun-26
CNTP	Construction NTP	0	26-Jun-26	
S1090	Design Implemenation Completion	0		17-Jul-26
S1110	Commissioning Commencement	0	20-Feb-29	
S1100	Construction Complete - PDB Option 2B	0		30-Nov-29
S1120	Commissioning Complete / Acceptance	0		30-Nov-29
S1140	Construction Complete - RFP Option	0		30-Nov-29
S1150	Construction Complete - PDB Option 2A	0		30-Nov-29

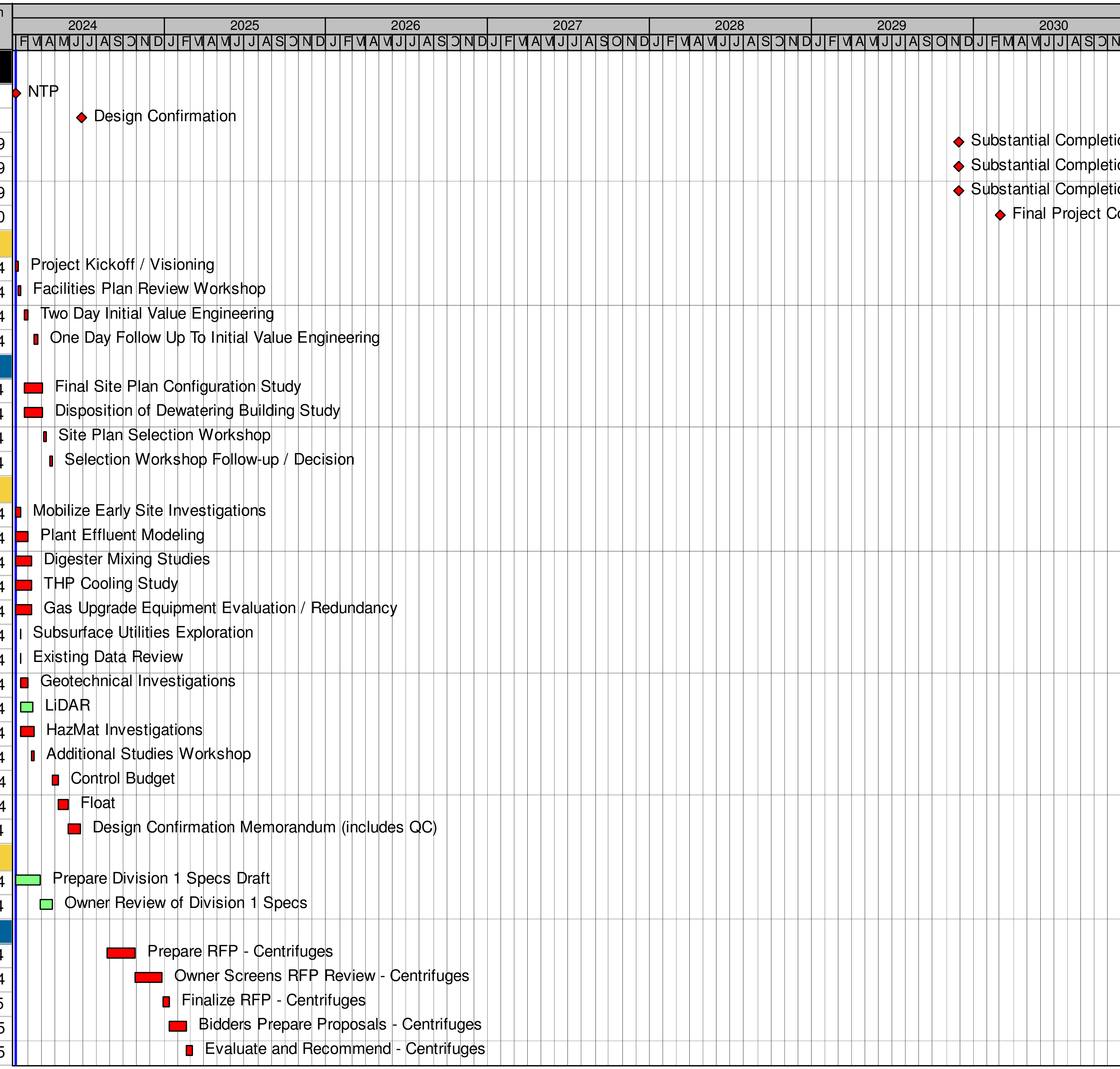


Start Date 01-Feb-24
Finish Date 02-Mar-30
Run Date 15-Dec-23

Level of Effort
Remaining Work
Critical Remaining Work
Milestone

ARLINGTON COUNTY
BIOSOLIDS UPGRADES,
PROPOSAL SCHEDULE
SUMMARY

Activity ID	Activity Description	Duration	Early Start	Early Finish
ARLINGTON COUNTY BIOSOLIDS UPGRADES, PROPOSAL SCHEDULE				
M1000	NTP	0	01-Feb-24	
M1010	Design Confirmation	0	30-Jun-24	
M1020	Substantial Completion - PDB Option 2B	0		30-Nov-29
M1040	Substantial Completion - RFP Option	0		30-Nov-29
M1050	Substantial Completion - PDB Option 2A	0		30-Nov-29
M1030	Final Project Completion	0		02-Mar-30
Initial Estimate				
A1000	Project Kickoff / Visioning	4	01-Feb-24	06-Feb-24
A1010	Facilities Plan Review Workshop	5	07-Feb-24	13-Feb-24
A1020	Two Day Initial Value Engineering	5	22-Feb-24	28-Feb-24
A1050	One Day Follow Up To Initial Value Engineering	5	15-Mar-24	21-Mar-24
Baseline Milestone Schedule				
A1040	Final Site Plan Configuration Study	30	22-Feb-24	03-Apr-24
A1060	Disposition of Dewatering Building Study	30	22-Feb-24	03-Apr-24
A1080	Site Plan Selection Workshop	5	04-Apr-24	10-Apr-24
A1090	Selection Workshop Follow-up / Decision	5	18-Apr-24	24-Apr-24
Introduction Site Plan				
A1180	Mobilize Early Site Investigations	9	01-Feb-24	13-Feb-24
A1150	Plant Effluent Modeling	20	01-Feb-24	29-Feb-24
A1120	Digester Mixing Studies	25	01-Feb-24	07-Mar-24
A1130	THP Cooling Study	25	01-Feb-24	07-Mar-24
A1140	Gas Upgrade Equipment Evaluation / Redundancy	25	01-Feb-24	07-Mar-24
A1200	Subsurface Utilities Exploration	0	14-Feb-24	14-Feb-24
A1210	Existing Data Review	0	14-Feb-24	14-Feb-24
A1220	Geotechnical Investigations	10	14-Feb-24	28-Feb-24
A1190	LiDAR	19	14-Feb-24	12-Mar-24
A1230	HazMat Investigations	20	14-Feb-24	13-Mar-24
A1110	Additional Studies Workshop	5	08-Mar-24	14-Mar-24
A1100	Control Budget	10	25-Apr-24	08-May-24
A1160	Float	15	09-May-24	30-May-24
A1170	Design Confirmation Memorandum (includes QC)	20	31-May-24	27-Jun-24
Major Equipment Blackbox				
A1350	Prepare Division 1 Specs Draft	40	01-Feb-24	28-Mar-24
A1360	Owner Review of Division 1 Specs	20	29-Mar-24	25-Apr-24
Centrifuges				
A1370	Prepare RFP - Centrifuges	45	26-Aug-24	28-Oct-24
A1380	Owner Screens RFP Review - Centrifuges	40	29-Oct-24	27-Dec-24
A1390	Finalize RFP - Centrifuges	10	30-Dec-24	13-Jan-25
A1400	Bidders Prepare Proposals - Centrifuges	25	14-Jan-25	19-Feb-25
A1410	Evaluate and Recommend - Centrifuges	10	20-Feb-25	05-Mar-25



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Remaining Work
Critical Remaining Work
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ARLINGTON COUNTY
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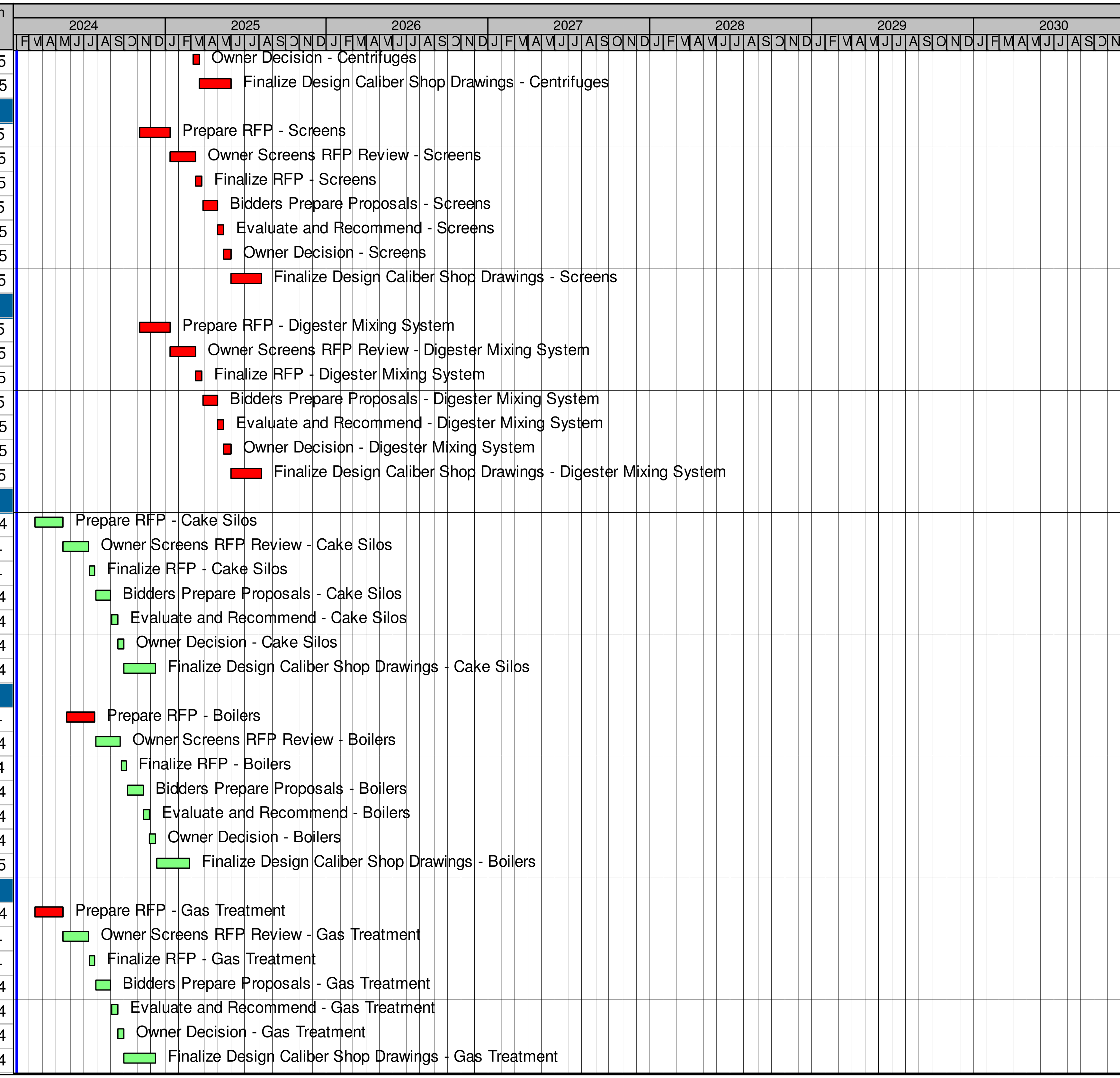
Activity ID	Activity Description	Duration	Early Start	Early Finish
A1420	Owner Decision - Centrifuges	10	06-Mar-25	19-Mar-25
A1430	Finalize Design Caliber Shop Drawings - Centrifuges	50	20-Mar-25	29-May-25
Screens				
A1440	Prepare RFP - Screens	45	05-Nov-24	13-Jan-25
A1450	Owner Screens RFP Review - Screens	40	14-Jan-25	12-Mar-25
A1460	Finalize RFP - Screens	10	13-Mar-25	26-Mar-25
A1470	Bidders Prepare Proposals - Screens	25	27-Mar-25	30-Apr-25
A1480	Evaluate and Recommend - Screens	10	01-May-25	14-May-25
A1490	Owner Decision - Screens	10	15-May-25	29-May-25
A1500	Finalize Design Caliber Shop Drawings - Screens	50	30-May-25	08-Aug-25
Digester Mixing System				
A1510	Prepare RFP - Digester Mixing System	45	05-Nov-24	13-Jan-25
A1520	Owner Screens RFP Review - Digester Mixing System	40	14-Jan-25	12-Mar-25
A1530	Finalize RFP - Digester Mixing System	10	13-Mar-25	26-Mar-25
A1540	Bidders Prepare Proposals - Digester Mixing System	25	27-Mar-25	30-Apr-25
A1550	Evaluate and Recommend - Digester Mixing System	10	01-May-25	14-May-25
A1560	Owner Decision - Digester Mixing System	10	15-May-25	29-May-25
A1570	Finalize Design Caliber Shop Drawings - Digester Mixing System	50	30-May-25	08-Aug-25
Cake Silos				
A1650	Prepare RFP - Cake Silos	45	14-Mar-24	15-May-24
A3400	Owner Screens RFP Review - Cake Silos	40	16-May-24	12-Jul-24
A3410	Finalize RFP - Cake Silos	10	15-Jul-24	26-Jul-24
A3420	Bidders Prepare Proposals - Cake Silos	25	29-Jul-24	30-Aug-24
A3430	Evaluate and Recommend - Cake Silos	10	03-Sep-24	16-Sep-24
A3440	Owner Decision - Cake Silos	10	17-Sep-24	30-Sep-24
A3450	Finalize Design Caliber Shop Drawings - Cake Silos	50	01-Oct-24	12-Dec-24
Boilers				
A1580	Prepare RFP - Boilers	45	23-May-24	26-Jul-24
A1590	Owner Screens RFP Review - Boilers	40	29-Jul-24	23-Sep-24
A1600	Finalize RFP - Boilers	10	24-Sep-24	07-Oct-24
A1610	Bidders Prepare Proposals - Boilers	25	08-Oct-24	12-Nov-24
A1620	Evaluate and Recommend - Boilers	10	13-Nov-24	26-Nov-24
A1630	Owner Decision - Boilers	10	27-Nov-24	12-Dec-24
A1640	Finalize Design Caliber Shop Drawings - Boilers	50	13-Dec-24	26-Feb-25
Gas Treatment				
A1660	Prepare RFP - Gas Treatment	45	14-Mar-24	15-May-24
A1670	Owner Screens RFP Review - Gas Treatment	40	16-May-24	12-Jul-24
A1680	Finalize RFP - Gas Treatment	10	15-Jul-24	26-Jul-24
A1690	Bidders Prepare Proposals - Gas Treatment	25	29-Jul-24	30-Aug-24
A1700	Evaluate and Recommend - Gas Treatment	10	03-Sep-24	16-Sep-24
A1710	Owner Decision - Gas Treatment	10	17-Sep-24	30-Sep-24
A1720	Finalize Design Caliber Shop Drawings - Gas Treatment	50	01-Oct-24	12-Dec-24



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ARLINGTON COUNTY
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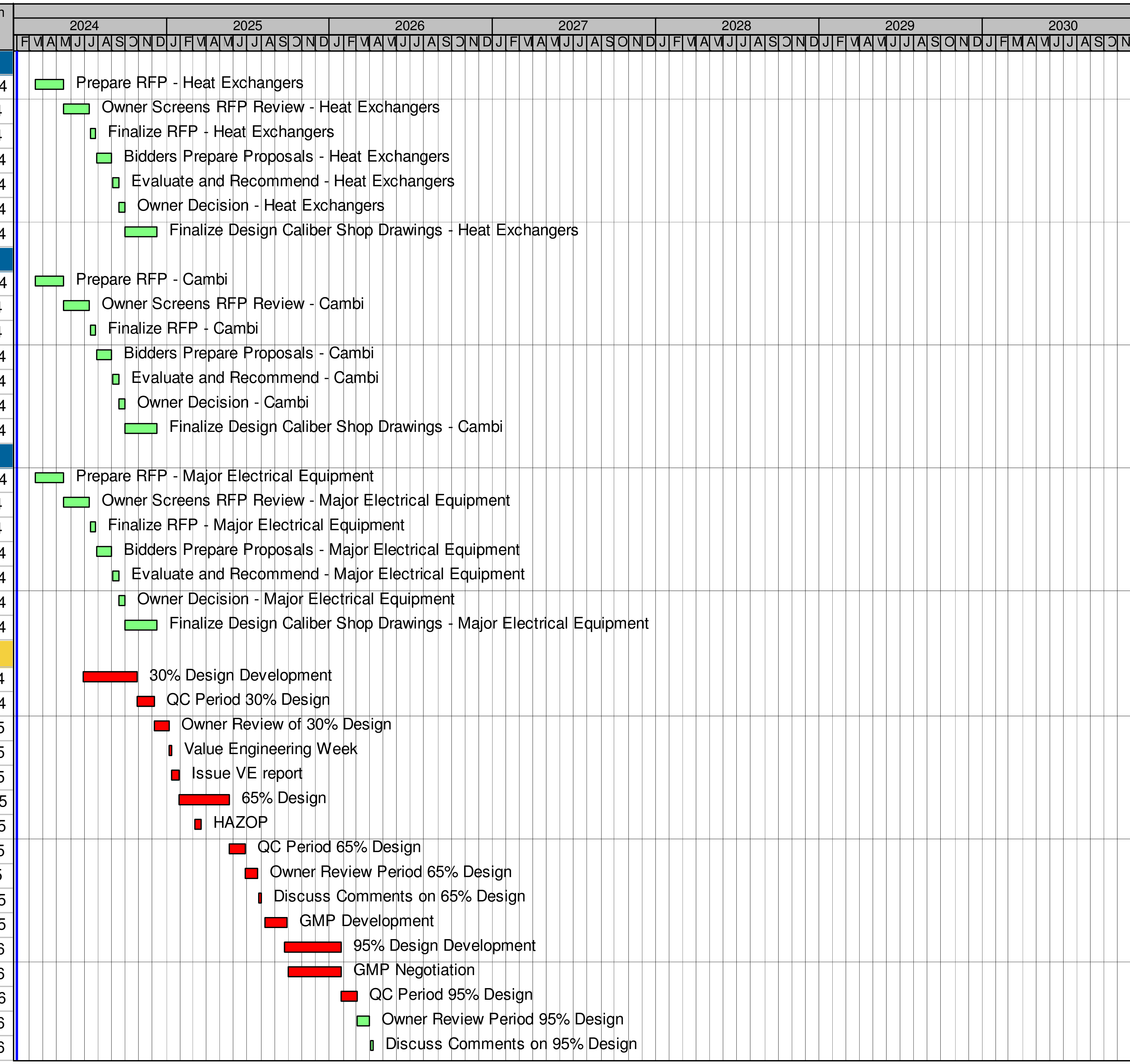
Activity ID	Activity Description	Duration	Early Start	Early Finish
Heat Exchangers				
A2700	Prepare RFP - Heat Exchangers	45	14-Mar-24	15-May-24
A2710	Owner Screens RFP Review - Heat Exchangers	40	16-May-24	12-Jul-24
A2720	Finalize RFP - Heat Exchangers	10	15-Jul-24	26-Jul-24
A2730	Bidders Prepare Proposals - Heat Exchangers	25	29-Jul-24	30-Aug-24
A2740	Evaluate and Recommend - Heat Exchangers	10	03-Sep-24	16-Sep-24
A2750	Owner Decision - Heat Exchangers	10	17-Sep-24	30-Sep-24
A2760	Finalize Design Caliber Shop Drawings - Heat Exchangers	50	01-Oct-24	12-Dec-24
Cambi				
A2770	Prepare RFP - Cambi	45	14-Mar-24	15-May-24
A2780	Owner Screens RFP Review - Cambi	40	16-May-24	12-Jul-24
A2790	Finalize RFP - Cambi	10	15-Jul-24	26-Jul-24
A2800	Bidders Prepare Proposals - Cambi	25	29-Jul-24	30-Aug-24
A2810	Evaluate and Recommend - Cambi	10	03-Sep-24	16-Sep-24
A2820	Owner Decision - Cambi	10	17-Sep-24	30-Sep-24
A2830	Finalize Design Caliber Shop Drawings - Cambi	50	01-Oct-24	12-Dec-24
Major Electrical Equipment				
A2840	Prepare RFP - Major Electrical Equipment	45	14-Mar-24	15-May-24
A2850	Owner Screens RFP Review - Major Electrical Equipment	40	16-May-24	12-Jul-24
A2860	Finalize RFP - Major Electrical Equipment	10	15-Jul-24	26-Jul-24
A2870	Bidders Prepare Proposals - Major Electrical Equipment	25	29-Jul-24	30-Aug-24
A2880	Evaluate and Recommend - Major Electrical Equipment	10	03-Sep-24	16-Sep-24
A2890	Owner Decision - Major Electrical Equipment	10	17-Sep-24	30-Sep-24
A2900	Finalize Design Caliber Shop Drawings - Major Electrical Equipn	50	01-Oct-24	12-Dec-24
Main Design Development				
A1730	30% Design Development	85	28-Jun-24	28-Oct-24
A1740	QC Period 30% Design	25	29-Oct-24	05-Dec-24
A1750	Owner Review of 30% Design	20	06-Dec-24	06-Jan-25
A1760	Value Engineering Week	5	07-Jan-25	13-Jan-25
A1770	Issue VE report	10	14-Jan-25	28-Jan-25
A1790	65% Design	80	29-Jan-25	21-May-25
A1780	HAZOP	10	06-Mar-25	19-Mar-25
A1800	QC Period 65% Design	25	22-May-25	26-Jun-25
A1810	Owner Review Period 65% Design	20	27-Jun-25	25-Jul-25
A1820	Discuss Comments on 65% Design	5	28-Jul-25	01-Aug-25
A1830	GMP Development	35	11-Aug-25	29-Sep-25
A1850	95% Design Development	85	23-Sep-25	27-Jan-26
A1840	GMP Negotiation	80	30-Sep-25	27-Jan-26
A1860	QC Period 95% Design	25	28-Jan-26	04-Mar-26
A1870	Owner Review Period 95% Design	20	05-Mar-26	01-Apr-26
A1880	Discuss Comments on 95% Design	5	02-Apr-26	08-Apr-26



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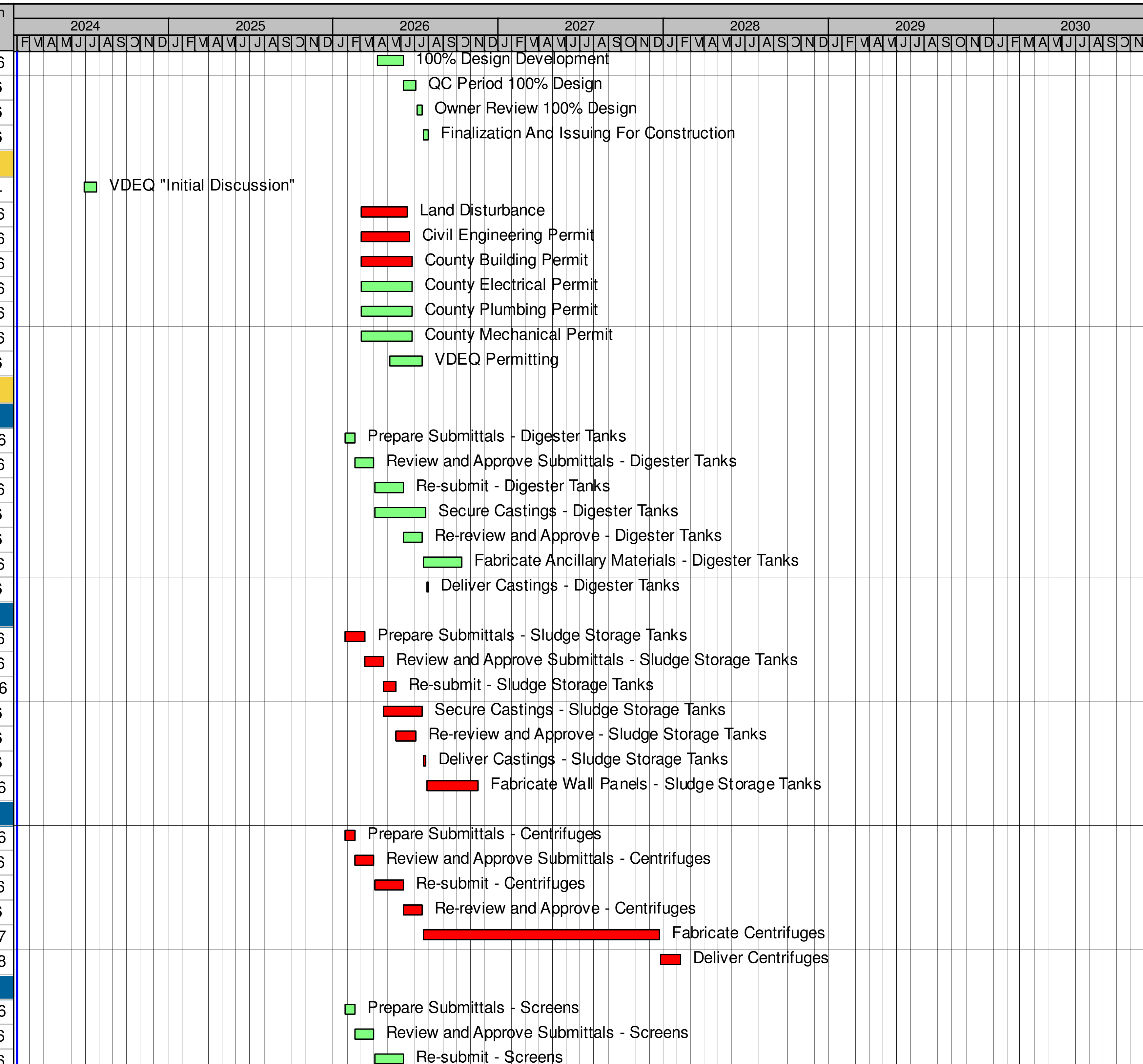
A1890	100% Design Development	40	09-Apr-26	04-Jun-26
A1900	QC Period 100% Design	20	05-Jun-26	02-Jul-26
A1910	Owner Review 100% Design	10	06-Jul-26	17-Jul-26
A1920	Finalization And Issuing For Construction	10	20-Jul-26	31-Jul-26
Permits				
P1070	VDEQ "Initial Discussion"	20	28-Jun-24	26-Jul-24
P1020	Land Disturbance	100	05-Mar-26	12-Jun-26
P1010	Civil Engineering Permit	75	05-Mar-26	18-Jun-26
P1030	County Building Permit	80	05-Mar-26	25-Jun-26
P1060	County Electrical Permit	80	05-Mar-26	25-Jun-26
P1040	County Plumbing Permit	80	05-Mar-26	25-Jun-26
P1050	County Mechanical Permit	80	05-Mar-26	25-Jun-26
P1080	VDEQ Permitting	50	07-May-26	17-Jul-26
Procurement				
Digester Tanks				
A3330	Prepare Submittals - Digester Tanks	15	28-Jan-26	18-Feb-26
A3340	Review and Approve Submittals - Digester Tanks	30	19-Feb-26	01-Apr-26
A3620	Re-submit - Digester Tanks	45	02-Apr-26	04-Jun-26
A3360	Secure Castings - Digester Tanks	80	02-Apr-26	24-Jul-26
A3630	Re-review and Approve - Digester Tanks	30	05-Jun-26	17-Jul-26
A3350	Fabricate Ancillary Materials - Digester Tanks	60	20-Jul-26	12-Oct-26
A3390	Deliver Castings - Digester Tanks	5	27-Jul-26	31-Jul-26
Sludge Storage Tanks				
A3720	Prepare Submittals - Sludge Storage Tanks	30	28-Jan-26	11-Mar-26
A3730	Review and Approve Submittals - Sludge Storage Tanks	30	12-Mar-26	22-Apr-26
A3750	Re-submit - Sludge Storage Tanks	20	23-Apr-26	20-May-26
A3740	Secure Castings - Sludge Storage Tanks	60	23-Apr-26	17-Jul-26
A3760	Re-review and Approve - Sludge Storage Tanks	30	21-May-26	02-Jul-26
A3780	Deliver Castings - Sludge Storage Tanks	5	20-Jul-26	24-Jul-26
A3770	Fabricate Wall Panels - Sludge Storage Tanks	80	27-Jul-26	17-Nov-26
Centrifuges				
A2910	Prepare Submittals - Centrifuges	15	28-Jan-26	18-Feb-26
A2920	Review and Approve Submittals - Centrifuges	30	19-Feb-26	01-Apr-26
A3600	Re-submit - Centrifuges	45	02-Apr-26	04-Jun-26
A3610	Re-review and Approve - Centrifuges	30	05-Jun-26	17-Jul-26
A2930	Fabricate Centrifuges	360	20-Jul-26	23-Dec-27
A2940	Deliver Centrifuges	30	27-Dec-27	08-Feb-28
Screens				
A2950	Prepare Submittals - Screens	15	28-Jan-26	18-Feb-26
A2960	Review and Approve Submittals - Screens	30	19-Feb-26	01-Apr-26
A3580	Re-submit - Screens	45	02-Apr-26	04-Jun-26



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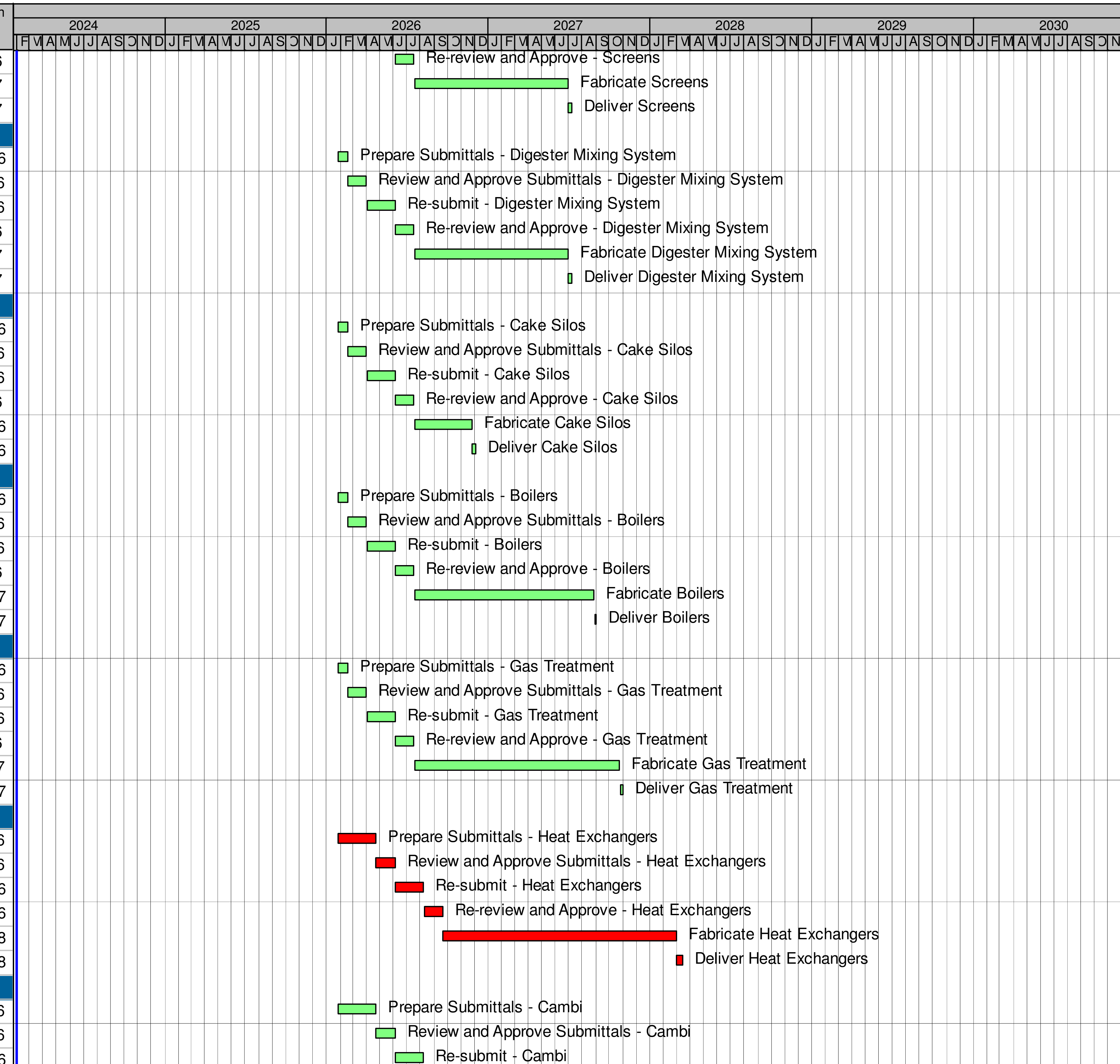
Activity ID	Activity Description	Duration	Early Start	Early Finish
A3590	Re-review and Approve - Screens	30	05-Jun-26	17-Jul-26
A2970	Fabricate Screens	240	20-Jul-26	01-Jul-27
A2980	Deliver Screens	5	02-Jul-27	09-Jul-27
Digester Mixing System				
A2990	Prepare Submittals - Digester Mixing System	15	28-Jan-26	18-Feb-26
A3000	Review and Approve Submittals - Digester Mixing System	30	19-Feb-26	01-Apr-26
A3560	Re-submit - Digester Mixing System	45	02-Apr-26	04-Jun-26
A3570	Re-review and Approve - Digester Mixing System	30	05-Jun-26	17-Jul-26
A3010	Fabricate Digester Mixing System	240	20-Jul-26	01-Jul-27
A3020	Deliver Digester Mixing System	5	02-Jul-27	09-Jul-27
Cake Silos				
A3030	Prepare Submittals - Cake Silos	15	28-Jan-26	18-Feb-26
A3040	Review and Approve Submittals - Cake Silos	30	19-Feb-26	01-Apr-26
A3540	Re-submit - Cake Silos	45	02-Apr-26	04-Jun-26
A3550	Re-review and Approve - Cake Silos	30	05-Jun-26	17-Jul-26
A3050	Fabricate Cake Silos	90	20-Jul-26	24-Nov-26
A3060	Deliver Cake Silos	5	25-Nov-26	03-Dec-26
Boilers				
A3110	Prepare Submittals - Boilers	15	28-Jan-26	18-Feb-26
A3120	Review and Approve Submittals - Boilers	30	19-Feb-26	01-Apr-26
A3520	Re-submit - Boilers	45	02-Apr-26	04-Jun-26
A3530	Re-review and Approve - Boilers	30	05-Jun-26	17-Jul-26
A3130	Fabricate Boilers	280	20-Jul-26	27-Aug-27
A3140	Deliver Boilers	5	30-Aug-27	03-Sep-27
Gas Treatment				
A3070	Prepare Submittals - Gas Treatment	15	28-Jan-26	18-Feb-26
A3080	Review and Approve Submittals - Gas Treatment	30	19-Feb-26	01-Apr-26
A3500	Re-submit - Gas Treatment	45	02-Apr-26	04-Jun-26
A3510	Re-review and Approve - Gas Treatment	30	05-Jun-26	17-Jul-26
A3090	Fabricate Gas Treatment	320	20-Jul-26	25-Oct-27
A3100	Deliver Gas Treatment	5	26-Oct-27	01-Nov-27
Heat Exchangers				
A3150	Prepare Submittals - Heat Exchangers	60	28-Jan-26	22-Apr-26
A3160	Review and Approve Submittals - Heat Exchangers	30	23-Apr-26	04-Jun-26
A3480	Re-submit - Heat Exchangers	45	05-Jun-26	07-Aug-26
A3490	Re-review and Approve - Heat Exchangers	30	10-Aug-26	21-Sep-26
A3170	Fabricate Heat Exchangers	360	22-Sep-26	01-Mar-28
A3180	Deliver Heat Exchangers	10	02-Mar-28	15-Mar-28
Cambi				
A3190	Prepare Submittals - Cambi	60	28-Jan-26	22-Apr-26
A3200	Review and Approve Submittals - Cambi	30	23-Apr-26	04-Jun-26
A3460	Re-submit - Cambi	45	05-Jun-26	07-Aug-26



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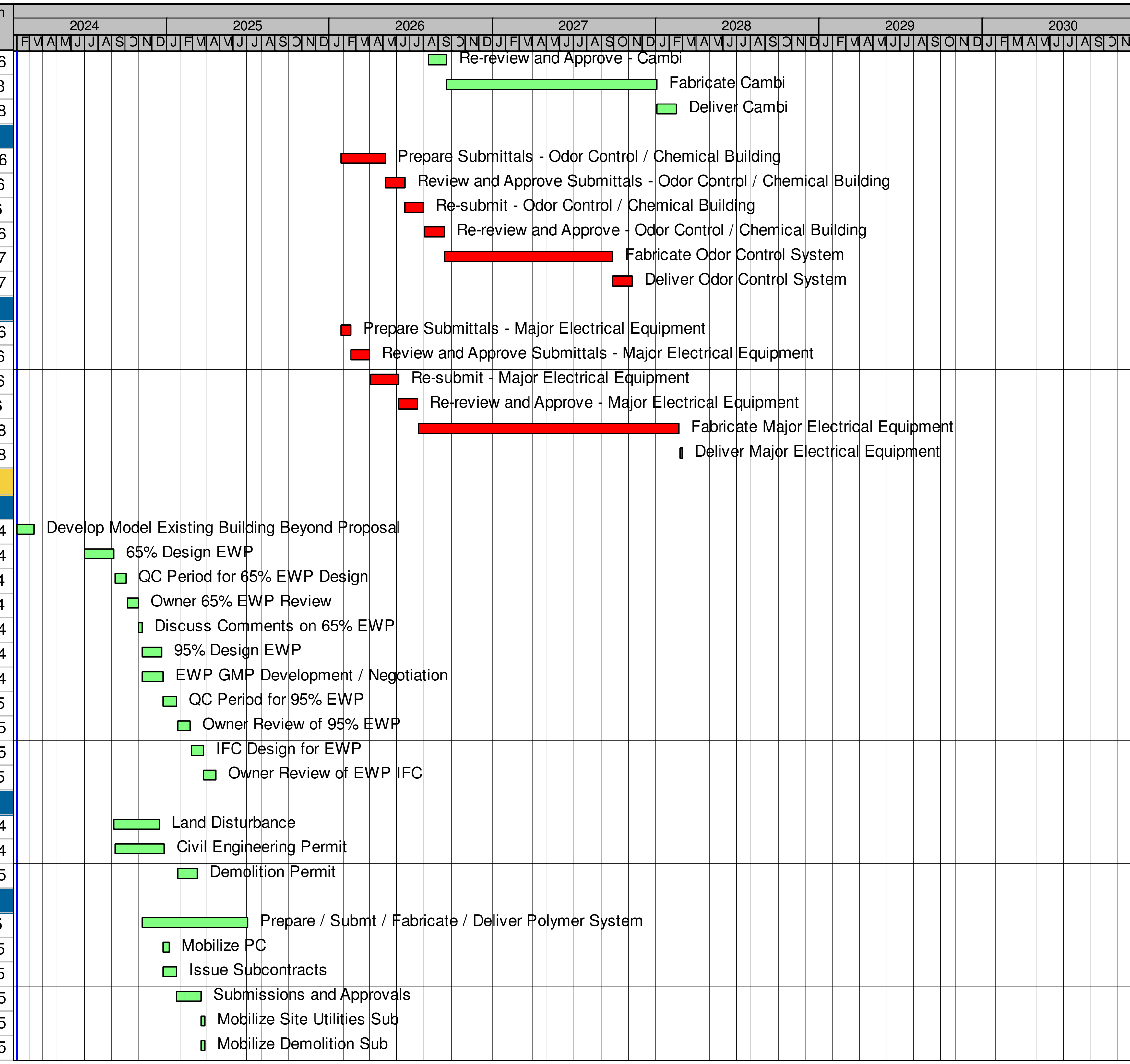
Activity ID	Activity Description	Duration	Early Start	Early Finish
A3470	Re-review and Approve - Cambi	30	10-Aug-26	21-Sep-26
A3210	Fabricate Cambi	320	22-Sep-26	03-Jan-28
A3220	Deliver Cambi	30	04-Jan-28	15-Feb-28
Odor Control System				
A3270	Prepare Submittals - Odor Control / Chemical Building	70	28-Jan-26	06-May-26
A3280	Review and Approve Submittals - Odor Control / Chemical Build	30	07-May-26	18-Jun-26
A3310	Re-submit - Odor Control / Chemical Building	30	19-Jun-26	31-Jul-26
A3320	Re-review and Approve - Odor Control / Chemical Building	30	03-Aug-26	14-Sep-26
A3290	Fabricate Odor Control System	260	15-Sep-26	27-Sep-27
A3300	Deliver Odor Control System	30	28-Sep-27	08-Nov-27
Major Electrical Equipment				
A3230	Prepare Submittals - Major Electrical Equipment	15	28-Jan-26	18-Feb-26
A3240	Review and Approve Submittals - Major Electrical Equipment	30	19-Feb-26	01-Apr-26
A3640	Re-submit - Major Electrical Equipment	45	02-Apr-26	04-Jun-26
A3650	Re-review and Approve - Major Electrical Equipment	30	05-Jun-26	17-Jul-26
A3250	Fabricate Major Electrical Equipment	400	20-Jul-26	23-Feb-28
A3260	Deliver Major Electrical Equipment	5	24-Feb-28	01-Mar-28
Early Works Package				
Design				
A1240	Develop Model Existing Building Beyond Proposal	28	01-Feb-24	12-Mar-24
A1250	65% Design EWP	48	01-Jul-24	06-Sep-24
A1260	QC Period for 65% EWP Design	20	09-Sep-24	04-Oct-24
A1270	Owner 65% EWP Review	19	07-Oct-24	31-Oct-24
A1280	Discuss Comments on 65% EWP	5	01-Nov-24	07-Nov-24
A1300	95% Design EWP	29	08-Nov-24	23-Dec-24
A1290	EWP GMP Development / Negotiation	30	08-Nov-24	24-Dec-24
A1310	QC Period for 95% EWP	20	26-Dec-24	24-Jan-25
A1320	Owner Review of 95% EWP	20	27-Jan-25	24-Feb-25
A1330	IFC Design for EWP	20	25-Feb-25	24-Mar-25
A1340	Owner Review of EWP IFC	20	25-Mar-25	21-Apr-25
Permit				
P1100	Land Disturbance	100	07-Sep-24	15-Dec-24
P1110	Civil Engineering Permit	75	09-Sep-24	26-Dec-24
P1090	Demolition Permit	30	27-Jan-25	10-Mar-25
Construction				
A2130	Prepare / Submt / Fabricate / Deliver Polymer System	160	08-Nov-24	01-Jul-25
A1970	Mobilize PC	10	24-Dec-24	08-Jan-25
A1940	Issue Subcontracts	20	24-Dec-24	23-Jan-25
A1960	Submissions and Approvals	39	24-Jan-25	20-Mar-25
A1980	Mobilize Site Utilities Sub	5	21-Mar-25	27-Mar-25
A1990	Mobilize Demolition Sub	5	21-Mar-25	27-Mar-25



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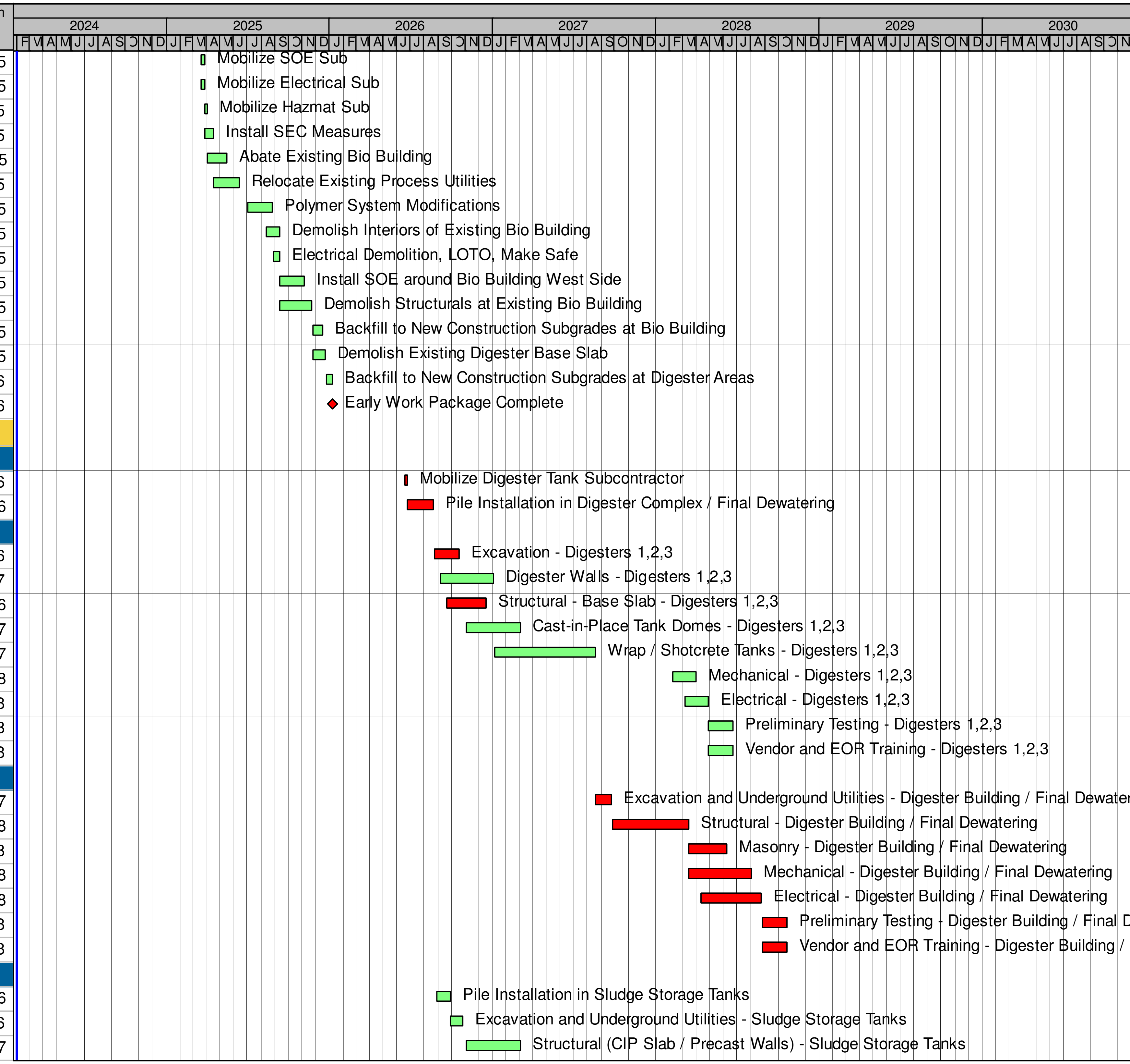
A2010	Mobilize SOE Sub	5	21-Mar-25	27-Mar-25
A2020	Mobilize Electrical Sub	5	21-Mar-25	27-Mar-25
A2000	Mobilize Hazmat Sub	5	28-Mar-25	03-Apr-25
A2030	Install SEC Measures	14	28-Mar-25	16-Apr-25
A2050	Abate Existing Bio Building	30	04-Apr-25	15-May-25
A2100	Relocate Existing Process Utilities	40	17-Apr-25	12-Jun-25
A2140	Polymer System Modifications	40	02-Jul-25	27-Aug-25
A2080	Demolish Interiors of Existing Bio Building	20	14-Aug-25	11-Sep-25
A2070	Electrical Demolition, LOTO, Make Safe	10	28-Aug-25	11-Sep-25
A2040	Install SOE around Bio Building West Side	40	12-Sep-25	06-Nov-25
A2090	Demolish Structurals at Existing Bio Building	50	12-Sep-25	21-Nov-25
A2120	Backfill to New Construction Subgrades at Bio Building	15	24-Nov-25	16-Dec-25
A2060	Demolish Existing Digester Base Slab	20	24-Nov-25	23-Dec-25
A2110	Backfill to New Construction Subgrades at Digester Areas	10	24-Dec-25	08-Jan-26
A2150	Early Work Package Complete	0		08-Jan-26
Construction - RFP Option (Renovate)				
Digester Complex				
A3370	Mobilize Digester Tank Subcontractor	5	19-Jun-26	25-Jun-26
A2160	Pile Installation in Digester Complex / Final Dewatering	40	26-Jun-26	21-Aug-26
Digesters 1, 2, 3				
A2170	Excavation - Digesters 1,2,3	40	24-Aug-26	19-Oct-26
A3380	Digester Walls - Digesters 1,2,3	80	08-Sep-26	04-Jan-27
A2180	Structural - Base Slab - Digesters 1,2,3	60	22-Sep-26	17-Dec-26
A3700	Cast-in-Place Tank Domes - Digesters 1,2,3	80	03-Nov-26	03-Mar-27
A3710	Wrap / Shotcrete Tanks - Digesters 1,2,3	160	05-Jan-27	20-Aug-27
A2190	Mechanical - Digesters 1,2,3	37	09-Feb-28	31-Mar-28
A2200	Electrical - Digesters 1,2,3	38	07-Mar-28	27-Apr-28
A2210	Preliminary Testing - Digesters 1,2,3	40	28-Apr-28	23-Jun-28
A4560	Vendor and EOR Training - Digesters 1,2,3	40	28-Apr-28	23-Jun-28
Digester Building / Final Dewatering				
A2220	Excavation and Underground Utilities - Digester Building / Final	27	18-Aug-27	24-Sep-27
A2230	Structural - Digester Building / Final Dewatering	116	27-Sep-27	15-Mar-28
A2270	Masonry - Digester Building / Final Dewatering	59	16-Mar-28	07-Jun-28
A2240	Mechanical - Digester Building / Final Dewatering	98	16-Mar-28	02-Aug-28
A2250	Electrical - Digester Building / Final Dewatering	96	12-Apr-28	25-Aug-28
A2260	Preliminary Testing - Digester Building / Final Dewatering	40	28-Aug-28	20-Oct-28
A4570	Vendor and EOR Training - Digester Building / Final Dewatering	40	28-Aug-28	20-Oct-28
Sludge Storage Tank				
A2330	Pile Installation in Sludge Storage Tanks	20	31-Aug-26	28-Sep-26
A2280	Excavation and Underground Utilities - Sludge Storage Tanks	20	29-Sep-26	26-Oct-26
A2290	Structural (CIP Slab / Precast Walls) - Sludge Storage Tanks	80	03-Nov-26	03-Mar-27



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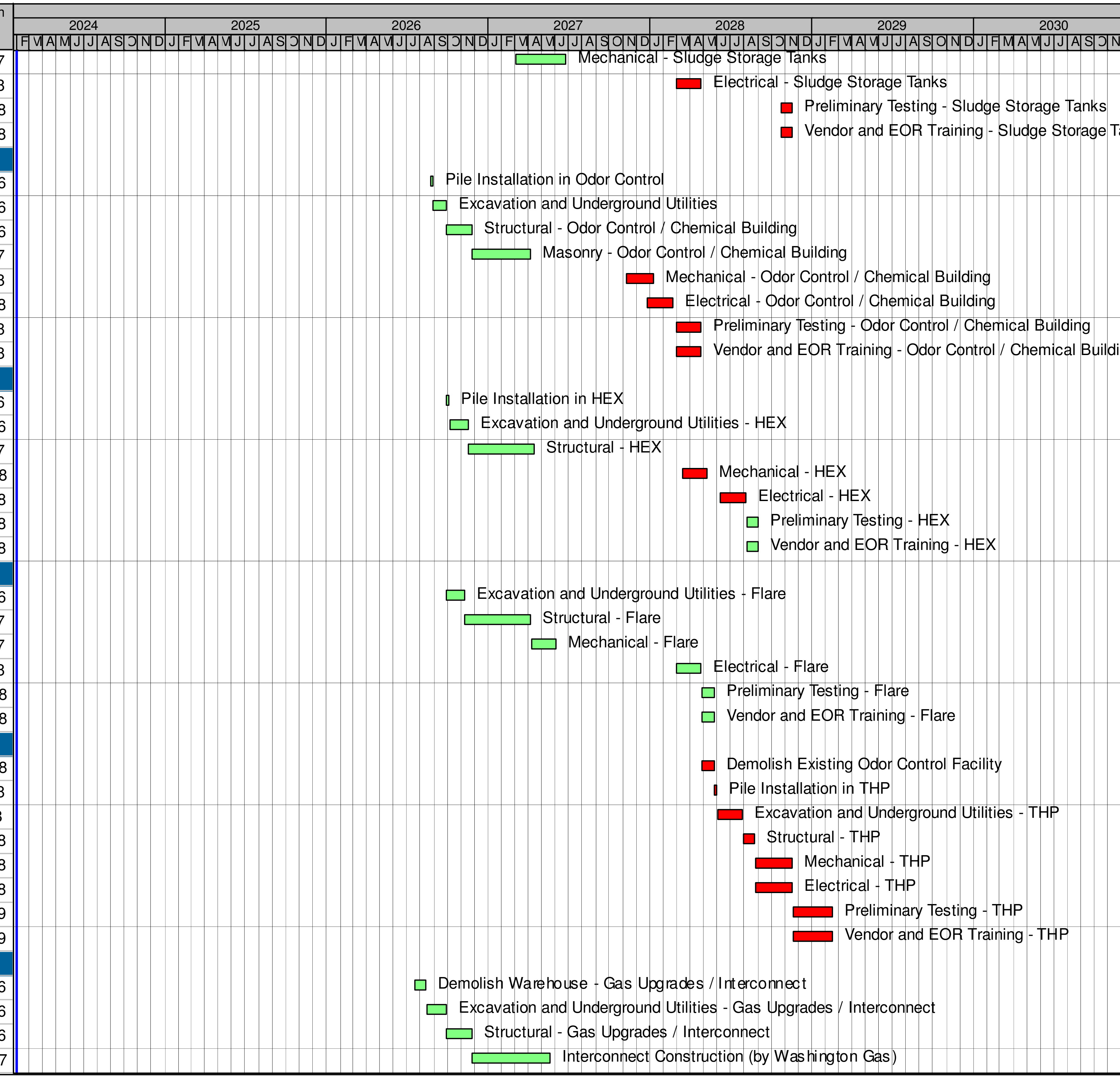
A2300	Mechanical - Sludge Storage Tanks	80	04-Mar-27	24-Jun-27
A2310	Electrical - Sludge Storage Tanks	40	02-Mar-28	26-Apr-28
A2320	Preliminary Testing - Sludge Storage Tanks	20	23-Oct-28	17-Nov-28
A4580	Vendor and EOR Training - Sludge Storage Tanks	20	23-Oct-28	17-Nov-28
Odor Control / Chemical Building				
A2390	Pile Installation in Odor Control	5	24-Aug-26	28-Aug-26
A2340	Excavation and Underground Utilities	20	31-Aug-26	28-Sep-26
A2350	Structural - Odor Control / Chemical Building	40	29-Sep-26	24-Nov-26
A2400	Masonry - Odor Control / Chemical Building	90	25-Nov-26	07-Apr-27
A2360	Mechanical - Odor Control / Chemical Building	40	09-Nov-27	10-Jan-28
A2370	Electrical - Odor Control / Chemical Building	40	27-Dec-27	23-Feb-28
A2380	Preliminary Testing - Odor Control / Chemical Building	40	02-Mar-28	26-Apr-28
A4590	Vendor and EOR Training - Odor Control / Chemical Building	40	02-Mar-28	26-Apr-28
HEX				
A2460	Pile Installation in HEX	5	29-Sep-26	05-Oct-26
A2410	Excavation and Underground Utilities - HEX	30	06-Oct-26	17-Nov-26
A2420	Structural - HEX	100	18-Nov-26	14-Apr-27
A2430	Mechanical - HEX	40	16-Mar-28	10-May-28
A2440	Electrical - HEX	40	09-Jun-28	04-Aug-28
A2450	Preliminary Testing - HEX	20	07-Aug-28	01-Sep-28
A4600	Vendor and EOR Training - HEX	20	07-Aug-28	01-Sep-28
Flare				
A3830	Excavation and Underground Utilities - Flare	30	29-Sep-26	09-Nov-26
A3840	Structural - Flare	100	10-Nov-26	07-Apr-27
A3850	Mechanical - Flare	40	08-Apr-27	03-Jun-27
A3860	Electrical - Flare	40	02-Mar-28	26-Apr-28
A3870	Preliminary Testing - Flare	20	27-Apr-28	24-May-28
A4610	Vendor and EOR Training - Flare	20	27-Apr-28	24-May-28
THP				
A3670	Demolish Existing Odor Control Facility	20	27-Apr-28	24-May-28
A2530	Pile Installation in THP	5	25-May-28	01-Jun-28
A2480	Excavation and Underground Utilities - THP	40	02-Jun-28	28-Jul-28
A2490	Structural - THP	20	31-Jul-28	25-Aug-28
A2500	Mechanical - THP	60	28-Aug-28	17-Nov-28
A2510	Electrical - THP	60	28-Aug-28	17-Nov-28
A2520	Preliminary Testing - THP	60	20-Nov-28	16-Feb-29
A4620	Vendor and EOR Training - THP	60	20-Nov-28	16-Feb-29
Gas Upgrades / Interconnect				
A3810	Demolish Warehouse - Gas Upgrades / Interconnect	20	20-Jul-26	14-Aug-26
A2540	Excavation and Underground Utilities - Gas Upgrades / Interconn	30	17-Aug-26	28-Sep-26
A2550	Structural - Gas Upgrades / Interconnect	40	29-Sep-26	24-Nov-26
A2590	Interconnect Construction (by Washington Gas)	120	25-Nov-26	19-May-27

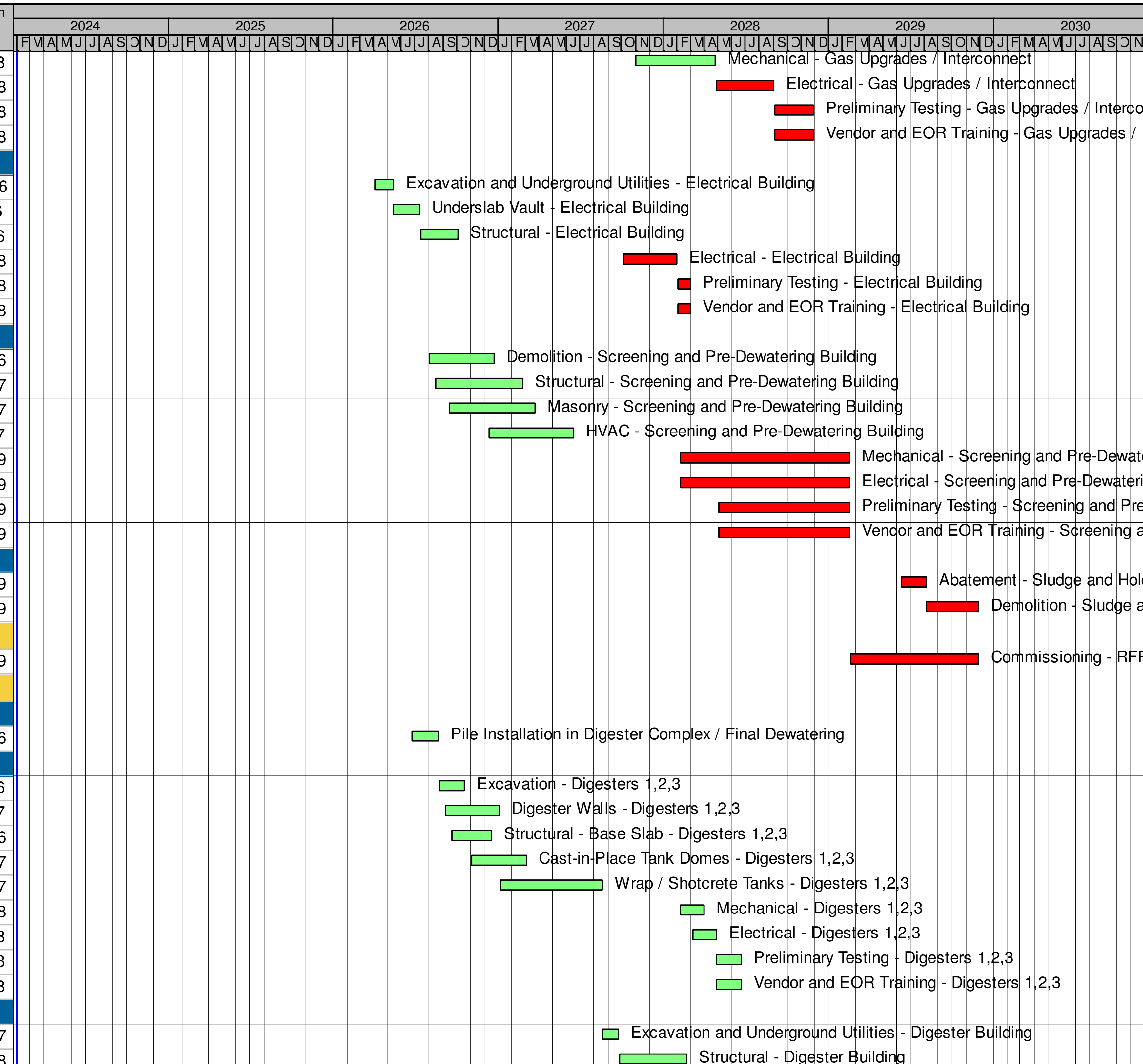


Start Date	01-Feb-24
Finish Date	02-Mar-30
Run Date	15-Dec-23

Level of Effort
Remaining Work
Critical Remaining Work
Milestone

ARLINGTON COUNTY
BIOSOLIDS UPGRADES,
PROPOSAL SCHEDULE

Activity ID	Activity Description	Duration	Early Start	Early Finish
A2560	Mechanical - Gas Upgrades / Interconnect	120	02-Nov-27	26-Apr-28
A2570	Electrical - Gas Upgrades / Interconnect	90	27-Apr-28	01-Sep-28
A2580	Preliminary Testing - Gas Upgrades / Interconnect	60	04-Sep-28	28-Nov-28
A4630	Vendor and EOR Training - Gas Upgrades / Interconnect	60	04-Sep-28	28-Nov-28
Electrical Building				
A2600	Excavation and Underground Utilities - Electrical Building	30	02-Apr-26	13-May-26
A2610	Underslab Vault - Electrical Building	40	14-May-26	10-Jul-26
A2620	Structural - Electrical Building	60	13-Jul-26	05-Oct-26
A2630	Electrical - Electrical Building	80	05-Oct-27	01-Feb-28
A2640	Preliminary Testing - Electrical Building	20	02-Feb-28	01-Mar-28
A4640	Vendor and EOR Training - Electrical Building	20	02-Feb-28	01-Mar-28
Screening and Pre-Dewatering Building				
A2650	Demolition - Screening and Pre-Dewatering Building	100	03-Aug-26	24-Dec-26
A2660	Structural - Screening and Pre-Dewatering Building	130	17-Aug-26	24-Feb-27
A3680	Masonry - Screening and Pre-Dewatering Building	130	15-Sep-26	24-Mar-27
A3690	HVAC - Screening and Pre-Dewatering Building	130	11-Dec-26	17-Jun-27
A2670	Mechanical - Screening and Pre-Dewatering Building	260	09-Feb-28	16-Feb-29
A2680	Electrical - Screening and Pre-Dewatering Building	260	09-Feb-28	16-Feb-29
A2690	Preliminary Testing - Screening and Pre-Dewatering Building	200	04-May-28	16-Feb-29
A4650	Vendor and EOR Training - Screening and Pre-Dewatering Buildi	200	04-May-28	16-Feb-29
Phase 2 Demo of Existing Sludge Holding Tanks and Building				
A3790	Abatement - Sludge and Holdings Tanks	40	12-Jun-29	06-Aug-29
A3800	Demolition - Sludge and Holdings Tanks	80	07-Aug-29	30-Nov-29
Commissioning - RFP Option (Renovate)				
A3660	Commissioning - RFP Option (Renovate)	200	20-Feb-29	30-Nov-29
Construction - PDB Option 2A (Combined Pre- and Final Dewatering with Internal Loadout)				
Digester Complex				
A3880	Pile Installation in Digester Complex / Final Dewatering	40	26-Jun-26	21-Aug-26
Digesters 1, 2, 3				
A3890	Excavation - Digesters 1,2,3	40	24-Aug-26	19-Oct-26
A3940	Digester Walls - Digesters 1,2,3	80	08-Sep-26	04-Jan-27
A3900	Structural - Base Slab - Digesters 1,2,3	60	22-Sep-26	17-Dec-26
A3950	Cast-in-Place Tank Domes - Digesters 1,2,3	80	03-Nov-26	03-Mar-27
A3960	Wrap / Shotcrete Tanks - Digesters 1,2,3	160	05-Jan-27	20-Aug-27
A3910	Mechanical - Digesters 1,2,3	37	09-Feb-28	31-Mar-28
A3920	Electrical - Digesters 1,2,3	38	07-Mar-28	27-Apr-28
A3930	Preliminary Testing - Digesters 1,2,3	40	28-Apr-28	23-Jun-28
A4660	Vendor and EOR Training - Digesters 1,2,3	40	28-Apr-28	23-Jun-28
Digester Building				
A3970	Excavation and Underground Utilities - Digester Building	27	18-Aug-27	24-Sep-27
A3980	Structural - Digester Building	100	27-Sep-27	22-Feb-28

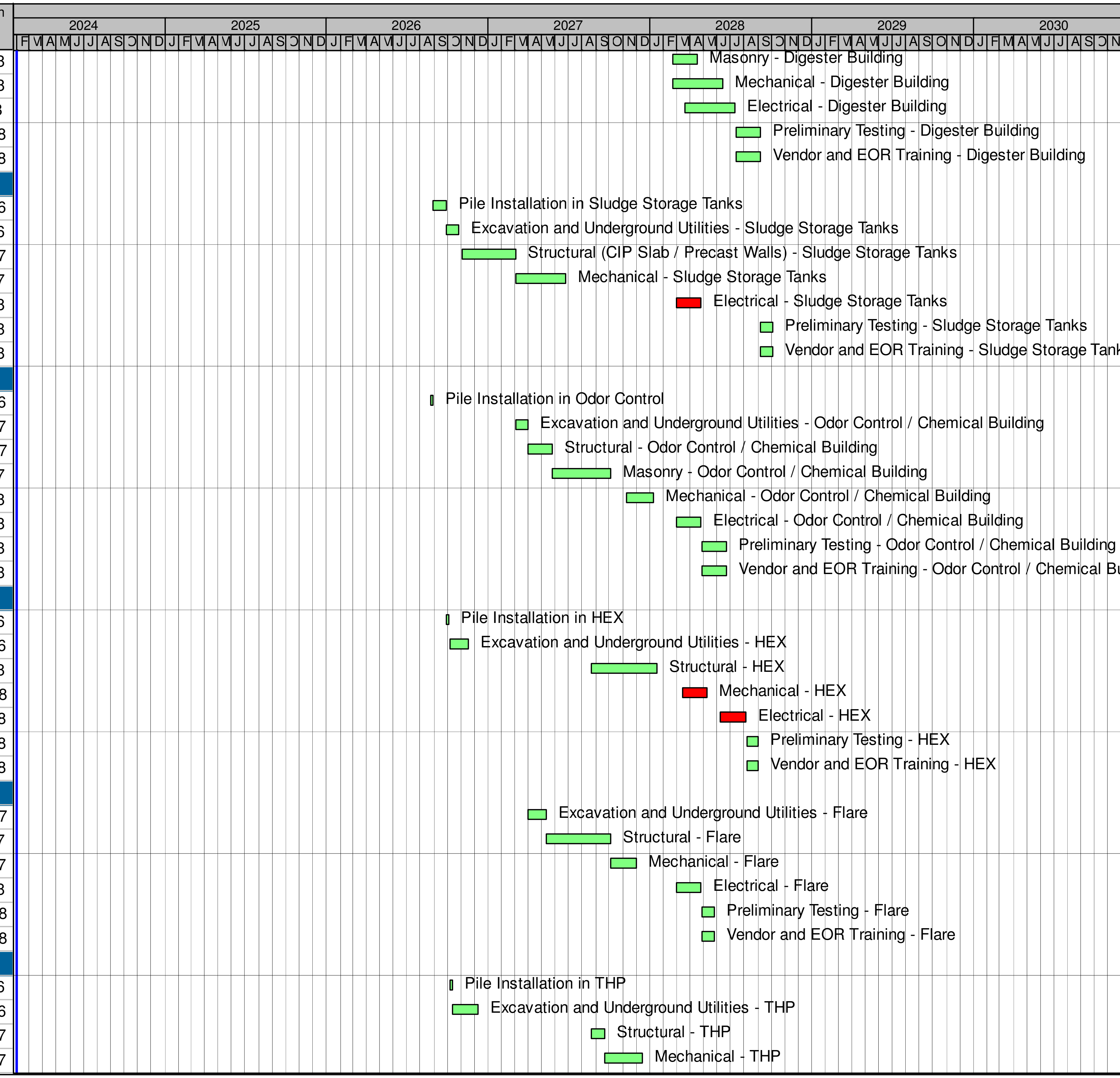


Start Date 01-Feb-24
Finish Date 02-Mar-30
Run Date 15-Dec-23

Level of Effort
Remaining Work
Critical Remaining Work
Milestone

ARLINGTON COUNTY
BIOSOLIDS UPGRADES,
PROPOSAL SCHEDULE

Activity ID	Activity Description	Duration	Early Start	Early Finish
A4020	Masonry - Digester Building	40	23-Feb-28	18-Apr-28
A3990	Mechanical - Digester Building	80	23-Feb-28	14-Jun-28
A4000	Electrical - Digester Building	80	21-Mar-28	12-Jul-28
A4010	Preliminary Testing - Digester Building	40	13-Jul-28	06-Sep-28
A4670	Vendor and EOR Training - Digester Building	40	13-Jul-28	06-Sep-28
Sludge Storage Tank				
A4080	Pile Installation in Sludge Storage Tanks	20	31-Aug-26	28-Sep-26
A4030	Excavation and Underground Utilities - Sludge Storage Tanks	20	29-Sep-26	26-Oct-26
A4040	Structural (CIP Slab / Precast Walls) - Sludge Storage Tanks	80	03-Nov-26	03-Mar-27
A4050	Mechanical - Sludge Storage Tanks	80	04-Mar-27	24-Jun-27
A4060	Electrical - Sludge Storage Tanks	40	02-Mar-28	26-Apr-28
A4070	Preliminary Testing - Sludge Storage Tanks	20	07-Sep-28	04-Oct-28
A4680	Vendor and EOR Training - Sludge Storage Tanks	20	07-Sep-28	04-Oct-28
Odor Control / Chemical Building				
A4140	Pile Installation in Odor Control	5	24-Aug-26	28-Aug-26
A4090	Excavation and Underground Utilities - Odor Control / Chemical	20	04-Mar-27	31-Mar-27
A4100	Structural - Odor Control / Chemical Building	40	01-Apr-27	26-May-27
A4150	Masonry - Odor Control / Chemical Building	90	27-May-27	04-Oct-27
A4110	Mechanical - Odor Control / Chemical Building	40	09-Nov-27	10-Jan-28
A4120	Electrical - Odor Control / Chemical Building	40	02-Mar-28	26-Apr-28
A4130	Preliminary Testing - Odor Control / Chemical Building	40	27-Apr-28	22-Jun-28
A4690	Vendor and EOR Training - Odor Control / Chemical Building	40	27-Apr-28	22-Jun-28
HEX				
A4210	Pile Installation in HEX	5	29-Sep-26	05-Oct-26
A4160	Excavation and Underground Utilities - HEX	30	06-Oct-26	17-Nov-26
A4170	Structural - HEX	100	23-Aug-27	18-Jan-28
A4180	Mechanical - HEX	40	16-Mar-28	10-May-28
A4190	Electrical - HEX	40	09-Jun-28	04-Aug-28
A4200	Preliminary Testing - HEX	20	07-Aug-28	01-Sep-28
A4700	Vendor and EOR Training - HEX	20	07-Aug-28	01-Sep-28
Flare				
A4480	Excavation and Underground Utilities - Flare	30	01-Apr-27	12-May-27
A4490	Structural - Flare	100	13-May-27	04-Oct-27
A4500	Mechanical - Flare	40	05-Oct-27	02-Dec-27
A4510	Electrical - Flare	40	02-Mar-28	26-Apr-28
A4520	Preliminary Testing - Flare	20	27-Apr-28	24-May-28
A4710	Vendor and EOR Training - Flare	20	27-Apr-28	24-May-28
THP				
A4270	Pile Installation in THP	5	06-Oct-26	12-Oct-26
A4220	Excavation and Underground Utilities - THP	40	13-Oct-26	10-Dec-26
A4230	Structural - THP	20	23-Aug-27	20-Sep-27
A4240	Mechanical - THP	60	21-Sep-27	16-Dec-27



Start Date 01-Feb-24
Finish Date 02-Mar-30
Run Date 15-Dec-23

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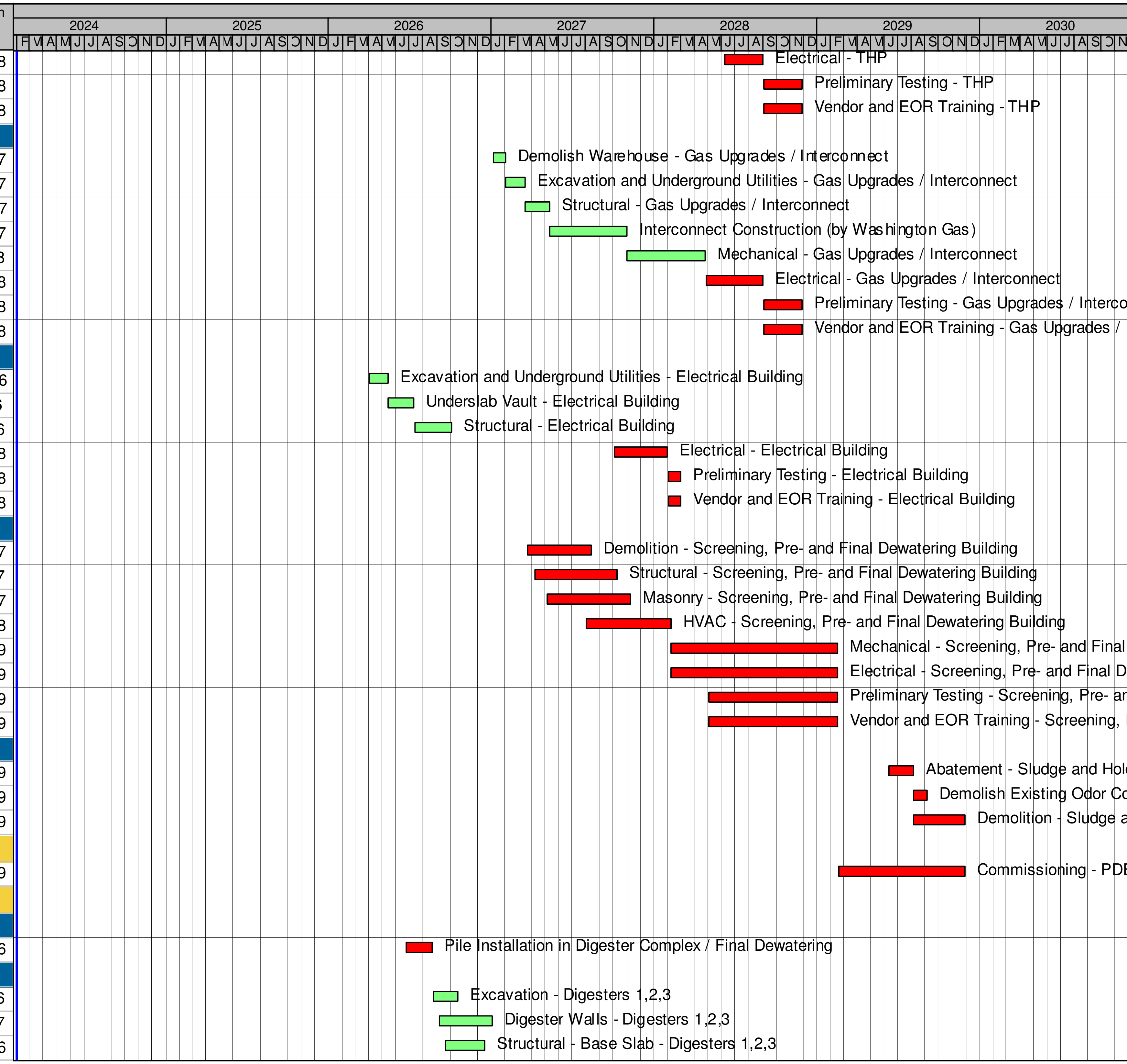
ARLINGTON COUNTY
BIOSOLIDS UPGRADES,
PROPOSAL SCHEDULE

Activity ID	Activity Description	Duration	Early Start	Early Finish
A4250	Electrical - THP	60	09-Jun-28	01-Sep-28
A4260	Preliminary Testing - THP	60	04-Sep-28	28-Nov-28
A4720	Vendor and EOR Training - THP	60	04-Sep-28	28-Nov-28
Gas Upgrades / Interconnect				
A4350	Demolish Warehouse - Gas Upgrades / Interconnect	20	05-Jan-27	02-Feb-27
A4290	Excavation and Underground Utilities - Gas Upgrades / Interconn	30	03-Feb-27	17-Mar-27
A4300	Structural - Gas Upgrades / Interconnect	40	18-Mar-27	12-May-27
A4340	Interconnect Construction (by Washington Gas)	120	13-May-27	01-Nov-27
A4310	Mechanical - Gas Upgrades / Interconnect	120	02-Nov-27	26-Apr-28
A4320	Electrical - Gas Upgrades / Interconnect	90	27-Apr-28	01-Sep-28
A4330	Preliminary Testing - Gas Upgrades / Interconnect	60	04-Sep-28	28-Nov-28
A4730	Vendor and EOR Training - Gas Upgrades / Interconnect	60	04-Sep-28	28-Nov-28
Electrical Building				
A4360	Excavation and Underground Utilities - Electrical Building	30	02-Apr-26	13-May-26
A4370	Underslab Vault - Electrical Building	40	14-May-26	10-Jul-26
A4380	Structural - Electrical Building	60	13-Jul-26	05-Oct-26
A4390	Electrical - Electrical Building	80	05-Oct-27	01-Feb-28
A4400	Preliminary Testing - Electrical Building	20	02-Feb-28	01-Mar-28
A4740	Vendor and EOR Training - Electrical Building	20	02-Feb-28	01-Mar-28
Screening, Pre- and Final Dewatering Building				
A4410	Demolition - Screening, Pre- and Final Dewatering Building	100	25-Mar-27	13-Aug-27
A4420	Structural - Screening, Pre- and Final Dewatering Building	130	08-Apr-27	11-Oct-27
A4460	Masonry - Screening, Pre- and Final Dewatering Building	130	06-May-27	08-Nov-27
A4470	HVAC - Screening, Pre- and Final Dewatering Building	130	02-Aug-27	08-Feb-28
A4430	Mechanical - Screening, Pre- and Final Dewatering Building	260	09-Feb-28	16-Feb-29
A4440	Electrical - Screening, Pre- and Final Dewatering Building	260	09-Feb-28	16-Feb-29
A4450	Preliminary Testing - Screening, Pre- and Final Dewatering Build	200	04-May-28	16-Feb-29
A4750	Vendor and EOR Training - Screening, Pre- and Final Dewaterin	200	04-May-28	16-Feb-29
Phase 2 Demo of Existing Sludge Holding Tanks and Building				
A4530	Abatement - Sludge and Holdings Tanks	40	12-Jun-29	06-Aug-29
A4280	Demolish Existing Odor Control Facility	20	07-Aug-29	04-Sep-29
A4540	Demolition - Sludge and Holdings Tanks	80	07-Aug-29	30-Nov-29
Commissioning - PDB Option 2A (Combined Pre- and Final Dewatering with Internal Loadout)				
A4550	Commissioning - PDB Option 2A	200	20-Feb-29	30-Nov-29
Construction - PDB Option 2B (Combined Pre- and Final Dewatering with External Loadout)				
Digester Complex				
A4770	Pile Installation in Digester Complex / Final Dewatering	40	26-Jun-26	21-Aug-26
Digesters 1, 2, 3				
A4780	Excavation - Digesters 1,2,3	40	24-Aug-26	19-Oct-26
A4830	Digester Walls - Digesters 1,2,3	80	08-Sep-26	04-Jan-27
A4790	Structural - Base Slab - Digesters 1,2,3	60	22-Sep-26	17-Dec-26

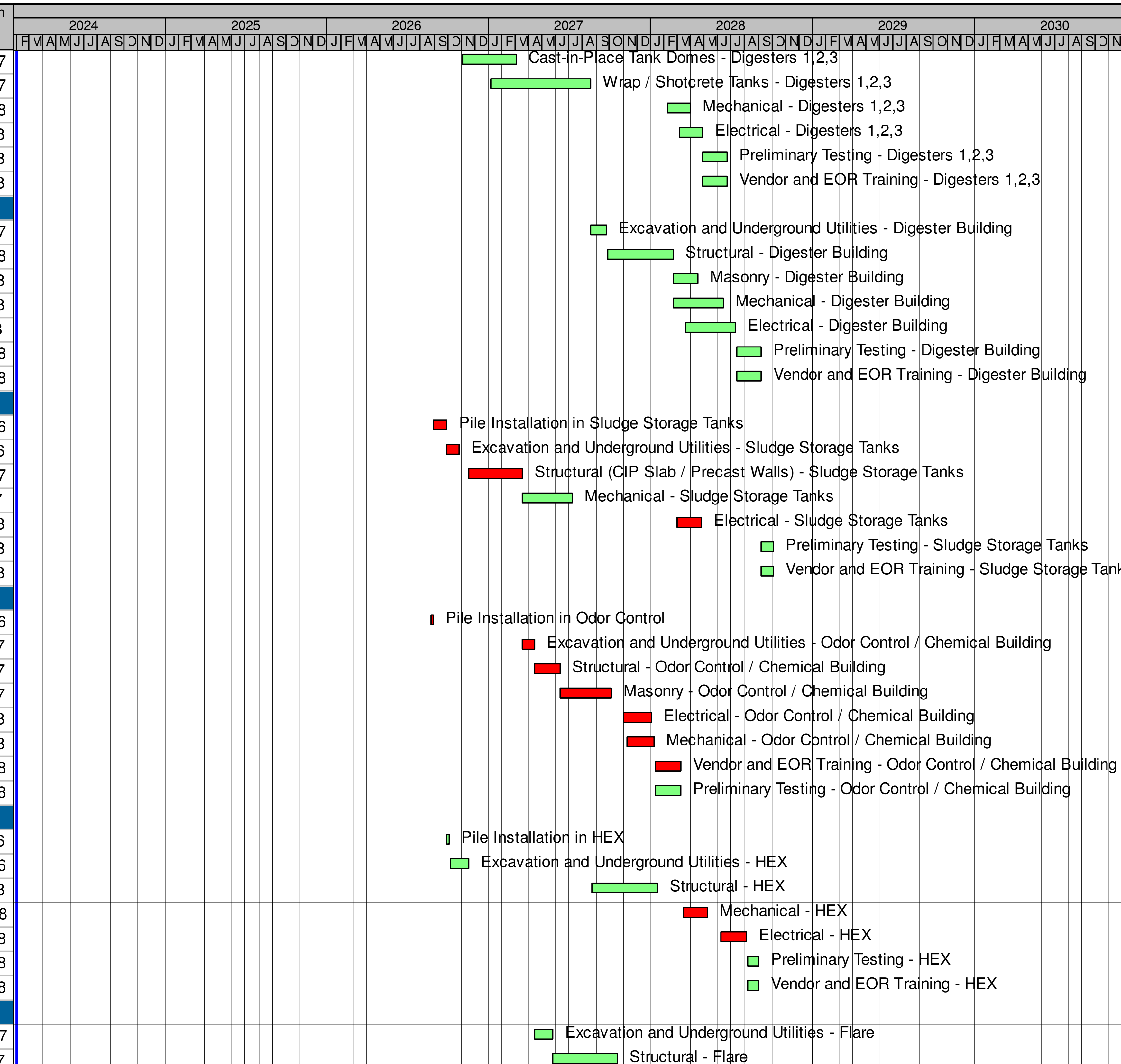


Start Date 01-Feb-24
Finish Date 02-Mar-30
Run Date 15-Dec-23

Level of Effort
Remaining Work
Critical Remaining Work
Milestone

ARLINGTON COUNTY
BIOSOLIDS UPGRADES,
PROPOSAL SCHEDULE

Activity ID	Activity Description	Duration	Early Start	Early Finish
A4840	Cast-in-Place Tank Domes - Digesters 1,2,3	80	03-Nov-26	03-Mar-27
A4850	Wrap / Shotcrete Tanks - Digesters 1,2,3	160	05-Jan-27	20-Aug-27
A4800	Mechanical - Digesters 1,2,3	37	09-Feb-28	31-Mar-28
A4810	Electrical - Digesters 1,2,3	38	07-Mar-28	27-Apr-28
A4820	Preliminary Testing - Digesters 1,2,3	40	28-Apr-28	23-Jun-28
A5440	Vendor and EOR Training - Digesters 1,2,3	40	28-Apr-28	23-Jun-28
Digester Building				
A4860	Excavation and Underground Utilities - Digester Building	27	18-Aug-27	24-Sep-27
A4870	Structural - Digester Building	100	27-Sep-27	22-Feb-28
A4910	Masonry - Digester Building	40	23-Feb-28	18-Apr-28
A4880	Mechanical - Digester Building	80	23-Feb-28	14-Jun-28
A4890	Electrical - Digester Building	80	21-Mar-28	12-Jul-28
A4900	Preliminary Testing - Digester Building	40	13-Jul-28	06-Sep-28
A5450	Vendor and EOR Training - Digester Building	40	13-Jul-28	06-Sep-28
Sludge Storage Tank				
A4970	Pile Installation in Sludge Storage Tanks	20	31-Aug-26	28-Sep-26
A4920	Excavation and Underground Utilities - Sludge Storage Tanks	20	29-Sep-26	26-Oct-26
A4930	Structural (CIP Slab / Precast Walls) - Sludge Storage Tanks	80	18-Nov-26	17-Mar-27
A4940	Mechanical - Sludge Storage Tanks	80	18-Mar-27	09-Jul-27
A4950	Electrical - Sludge Storage Tanks	40	02-Mar-28	26-Apr-28
A4960	Preliminary Testing - Sludge Storage Tanks	20	07-Sep-28	04-Oct-28
A5460	Vendor and EOR Training - Sludge Storage Tanks	20	07-Sep-28	04-Oct-28
Odor Control / Chemical Building				
A5030	Pile Installation in Odor Control	5	24-Aug-26	28-Aug-26
A4980	Excavation and Underground Utilities - Odor Control / Chemical	20	18-Mar-27	14-Apr-27
A4990	Structural - Odor Control / Chemical Building	40	15-Apr-27	10-Jun-27
A5040	Masonry - Odor Control / Chemical Building	80	11-Jun-27	04-Oct-27
A5010	Electrical - Odor Control / Chemical Building	40	02-Nov-27	03-Jan-28
A5000	Mechanical - Odor Control / Chemical Building	40	09-Nov-27	10-Jan-28
A5470	Vendor and EOR Training - Odor Control / Chemical Building	40	11-Jan-28	08-Mar-28
A5020	Preliminary Testing - Odor Control / Chemical Building	40	11-Jan-28	08-Mar-28
HEX				
A5100	Pile Installation in HEX	5	29-Sep-26	05-Oct-26
A5050	Excavation and Underground Utilities - HEX	30	06-Oct-26	17-Nov-26
A5060	Structural - HEX	100	23-Aug-27	18-Jan-28
A5070	Mechanical - HEX	40	16-Mar-28	10-May-28
A5080	Electrical - HEX	40	09-Jun-28	04-Aug-28
A5090	Preliminary Testing - HEX	20	07-Aug-28	01-Sep-28
A5480	Vendor and EOR Training - HEX	20	07-Aug-28	01-Sep-28
Flare				
A5370	Excavation and Underground Utilities - Flare	30	15-Apr-27	26-May-27
A5380	Structural - Flare	100	27-May-27	18-Oct-27



Start Date	01-Feb-24
Finish Date	02-Mar-30
Run Date	15-Dec-23

Level of Effort
Remaining Work
Critical Remaining Work
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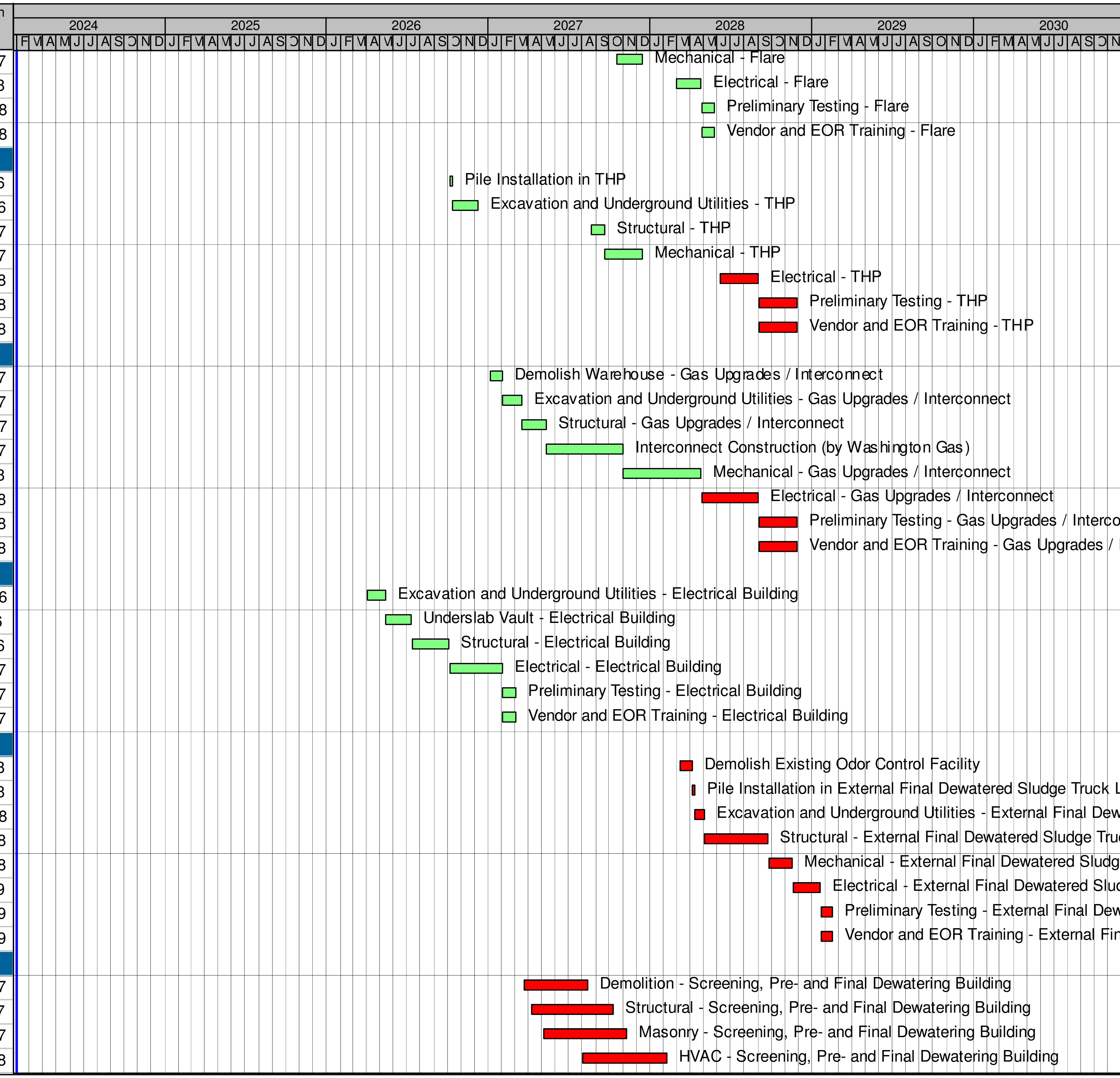
ARLINGTON COUNTY
BIOSOLIDS UPGRADES,
PROPOSAL SCHEDULE

Activity ID	Activity Description	Duration	Early Start	Early Finish
A5390	Mechanical - Flare	40	19-Oct-27	16-Dec-27
A5400	Electrical - Flare	40	02-Mar-28	26-Apr-28
A5410	Preliminary Testing - Flare	20	27-Apr-28	24-May-28
A5490	Vendor and EOR Training - Flare	20	27-Apr-28	24-May-28
THP				
A5160	Pile Installation in THP	5	06-Oct-26	12-Oct-26
A5110	Excavation and Underground Utilities - THP	40	13-Oct-26	10-Dec-26
A5120	Structural - THP	20	23-Aug-27	20-Sep-27
A5130	Mechanical - THP	60	21-Sep-27	16-Dec-27
A5140	Electrical - THP	60	09-Jun-28	01-Sep-28
A5150	Preliminary Testing - THP	60	04-Sep-28	28-Nov-28
A5500	Vendor and EOR Training - THP	60	04-Sep-28	28-Nov-28
Gas Upgrades / Interconnect				
A5240	Demolish Warehouse - Gas Upgrades / Interconnect	20	05-Jan-27	02-Feb-27
A5180	Excavation and Underground Utilities - Gas Upgrades / Intercon	30	03-Feb-27	17-Mar-27
A5190	Structural - Gas Upgrades / Interconnect	40	18-Mar-27	12-May-27
A5230	Interconnect Construction (by Washington Gas)	120	13-May-27	01-Nov-27
A5200	Mechanical - Gas Upgrades / Interconnect	120	02-Nov-27	26-Apr-28
A5210	Electrical - Gas Upgrades / Interconnect	90	27-Apr-28	01-Sep-28
A5220	Preliminary Testing - Gas Upgrades / Interconnect	60	04-Sep-28	28-Nov-28
A5510	Vendor and EOR Training - Gas Upgrades / Interconnect	60	04-Sep-28	28-Nov-28
Electrical Building				
A5250	Excavation and Underground Utilities - Electrical Building	30	02-Apr-26	13-May-26
A5260	Underslab Vault - Electrical Building	40	14-May-26	10-Jul-26
A5270	Structural - Electrical Building	60	13-Jul-26	05-Oct-26
A5280	Electrical - Electrical Building	80	06-Oct-26	02-Feb-27
A5290	Preliminary Testing - Electrical Building	20	03-Feb-27	03-Mar-27
A5520	Vendor and EOR Training - Electrical Building	20	03-Feb-27	03-Mar-27
External Final Dewatered Sludge Truck Loadout				
A5170	Demolish Existing Odor Control Facility	20	09-Mar-28	05-Apr-28
A5590	Pile Installation in External Final Dewatered Sludge Truck Loadc	5	06-Apr-28	12-Apr-28
A5540	Excavation and Underground Utilities - External Final Dewatered	15	13-Apr-28	03-May-28
A5550	Structural - External Final Dewatered Sludge Truck Loadout	100	04-May-28	22-Sep-28
A5560	Mechanical - External Final Dewatered Sludge Truck Loadout	40	25-Sep-28	17-Nov-28
A5570	Electrical - External Final Dewatered Sludge Truck Loadout	40	20-Nov-28	19-Jan-29
A5580	Preliminary Testing - External Final Dewatered Sludge Truck Loa	20	22-Jan-29	16-Feb-29
A5600	Vendor and EOR Training - External Final Dewatered Sludge Tru	20	22-Jan-29	16-Feb-29
Screening, Pre- and Final Dewatering Building				
A5300	Demolition - Screening, Pre- and Final Dewatering Building	100	25-Mar-27	13-Aug-27
A5310	Structural - Screening, Pre- and Final Dewatering Building	130	08-Apr-27	11-Oct-27
A5350	Masonry - Screening, Pre- and Final Dewatering Building	130	06-May-27	08-Nov-27
A5360	HVAC - Screening, Pre- and Final Dewatering Building	130	02-Aug-27	08-Feb-28

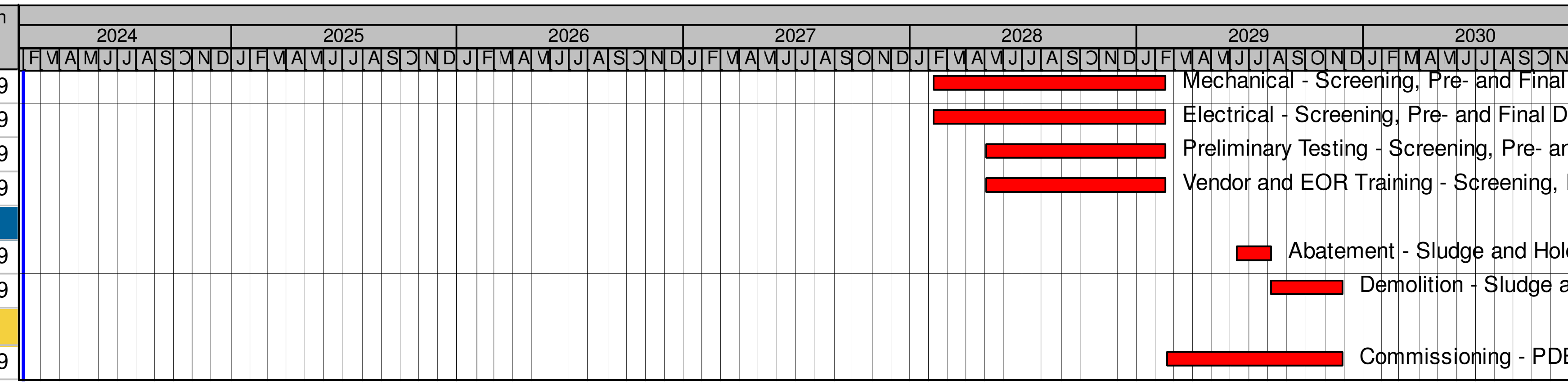


Start Date 01-Feb-24
Finish Date 02-Mar-30
Run Date 15-Dec-23

Level of Effort
Remaining Work
Critical Remaining Work
Milestone

ARLINGTON COUNTY
BIOSOLIDS UPGRADES,
PROPOSAL SCHEDULE

Activity ID	Activity Description	Duration	Early Start	Early Finish
A5320	Mechanical - Screening, Pre- and Final Dewatering Building	260	09-Feb-28	16-Feb-29
A5330	Electrical - Screening, Pre- and Final Dewatering Building	260	09-Feb-28	16-Feb-29
A5340	Preliminary Testing - Screening, Pre- and Final Dewatering Build	200	04-May-28	16-Feb-29
A5530	Vendor and EOR Training - Screening, Pre- and Final Dewaterin	200	04-May-28	16-Feb-29
Phase 2 Demo of Existing Sludge Holding Tanks and Building				
A5420	Abatement - Sludge and Holdings Tanks	40	12-Jun-29	06-Aug-29
A5430	Demolition - Sludge and Holdings Tanks	80	07-Aug-29	30-Nov-29
Commissioning - PDB Option 2B (Combined Pre- and Final Dewatering with External Loadout)				
A4760	Commissioning - PDB Option 2B	200	20-Feb-29	30-Nov-29



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ARLINGTON COUNTY
BIOSOLIDS UPGRADES,
PROPOSAL SCHEDULE

EXHIBIT H

INSURANCE REQUIREMENTS

Review this section carefully with your insurance agent or broker prior to submitting a bid or proposal. See the Insurance Checklist (part of the Proposal Form) for specific coverages applicable to this Contract. The term "Contract," as used in this section, shall mean the fully executed Agreement covering the work entered into between the County and the Contractor.

1. General

1.1 The Contract with the Contractor will not be executed by the County until the Contractor has obtained, at its own expense, all of the insurance called for hereunder and such insurance has been approved by the County; additionally, the Contractor shall not allow any subcontractor to start work on any subcontract until all insurance required of the subcontractor has been so obtained and approved by the Contractor. The Contractor shall submit to the County Purchasing Agent copies of all required endorsements and documentation of coverage consistent with the requirements herein or, alternately, at the County's request, certified copies of the required insurance policies in compliance with the insurance requirements. All endorsements and documentation shall state this Contract’s number and title.

1.2 The Contractor shall require all subcontractors to maintain during the term of this Agreement, Commercial General Liability insurance, Business Automobile Liability insurance, and Workers' Compensation, Employers' Liability insurance, or any other insurance required by the Contract in the same manner and form as specified for the Contractor. The Contractor shall furnish subcontractors' evidence of insurance and copies of endorsements to the County Purchasing Agent immediately upon request by the County and/or prior to the subcontractor’s performance of work related to this Contract.

1.3 If there is a material change or reduction in coverage, nonrenewal of any insurance coverage or cancellation of any insurance coverage required by this contract, the Contractor shall notify the Purchasing Agent immediately. It is the Contractor’s responsibility to notify the County upon receipt of a notice indicating that the policy will not be renewed or will be materially changed. Any policy on which the Contractor has received notification from an insurer that the policy has or will be cancelled or materially changed or reduced must be immediately replaced with another policy consistent with the terms of this Contract and in such a manner that there is no lapse in coverage, and the County immediately notified of the replacement. Not having the required insurance throughout the Contract is considered a material breach of this Contract and grounds for termination. The Contractor shall also obtain an endorsement providing to the County thirty (30) days advance notice of cancellation or nonrenewal (ten days for nonpayment of premium. A copy of that endorsement shall be provided to the County Purchasing Agent prior to the execution of this Contract or any Contract extension thereafter.

1.4 No acceptance and/or approval of any insurance by the County shall be construed as relieving or excusing the Contractor, any surety, or any bond, from any liability or obligation imposed under this Agreement.

1.5 Arlington County, and its officers, elected and appointed officials, employees, and agents are to be listed as additional insureds under all coverages except Workers' Compensation, Professional Liability, and Automobile Liability, and the endorsement must clearly identify the County as an additional insured permitted to enjoy all the benefits under the applicable policy of insurance. The certified policy, if requested, must so state coverage afforded under this paragraph shall be primary as respects the County, its officers, elected and appointed officials, agents and employees. The following definition of the term "County" applies to all policies issued under the Contract and to all applicable endorsements:

> "The County Board of Arlington County and any affiliated or subsidiary Board, Authority, Committee, Commission, or Independent Agency (including those newly constituted), provided that such affiliated or subsidiary Board, Authority, Committee, Commission, or Independent Agency is either a Body Politic created by the County Board of Arlington County, Virginia, or one in which controlling interest is vested in Arlington County; and Arlington County Constitutional Officers."

1.6 The Contractor shall be responsible for the work performed under the Contract Documents and every part thereof, and for all materials, tools, equipment, appliances, and property of any description used in connection with the work. The Contractor assumes all risks for direct and indirect damage or injury to the property or persons used or employed on or in connection with the Work contracted for, and of all damage or injury to any person or property wherever located, resulting from any action, omission, commission or operation under the Contract, or in connection in any way whatsoever with the contracted work, to the extent of Contractor's indemnity obligations under Section 28 of the Contract.

1.7 The insurance coverage required shall remain in force throughout the Contract or as otherwise stated in the Contract Documents or these Insurance Requirements. If the Contractor fails to provide acceptable evidence of current insurance within seven (7) days of written notice at any time during the Contract, the County shall have the absolute right to terminate the Contract without any further obligation to the Contractor.

1.8 Contractual and other liability insurance provided under this Contract shall not contain a supervision, inspection or engineering services exclusion that would preclude the County from supervising or inspecting the work as to the end result. The Contractor shall assume all on-the-job responsibilities as to the control of persons directly employed by it and of the subcontractors and any persons employed by the subcontractor and/or carriers delivering and receiving materials from the Project.

1.9 If any policy contains a warranty stating that coverage is null and void (or words to that effect) if the Contractor does not comply with the most stringent regulations governing the work, such policy shall be modified so that coverage shall be afforded in all cases except for the Contractor's willful or intentional noncompliance with applicable government regulations.

1.10 All policies shall include the following language: "The insolvency or bankruptcy of the insured or of the insured's estate will not relieve the insurance company of its obligations under this policy."

1.11 All policy forms, except for Professional Liability, must "Pay on behalf of" rather than "Indemnify" the insured.

1.12 Nothing contained in these Insurance Requirements or the Contract Documents shall be construed as creating any contractual relationship between any subcontractor and the County. The Contractor shall be as fully responsible to the County for the acts and omissions of its subcontractors and of persons employed by them as it is for acts and omissions of persons directly employed by it.

1.13 Precaution shall be exercised by the Contractor at all times for the protection of persons, (including employees) and property. All existing structures, utilities, roads, services, trees and shrubbery shall be protected against damage or interruption of service at all times by the Contractor and its subcontractors during the term of the Contract, and the Contractor shall be held responsible for any damage to property occurring by reason of its work under the Contract whether identified on the Contract Documents or not.

1.14 For any claims related to this work, the Contractor's insurance shall be deemed primary and non-contributory to all other applicable coverage and in particular with respect to Arlington County, its representatives, officials, employees, and agents. Any insurance or self-insurance maintained by Arlington County shall be excess and non-contributory of the Contractor's insurance. The Contractor shall waive its right of subrogation for all insurance claims.

1.15 If the Contractor does not meet the insurance requirements set forth by the Contract Documents, alternate insurance coverage or self-insurance, satisfactory to the Purchasing Agent, may be considered. Written requests for consideration of alternate coverages including the Contractor's most recent actuarial report and a copy of its self-insurance resolution to determine the adequacy of the insurance funding must be received by the County Purchasing Agent at least ten (10) working days prior to the date set for receipt of bids or proposals. If the County denies the request for alternate coverages, the specified coverages will be required to be submitted. If the County permits alternate coverage, an Addendum to the Insurance Requirements will be prepared and distributed prior to the time and date set for receipt of bids or proposals.

1.16 All required insurance coverages must be acquired from insurers authorized to do business in the Commonwealth of Virginia and acceptable to the County. The insurers must also have a policyholders' with a rating of "A-VII" in the latest edition of the A.M. Best Co.'s Insurance Reports, unless the County grants specific approval for an exception, in the same manner as described in 1.16 above.

1.17 The Contractor shall be responsible for payment of any deductibles applicable to the coverages.

1.18 The Contractor must disclose the amount of any deductible or self-insurance component applicable to the General Liability, Automobile Liability, Professional Liability, Intellectual Property or any other policies, if any. The County reserves the right to request additional information to determine if the Contractor has the financial capacity to meet its obligations under a deductible.

2. <u>Contractor's Insurance:</u>

2.1 The Contractor shall purchase the following insurance coverages, including the terms, provisions and limits shown in the Insurance Checklist.

2.1.1 Commercial General Liability - Such Commercial General Liability policy shall include any or all of the following as indicated on the Checklist:

i. General aggregate limit is to apply per project;

ii Premises/Operations;

iii. Actions of Independent Contractors;

iv. Products/Completed Operations to be maintained for five (5) years after completion of the Work;

v. Contractual Liability, including protection for the Contractor from claims arising out of liability assumed under this Contract;

vi. Personal Injury Liability including, including but not limited to, coverage for offenses related to employment and copyright infringement;

vii. Explosion, Collapse, or Underground (XCU) hazards.

2.1.2 Business Automobile Liability, including coverage for any owned, hired, or non-owned motor vehicles, Uninsured Motorists coverage, and automobile contractual liability.

2.1.3 Workers' Compensation - statutory benefits as required by Virginia law or the U.S. Longshoremen's and Harbor Workers' Compensation Act, or other laws as required by labor union agreements, including standard Other States coverage; Employers' Liability coverage with limits of $1,000,000/$1,000,000/$1,000,000. The policy shall not contain any provision or definition which would serve to eliminate third party action over claims, including exclusion for bodily injury to an employee of the insured, employees of the premises owner, or employees of the general contractor to which the insured is subcontracted; or employees of the insured's subcontractor.

2.1.4 The Contractor shall maintain Professional Liability Insurance that covers all Work under this Contract, to include the work of the subcontractors, with per claim and aggregate limits of no less than $5,000,000 per claim, with such insurance to stay in place for a period of three years after completion of the Project.

2.1.5 General Environmental Remediation Projects

In addition to the Insurance Requirements specified in the general provision or elsewhere in the Contract Documents, the Contractor shall not commence work under this Contract until all insurance as required hereafter has been obtained, and certificates of insurance, naming the County as an additional insured, of such insurance have been submitted and accepted by the Purchasing Agent. Redacted copies of insurance policies will be made available to the County upon written request.

i. An environmental remediation contractor or subcontractor shall be responsible for purchasing and maintaining Business Automobile Liability insurance and Workers' Compensation insurance as described in 2.1.2, 2.1.3, and 2.1.8.

ii. Acceptance by Arlington County of insurance submitted by the Contractor does not relieve or decrease in any manner the liability of the Contractor for performance of environmental remediation Work under the Contract.

iii. The Contractor is responsible for any losses, claims, and costs of any kind, which exceed the Contractor's limits of liability, or which may be outside the coverage scope of the policies. The limits and coverage requirements may be revised at the option of the Arlington County Risk Manager. If coverage requirements are revised by the Arlington County Risk Manager, the parties may negotiate additional compensation. The requirements outlined shall in no way be construed to limit or eliminate the liability of the Contractor, which arises from performance of work under the Contract.

2.1.6 Contractors Pollution Liability (CPL) Policy

i. Minimum liability limits required shall be $3,000,000 Per Loss and $6,000,000 Total All Losses, including, but not limited to, property damage, bodily injury, loss of use, and clean up costs.

ii. Limits must be dedicated to work performed under this Contract only, unless prior approval by the Arlington County Risk Manager has been obtained. The policy of insurance shall contain or be endorsed to include the following:

a. Pollution coverage as respects asbestos, lead, VOC and PCB's.

b. "Covered Operations" designated by the CPL policy must specifically include all work performed under this contract. (This would include and not be limited to excavation, off-site incineration of soils, demolition, asbestos abatement, drum removal and disposal, in-situ vapor extraction, etc.) and exclusions or limitations affecting work performed under this contract must be deleted. (i.e., lead, asbestos, pollution, testing, underground storage tanks, radioactive matter, etc.)

c. Contractor must comply with all applicable DOT and EPA requirements.

d. Premises/Operations.

e. Broad form property damage.

f. Products/Completed Operations coverage for a minimum of five (5) years after Final Payment.

g. Contractual liability coverage in accordance with ISO policy form CG 00 01 11 85. Modifications to the standard provision will not be acceptable if they serve to reduce coverage.

h. Cross liability/severability of interest.

i. The scope of work and all related activities under this Contract shall be included as “Covered Operations” under this policy.

j. Coverage is included on behalf of the insured for covered claims arising out of the actions of independent contractors. If insured is utilizing subcontractors, the CPL policy must use “By or On behalf of” language with regards to coverage.

k. Loading and unloading exclusions must be amended so as to include coverage for mobile equipment and automobiles.

2.1.7 Environmental Impairment Liability, to the extent not covered by Contractor’s Pollution Liability Policy, including coverage of insureds’ on-site clean up, with the following minimum limits of liability:

Bodily Injury and Property Damage Liability	3,000,000 each occurrence 6,000,000 annual aggregate

The County Board of Arlington County, Virginia, is to be named as Additional Name Insured or a Broad Form Contractual Endorsement may be added to the policy as respects any liability that may arise out of or result from the handling of Work on this Project including specifically but without limitation thereto, the indemnity provisions in the Agreement. Such policies will be endorsed to provide that they are primary to an insurance carried by the County Board of Arlington County, Virginia.

2.1.8 Should any of the Work hereunder involve the cleanup, remediation and/or removal of bio-solids, bio-hazards waste, or any hazardous or toxic materials, trash, debris, refuse, or waste, the Contractor shall provide, to the extent not covered by Contractor’s Pollution Liability Policy, or shall require its subcontractor performing the work to provide, to the extent not covered by subcontractor’s pollution liability policy, the following coverage in addition to the above requirements:

a) Environmental Liability and Cleanup Coverage – with limits of not less than $3,000,000 per occurrence.
b) Business Automobile Liability – for transportation or regulated and/or hazardous waste, products, or materials with limits of not less than $2,000,000, per occurrence. Said coverage shall include County as an additional insured and shall include both the MCS-90 and CA 9948 (or equivalent) endorsements, which shall be specifically referenced on the certificate of insurance.

3. <u>Commercial General or other Liability Insurance - Claims-made Basis:</u>

3.1 Claims-Made Coverage - If Commercial General or other liability insurance purchased by the Contractor has been issued on a claims-made basis, the Contractor must comply with the following additional conditions. The limits of liability and the extensions to be included as described in the Insurance Checklist and/or the Agreement remain the same. The Contractor must either:

- Provide Certificates of Insurance evidencing the claims-made coverages for a period of five years after final payment for the Contract or the end of the warranty period, whichever is greater, to ensure the coverage is in effect. Such certificates shall evidence a retroactive date, no later than the beginning of the Contractors or subcontractors' work under this contract,

or

- Purchase an extended (minimum five years or the end of the warranty period, whichever is greater) reporting period endorsement for the policy or policies in force during the term of this contract and evidence the purchase of this extended reporting period endorsement by means of a certificate of insurance or a copy of the endorsement itself.

4. <u>Builder's Risk Insurance</u>

4.1 Beginning at the commencement of early work construction, the Contractor shall purchase and maintain builder's risk insurance with a limit equal to the value of early work construction, and any amendments to the Contract which affect the project cost on a replacement cost basis. Builder's risk insurance shall be maintained until Substantial Completion under the Contract has been made or until no person or entity other than the County has an insurable interest in the covered property, whichever is earlier. Upon Substantial Completion the Owner shall be responsible to maintain property insurance on the Facility. The builder's risk insurance shall include the County as defined in Section 1.5, Contractor, subcontractors and sub-subcontractors as named insureds.

4.2 Insurance shall be on an all-risks policy form including the perils of fire, theft, vandalism, malicious mischief, lightning, wind, force majeure, collapse, and earthquake. Coverage is to apply for demolition occasioned by enforcement of any applicable legal requirements, and Architect's fees. Coverage for the peril of flood shall not be required unless otherwise required in the Contract Documents.

4.3 Unless otherwise provided in the Contract Documents, the builder's risk insurance shall also cover materials to be incorporated into the project which are stored off-site.

4.4 The Contractor shall purchase and maintain Boiler and Machinery insurance, if required by the contract documents or by law, with a limit satisfactory to the County. The Boiler and Machinery insurance shall cover objects during installation and until Final Acceptance by the County. The County shall be included as a named insured.

4.5 Any loss under builder's risk insurance shall be payable to the County as fiduciary for the insureds, as their interests may appear, subject to any mortgagee clause. The Contractor shall pay subcontractors their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require subcontractors to make payments to their sub-subcontractors in similar manner. The County, as fiduciary, shall have the right to adjust and settle a loss with insurers.

4.6 The insurance company providing the builder's risk coverage shall grant permission for the County to partially occupy or use the premises under construction prior to final acceptance without removing or affecting the coverage.

INSURANCE CHECKLIST

CERTIFICATE OF INSURANCE MUST SHOW ALL COVERAGE AND ENDORSEMENTS MARKED "X".

COVERAGES REQUIRED **COVERAGE MINIMUM(S)**

X 1. Workers' Compensation ....Statutory limits of Virginia
X 2. Employer's Liability .... $1 Million accident, $1 Million disease, $1 Million disease policy limit
X 3. Commercial General Liability.................... $2,000,000 BI/PD each occurrence, $5 Million annual aggregate
X 4. Premises/Operations .... $2,000,000 BI/PD each occurrence, $5 Million annual aggregate
X 5. Automobile Liability....................$2 Million BI/PD each accident, Uninsured Motorist
X 6. Owned/Hired/Non-Owned Vehicles....................$2 Million BI/PD each accident, Uninsured Motorist
X 7. Independent Contractors .... $2,000,000 BI/PD each occurrence, $5 Million annual aggregate
X 8. Products Liability.................... $2,000,000 BI/PD each occurrence, $5 Million annual aggregate
X 9. Completed Operations .... $2,00,000 BI/PD each occurrence, $5 Million annual aggregate
X 10. Contractual Liability (Must be shown on Certificate)$2,000,000 BI/PD each occurrence,$5 Million annual aggregate
__11. Personal and Advertising Injury Liability.................... $1 Million each offense, $1 Million annual aggregate
X 12. Umbrella Liability .... $5 Million Bodily Injury, Property Damage and Personal Injury
__13. Per Project Aggregate
X 14. Professional Liability
  X a. Architects and Engineers .... $5 Million per occurrence/claim
  __b. Asbestos Removal Liability .... $2 Million per occurrence/claim
  __c. Medical Malpractice .... $1 Million per occurrence/claim
  __d. Medical Professional Liability .... $ Limits as set forth in Virginia Code 8.01.581.15
X 15. Miscellaneous E&O/Professional Liability .... $5 Million per occurrence/claim
X 16. Motor Carrier Act End. (MCS-90)....................$2 Million BI/PD each accident, Uninsured Motorist
__17. Motor Cargo Insurance
__18. Garage Liability .... $1 Million Bodily Injury, Property Damage per occurrence
__19. Garagekeepers Liability .... $500,000 Comprehensive, $500,000 Collision
__20. Inland Marine-Bailee's Insurance .... $____________________
__21. Moving and Rigging Floater ....Endorsement to CGL
__22. Dishonesty Bond.................... $____________________
X 23. Builder's Risk.................... Provide Coverage in the full amount of Contract, including any amendments
X 24. XCU Coverage ....Endorsement to CGL
__25. USL&H .... Federal Statutory Limits
X 26. Carrier Rating shall be A.M. Best Co.'s Rating of A-VII or better or equivalent
X 27. Notice of Cancellation, nonrenewal or material change in coverage shall be provided to County at least 30 days prior to action.
X 28. The County shall be an Additional Insured on all policies except Workers Compensation, Errors/Omissions/ Professional Liability and Auto.
X 29. Certificate of Insurance shall show RFP Number and RFP Title.
X 30. Environmental Impairment Liability, including coverage of on-site clean up……BI/PD $3 Million occurrence/ $6 Million Annual Aggregate
__31. Cyber insurance....................$2Million per occurrence/Aggregate
__32. OTHER INSURANCE REQUIRED: ____