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General Specification 002 – Definitions and General Statements

1. Definitions

Owner – Shall mean Highlands County Board of County Commissioners (BCC) and its employees

Contractor – Shall mean Owner’s designated State of Florida Licensed General Contractor.

Engineer – Highlands County Project Manager.

Subcontractor – Refers to the contractor directly under control and with whom the General Contractor has entered into a contractual agreement to perform work on behalf of the Owner.

Surveyor – Shall mean the State of Florida Registered Land Surveyor which is a subcontractor of the Contractor who will provide services for the project as outlined in Section CS007.

Geotech – Shall mean the State of Florida Licensed Geotechnical Testing firm which is a subcontractor of the Contractor who will provide Quality Assurance testing as specified in various sections of these specifications.

2. General Statements

The work to be done under this contract may be completed by multiple subcontractors working under the direct control of the Contractor. All communications and payments for work will be through the Contractor. Subcontractors should not contact the Engineer or Owner directly instead the Subcontractor should seek clarification from the Contractor and the Contractor should seek clarification from the Engineer.

Potential Subcontractors shall be required to meet the Contractor’s minimum standards for licensing and insurance coverage. Proof of compliance of this requirement will become part of the agreement between the two parties and must remain in good standing for the term of the work and warranty period.

The specifications herein shall become an integral part of the engineering design plans. Subcontractors shall familiarize themselves with the content and conditions of the design plans and specifications. If questions arise during the course of their work, the Subcontractor should seek clarification from the Contractor.

There is a potential for other contractors and workers to be performing work on or near the site under separate agreement for the Owner/Engineer. A brief list examples includes:

1. Electric utility company
2. General site ditch maintenance crews
3. Water quality testing lab personnel
4. Normal farm and ranch operations

3. Priority

Detail drawings, call outs and general notes on the plan sheets shall have priority over statements or conditions in these specifications.

General Specification 005 – General Requirements

1. Scope

The work to be done consists of the furnishing of all labor, materials and equipment, and the performance of all work included in this contract. The Summary of the Work is presented in General Specification 10.

The Contractor shall furnish all labor, superintendence, safety professional, materials, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, and other means of construction necessary or proper for performing and completing the work. He shall obtain and pay for all required permits. He shall perform and complete the work in the manner best calculated to promote rapid construction consistent with safety of life and property and to the satisfaction of the Engineer, and in strict accordance with the contract documents. The Contractor shall clean up the work and maintain it during and after construction, until accepted, and shall do all work and pay all costs incidental thereto. He shall repair or restore all structures and property that may be damaged or disturbed during performance of the work.

The Contractor shall provide and maintain such modern plant, tools, and equipment as may be necessary, in the opinion of the Engineer, to perform in a satisfactory and acceptable manner all the work required by this contract. Only equipment of established reputation and proven efficiency shall be used. The Contractor shall be solely responsible for the adequacy of his workmanship, materials and equipment, prior approval of the Engineer notwithstanding.

2. Existing utilities

The contract documents contain data relative to existing utility installations and structures above and below the ground surface. These data are not guaranteed as to their completeness or accuracy. It is the responsibility of the Contractor to make his own investigations to inform himself fully of the character, condition and extent of all such installations and structures as may be encountered and as may affect the construction operations.

The Contractor shall protect all utility installations and structures from damage during the course of the work. Access across any buried utility installation or structure shall be made only in such locations and by means approved by the Engineer. The Contractor shall so arrange his operations as to avoid any damage to these facilities. All required protective devices and construction shall be provided by the Contractor at his expense. All existing utilities damaged by the Contractor that are shown on the plans or have been located in the field by the utility shall be repaired by the Contractor, at his expense, as directed by the Engineer. No separate payment shall be made for such protection or repairs to public utility installations or structures.

Where utility installations or structures owned or controlled by the Owner, or others, are encountered during the course of the work, and are not indicated on the plans or in the specifications, and when, in the opinion of the Engineer, removal, relocation, replacement or rebuilding is necessary to complete the work under this contract, such work shall be accomplished by the utility having jurisdiction, or such work may be ordered, in writing by the Engineer, for the Contractor to accomplish. If such work is accomplished by the utility having jurisdiction it will be carried out expeditiously and the Contractor shall give full cooperation to permit the utility to complete the removal, relocation, replacement or rebuilding as required. If such work is accomplished by the Contractor, it will be paid for as extra work as provided in the agreement.

The Contractor shall, at all times in performance of the work, employ approved methods and exercise reasonable care and skill so as to avoid unnecessary delay, injury, damage or destruction of utility installations and structures; and shall, at all times in the performance of the work, avoid unnecessary interference with, or interruption of, utility services, and shall cooperate fully with the Engineer thereof

to that end.

All governmental utility departments and other companies of public utilities which may be affected by the work will be informed in writing by the Contractor within two weeks after the execution of the contract or contracts covering the work. Such notice will set out, in general, and direct attention to the responsibilities of the Contractor and other governmental utility departments and other companies of public utilities for such installations and structures as may be affected by the work and will be accompanied by one set of Plans and Specifications covering the work under such contract or contracts.

No foreseeable work shall interrupt utility service without prior approval and direct coordination with the utility company. A written proposal shall be provided to the utility company for approval a minimum of ninety-six hours before proposed work. The Contractor shall notify in writing all affected customers a minimum of forty-eight hours before the proposed work. The utility company shall maintain the ultimate authority to cease work and reinstate utility service at any time during shutdown if the approved scope of work is not strictly adhered to.

The maintenance, repair, removal, relocation or rebuilding of public utility installations and structures, when accomplished by the Contractor as herein provided, shall be done by methods approved by the Engineer.

3. Plans and Specifications

When obtaining data and information from the Plans, figures shall be used in preference to scaled dimensions, and large-scale drawings in preference to small scale drawings.

When the Contractor has identified a conflict between the Plans and Specifications he should immediately notify the Engineer for clarification. In absence of such clarification, the engineering design plans shall have priority.

After the contract has been executed, the Contractor will be furnished a PDF of the Plans and Specification. The Contractor will be responsible for the cost of printing the Plans and Specifications.

The Contractor shall furnish each of the Subcontractors, manufacturers, and material suppliers such copies of the contract documents as may be required for their work.

When, in the opinion of the Engineer, it becomes necessary to explain more fully the work to be done or to illustrate the work further or to show any changes which may be required, drawings known as Supplementary Drawings, with specifications pertaining thereto, will be prepared by the Engineer and a PDF thereof will be given to the Contractor.

The Supplementary Drawings shall be binding upon the Contractor with the same force as the Plans. Where such Supplementary Drawings require either less or more than the estimated quantities of work, credit to the Owner or compensation therefore to the Contractor shall be subject to the terms of the Agreement.

The Contractor shall verify all dimensions, quantities and details shown on the Plans, Supplementary Drawings, schedules, Specifications or other data received from the engineer, and shall notify him of all errors, omissions, conflicts, and discrepancies found therein. Failure to discover or correct errors, conflicts or discrepancies shall not relieve the Contractor of full responsibility for unsatisfactory work, faulty construction or improper operation resulting therefrom nor from rectifying such conditions at his own expense. He will not be allowed to take advantage of any errors or omissions, as full instructions will be furnished by the engineer, should such errors or omissions be discovered. All schedules are given for the convenience of the engineer and the Subcontractor and are not guaranteed to be complete. The Contractor shall assume all responsibility for the making of estimates of the size, kind, and quality of materials and equipment included in work to be done under the contract.

The Technical Specifications consist of four parts: General (GS), Construction (CS), Material (MS) and

Electrical (ES). The General Specifications contain general requirements that govern the work. Construction and Material Specifications modify and supplement these by detailed requirements for the work and shall always govern whenever there appears to be a conflict. Electrical Specifications provide minimum standards and guidance for all electrical work which is part of the project.

All work called for in the Specifications applicable to this contract, but not shown on the Plans in their present form, or vice versa, shall be of like effect as if shown or mentioned in both. Work not specified in either the Plans or in the Specifications but involved in carrying out their intent or in the complete and proper execution of the work, is required and shall be performed by the Contractor as though it were specifically delineated or described.

The apparent silence of the Specifications as to any detail, or the apparent omission from them of a detailed description concerning any work to be done and materials to be furnished, shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of the best quality is to be used, and interpretation of these Specifications shall be made upon that basis. If clarification of the Engineer's intent is required the Contractor is encouraged to contact the Engineer directly on a timely basis as not to delay the work progress.

4. Materials and equipment

The names of proposed manufacturers, material suppliers, and dealers who are to furnish materials, fixtures, equipment, appliances or other fittings shall be submitted to the Engineer for approval, as early as possible, to afford proper investigation and checking. Such approval must be obtained before Shop Drawings will be checked. No manufacturer will be approved for any materials to be furnished under this contract unless he shall be of good reputation and have a plant of ample capacity. He shall, upon the request of the engineer, be required to submit evidence that he has manufactured a similar product to the one specified and that it has been previously used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.

All transactions with the manufacturers or Subcontractors shall be through the Contractor, unless the Contractor requests, in writing and the engineer approves, that the manufacturer or Subcontractor deal directly with the Engineer. Any such transactions shall not in any way release the Contractor from his full responsibility under this contract.

Any two or more pieces of material or equipment of the same kind, type or classification, and being used for identical types of service, shall be made by the same manufacturer.

The Contractor shall deliver materials in ample quantities to ensure the most speedy and uninterrupted progress of the work so as to complete the work within the allotted time. The Contractor shall also coordinate deliveries in order to avoid delay in, or impediment of, the progress of the work of any related Contractor.

The Contractor shall, unless otherwise stated in the contract documents, furnish with each type, kind or size of equipment, one complete set of suitably marked high grade special tools and appliances (unless they are commonly available mechanic's tools) that may be needed to adjust, operate, maintain or repair the equipment. Such tools and appliances shall be furnished in tool cases as approved by Engineer.

Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, weight and principal rating data. The supplier and manufacturer's contact information shall also be provided in the Operation and Maintenance manual for future reference.

The Contractor shall have on hand sufficient proper equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character.

Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Plans, unless directed otherwise by the Engineer during installation. All

equipment shall be correctly aligned, leveled and adjusted for satisfactory operation and shall be installed so that proper and necessary connections can be made readily between the various units.

The Contractor shall furnish, install and protect all necessary anchor and attachment bolts and all other appurtenances needed for the installation of the devices included in the equipment specified. Anchor bolts shall be as approved by the Engineer and made of ample size and strength for the purpose intended. Substantial templates and working drawings for installation shall be furnished.

The Contractor shall, at his own expense, furnish all materials and labor for, and shall properly bed in non-shrink grout, each piece of equipment on its supporting base that rests on masonry foundations. Grout shall completely fill the space between the equipment base and the foundation.

The contract prices for equipment shall include the cost of furnishing a competent and experienced engineer or superintendent who shall represent the manufacturer and shall assist the Contractor, when required, to install, adjust, test and place in operation the equipment in conformity with the contract documents. After the equipment is placed in permanent operation by the Owner, such engineer or superintendent shall make all adjustments and tests required by the engineer to prove that such equipment is proper and satisfactory operating condition, and shall instruct such personnel as may be designated by the engineer in the proper operation and maintenance of such equipment.

5. Inspection and testing

Inspection and testing of materials will be performed by the Contractor or his suppliers and manufacturers as directed by the Engineer unless otherwise specified without additional cost to Owner.

For tests specified to be made by the Contractor, the testing personnel shall make the necessary inspections and tests and the reports thereof shall be in such form as will facilitate checking to determine compliance with the contract documents. Three copies of the reports shall be submitted and authoritative certification thereof must be furnished to the Engineer as a prerequisite for the acceptance of any material or equipment.

If, in the making of any test of any material or equipment, it is ascertained by the Engineer that the material or equipment does not comply with the contract, the Contractor will be notified thereof and he will be directed to refrain from delivering said material or equipment, or to remove it promptly from the site or from the work and replace it with acceptable material, without cost to the Owner.

Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with recognized test codes of the ANSI, ASME, or the IEEE, except as may otherwise be stated herein.

The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage that may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

All inspection and testing of materials furnished under this contract will be performed by the Contractor or duly authorized inspection engineers or inspection bureaus.

The cost of shop and field tests of equipment and of certain other tests specifically called for in the contract documents shall be borne by the Contractor and such costs shall be deemed to be included in the contract price.

Materials and equipment submitted by the Contractor as the equivalent to those specifically named in the contract may be tested by the Engineer for compliance. The Contractor shall reimburse the Owner for the expenditures incurred in making such tests on materials and equipment that are rejected for non-compliance.

The Contractor shall give notice in writing to the Engineer, sufficiently in advance of his intention to commence the manufacture or preparation of materials especially manufactured or prepared for use in or as part of the permanent construction. Such notice shall contain a request for inspection, the date of

commencement and the expected date of completion of the manufacture or preparation of materials. Upon receipt of such notice, the Engineer will arrange to have a representative present at such times during the manufacture as may be necessary to inspect the materials or he will notify the Contractor that the inspection will be made at a point other than the point of manufacture, or he will notify the Contractor that inspection will be waived. The Contractor must comply with these provisions before shipping any material. Such inspection shall not release the Contractor from the responsibility for furnishing materials meeting the requirements of the contract documents.

When inspection is waived or when the Engineer so requires, the Contractor shall furnish to him authoritative evidence in the form of Certificates of Manufacture that the materials to be used in the work have been manufactured and tested in conformity with the contract documents. These certificates shall be notarized and shall include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer. The certificates shall be delivered to the Engineer prior to shipment of the materials.

Each piece of equipment for which pressure, duty, capacity, rating, efficiency, performance, function or special requirements are specified shall be tested in the shop of the maker in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the contract documents. No such equipment shall be shipped to the work site until the Engineer notifies the Contractor, in writing, that the results of such tests are acceptable.

Three copies of the manufacturer's actual test data and interpreted results thereof, accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company, shall be forwarded to the Engineer for approval.

The cost of shop tests and of furnishing manufacturer's preliminary and shop test data of operating equipment shall be borne by the Subcontractor.

As soon as conditions permit, the Contractor shall furnish all labor, materials, and instruments and shall make preliminary field tests of equipment. If the preliminary field tests disclose any equipment furnished under this contract that does not comply with the requirements of the contract documents, the Contractor shall, prior to the acceptance tests, make all changes, adjustments and replacements required. The Contractor shall assist in the preliminary field tests as applicable.

Upon completion of the work and prior to final payment, all equipment and piping installed under this contract shall be subjected to acceptance tests as specified or required to prove compliance with the contract documents.

The Contractor shall furnish labor, fuel, energy, water and all other materials, equipment and instruments necessary for all acceptance tests, at no additional cost to the Contractor. The Contractor shall assist in the final field tests as applicable.

Any defects in the materials and equipment or their failure to meet the tests, guarantees or requirements of the contract documents shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the contract shall be final and conclusive. If the Contractor fails to make these corrections or if the improved materials and equipment, when tested, shall again fail to meet the guarantees or specified requirements, the Engineer, notwithstanding its partial payment for work, and materials and equipment, may reject the materials and equipment and may order the Contractor to remove them from the site at his own expense.

If the failure during testing is fully or partly due to the equipment provided by the Contractor, as determined by the Engineer, the Contractor shall make all required improvements at no cost to the Owner.

In case the Engineer rejects any materials and equipment, then the Contractor shall replace the rejected

materials and equipment within a reasonable time. If he fails to do so, the Engineer may, after the expiration of a period of thirty (30) calendar days after giving him notice in writing, proceed to replace such rejected materials and equipment, and the cost thereof shall be deducted from any compensation due or which may become due the Contractor under his contract.

The Contractor agrees to obtain other equipment within a reasonable time and the Engineer agrees that the Contractor may use the equipment furnished by him without rental or other charges until the new equipment is obtained.

During such final inspections, the work shall be clean and free from water. In no case will the final estimate be prepared until the Contractor has complied with all requirements set forth and the Engineer has made his final inspection of the entire work and is satisfied that the entire work is properly and satisfactorily constructed in accordance with the requirements of the contract documents.

6. Temporary structures

If, during the course of the work, it is necessary to remove or disturb any fence or part thereof, the Contractor shall provide a suitable temporary fence at his own expenses, which shall be maintained until the permanent fence is replaced. The Engineer shall be solely responsible for the determination of the necessity for providing a temporary fence and the type of temporary fence to be used.

In accepting the contract, the Contractor assumes full responsibility for the sufficiency and safety of all temporary structures or work and for any damage which may result from their failure or their improper construction, maintenance or operation and will indemnify and save harmless the Owner and Engineer from all claims, suits or actions and damages or costs of every description arising by reason of failure to comply with the above provisions.

7. Safety

Precautions shall be exercised at all times for the protection of person and property. The safety provisions of applicable laws, building and construction codes shall be observed. The Contractor and all Subcontractors shall comply with the U.S. Department of Labor Safety and Health Regulations for construction promulgated under the Occupational Safety and Health Act of 1970 (PL 91-596), and under Section 107 of the contract Work Hours and Safety Standards Act (PL 91- 54), except where state and local safety standards exceed the federal requirements and except where state safety standards have been approved by the Secretary of Labor in accordance with provisions of the Occupational Safety and Health Act, shall be complied with.

The Contractor shall keep on-site, at each location where work is in progress, a completely equipped first aid kit and shall provide ready access thereto at all times when men are employed on the work.

See HSE Requirements specification for additional information and requirements.

8. Lines and grades

All work under this contract shall be constructed in accordance with the lines and grades shown on the Plans, or as given by the Engineer. The full responsibility for keeping alignment and grade shall rest upon the Contractor.

The Contractor shall use a Florida Licensed Certified Land Surveyor to establish bench marks and base line controlling points. Reference marks for lines and grades as the work progresses will be located to cause as little inconvenience to the prosecution of the work as possible. The Contractor shall so place excavation and other materials as to cause no inconvenience in the use of the reference marks provided. He shall remove any obstructions placed by him contrary to this provision.

The Contractor shall furnish and maintain, at his own expense, stakes and other such materials, and give such assistance, including qualified helpers, as may be required by the Engineer for setting reference marks. The Contractor shall check such reference marks by such means as he may deem necessary and,

before using them, shall call the Engineer's attention to any inaccuracies. The Contractor shall, at his own expense, establish all working or construction lines and grades as required from the reference marks and shall be solely responsible for the accuracy thereof. He shall, however, be subject to the check and review of the Engineer. It is the intention not to delay the work for the establishment of reference marks but, when necessary, working operations shall be suspended for such reasonable time as the Engineer may require for this purpose.

The Contractor shall safeguard all points, stakes, grade marks, monuments and bench marks made or established on the work, bear the cost of reestablishing them if disturbed, and bear the entire expense of rectifying work improperly installed due to not maintaining or protecting or to removing without authorization such established points, stakes and marks.

The Contractor shall safeguard all existing and known property corners, monument and marks adjacent to but not related to the work and, if required, shall bear the cost of reestablishing them if disturbed or destroyed. All elevations indicated or specified refer to the North American Vertical Datum of 1988 (NAVD88).

9. Adjacent structures and landscaping

The Contractor shall also be entirely responsible and liable for all damage or injury as a result of his operations to all other adjacent public and private property, structures of any kind and appurtenances thereto met with during the progress of the work. The cost of protection, replacement in their original locations and conditions or payment of damages for injuries to such adjacent public and private property and structures affected by the work, whether or not shown on the Plans, and the removal, relocation and reconstruction of such items called for on the Plans or specified shall be included in the lump sum price and no separate payments will be made therefor.

The Contractor is expressly advised that the protection of buildings, structures, tunnels, tanks, pipelines, etc. and related work adjacent and in the vicinity of his operations, wherever they may be, is solely his responsibility. Conditional inspection of buildings or structures in the immediate vicinity of the project which may reasonably be expected to be affected by the work shall be performed by and be the responsibility of the Contractor.

The Contractor shall, before starting operations, make an examination of the interior and exterior of the adjacent structures, buildings, facilities, etc., and record by notes, measurements, photographs, etc., conditions which might be aggravated by open excavation and construction. Repairs or replacement of all conditions disturbed by the construction shall be made to the satisfaction of the Contractor and to the satisfaction of the Engineer. This does not preclude conforming to the requirements of the insurance underwriters. Copies of surveys, photographs, reports, etc., shall be given to the Engineer upon request.

Prior to the beginning of any excavations the Contractor shall advise the Engineer of all buildings or structures on which he intends to perform work or which performance of the project work will affect.

All trees and shrubs shall be adequately protected by the Contractor in accordance with ordinances governing the protection of trees. No excavated materials shall be placed so as to injure such trees or shrubs. Trees or shrubs destroyed by negligence of the Contractor or his employees shall be replaced by him with new stock of similar size and age, at the proper season and at the sole expense of the Contractor. Beneath trees or other surface structures, where possible, pipelines may be built in short tunnels, backfilled with excavated materials, except as otherwise specified, or the trees or structures carefully supported and protected from damage. The Engineer may order the Contractor, for the convenience of the Engineer, to remove trees along the line or trench excavation. If so ordered the Engineer will obtain any permits required for removal of trees. Such tree removal ordered shall be paid for under the associated contract items.

Lawn areas shall be left in as good condition as before the starting of the work. Where sod is to be removed, it shall be carefully removed, and later replaced, or the area where sod has been removed shall

be restored with new sod to a similar condition as before the starting of the work at the expense of the Contractor.

Any fence, or part thereof, that is damaged or removed during the course of the work shall be replaced or repaired by the Contractor and shall be left in similar condition as before the starting of the work. The manner in which the fence is repaired or replaced, the materials used in such work shall be subject to the approval of the Engineer. The cost of all labor, materials, equipment, and work for the replacement or repair of any fence shall be deemed included in the lump sum price and no additional payment will be made thereof.

10. Protection of work and public

During the prosecution of the work, the Contractor shall put up and maintain at all times such barriers and lights as will effectually prevent accidents and/or injury. Where appropriate, as determined by the Contractor, proper signs, warning devices, and flagmen shall be maintained as required by DOT Manual of Uniform Traffic Control and Safe Practices.

The Contractor shall use hard coal, coke, oil or gas as fuel for equipment generating steam. A strict compliance with ordinances regulating the production and emission of smoke will be required.

The Contractor shall eliminate noise to as great an extent as practicable at all times. Air compressing plants shall be equipped with silencers and the exhaust of all gasoline motors or other power equipment shall be provided with mufflers. In the vicinity of hospitals and schools, special care shall be used to avoid noise or other nuisances. The Contractor shall strictly observe all local regulations and ordinances covering noise control.

The Contractor shall prevent dust nuisance from his operations or from traffic by keeping the roads and/or construction areas sprinkled with water at all times.

11. Cutting and patching

The Contractor shall do all cutting, fitting or patching of his portion of the work that may be required to make the several parts thereof join and coordinate in a manner satisfactory to the Engineer and in accordance with the Plans and Specifications. The work must be done by competent workmen skilled in the trade required by the restoration.

12. Cleaning

During construction of the work, the Contractor shall, at all times, keep the site of the work and adjacent premises as free from material, debris and rubbish as is practicable and shall remove the same from any portion of the site if, in the opinion of the Engineer, such material, debris, or rubbish constitutes a nuisance or is objectionable.

The Contractor shall remove from the site all of his surplus materials and temporary structures when no further need therefore develops. Contractor shall be responsible and liable for all spillage and incur all associated costs including, but not limited to, costs related to repair and maintenance resulting from damages thereof.

At the conclusion of the work, all erection plant, tools, temporary structures and materials belonging to the Contractor shall be promptly taken away, and he shall remove and promptly dispose of all water, dirt, rubbish or any other foreign substances.

The Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver such materials and equipment undamaged in a bright, clean, polished and new operating condition.

13. Miscellaneous

The Contractor will be responsible for filing a Storm Water Pollution Prevention (SWPP) plan. The Contractor shall abide by all applicable terms of the SWPP plan and implementing relevant components

related to their scope of work. The Contractor will monitor and report adherence to the SWPP plan.

The Contractor shall arrange his operations to minimize siltation and bank erosion on construction sites and on existing or proposed water courses and drainage ditches. The Contractor, at his own expense, shall remove any siltation deposits and correct any erosion problems as directed by the Engineer which results from his construction operations.

The Contractor shall properly dispose of all surplus material, including spoil, in accordance with Local, State, and Federal regulations. Under no circumstances shall surplus material be disposed of in wetland areas as defined by the Florida Department of Environmental Protection.

The work shall be so conducted to maintain existing facilities in operation. Requirements and schedules of operations for maintaining existing facilities in service during construction shall be as described in these Specifications.

All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with instructions. All chemicals and flammables will be in approved containers and labeled appropriately. All work to be in compliance with 29CFR 1926 Subpart D OSHA standards.

During progress of work under this contract, it may be necessary for other contractors and persons employed by the Owner to work in or about the site. The company reserves the right to put such other contractors and persons to work and to afford such access to the site of the work to be performed hereunder at such times as the company deems proper. The Contractor shall not impede or interfere with the work of such other contractors and persons engaged in or about the work and shall so arrange and conduct his work that such other contractors and persons may complete their work at the earliest date possible.

General Specification 010 – Summary of Work

1. Scope

Furnish all labor, materials, equipment and incidentals required to construct an above ground impoundment and pump station for stormwater reuse as shown on the engineering design plans in its entirety and as detailed in these specifications.

The work includes, but is not necessarily limited to, the following:

- 1) Surveying necessary to:
 - A. Work with the Contractor to develop a Quality Assurance Plan for the project which will be submitted to the Engineer for review and approval before work begins.
 - B. Establish lines, grades, and elevations for project components
 - C. Measurements and calculations to certify to the Engineer the job progress
 - D. Record plans and final certification.
- 2) Geotechnical services to:
 - A. Work with the Contractor to develop a Quality Assurance Plan for the project which will be submitted to the Engineer for review and approval before work begins.
 - B. Classify soils and establish their suitability for construction.
 - C. Complete progress compaction tests and submit required reports to the Engineer on a timely basis.
 - D. Remain on-site during critical infrastructure installation and to submit report to the Engineer.
- 3) Installing and maintaining erosion controls throughout the project duration.
- 4) Creation and maintenance of a safety plan for the project.
- 5) Clearing and/or grubbing of project site areas upon which project components are to be constructed.
- 6) Installing fences and gates where specified on the plans.
- 7) Removal of existing fences and gates where specified on the plans.
- 8) Erection of temporary fences to limit access and for animal control.
- 9) Removing and burning of trees and vegetation identified on drawings or as required to complete work (See CS002).
- 10) Removing existing culverts and structures as required by drawings.
- 11) Removal and disposal of unsuitable and excess soil.
- 12) Ditch covering as specified on the plans.
- 13) Excavation, hauling, placement and compaction of earthfill for above ground impoundment berm construction.
- 14) Excavation, hauling, placement and compaction of earthfill for the access roads.
- 15) Excavation of new water supply canal and connecting culverts.
- 16) Installation of culverts under Channel A.
- 17) Installation of precast concrete structures for sluice gate, pumps and emergency overflow.

- 18) Installation of one drainage pump station with two (2) pumps.
- 19) Installation of electric rack, motor controls and level sensors.
- 20) Installation of a pre-engineered shelter, fence and gate for item 19.
- 21) Installation of seepage control ditch.
- 22) Installation of various water control structures and culverts as shown on plans.
- 23) Establish sod and hydroseed for site stabilization
- 24) Site cleanup.
- 25) Demobilization.
- 26) Testing and training of Owner's personnel.
- 27) Preparation of Operation and Maintenance Manual(s) and Construction As-Built Drawings.

2. Location of Work

All of the work of this contract is on the Istokpoga Marsh Watershed Improvement District (IMWID) Impoundment Phase II project in Highlands County, Florida as shown in the engineering design plans.

General Specification 020 – Project Coordination

1. Work quality and progress

The Subcontractor shall furnish personnel and equipment that will be efficient, appropriate and large enough to secure a satisfactory quality of work and a rate of progress that will ensure the completion of the work within the time stipulated. If at any time such personnel appears to the Engineer to be inefficient, inappropriate or insufficient for securing the quality of work required, or for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character, or increase the personnel and equipment, and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress.

2. Private land

The Contractor shall not enter or occupy private land outside of easements, except by the written permission of the appropriate land owner and express authorization of the Engineer.

3. Pipeline and utility locations

Pipelines and utilities shall be located substantially as indicated on the Drawings, but the engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures, or for other reasons. Where fittings are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

4. Open excavations

All excavation activities will be in compliance with OSHA 29 CFR 1926 Subpart P. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons, and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by workmen.

5. Maintenance of traffic within road right-of-ways

Unless permission is received in writing from the proper authority, two-way traffic shall be maintained at all times.

Where appropriate, as determined by the engineer, proper signs, warning devices, and flagmen shall be maintained as required by Department of Transportation Manual of Uniform Traffic Control and Safe Practices.

The Contractor shall take precautions to prevent injury to the public as a result of open trenches. All trenches opened during the day shall be closed at the end of the workday, and excavated material shall not be placed on traveled road surfaces, even temporarily.

6. Care and protection of property

The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition similar or equal to that existing before the damage was done, or he shall make good the damage in another manner acceptable to the Engineer.

7. Operation within this contract

All firms or persons authorized to perform any work under this Contract shall cooperate with the

Contractor (and his subcontractors or trades) shall assist in incorporating the work of other Subcontractors where necessary or required.

Cutting and patching, drilling and fitting shall be carried out where required by the trade or contractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

8. Protection of construction and equipment

All newly constructed work shall be carefully protected from injury in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions injured shall be reconstructed by the Contractor at his own expense.

All work items shall be protected in a manner approved by the Engineer. Should any work items become heaved, cracked, eroded or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor at his own expense and to the satisfaction of the Engineer. If, in the final inspection of the work, any defects, faults or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for the guarantee period described in the contract.

General Specification 025 – Special Provisions

1. Installation of equipment

Special care shall be taken to ensure proper alignment of all equipment with particular reference to pumps and electric drives. Units shall be carefully aligned on their foundations by qualified millwrights after their sole plates have been shimmed to true alignment at the anchor bolts. Anchor bolts shall be set in place and nuts tightened against the shims. Alignment of equipment shall be further checked after securing to the foundations, and after conformation of all alignments, the sole plates shall be finally grouted in place. The Contractor shall be responsible for the exact alignment of equipment with associated piping, and under no circumstances will tension in the components caused by misalignment be allowed.

All wedges, shims, filling pieces, keys, packing, grout, or other materials necessary to properly align, level, and secure apparatus in place shall be furnished by the Contractor. All parts intended to be plumb or level must be proven exactly so. Perform all grinding necessary to bring parts to proper bearing after erection at the Contractor's expense.

2. Shop drawings

The Engineer understands that some components or facilities specified on the design plans or are required to complete this project will vary slightly from those specified in areas such as dimension, mounting details, and installation methods. The Contractor is responsible to coordinate his work with the suppliers and manufacturers selected to provide a completed installation which will meet the goals of the project. To ensure that the materials proposed will be acceptable to the Engineer the Contractor shall submit shop drawings, performance data and supporting documents for approval to the Engineer prior to committing financially to the purchase of the items. The Engineer will make every effort to provide comments and written approval/rejection in a timely manner but not exceeding 30 days from the submittal being completed. Shop drawings shall include material specifications, mounting details and corrosion protection information. For this project shop drawings are required for at least the following items:

- 1) Drainage pumps, motors, drives, flap gates and related equipment
- 2) Pump discharge pipe supports
- 3) Sluice gate and operator
- 4) Hand rails and catwalk for pump station & sluice gate
- 5) Precast concrete components for (2) pump sumps, (1) sluice gate
- 6) Electric rack, wiring plan and conduit sizes (by electrician)
- 7) Pre-engineered shelter, fence and gate for pump station controls
- 8) Motor controls (by selected automation company)
- 9) PLC logic program (by selected automation company)
- 10) Level sensors with mounting details – (2) analog, (2) level switched (by selected automation company)
- 11) Aluminum flash board risers and associated catwalks and hand rails
- 12) Any changes proposed by the Contractor
- 13) HDPE culverts and aluminum culverts
- 14) Flexamat for emergency overflow

15) Relocating Structure 2 catwalk and replacing culvert.

3. Sleeves and openings

The Contractor shall provide all openings, channels, chases, etc., in new construction and furnish and install anchor bolts and other items to be embedded in concrete, as required to complete the work under this contract. The Contractor shall do all cutting, coring and rough and finish patching required in existing construction for the work of all trades.

Contractors shall furnish all sleeves, inserts, hangers, anchor bolts, etc., required for the execution of their work. It shall be their responsibility before the work of the Contractor is begun to furnish him with the above items and with templates, drawings or written information covering chases, openings, etc., which they require, and to follow up the work of the Contractor as it progresses, making sure that their drawings and written instructions are carried out. Failing to do this, they shall be responsible for the cost of any corrective measures that may be required to provide necessary openings, etc. If the Contractor fails to carry out the directions given him, covering details and locations of openings, etc., he shall be responsible for any cutting and refinishing required to make the necessary corrections. In no case shall beams, lintels, or other structural members be cut without the approval of the Engineer.

4. Noise limitations

All equipment to be furnished under this contract, unless specified otherwise in the technical specifications, shall be designed to ensure that the sound pressure level does not exceed 85 decibels over a frequency range of 37.8 to 9,600 cycles per second at a distance of three feet from any portion of the equipment, under any load condition, when tested using standard equipment and methods. Noise levels shall include the noise from the motor. Mufflers or external baffles shall not be acceptable for the purpose of reducing noise. Data on noise levels shall be included with the shop drawing submittal.

5. Obstructions

The attention of the Contractor is drawn to the fact that during excavation at the Project site, the possibility exists of the Contractor encountering various water, chemical, electrical, or other lines not shown on the Drawings. The Contractor shall exercise extreme care before and during excavation to locate and flag these lines so as to avoid damage to the existing lines. Should damage occur to an existing line, the Contractor shall repair the line at no cost to the Owner.

It is the responsibility of the Contractor to ensure that all utility or other poles, the stability of which may be endangered by the close proximity of excavation, are temporarily stayed in position while work proceeds in the vicinity of the pole and that the utility or other companies concerned be given reasonable advance notice of any such excavation by the Contractor.

6. Utility crossings

It is intended that wherever existing utilities such as water, chemical, electrical or other service lines must be crossed, deflection of the pipe within recommended limits and cover shall be used to satisfactorily clear the obstruction unless otherwise indicated on the Drawings. However, when in the opinion of the Contractor or Engineer this procedure is not feasible he may direct the use of fittings for a utility crossing as detailed on the Drawings.

7. Connections to existing systems

The Contractor shall perform all work necessary to locate, excavate and prepare for connections to existing utilities as shown on the Drawings or where directed by the Contractor. The cost for this work and for the actual connection to existing utilities shall be included in the bid for the project and shall not result in any additional cost to the Contractor.

It is the responsibility of the Contractor to expose existing pipelines at the tie-in locations and, if necessary, any buried utilities in the immediate area of the tie-in that may affect the installation of new

pipe as shown on the Drawings. The Contractor is fully responsible for ordering any additional material, such as fittings and restrained pipe that may be needed to avoid existing buried utilities should such material not be shown on the Drawings or included in the Contractor's Schedule of Prices. The Contractor may not schedule any tie-in activity until such additional material is on-site.

8. Provisions for erosion control

Sufficient precautions shall be taken during construction to minimize the run-off of polluting substances such as silt, clay, fuels, oils, bitumens, calcium chloride, or other polluting materials harmful to humans, fish, or other life, into the supplies and Surface Waters of the State. Control measures must be adequate to assure that turbidity in the receiving water will not be increased more than 10 nephelometric turbidity units (NTU), or as otherwise required by the State or other controlling body, in water used for public water supply or fish unless limits have been established for the particular water. In surface water used for other purposes, the turbidity must not exceed 29 NTU unless otherwise permitted (See CS005). Special precautions shall be taken in the use of construction equipment to prevent operations that promote erosion. Contractor shall reference Florida Stormwater, Erosion and Sedimentation Control Inspection manual.

9. Provisions for dust and litter control

Sufficient precautions to prevent nuisance to adjacent property owners and the general public shall be taken during construction (including clearing and grubbing) to minimize the amount of dust created. Wetting down the site may be required or as directed by the Engineer to prevent dust as a result of vehicular traffic. Control of blowing litter caused by any re-grading by the Contractor shall be the responsibility of the Contractor. The Contractor shall use dust control methods and materials approved by the Engineer.

10. Damage caused by high water

Contractor will hold himself responsible for all damage done to his work by heavy rains or floods and he shall take all reasonable precautions to provide against damages by building such temporary dikes, channels, or shoring to carry off storm water as the nature of the work may require.

11. Emergency phone numbers and accident reports

Emergency phone numbers (fire, medical, police) shall be posted at the job site or in a location approved by Owner/Engineer and its locations be made to known to all workers.

Accidents shall be reported immediately to the Owner/Engineer by messenger or phone.

All accidents shall be documented by the Contractor and a fully detailed written report submitted by the Contractor to the Owner/Engineer after each accident.

12. Items specified on drawings

Items of material, equipment, machinery and the like may be specified on the drawings and not in the specifications. The Contractor shall provide such items in accordance with the specification on the drawings.

13. Workmanship, materials, and equipment

When a particular product is specified or called for, it is intended and shall be understood that the proposal tendered by the Contractor included those products in his bid. Should the Contractor desire equal to those specified, the Contractor shall furnish information as described in the Standard General Conditions. The alternate product or products submitted by the Contractor shall meet the requirements of the specifications and shall, in all respects, be equal to the products specified by name herein.

All apparatus, mechanism, equipment, machinery and manufactured articles for incorporation into the work shall be the new and unused standard products of recognized reputable Manufacturers.

14. Services of manufacturer's field service technician

As directed by the Engineer, bid prices of equipment furnished shall include the cost of a competent field service technician of the manufacturers of all equipment to supervise the installation, adjustment, and testing of the equipment and to instruct the Owner's operating personnel on operation and maintenance. The approved Manufacturer's operation and maintenance data as specified elsewhere herein shall be delivered to the Engineer prior to instructing the Owner's personnel. This supervision may be divided into two or more time periods as required by the installation program or as directed by the Engineer.

After installation of the equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the Manufacturer's field service technician shall inspect, operate, test and adjust the equipment. The inspection shall include at least the following points where applicable:

- 1) Soundness (without cracked or otherwise damaged parts).
- 2) Completeness in all details, as specified and required.
- 3) Correctness of setting, alignment, and relative arrangement of various parts.
- 4) Adequacy and correctness of packing, sealing, and lubricants.
- 5) Calibration and adjustment of all related instrumentation and controls.
- 6) Energize equipment.
- 7) Deficiency correction
- 8) Demonstration of compliance with application performance specification.

The operation, testing, and adjustment shall be as required to prove that the equipment has been left in proper condition for satisfactory operation under the conditions specified.

Upon completion of this work, the Manufacturer's field service technician shall submit, in duplicate, to the Engineer a complete, signed report of the results of his inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance.

Each equipment Manufacturer shall provide instruction to the Owner's operating personnel. Training shall not be performed until the above requirements have been fully satisfied and any specified performance testing completed. Duration of training shall be sufficient to completely familiarize Owner's operating personnel which may require multiple training sessions. Training time and date shall be provided when convenient of the proposed operators of the equipment. Training shall not be concurrent with on-going testing debugging or installation activities; but shall be a separate activity devoted exclusively to the instruction of the Owner's personnel in the operation and maintenance of the Manufacturer's equipment. Training shall be performed by qualified representatives of each equipment Manufacturer specifically skilled in providing instruction to operation personnel. Training shall provide an overview of operations and maintenance requirements and shall include but not be limited to:

- 1) Description of unit and component parts.
- 2) Operating capabilities and performance criteria.
- 3) Operating procedures.
- 4) Maintenance procedures
- 5) Servicing and lubrication schedules.
- 6) Troubleshooting.

A certificate from the Manufacturer stating that the installation of the equipment is satisfactory, that the unit has been satisfactorily tested, is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit shall be submitted before start-up and acceptance by the Engineer. The certificate shall indicate date and time instruction was given and names of operating personnel in attendance. This certification shall be submitted on the certification sheet, the form of which is at the end of this section.

See the detailed Specifications for additional requirements for furnishing the services of the Manufacturer's field service technician.

For equipment furnished under other specifications, the Contractor, unless otherwise specified, shall furnish the services of accredited field services technicians of the Manufacturer only when some evident malfunction or over-heating makes such services necessary in the opinion of the Engineer.

15. Operation and maintenance data

Operating and maintenance data covering all equipment furnished shall be delivered directly to the Engineer, for approval within 60 days of installation and before final acceptance. No payment shall be made for equipment installed or stored on-site until the Engineer has approved the adequacy and completeness of the operating and maintenance data. Final approved copies of operating and maintenance data shall have been delivered to the Engineer on Owner's behalf two weeks prior to scheduling the instruction period with the Owner.

16. Responsibility of Contractor

The Contractor shall be responsible for the entire work determined by the Drawings, Specifications and contract from the date of the starting of the work until it is accepted as evidence of approval of the Completion Certificate by the Contractor. He shall be responsible for removals, renewals and replacements due to action of the elements and all other causes except as otherwise provided in the Specifications. The Contractor shall keep the contract under his own control and it shall be his responsibility to see that the work is properly supervised and carried on faithfully and efficiently.

The Contractor shall supervise the work personally or shall have a competent, English speaking superintendent or representative, who shall be on the site of the project at all working hours, and who shall be given full authority by the Contractor to direct the performance of the work and make arrangement for all necessary materials, equipment and labor without delay.

Renewals or repairs necessitated because of defective materials or workmanship, or due to action of the elements or other natural causes, including weather events, fire and flood, prior to the acceptance as determined by the Completion Certificate, shall be done anew in accordance with the contract and Specifications at the expense of the Contractor.

17. Construction conditions and subsurface investigation

The Contractor shall strictly adhere to the specific requirements of the governmental unit(s) or agency(ies) having jurisdiction over the work. Wherever there is a difference in the requirements of a jurisdictional body and these Specifications, the more stringent shall apply.

The Contractor shall be responsible for having determined to his satisfaction, prior to the submission of his bid, the nature and location of the work, the conformation of the ground, the character and quality of the substrata, the types and quantity of materials to be encountered, the nature of the groundwater conditions, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions and all other matters which can in any way affect the work under this contract. The prices established for the work to be done will reflect all costs pertaining to the work. Any claims for extras based on substrata, groundwater table, and other such conditions will not be allowed.

18. Suspension of work because of weather

During inclement weather, Contractor shall halt all work that might be damaged or rendered inferior by such weather conditions. The Engineer may also give orders to suspend work if he has made a determination that the quality of work is being compromised due to weather and his decision shall be final and binding. The ability for the Engineer to issue such an order shall not be interpreted as a requirement to do so. During suspension of the work from any cause, the work shall be suitably covered and protected so as to preserve it from injury by the weather or otherwise; and, if the Engineer shall so direct, the rubbish and surplus materials shall be removed.

In the event of inclement weather, the Contractor shall protect the work and materials from damage or injury from the weather. If, in the opinion of the Engineer, any portion of the work or materials has been damaged, such work and materials shall be removed and replaced with new materials and work to the satisfaction of the Engineer at the expense of the Contractor. In any case to cost to repair damages to work due to weather shall be born completely by Contractor and at no expense to Owner.

19. Permits

Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the Engineer to do the work from the appropriate governmental agency or agencies. No work shall commence until all applicable permits have been obtained and copies delivered to the Engineer. The costs for obtaining all permits shall be borne by the Contractor.

20. Pumping

The Contractor with equipment provided by him shall do all pumping necessary to complete and protect the work as shown on the design plans during the entire construction and acceptance period of the contract. If temporary bypass of existing water ways is planned to be implemented by pumping it will also be the responsibility of the Contractor.

21. Owner occupancy and operation of completed facilities

It is assumed that portions of the work will be completed prior to completion of the entire work. Upon completion of construction in each individual facility, including testing, if the Engineer, at his sole discretion, desires to accept the individual facility, the Contractor will be issued a dated certificate of completion and acceptance for each individual facility. The Owner will assume ownership and begin operation of the individual facility on that date and the one year guarantee period shall commence on that date. The Owner has the option of not accepting any individual completed facility, but accepting the entire work as a whole when it is completed and tested.

22. Claims for property damage

Upon notification by the Owner/Engineer, the Contractor shall investigate each claim for property damage and shall file, within ten (10) days of such notification, a statement with Owner/Engineer setting forth all facts and details relative to such claim.

23. Existing underground piping, structures, and utilities

The locations of existing underground utilities are from information obtained from the respective utility companies. The locations are shown without express or implied representation, assurance, or guarantee that they are complete or correct or that they represent a true picture of underground piping to be encountered.

24. Coordination of work

The Contractor shall afford other contractors and subcontractors, if any, reasonable opportunity for the introduction and storage of their materials and equipment and the execution of their work and shall properly connect and coordinate the work with such other work. The Contractor shall coordinate his

work with other contractors and subcontractors to store his apparatus, materials, supplies and equipment in such orderly fashion at the site of the work as will not unduly interfere with the progress of the work or the work of any others.

If the execution or result of any part of the work depends upon any work of any separate contractor or utility, the Contractor shall, prior to proceeding with the work, inspect and promptly report to the Owner/Engineer in writing any apparent discrepancies or defects in such work of any separate contractor or utility that render it unsuitable for the proper execution or result of any part of the work.

Failure of the Contractor to so inspect and report discrepancies or defects shall constitute an acceptance of the separate contractor's or utility's work as fit and proper to receive the work, except as to defects which may develop in the separate contractor's work after completion of the work and which the Contractor could not have discovered by its inspection prior to completion of the work.

Should the Contractor cause damage to the work of separate contractors or the Owner's property, or to other work on the Site, or delay or interfere with other contractor's work on ongoing operations or facilities or adjacent facilities or said separate contractor's work, the Contractor shall be liable for the same; and, in the case of another contractor, the Contractor shall attempt to settle said claim with such other contractor prior to such other contractor's institution of litigation or other proceedings against the Contractor.

If such separate contractor sues the Engineer/Owner because of any damage, delay or interference caused or alleged to have been so caused by the Contractor, the Engineer/Owner shall notify the Contractor, who shall defend the Engineer/Owner in such proceedings at the Contractor's expense. If any judgment or award is entered against the Owner, the Contractor shall satisfy the same and shall reimburse the Engineer/Owner for all damages, expenses, attorney's fees and other costs that the Engineer/Owner incurs as a result thereof.

Should a separate contractor cause damage to the work or to the property of the Contractor or cause delay or interference with the Contractor's performance of the work, the Contractor shall present directly to said separate contractor any claims it may have as a result of such damage, delay or interference (with an information copy to the Contractor) and shall attempt to settle its claim against said separate contractor prior to the institution of litigation or other proceedings against said separate contractor.

In no event shall the Contractor seek to recover from the Owner or the Engineer, and the Contractor hereby represents to the Owner and the Engineer that it will not seek to recover from them, or either of them, any costs, expenses, (including, but not limited to, attorney's fees) or losses of profit incurred by the Contractor as a result of any damage to the work or property of the Contractor or any delay or interference caused or allegedly caused by any separate contractor.

Any difference or conflict which may arise between the Contractor and other contractors who may be performing work on behalf of the Owner or between the Contractor and workmen of the Contractor in regard to their work shall be adjusted and determined by the Engineer. If the work of the Contractor is delayed because of any acts of omissions of any other contractor of the Contractor, the Contractor shall on that account have no claim against the Owner other than for an extension of time.

25. Final guarantee

All work shall be guaranteed by the Contractor for a period of one year from and after the date of substantial completion.

If, within the guarantee period, repairs or changes are required in connection with guaranteed work, which, in the opinion of the Engineer, is rendered necessary as the result of the use of materials, equipment or workmanship which are inferior, defective, or not in accordance with the terms of the contract, the Contractor shall, promptly upon receipt of notice from the Contractor and without expense to the Contractor, do the following:

- 1) Place in satisfactory condition in every particular all of such guaranteed work and correct all defects therein.
- 2) Make good all damage to the facility, site, equipment, piping or contents thereof, which, in the opinion of the Engineer, is the result of the use of materials, equipment or workmanship which are inferior, defective, or not in accordance with the terms of the contract.
- 3) Make good any work or material, or the equipment and contents of building, structure or site disturbed in fulfilling any such guarantee.

If the Contractor, after notice, fails within ten days to proceed to comply with the terms of this guarantee, the Owner may have the defects corrected, and the Contractor and his surety shall be liable for all expense incurred, provided, however, that in case of an emergency where, in the opinion of the Owner, delay would cause loss or damage, repairs may be started without notice being given to the Contractor and the Contractor shall pay the cost thereof.

All special guarantees or warranties applicable to specific parts of the work as may be stipulated in the contract Specifications or other papers forming a part of this contract shall be subject to the terms of this paragraph during the first year of life of each such guarantee. All special guarantees and Manufacturers' warranties shall be assembled by the Contractor and delivered to the Engineer, along with a summary list thereof, before the acceptance of the work.

26. Automatically controlled equipment

Whenever automatically controlled equipment is required to be operated under the contract and a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually or by other methods for a period of 48 hours, or another period approved by the Engineer, following the breakdown or malfunction, provided this method of operation is safe, will not damage the equipment and will produce results otherwise meeting specifications.

27. Equipment data forms

Obtain, prepare, and submit a complete, detailed listing of equipment and motor data for all electrical items furnished under this contract. This listing shall be submitted with the preliminary draft of Operations and Maintenance Data Manuals on Equipment Data sheets, Equipment Manufacturer's Certificate of Installation, Testing and Instruction, and Warranty for Equipment Item forms, samples of which are at the end of this section.

28. Rights in and use of materials found on the work site

The Contractor, with the approval of the Engineer, may use on the project such stone, gravel, sand, or other material determined suitable by the Engineer, as may be found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. He shall replace at his own expense with other acceptable material all of that portion of the excavation materials so removed and used which was needed for use in the embankments, backfills, approaches, or otherwise. No charge for the materials so used will be made against the Owner.

General Specification 025A – Special Provisions, HSE Requirements

1. Scope

The Owner requires a safe environment for all employees and subcontractors on the project. Construction project safety is the highest priority and breaches of safety protocols is not acceptable. Therefore, each contractor working on the site shall provide a comprehensive health, safety, and environment (HSE) plan and show proof by supporting documents that every employee in their offices has satisfactorily completed their company safety training program.

2. Qualifications

All HSE plans shall meet at least the minimum Occupational Safety and Health Administration (OSHA) standards. Standards can be found online at <http://www.osha.gov>. HSE plan must also meet any local, state or other federal government standards.

3. Submittals

Submittals made with bid shall include the bidding Owner's HSE plan along with any sub-contractor's HSE plan. Electronic submission is allowed. All subcontractors shall sign at the bottom of the page verifying that the Subcontractor has read and understands the HSE procedures.

4. Basis of acceptance

The acceptability of the HSE plan shall be determined by inspections to check compliance with the provisions of this standard with respect to all standards required. Contractor will then provide all HSE certificates for employees before work starts and shall maintain a file onsite at all times.

5. Safety Manager

Contractor will be required to have a designated, qualified Site Safety Manager on site at all times work is being performed whose primary duty will be to oversee all aspects of the site HSE program for the Contractor and any Subcontractors and will be the principle interface for concerning safety matters.

Print: __

Title: __

Sign: __

Date: __

Construction Specification 002—Clearing and Grubbing

1. Scope

The work consists of clearing, grubbing, and disposing of trees, snags, logs, brush, stumps, shrubs, grass and other vegetation from the designated areas.

2. Protection of existing vegetation

Trees and other vegetation designated to remain undisturbed shall be protected from damage throughout the duration of the construction period. The Contractor shall repair any damages resulting from the Contractor's operations or neglect.

Earthfill, stockpiling of materials, vehicular parking, and excessive foot or vehicular traffic shall not be allowed within the drip line of vegetation designated to remain in place. Vegetation damaged by any of these or similar actions shall be replaced with viable vegetation of the same species, similar condition, and like size, unless otherwise approved by the Engineer.

Any cuts, skins, scrapes, or bruises to the bark of the vegetation shall be carefully trimmed and local nursery accepted procedures used to seal damaged bark.

Any limbs or branches 0.5 inches or larger in diameter that are broken, severed, or otherwise seriously damaged during construction shall be cut at the base of the damaged limb or branch, flush with the adjacent limb or tree trunk. All roots 1-inch or larger in diameter that are cut, broken, or otherwise severed during construction operations shall have the end smoothly cut perpendicular to the root. Roots exposed during excavation or other operations shall be covered with moist earth or backfilled as soon as possible to prevent the roots from drying.

3. Marking

In general, all trees, shrubs, or bushes that lie within the boundary of the project site shall be removed in the most efficient manner possible. Any specific trees, shrubs, or bushes that are to remain will be clearly marked by the Engineer for preservation.

4. Clearing and grubbing

All trees not marked for preservation and all snags, logs, brush, stumps, shrubs, rubbish, and similar materials shall be cleared from within the limits of the designated areas. Unless otherwise specified, all stumps, roots, and root clusters that have a diameter of 1 inch or larger shall be grubbed out to a depth of at least 2 feet below subgrade for concrete structures and 1 foot below the ground surface at embankment sites and other designated areas.

Trees and shrubs located on or near the banks of existing ditches, which are to remain in the final drainage plan and might damage the banks if removed, shall be removed by a mechanical grinder to 6" below ground and treated with an herbicide that has been approved by the Engineer. If any repeated treatments are necessary to provide 100% control, the Contractor shall provide the extra treatments as an option.

5. Disposal

All materials cleared and grubbed from the designated areas shall be disposed at locations approved by the Engineer. Burning of any cleared material shall be coordinated by the Contractor and permitted by the proper local authorities. All necessary equipment and procedures shall be supplied by the Contractor. The Contractor is responsible for complying with all local rules and regulations and the payment of any and all fees that may result from disposal at locations away from the project site.

6. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Clearing

- 1) Removal of exotic vegetation in approximately 8000' of existing channels which will be improved to supply water to the pump station and impoundment.
- 2) Removal of exotic vegetation in approximately 850' of existing channel to connect proposed relocated pump to the proposed water supply ditch.
- 3) Removal of exotic vegetation in approximately 2500' of existing ditch and fence line on the west side of the impoundment property.
- 4) Removal of scattered exotic vegetation in the northwest corner of the impoundment as needed for construction of the pump station, pump sump, roads and impoundment berm.
- 5) The impoundment property site has very few trees or bushes and the Engineer does not require for any to be cleared unless they present an obstruction to the completion of the proposed earthwork.
- 6) Clearing shall be restricted to the area within the limits of work. All other areas shall be left undisturbed.
- 7) All clearing shall be accomplished in such a manner as to minimize air and water pollution. Contractor should leave waterways that are adjacent to the clearing activities in the same condition as before the Contractor commenced work.
- 8) Some disturbance of the existing site work is expected and will need to be repaired. However, the Contractor must make every effort to minimize this disturbance and communicate his concerns with the Engineer if any of the clearing activities is likely to cause substantial damage.
- 9) All cleared materials shall become the property and responsibility of the Contractor and shall be disposed of by the Contractor.

Grubbing

- 1) This item shall consist of the removal of vegetation and unsuitable soils from the areas under the proposed berms, slabs, and structures.
- 2) Grubbing shall be restricted to the area within the limits of work. All other areas shall be left undisturbed.
- 3) All grubbing shall be accomplished in such a manner as to minimize air and water pollution.
- 4) All grubbed materials shall become the property and responsibility of the Contractor and shall be disposed of by the Contractor.

Ditch Cleaning

- 1) This item shall remove debris and silt from existing ditches as indicated on the plans.
- 2) Ditch cleaning will be performed after exotic vegetation has been removed.

Construction Specification 005—Pollution Control

1. Scope

The work consists of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air from construction activities.

2. Material

All material furnished shall meet the requirements of the material specifications listed in section 7 of this specification.

3. Erosion and sediment control measures and works

The measures and works shall include, but are not limited to, the following:

Staging of earthwork activities: The excavation and moving of soil materials shall be scheduled to minimize the size of areas disturbed and unprotected from erosion for the shortest reasonable time.

Seeding: Seeding to protect disturbed areas shall occur as soon as reasonably possible following completion of that earthwork activity.

Mulching: Mulching to provide temporary protection of the soil surface from erosion.

Diversions: Diversions to divert water from work areas and to collect water from work areas for treatment and safe disposition. They are temporary and shall be removed and the area restored to its near original condition when the diversions are no longer required or when permanent measures are installed.

Channel crossings: Culverts or bridges where equipment must cross channels. They are temporary and shall be removed and the area restored to its near original condition when the crossings are no longer required or when permanent measures are installed.

Sediment basins: Sediment basins collect, settle, and eliminate sediment from eroding areas from impacting properties and channel below the construction site(s). These basins are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Sediment filters: Straw bale filters or geotextile sediment fences trap sediment from areas of limited runoff. Sediment filters shall be properly anchored to prevent erosion under or around them. These filters are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Waterways: Waterways for the safe disposal of runoff from fields, diversions, and other structures or measures. These works are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Other: Additional protection measures as specified in section 7 of this specification or required by Federal, State, or local government. Contractor shall reference Florida Stormwater Erosion and Sedimentation Control Inspector's Manual.

4. Chemical pollution

The Contractor shall provide watertight tanks or barrels or construct a sump sealed with plastic sheets to dispose of chemical pollutants, such as drained lubricating or transmission fluids, grease, soaps, concrete mixer washwater, or asphalt, produced as a by-product of the construction activities.

At the completion of the construction work, sumps shall be removed, and the area restored to its original condition as specified in section 7 of this specification. Sump removal shall be conducted without causing pollution.

Sanitary facilities, such as chemical toilets or septic tanks, shall not be located next to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water source. At the completion of construction activities, facilities shall be disposed of without causing pollution as specified in section 7 of this specification.

5. Air pollution

The burning of brush or slash and the disposal of other materials shall adhere to State and local regulations.

Fire prevention measures shall be taken to prevent the start or spreading of wildfires that may result from project activities. Firebreaks or guards shall be constructed and maintained at locations shown on the drawings.

All public access or haul roads used by the Contractor during construction of the project shall be sprinkled or otherwise treated to fully suppress dust. All dust control methods shall ensure safe construction operations at all times. If chemical dust suppressants are applied, the material shall be a commercially available product specifically designed for dust suppression and the application shall follow manufacturer's requirements and recommendations. A copy of the product data sheet and manufacturer's recommended application procedures shall be provided to the Engineer 5 working days before the first application.

6. Maintenance, removal, and restoration

All pollution control measures and temporary works shall be adequately maintained in a functional condition for the duration of the construction period. All temporary measures shall be removed, and the site restored to near original condition.

7. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details therefore are:

Pollution Control

- 1) This item shall consist of precautions taken by the Contractor to minimize degradation of water quality passing through the job site during construction operations. All necessary precautions shall be taken to ensure compliance with water quality standards of the State of Florida. Attention is called to Chapter 62-3, Florida Administrative Code and, in particular, the requirements that turbidity shall not exceed 29 Nephelometric Turbidity Units (NTU's) above natural background. Adequate silt containment procedures and equipment shall be used to control turbidity at all times.
- 2) The Contractor shall be responsible for containment of pollution sources, including, but not limited to, excavations, clearing and grubbing, earthfill, and other disturbed areas.
- 3) Turbidity barriers shall be installed prior to any excavation, structural removal, or placement of fill material and shall be maintained in effective condition at all locations until construction and vegetative measures are completed.

Construction Specification 006—Seeding, Mulching, and Sod

1. Scope

The work consists of preparing berm side slopes, ditch side slopes and earthen above ground impoundment side slopes above the normal water level. Also included is appropriating disturbed areas for treatment, furnishing and placing seed, mulch, fertilizer, inoculant, lime, and other soil amendments, and anchoring mulch in designated areas as specified.

2. Material

Seed: All seed shall conform to the current rules and regulations of the Florida Department of Transportation (FDOT) and shall be from the latest crop available. It shall meet or exceed the standard for purity and germination listed in section 9.

Seed shall be labeled in accordance with state laws and the U.S. Department of Agriculture (USDA) rules and regulations under the Federal Seed Act in effect on the date of invitations for bids. Bag tag figures are evidence of purity and germination. No seed will be accepted with a test date of more than 9 months before the delivery date to the site.

Seed that has become wet, moldy, or otherwise damaged in transit or storage will not be accepted. The percent of noxious weed seed allowable shall be as defined in the current State laws relating to agricultural seeds. Each type of seed shall be delivered in separately sealed containers and fully tagged, unless exception is granted in writing by the Engineer.

Fertilizer: Unless otherwise specified, the fertilizer shall be a commercial grade fertilizer. It shall meet the standard for grade and quality specified by state law. Where fertilizer is furnished from bulk storage, the Contractor shall furnish a supplier's certification of analysis and weight. When required by the contract, a representative sample of the fertilizer shall be furnished to the Engineer for chemical analysis.

Inoculants: The inoculant for treating legume seeds shall be a pure culture of nitrogen-fixing bacteria prepared specifically for the species and shall not be used later than the date indicated on the container or as otherwise specified. A mixing medium, as recommended by the manufacturer, shall be used to bond the inoculant to the seed. Two times the amount of the inoculant recommended by the manufacturer shall be used, except four times the amount shall be used when seed is applied using a hydraulic seeder. Seed shall be sown within 24 hours of treatment and shall not remain in the hydraulic seeder longer than 4 hours.

Lime and other soil amendments: Lime shall consist of standard ground agriculture limestone or approved equivalent. Standard ground agriculture limestone is defined as ground limestone meeting current requirements of the state Department of Agriculture. Other soil amendments shall meet quality criteria and application requirements specified in section 8.

Straw mulch material: Straw mulch shall consist of wheat, barley, oat or rye straw, hay, grass cut from native grasses, or other plants as specified in section 8. The mulch material shall be air-dry, reasonably light in color, and shall not be musty, moldy, caked, or otherwise of low quality. The use of mulch that contains noxious weeds is not permitted. The Contractor shall provide a method satisfactory to the Engineer for determining weight of mulch furnished.

Other mulch materials: Mulching materials, such as wood cellulose fiber mulch, mulch tackifiers, synthetic fiber mulch, netting, and mesh, are other mulching materials that may be required for specialized locations and conditions. These materials, when specified, must be accompanied by the manufacturer's recommendations for methods and coverage rate of application. All such materials used for Hydroseeding shall meet FDOT standards.

3. Seeding mixtures, sod, sprigs, and dates of planting

The application rate per acre for seed mixtures, sprigs, or sod and date of seeding or planting shall be according to FDOT standards, as shown on the plans, or as specified in section 8.

4. Seedbed preparation and treatment

Areas to be treated shall be dressed to a smooth, firm surface. On sites where equipment can operate on slopes safely, the seedbed shall be adequately loosened (a few inches deep) and smoothed. Depending on soil and moisture conditions, disking, cultipacking, or both may be necessary to properly prepare a seedbed. Where equipment cannot operate safely, the seedbed shall be prepared by hand methods by scarifying to provide a roughened soil surface so that broadcast seed will remain in place.

If seeding is to be accomplished immediately following construction operations, seedbed preparation may not be required except on a compacted, polished, or freshly cut soil surface.

Rocks larger than 6 inches in diameter, trash, weeds, and other debris that will interfere with seeding or maintenance operations shall be removed or disposed of as specified in section 8.

Seedbed preparation shall be discontinued when soil moisture conditions are not suitable for the preparation of a satisfactory seedbed as determined by the Engineer.

5. Seeding, sprigging, fertilizing, mulching, and stabilizing

All seeding or sprigging operations shall be performed in such a manner that the seed or sprigs are uniformly applied in the specified quantities in the designated areas. The method and rate of seed application shall be according to FDOT standards or as specified in section 8. Unless otherwise specified, seeding or sprigging shall be accomplished within 2 days after final grading is completed and approved.

Fertilizer, lime, and other soil amendments shall be according to FDOT standards or as specified in section 8. When specified, the fertilizer and soil amendments shall be thoroughly incorporated into the soil immediately following surface application.

The rate, amount, and kind of mulching or mesh shall be according to FDOT standards or as specified in section 8. Mulches shall be applied uniformly to the designated areas. They shall be applied to areas seeded no later than 2 working days after seeding has been performed. Straw mulch material shall be stabilized within 24 hours of application using a mulch crimper or equivalent anchoring tool or by a suitable tackifier. When the mulch crimper or equivalent anchoring tool is used, it shall have straight blades and be the type manufactured expressly for and capable of firmly punching the mulch into the soil. Where the equipment can be safely operated, it shall be operated on the contour. Hand methods shall be used where equipment cannot safely operate to perform the work required.

6. Sod

Sod shall be used in critical areas as listed in section 8 below to prevent erosion. Sod shall be Bahia in rolls or pieces.

7. Contractor's Performance & Maintenance

The contractor shall establish a stand of grass in all areas designated on the plan and in these specifications. He shall water the grass at least once per week until full establishment unless there is sufficient rainfall to establish and maintain healthy grass. There must be at least 90% coverage of healthy grass prior to acceptance by the Engineer. The Engineer, at any time, may require restoration of the earthwork and replanting of grass in any areas in which the establishment or the grass stand does not appear to be developing satisfactorily.

8. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Work Items: Grassing for Stabilization

- 1) Contractor shall provide sod, hydroseed or seed and mulch in areas as shown on the plans to stabilize the proposed earthwork and disturbed areas. All grassing materials, methods and application rates shall meet FDOT standards for the grassing types specified. Contractor shall be responsible for the successful establishment and maintenance of grass stabilization until final completion of the project and acceptance by Engineer.
- 2) Sod – Sod is used in critical areas for stabilization and erosion control. Place sod using staggered joints. Sod laid on slopes shall be staked in place according to FDOT standards to prevent slipping. The following placement schedule assumes sod pieces are 16” wide x 24” long:
 - A. Entire 15’ wide top of the impoundment berm
 - B. Two running pieces of sod on each side of the top on the side slope of the impoundment berm
 - C. Two running pieces on each side of the access road
 - D. Two running pieces on each side of the access ramps
 - E. Two running pieces around the pump intake pond
 - F. For all proposed ditches place two running pieces on the side slope and one on the flat ground adjacent to the ditch
 - G. For culverts and water control structures where there is no rip rap specified, sod the side slopes 8’ on each side of the structure to the top of bank and at least one piece of sod on the flat ground.
- 3) Hydroseed – Hydroseed with Bahia the impoundment berm on both sides from the toe to the bottom of the sod. Also, hydroseed the side slopes of the access ramps. All hydroseed provided and installed shall meet FDOT 570-3 requirements.
- 4) Seed and Mulch – Seed and mulch with Bahia all other disturbed areas not covered by shell rock, sod or hydroseed to prevent erosion.

Construction Specification 007—Construction Surveys

1. Scope

The work consists of performing all surveys, measurements, and computations required by this specification.

2. Equipment and material

Equipment for construction surveys shall be of a quality and condition to provide the required accuracy. The equipment shall be maintained in good working order and in proper adjustment at all times. Records of repairs, calibration tests, accuracy checks, and adjustments shall be maintained and be available for inspection by the Engineer. Equipment shall be checked, tested, and adjusted as necessary in conformance with manufacturer's recommendations.

Materials include field notebooks, stakes, templates, platforms, equipment, spikes, steel pins, tools, and all other items necessary to perform the work specified.

3. Quality of work

All work shall follow recognized professional practice and the standards of the industry, unless otherwise specified in section 9 of this specification. The work shall be performed to the accuracy and detail appropriate for the type of job. Notes, sketches, and other data shall be complete, recorded neatly, legible, reproducible, and organized to facilitate ease in review and allow reproduction of copies for job documentation. Survey equipment that requires little or no manual recording of field data shall have survey information documented as outlined in section 9 of this specification.

All computations shall be mathematically correct and shall include information to identify the bid item, date, and who performed, checked, and approved the computations. Computations shall be legible, complete, and clearly document the source of all information used, including assumptions and measurements collected.

If a computer program is used to perform the computations, the Contractor shall provide the Engineer with the software identification, vendor's name, version number, and other pertinent data before beginning survey activities. Computer generated computations shall show all input data, including values assigned and assumptions made.

The elevations of permanent and temporary bench marks shall be determined and recorded to the nearest 0.01 foot. Differential leveling and transit traverses shall be of such precision that the error of vertical closure in feet shall not exceed plus or minus 0.1 times the square root of the traverse distance in miles. Linear measurements shall be accurate to within 1 foot in 5,000 feet, unless otherwise specified in section 9 of this specification. The angular error of closure for transit traverses shall not exceed 1 minute times the square root of the number of angles turned.

The minimum requirements for placing slope stakes shall be at 100-foot stations for tangents and as little as 25 feet for sharp curves, breaks in the original ground surface, and at any other intermediate stations necessary to ensure accurate location for construction layout and measurement. Slope stakes and cross sections shall be perpendicular to the centerline. Significant breaks in grade shall be determined for cross sections. Distances shall be measured horizontally and recorded to the nearest 0.1 foot. Side shots for interim construction stakes may be taken with a hand level.

Unless otherwise specified in section 9 of this specification, measurements for stationing and establishing the location of structures shall be made to the nearest 0.1 foot.

Elevations for concrete work, pipes, and mechanical equipment shall be determined and recorded to the nearest 0.01 foot. Elevations for earth work shall be determined and recorded to the nearest 0.1 foot.

4. Primary control

The baselines and bench marks for primary control, necessary to establish lines and grades needed for construction, are available in digital format and have been located on the job site.

These baselines and bench marks shall be used as the origin of all surveys, layouts, and measurements to establish construction lines and grades. The Contractor shall take all necessary precautions to prevent the loss or damage of primary control points. Any stakes or control points lost or damaged by construction activity will be re-established by the Contractor or at the Contractor's expense.

5. Construction surveys

Before work starts that requires Contractor performed surveys, the Contractor shall submit in writing for the Engineer's review the name, qualifications, and experience of the individuals to be assigned to the survey tasks.

Contractor performed surveys shall consist of all work necessary for:

- 1) establishing line and grade for all work
- 2) setting slope stakes for all work
- 3) checking and any supplemental or interim staking
- 4) establishing final grade stakes
- 5) performing quantity surveys, measurements, and computations for progress payments
- 6) performing original (initial) and final surveys for determinations of final quantities
- 7) other surveys as described in section 9 of this specification

6. Staking

The construction staking required for the item shall be completed before work on any item starts. Construction staking shall be completed as follows or as otherwise specified in section 9 of this specification:

Clearing and grubbing—The boundary of the area(s) to be cleared and grubbed shall be staked or flagged at a maximum interval of 500 feet, closer if needed, to clearly mark the limits of work.

Excavation and fill—Slope stakes shall be placed at the intersection of the specified slopes and ground line. Slope stakes and the reference stakes for slopes shall be marked with the stationing, required cut or fill, slope ratio, and horizontal distance from the centerline or other control line. The minimum requirements for placing slope stakes is outlined in section 3, Quality of work.

Structures—Centerline and offset reference line stakes for location, alignment, and elevation shall be placed for all structures.

7. Records

All survey data shall be recorded in fully identified, standard hard-bound, engineering survey field notebooks with consecutively numbered pages. All field notes and printed data shall include the purpose or description of the work, the date the work was performed, weather data, sketches, and the personnel who performed and checked the work. Electronically generated survey data and computations shall be bound, page numbered, and cross referenced in a bound field notebook containing the index for all survey activities. All work shall follow recognized professional practice.

The construction survey records shall be available at all times during the progress of the work for examination and use by the Engineer and, when requested, copies shall be made available. The original field notebooks and other records shall be provided to and become the property of the Engineer before final payment and acceptance of all work.

Complete documentation of computations and supporting data for progress payments shall be submitted to the Engineer with each invoice for payment as specified in section 9 of the specification. When the Contractor is required to conduct initial and final surveys, as outlined in section 5, Construction Surveys, notes shall be provided as soon as possible after completion to the.

8. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Work Items: Construction Surveys

- 1) This item shall consist of performing all surveys, measurements, and computations required to layout, certify and complete the work as designed.
- 2) Surveyor shall submit to the Engineer for his review and approval reports which will include supporting survey data and calculations for the purposes of certifying the job progress for payments to the Contractor.
- 3) Surveyor shall provide elevation “spot checks” as requested by the Engineer during the progress of job.
- 4) Surveyor shall complete data collection as required for final certification and record drawings.

Construction Specification 008—Mobilization and Demobilization

1. Scope

The work consists of the mobilization and demobilization of the Contractor's forces and equipment necessary for performing the work required under the contract. Mobilization will not be considered as work in fulfilling the contract requirements for commencement of work.

2. Equipment and material

Mobilization shall include all activities and associated costs for transportation of Contractor's personnel, equipment, and operating supplies to the site, establishment of offices, buildings, and other necessary general facilities for the Contractor's operations at the site, and premiums paid for performance and payment bonds, including coinsurance and reinsurance agreements as applicable.

Demobilization shall include all activities and costs for transportation of personnel, equipment, and supplies not required or included in the contract from the site, including the disassembly, removal, and site cleanup of offices, buildings, and other facilities assembled on the site specifically for this contract.

This work includes mobilization and demobilization required by the contract at the time of award. If additional mobilization and demobilization activities and costs are required during the performance of the contract as a result of changed, deleted, or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

Construction Specification 010—Water for Construction**1. Scope**

The work consists of furnishing, transporting, measuring, and applying water as specified.

2. Facilities and equipment

The Subcontractor shall install and maintain access and haul roads and furnish, operate, and maintain all pumps, meters, piping, tanks, storage, and other facilities required to load, transport, store, distribute, and use construction water as specified.

3. Dust abatement and haul road maintenance

Water for dust abatement and haul road maintenance shall be applied to haul roads and other dust producing areas as needed to prevent air pollution or excessive dust (which causes impaired vision on trafficked roads and in work areas) and to maintain the roads in good condition for safe and efficient operation during periods of use. Roads that may be jointly used with the public and by the Subcontractor's equipment shall have dust abatement provisions acceptable to the public entity that has road maintenance responsibility. No additional compensation to the contractor for water used for dust abatement and haul road maintenance shall be provided unless specified in section 7 of this specification.

4. Earthfill, drainfill, and rockfill

Water required for proper installation of earthfill, drainfill, and/or rockfill shall be used in the fill materials as specified in the applicable construction specification(s). Compensation for construction water used for earthfill, drainfill, and/or rockfill shall be included in the Contractor's cost for these items of work unless an exception is stated in section 7 of this specification.

5. Concrete, mortar, and grout

Water required in the mixing or curing of concrete, shotcrete, roller compacted concrete, or other portland cement mortar or grout shall meet the requirements of the applicable construction specifications and shall be used in conformance with those specifications.

6. Other construction requiring water

Water required and used for other construction activities under this contract, but not specifically covered by this specification, shall be considered subsidiary to the item(s) of work that requires its use.

Construction Specification 011—Removal of Water

1. Scope

The work consists of the removal of surface water and ground water as necessary to perform the construction required by the contract in accordance with the specifications. It shall include: (1) constructing, installing, building, and maintaining all necessary temporary water containment facilities, channels, and diversions, (2) furnishing, installing, and operating all necessary pumps, piping, and other facilities and equipment, and (3) removing all such temporary works and equipment after their intended function is no longer required.

2. Diverting surface water

The Contractor shall install, maintain, and operate all cofferdams, channels, flumes, sumps, and all other temporary diversion and protective works needed to divert stream flow and other surface water through or around the construction site. Control of surface water shall be continuous during the period that damage to construction work could occur. Unless otherwise specified and/or approved, the diversion outlet shall be into the same drainage way that the water would have reached before being diverted.

The Contractor shall furnish the Engineer, in writing, a proposed plan for diverting surface water before beginning any construction activities for which a diversion is required, unless waived by the Engineer. Acceptance of this plan or the waiving of the plan requirement will not relieve the Contractor of the responsibilities related to this activity during the process of completing the work as specified.

3. Dewatering the construction site

Foundations, cutoff trenches, and all other parts of the construction site shall be dewatered and kept free of standing water and muddy conditions as necessary for the proper execution of the work. The Contractor shall furnish, install, operate, and maintain all drains, sumps, pumps, casings, well points, and all other equipment required to properly dewater the site as specified. Dewatering systems that cause a loss of soil from the foundation areas will not be permitted.

The Contractor shall furnish the Engineer, in writing, a proposed plan for dewatering before commencing with any construction activity for which dewatering may be required, unless waived by the Engineer. Acceptance of this plan or the waiving of the plan requirement will not relieve the Contractor of the responsibilities for completing the specified work.

4. Erosion and pollution control

Removal of water from the construction site, including the borrow areas, shall be accomplished so that erosion and the transporting of sediment and other pollutants are minimized. Dewatering activities shall be accomplished in a manner that the water table water quality is not altered.

Pollution control activities shall not conflict with the requirements of Construction Specification 5, Pollution Control. Contractor must have a pollution control plan approved by the Florida Department of Environmental Protection and a dewatering plan approved by South Florida Water Management District before pumping or dewatering.

5. Removal of temporary works

When temporary works are no longer needed, the Contractor shall remove them and return the area to a condition similar to that which existed before construction. Areas where temporary works were located shall be graded for sightly appearance with no obstruction to natural surface water flows or the proper functioning and access to the works of improvement installed. The Contractor shall exercise extreme care during the removal stages to minimize the loss of soil sediment and debris trapped during construction.

Pipes, casings, and any other material used to dewater the site shall be removed from temporary wells.

The wells shall be filled to ground level with clean gravel or other suitable material approved by the Contractor. The Contractor shall exercise extreme care to prevent pollution of the ground water by these actions.

Construction Specification 021—Excavation

1. Scope

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. Classification

Excavation is classified as common excavation or unclassified excavation in accordance with the following definitions.

Common excavation is defined as the excavation of all materials that can be excavated, transported, and unloaded using heavy ripping equipment and wheel tractor-scrappers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by excavators, having a rated capacity of one cubic yard or larger and equipped with attachments (shovel, bucket, backhoe, dragline, or clam shell) appropriate to the material type, character, and nature of the materials.

For the purpose of these classifications, the following definitions shall apply:

- 1) *Heavy ripping equipment* is a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a track type tractor, having a power rating of at least 250 flywheel horsepower, unless otherwise specified in section 10.
- 2) *Wheel tractor-scraper* is a self-loading (not elevating) and unloading scraper having a struck bowl capacity of at least 12 cubic yards.
- 3) *Pusher tractor* is a track type tractor, having a power rating of at least 250 flywheel horsepower, equipped with appropriate attachments.

Unclassified excavation is defined as the excavation of all materials encountered regardless of their nature or the manner in which they are removed.

3. Use of excavated material

Suitable material from the specified excavation may be used in the construction of required earthfill for the roads, berms, or included in the fill required for land leveling (see CS023). The suitability of material for specific purposes is determined by the Geotech to comply with the Engineer's specifications.

4. Disposal of waste materials

All excavated material will remain the sole property of the Owner, none shall be removed from the site unless directed in writing by the Engineer. Mineral soil will be used for construction of the proposed infrastructure items such as berms, road base or as general site filling and grading.

Organic soils will be used as topsoil for grass establishment on side slopes and in nontraffic areas of the construction site or may be evenly spread within the property in a manner that does not interfere with its intended use.

5. Excavation limits

Excavations shall comply with OSHA Construction Industry Standards (29 CFR Part 1926) Subpart P, Excavations, Trenching, and Shoring. All excavations shall be completed and maintained in a safe and stable condition throughout the total construction phase. Structure and trench excavations shall be completed to the specified elevations and to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work. Excavations outside the lines and limits shown on the drawings or specified herein required to meet safety requirements shall be the responsibility of the Contractor in constructing and maintaining a safe and stable excavation.

Borrow Ditch Excavation

When the quantities of suitable material obtained from Channel B, Channel B Diversion and the seepage ditch are insufficient to construct the specified earthfills and earth backfills, additional material shall be obtained from the borrow ditch as shown on the plans. The quantity of excavated material will be limited to complete the earthfills and earth backfills.

Over excavation

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved, compacted earthfill. The exception to this is that, if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding, or drainfill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding, or drainfill. Before correcting an over excavation condition, the Contractor shall review the planned corrective action with the Engineer and obtain approval of the corrective measures. No additional payment will be provided for over excavation.

6. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Work Items: Excavation – Common

- 1) This item shall consist of all common excavation necessary and incidental to construction of the design components as shown on the plans including:
 - A. Impoundment berm
 - B. Access and perimeter roads
 - C. Access ramps
 - D. Pump station
 - E. Pump sump
 - F. Water control structures and culverts
 - G. Water supply ditch
 - H. Borrow ditch
 - I. Seepage interception ditch

Construction Specification 023—Earthfill

1. Scope

The work consists of the construction of earth embankments, other earthfills, and earth backfills required by the drawings and specifications.

Earthfill is composed of natural earth materials that can be placed and compacted by construction equipment operated in a conventional manner.

Earth backfill is composed of natural earth material placed and compacted in confined spaces or adjacent to structures (including pipes) by hand tamping, manually directed power tampers or vibrating plates, or their equivalent.

2. Material

All fill material shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of material in the various fills shall be subject to approval by the Engineer.

The Contractor shall consider all materials encountered in excavations, excluding muck and peat, unless the quantities are less than 25 percent of the total volume, as suitable for use in random fill, providing they consist of two or more well graded soils to achieve the required compaction as specified in this section. Peat and muck materials excavated in the course of the project may be used for topsoil for grass establishment, spread in the field or disposed of on site as approved by the Engineer.

The Contractor shall use only material that is free of debris, roots, and organic matter in select backfill areas. Peat and muck materials are not suitable for use in select backfill.

- 1) Cohesionless materials includes gravels, gravel-sand mixtures, sands, and gravelly sands generally exclusive of clayey and silty material - materials that are free-draining and for which impact compaction will not produce a well-defined, moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods.
- 2) Cohesive materials include silts and clays generally exclusive of sands and gravel - materials for which impact compaction will produce a well-defined, moisture-density relationship curve.

The Contractor shall furnish materials for each type of fill indicated.

Select backfill

Select Backfill shall be material that is well graded, free of debris, roots, organic matter, and peat. Select backfill shall be material excavated for the work (native) or may be imported. The Contractor may blend native materials to achieve a material that meets the requirements for Select Backfill if approved by the Engineer. Select backfill shall be free of seeds of nuisance or exotic species. Select Backfill shall meet the following Unified Soil Classification System (ASTM D2487) designations:

- 1) Above Ground Impoundment Embankment: CL, ML, SC
- 2) Structure Backfill: SW, SP, SM

Random Backfill

Random backfill shall be material that is well graded, free of debris, roots, muck and peat. Random backfill shall be material excavated for the work (native) or may be imported. The Contractor may blend native materials to achieve a material that meets the requirements for Random Backfill if approved by Engineer. Random backfill shall be free of seeds of nuisance or exotic species. Random Backfill shall meet the following Unified Soil Classification System (ASTM D2487) designations in addition to the classifications identified for Select Backfill: CH.

Unclassified Backfill

Material excavated for the work or imported that can be compacted to the required density. Unclassified backfill shall be free of seeds of nuisance or exotic species.

The Contractor shall consider all materials encountered, regardless of type, character, composition, and condition thereof unclassified other than as indicated above. The Contractor shall estimate the quantity of various materials included prior to submitting Bid Form. Rock encountered shall be handled at no additional cost to the Contractor.

3. Foundation preparation

Foundation preparation is required for above ground impoundment berm, ramps, and access roads which shall be prepared as follows:

- 1) The berm and ramps for the above ground impoundment and borrow areas shall be stripped to a depth below ground as necessary to remove vegetation, roots and other unsuitable material (muck).
- 2) Access roads and shell rock roads shall also be stripped as described above.
- 3) All other activities and procedures related to clearing and grubbing not mentioned here can be found in CS002 Clearing and Grubbing.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earthfill and the surface material of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of 2 inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to produce a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose material by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be no steeper than one horizontal to one vertical, unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. Placement

Earthfill shall not be placed until the required excavation and foundation preparations have been completed and the foundation has been inspected and approved by the Engineer. Earthfill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified in section 8 or shown on the drawings. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted.

Hand compacted earth backfill shall be placed in layers, the thickness of which before compaction does not exceed the maximum thickness specified for layers of earth backfill compacted by manually directed power tampers.

Earth backfill shall be placed in a manner that prevents damage to the structures and allows the structures to assume the loads from the earth backfill gradually and uniformly. The height of the earth

backfill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earthfill and earth backfill in the above ground impoundment berm and other structures designed to restrain the movement of water shall be placed to meet the following additional requirements:

- 1) The distribution of materials throughout each zone shall be essentially uniform and the earthfill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material. Zone earthfills shall be constructed concurrently, unless otherwise specified.
- 2) If the surface of any layer becomes too hard and smooth for forming a proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.
- 3) The top surface of embankments shall be maintained approximately level during construction with one exception: A crown or cross-slope of about 2 percent shall be maintained to ensure effective drainage or as otherwise specified for drainfill or sectional zones.
- 4) Embankments built at different levels shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than 3 feet horizontal to 1 foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification and shall be scarified, moistened, and recompactd when the new earthfill is placed against it. This ensures a good bond with the new earthfill and obtains the specified moisture content and density at the contact of the in-place and new earthfills.

5. Control of Moisture Content

During placement and compaction of earthfill and earth backfill, the moisture content of the material being placed above water level within the limits of 3 percentage points above optimum to 2 percentage points below optimum moisture content as determined by ASTM D1557. Material that is not within the specified moisture content limits or is observed to be pumping shall be reworked to obtain the moisture content appropriate for that material type, regardless of density.

The application of water to the earthfill material shall be accomplished at the borrow areas in-so-far as practicable. Water may be applied by sprinkling the material after placement on the earthfill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the earthfill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted earthfill or a foundation in the zone of contact with the earthfill becomes too dry to permit a suitable bond, it shall either be removed or scarified and moistened by sprinkling water to an acceptable moisture content before placement of the next layer of earthfill.

6. Compaction

Earthfill—Earthfill shall be compacted according to the following requirements for the class of compaction specified:

- 1) Class A compaction—Each layer of earthfill shall be compacted as necessary to provide the density of the earthfill matrix not less than the minimum density specified in Section 8 or identified on the drawings. The earthfill matrix is defined as the portion of the earthfill material finer than the maximum particle size used in the compaction test method specified.
- 2) Class B compaction—Each layer of earthfill shall be compacted to a mass density not less than

the minimum density specified.

- 3) Class C compaction—Each layer of earthfill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Earth backfill—Earth backfill adjacent to structures shall be compacted to a density equivalent to that of the surrounding in-place earth material or adjacent required earthfill or earth backfill.

Compaction shall be accomplished by hand tamping or manually directed power tampers, plate vibrators, walk-behind, miniature, or self-propelled rollers. Unless otherwise specified, heavy equipment, including backhoe mounted power tampers or vibrating compactors and manually directed vibrating rollers, shall not be operated within 2 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist is not permitted.

The passage of heavy equipment will not be allowed:

- 1) Over cast-in-place conduits within 14-days after placement of the concrete
- 2) Over cradled or bedded precast conduits within 7 days after placement of the concrete cradle or bedding
- 3) Over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 2 feet, whichever is greater, except as may be specified in section 8.

Compacting of earth backfill adjacent to structures shall not be started until the concrete has attained the strength specified in section 8 for this purpose. The strength is determined by compression testing of test cylinders cast by the Contractor's quality control personnel for this purpose and cured at the work site in the manner specified in ASTM C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of earth backfill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

Structure	Time interval
Vertical or near-vertical walls with earth loading on one side only	14
Walls backfilled on both sides simultaneously	7
Conduits and spillway risers, cast-in-place (with inside forms in place)	7
Conduits and spillway risers, cast-in-place (inside forms removed)	14
Conduits, pre-cast, cradled	2
Conduits, pre-cast, bedded	1
Cantilever outlet bents (backfilled both sides simultaneously)	3

Reworking or removal and replacement of defective earthfill- Earthfill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable earthfill. The replacement earthfill and the foundation, abutment, and earthfill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control, and compaction.

7. Testing

During the course of the work, the Engineer may perform quality assurance tests required to identify material, determine compaction characteristics, determine moisture content, and determine density of

earthfill in place. Tests performed by the Engineer will be used to verify that the earthfills conform to contract requirements of the specifications and not as a replacement for the Contractor's quality control program. The Contractor shall use a certified geotechnical testing company to complete periodic testing as specified in Section 8 below to verify quality of work and the results.

The results of the compaction tests shall be submitted directly to the Engineer by the testing lab.

Densities of earthfill requiring Class A compaction will be determined in accordance with ASTM D 1556, D 2167, D 2922, or D 2,937, except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample before computation of density or, if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent composition for comparison (See ASTM D 4718). The density so computed is used to determine the percent compaction of the earthfill matrix. Unless otherwise specified, moisture content is determined by one of the following methods: ASTM D 2216, D 3017, D 4643, D 4944, or D 4959.

8. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Earthfill – General Site Grading

- 1) This item shall consist of pushing, loading, hauling, placement, and Class C compaction of all earthfill required for filling around construction areas and land smoothing.
- 2) Random *Backfill* material for general site grading will be from one of the following sources, listed in the order of preference:
 - A. Excavated material which does not meet Select Fill standards
 - B. General site grading
 - C. Nearby site work excavations
- 3) Compaction shall be Class C. The material shall be free of sod, brush, roots, or other perishable materials, large rocks, and hard lumps or clods larger than 6 inches in size. The moisture content of fill material shall be maintained within the limits necessary to permit efficient blending, bonding, and compaction of the materials. The fill materials shall be deposited evenly in layers no thicker than 6"-9". Each layer shall be thoroughly compacted by at least one pass over the entire surface by standard earth moving equipment in order to provide a uniformly dense fill. No compaction test submittals to the Engineer are required for General Site Grading.
- 4) All earthfill shall be placed in a manner so as to minimize air and water pollution.

Earthfill – Under Concrete Structures

- 1) This item shall consist of pushing, loading, hauling, placement, and Class A compaction of all earthfill required for foundations for concrete structures.
- 2) The Select Backfill material will be from mineral soil excavated from one of the following sources, listed in the order of preference:
 - A. Designated borrow site
 - B. Suitable overburden material cut from construction site
- 3) Compaction shall be Class A. The material shall be free of sod, brush, roots, or other perishable materials, large rocks and hard lumps or clods larger than 6 inches in size. The moisture content of fill material shall be maintained within the limits necessary to permit efficient blending, bonding, and compaction of the materials. The fill materials shall be deposited in 6-9-inch layers. Each layer shall be thoroughly compacted by at least three passes over the entire surface by

standard a vibratory roller or hand compacted with vibratory equipment in order to provide a uniformly dense road base to the height above ground specified in the drawings. The Engineer may request advance notice prior to the installation of concrete structures are installed to personally verify the foundation compaction techniques and density.

- 4) Compacted fill shall meet or exceed 95% density as per AASHTO T-180.
- 5) All earthfill shall be placed in a manner so as to minimize air and water pollution.

Earthfill – Culverts and Water Control Structures

- 1) This item shall consist of pushing, loading, hauling, placement, and Class A compaction of all earthfill required for the installation of culverts and water control structures.
- 2) The *Select Backfill* material will be from mineral soil excavated from one of the following sources, listed in the order of preference:
 - A. Designated borrow site
 - B. Suitable overburden material cut from construction site
- 3) Compaction shall be Class A. The material shall be free of sod, brush, roots, or other perishable materials, large rocks and hard lumps or clods larger than 6 inches in size. The moisture content of fill material shall be maintained within the limits necessary to permit efficient blending, bonding, and compaction of the materials. The fill materials shall be deposited in 6-9-inch layers. Each layer shall be thoroughly compacted by at least three passes over the entire surface by a vibratory hand compactor in order to provide a uniformly dense road base to the height above ground specified in the drawings. The Engineer may request advance notice prior to the installation of concrete structures are installed to personally verify the foundation compaction techniques and density.
- 4) Compacted fill shall meet or exceed 95% density as per AASHTO T-180.
- 5) The Geotech will oversee the installation of all structures and will verify compaction of each backfill layer by performing and documenting at least one standard compaction test before proceeding to the next layer. For long structures compaction tests will be required at a maximum spacing of 50' for each lift. The compaction tests should be staggered to new locations along the structure on consecutive lifts, do not use the same location for all layers tested. The Geotech shall provide compaction test reports to the Engineer for each structure installed for his review and approval. Structures that do not meet minimum compaction will be corrected at the Contractor's expense.
- 6) All earthfill shall be placed in a manner so as to minimize air and water pollution.

Earthfill – Above ground impoundment berm

- 1) This item shall consist of pushing, loading, hauling, placement, and Class A compaction of all earthfill required for forming berms and associated access ramps.
- 2) The above ground impoundment berm will be constructed from *Select Earthfill* excavated from one of the following sources, listed in the order of preference:
 - A. Designated borrow site
 - B. Suitable overburden material cut from construction site
- 3) Compaction shall be Class A. The material shall be free of sod, brush, roots, or other perishable materials, large rocks and hard lumps or clods larger than 6 inches in size. The moisture content of fill material shall be maintained within the limits necessary to permit efficient blending, bonding, and compaction of the materials. The fill materials shall be deposited in 6-9-inch layers.

Each layer shall be thoroughly compacted by at least three passes over the entire surface by standard a vibratory roller in order to provide a uniformly dense road base to the height above ground specified in the drawings.

- 4) Compacted fill shall meet or exceed 95% density as per AASHTO T-180.
- 5) All clearing shall be placed in a manner so as to minimize air and water pollution.
- 6) Prior to commencement of work the Contractor shall submit a quality assurance plan to the Engineer which will include geotechnical testing for the proposed berm. At least one test is required per lift in locations randomly selected by the Engineer or geotechnical testing firm at a maximum of 500 ft. intervals, or as recommended by the Geotech. Extra tests shall be required where the soil characteristics change (color, moisture content, particle size, etc.) Tests sites shall be staggered to new locations on consecutive lifts to provide maximum testing coverage. The Engineer, at his option, may require third party testing at the Owner's expense. Copies of results of each test shall be submitted directly to the Engineer.

Bid Item: Earthfill – Access Roads

- 1) This item shall consist of pushing, loading, hauling, placement, and Class A compaction of all earthfill required for constructing access roads to the site and around the perimeter of the impoundment.
- 2) The access road will be constructed from *Select Earthfill* excavated from one of the following sources, listed in the order of preference:
 - A. Designated borrow site
 - B. Suitable overburden material cut from construction site
 - C. Adjacent roadbed to be removed
- 3) Compaction shall be Class A. The material shall be free of sod, brush, roots, or other perishable materials, large rocks and hard lumps or clods larger than 6 inches in size. The moisture content of fill material shall be maintained within the limits necessary to permit efficient blending, bonding, and compaction of the materials. The fill materials shall be deposited in 6-9-inch layers. Each layer shall be thoroughly compacted by at least three passes over the entire surface by standard a vibratory roller in order to provide a uniformly dense road base to the height above ground specified in the drawings.
- 4) Compacted fill shall meet or exceed 95% density as per AASHTO T-180.
- 5) All clearing shall be placed in a manner so as to minimize air and water pollution.
- 6) The Geotech will perform compaction tests for the impoundment perimeter road on approximately 500' intervals. Test sites shall be relocated on consecutive lifts to provide maximum testing coverage. Testing is not required for the shell rock access road from Driggers Road to the impoundment.

Construction Specification 031/034M – Concrete, Form Work, and Reinforcing Steel

1. Scope

Furnish all materials, labor, and equipment necessary to complete all concrete work shown on the drawings and specified herein. The work shall include the following:

- 1) Form work for all footings, foundations, beams, slabs, equipment pads, etc.
- 2) The placing of all reinforcing steel.
- 3) The mixing, placing, curing, and finishing of all concrete work.

2. General requirements

All applicable provisions in the General Specifications shall govern the work under this section. Some of the items mentioned in this section are described further in other sections of these Specifications.

3. Qualifications of installers

Throughout the installation of the work of this section, provide at least one person who shall be thoroughly familiar with the specified requirements, codes, and standards applicable to this work. This person shall be trained and experienced in the necessary skills, shall be present at the site, and shall direct all work performed under this section. In acceptance or rejection of work performed under this section, the Engineer will make no allowance for lack of skill by the workers.

4. Material

Cement shall be type I "Portland Cement" to conform to the standard specifications for Portland Cement (ASTM designation C-150).

Aggregates, fine and coarse, shall conform to the "Tentative Specifications for Concrete Aggregates" (ASTM designation C-33). All aggregates shall be iron-free.

Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.

Reinforcing steel shall be Grade 60 deformed reinforcement steel. Bars shall be clean and free from loose rust, oil, or any other foreign material that will reduce bond. Bars shall conform to the applicable ASTM standards listed in ACI 318.

Admixtures to be used in concrete shall be subject to prior approval by the Engineer. Air-entraining admixtures, water-reducing admixtures, retarding admixtures, and accelerating admixtures shall conform to the applicable ASTM standards listed in ACI 318. Polymeric (synthetic) fibers shall be added to all concrete used in this project at a minimum rate of 1.5 pounds per cubic yard of concrete to control shrinkage cracking where specified.

Wood forms shall be made of sound lumber and shall conform to the dimensions of the members as shown on the drawings. They shall be built substantially water-tight to prevent leakage of water, cement, and finer particles of aggregates. Forms for concrete surfaces that are to be left exposed shall be made of a minimum of 5/8 inches thick waterproof plywood.

Isolation joints All expansion joint materials shall be 1/2 an inch asphalt-impregnated fiber strips.

5. Concrete mix design

Unless otherwise noted on the plan sheets, concrete for all work shall be designed for a minimum compressive strength of 4,000 psi at 28 days. Ballast concrete for water control structures may be 3000 psi at 28 days and does not require reinforcement steel or fiber-reinforcement.

All concrete for the slab and access steps shall be fiber-reinforced with fibrillated polypropylene fibers at a rate of 1.5 pounds of fiber per cubic yard of concrete.

The concrete mixture shall not exceed a maximum slump of 4 inches before addition of fiber and water reducing admixtures and 6 inches after the additions noted.

The proportions of aggregates to cement shall be such as to produce a workable mixture that will work readily into the corners and angles of the forms and around all reinforcing without permitting angles of the forms and around all reinforcing without permitting the materials in the mixture to segregate or for free water to collect on the surface.

All of the materials shall be mixed until an even and uniform distribution of materials is obtained. Ready mixed concrete shall conform to ASTM C-94 designation.

Under conditions where the temperature is 85° F or above a concrete retarding admixture shall be used in all design mixes and shall be added at the batch plant.

The batch plant is responsible for adjusting design mixes to maintain the specified concrete strength and slump.

6. Reinforcing steel

All reinforcing steel shall be thoroughly cleaned of rust and other coatings that will reduce bond with the concrete.

Place in the correct positions and of sizes, as shown on the drawings, and wired so that displacement will not occur when concrete is poured.

Reinforcing steel shall be bent around all corners and lapped not less than 40 diameters and securely tied with #18 gauge annealed wire.

All reinforcing shall be supported by approved precast concrete blocks, plastic chairs, or by galvanized metal spacers.

Reinforcing steel supports shall be placed at such an interval so as to properly hold the reinforcing steel and wire mesh in its proper position while the concrete is poured.

Reinforcing steel shall be so placed to provide a concrete covering of 3 inches on all footings and grade beams, 1/2 an inch in beams, and 3/4 of an inch in slabs.

Do not weld reinforcing steel except where noted.

7. Concrete placing

Concrete shall not be placed until all reinforcement, pipes, conduits, water-proofing and other set-in items have been inspected and approved.

Concrete shall not be placed on soft or water soaked ground.

All wood forms are to be thoroughly wetted or oiled before placing reinforcing steel.

In case of inclement weather, freshly poured concrete shall be protected against infiltration of external water by covering the concrete with tarpaulins or similar waterproof protection until the concrete has set.

The rate and method of placing the concrete between construction joints shall be poured in a continuous operation, with no more than one hour of lapse time between pours.

Footings shall have no horizontal joints.

If necessary, only vertical joints will be allowed, but may only be located at junctions of wide and narrow sections or where the strength of the footing will not be impaired.

All expansion joints shall be built into the work as shown and detailed on the drawings.

All concrete shall be thoroughly compacted with a mechanical vibrator or by other suitable means and shall be thoroughly worked around all reinforcement, corners of forms, pipes, and embedded fixtures.

Concrete shall not be poured during cold weather. The ambient temperatures must be above 40° F for at least 72 hours before concrete is placed.

The temperature of the concrete shall not be below 40° F nor above 120° F.

Concrete floor slabs on earth shall be placed over a well tamped and prepared sub-grade.

The concrete shall be poured at the required thickness and be properly screeded at the proper elevations to receive finish specified.

The Contractor shall be present on the site the entire time the slab is being poured and finished.

8. Concrete finishes

All exposed concrete foundation walls, piers, and/or footings shall be rubbed smooth. No honey-combed surfaces will be accepted.

All concrete slabs shall be integrally finished, screeded level, and floated. All concrete slabs shall receive a light broom finish.

9. Concrete curing

The Contractor shall maintain the concrete in a moist condition for at least seven (7) days after the placement of the concrete by flooding with water, covering with polyethylene, or using approved curing compounds.

10. Testing and control of concrete

If deemed necessary, the Engineer may, at his option, appoint and pay for the services of a testing laboratory for the testing of concrete.

Contractor shall furnish all concrete mix designs to the Engineer for review, if requested.

The Contractor shall furnish, without additional compensation, at least one standard cylinder test per 20 cubic yards of concrete but no less than one test per slab if poured in place. Test must be completed by a certified lab approved by the Engineer.

Testing of questionable areas as a result of laboratory reports indicating lower strengths than specified or retesting of any materials that have previously failed to meet specifications shall be paid for by the Contractor at no additional cost to the Owner.

11. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Concrete, Form Work, Reinforcing Steel:

- 1) Concrete slab for electrical rack and motor controls
- 2) Ballast for water control structures as specified on plans
- 3) Concrete for access slabs/steps to pump station and sluice gate.
- 4) Pump discharge pipe supports.

Construction Specification 035 – Precast Concrete

1. Scope

Furnish all materials, labor, hauling and equipment necessary to install precast concrete components as shown on the design plans.

2. General Requirements

All applicable provisions in the General Specifications shall govern the work under this section. Some of the items mentioned in this section are described further in other sections of these Specifications.

3. Qualifications of Installers

Throughout the installation of the work of this section, provide at least one person who shall be thoroughly familiar with the specified requirements, codes, and standards applicable to this work. This person shall be trained and experienced in the necessary skills, shall be present at the site, and shall direct all work performed under this section. In acceptance or rejection of work performed under this section, the Engineer will make no allowance for lack of skill by the workers.

4. Reference Standards

Precast concrete components shall be manufactured and installed according to the following standards:

- 1) ASTM C890
- 2) ACI 318

5. Items Included

Precast components include the following items:

- 1) Two concrete pump sumps for drainage pumps
- 2) One sump for sluice gate discharge structure

6. Reinforcing Steel

All reinforcing steel shall be designed by precast concrete supplier following Florida Department of Transportation (FDOT) specifications.

7. Precast Concrete Placing

The Contractor shall use care when handling the precast pieces not to damage the components in any way. The Contractor should lift the pieces through the lifting eyes provided by the manufacturer using approved straps. The foundations for precast pieces shall be properly prepared as shown on the plan sheets before installation. Precast shall be installed level, plumb and dimensionally correct.

8. Precast Concrete Finishes

All exposed concrete foundation walls, piers, and/or footings shall be rubbed smooth. No honey-combed surfaces will be accepted.

All concrete slabs shall receive a light broom finish.

9. Submittals

Submittals shall be provided according to GS 025.

10. Approved Suppliers

Precast concrete shall be designed and manufactured according to the plans by:

- 1) Forterra or equal

Construction Specification 036 – Flexamat®

1. General Description

Flexamat® is a tied concrete block system that is manufactured with a site-specific underlayment. The emergency overflow weir shall be stabilized as shown on the plans using Flexamat® with an integral synthetic erosion control blanket made of Recyclex® TRM-V. Additional underlayment is not required. All surfaces below elevation 34.7' which are exposed to potential water flow shall be stabilized, including both ends of the weir.

2. Shipping and Handling

Flexamat® is packaged in rolls for shipment. The rolls have a minimum weight of 10 pounds per square feet. Rolls are packaged with handling straps. For safety, it is recommended that these straps only be used for lifting below 2' as a means to place heavy duty lifting straps under rolls. Upon delivery, rolls may be left exposed for up to 30 days. If exposure will exceed 30 days, the rolls must be tarped or otherwise covered to minimize UV exposure.

3. Subgrade Preparation

The prepared subgrade shall provide a firm, unyielding foundation for the mats. The subgrade shall be prepared as detailed on the plans. Subgrade shall be constructed from Select Fill which is placed and compacted per Construction Specification 023 – Earthfill. Compaction may be completed by hand using repeated passes of a vibratory plate compactor. All surfaces which will receive mat placement shall be uniformly compacted. Undulations, rolls, knolls and rises in the subgrade to which the tied concrete mat is able to contour over and maintain intimate contact with the subgrade will be allowed. The Flexamat® block has a height of 2.25" and this dimension shall be considered when preparing subgrade. Before unrolling the Flexamat®, apply seed and soil amendments directly to the prepared soil prior to installation of mats. Alternately, if infilling the spaces between the blocks with soil, grass seed may be mixed with the soil before placement. Use seed and soil amendments or topsoil per project specifications.

4. Unrolling

Position the rolls in the direction to be unrolled, with the leading edge at the bottom of the roll with the line and grade shown on the plans and according to the manufacturer's installation guidelines.

Flexamat® can be unrolled down or across slopes. It is important to consider the direction of any overland or channel flow when anchoring and installing the succeeding rolls for seams or abutments in the design. All edges exposed to concentrated flows, especially the upstream leading edges must be terminated and properly anchored according to engineer drawings. Overlapping seam should be installed like a shingle on a roof.

5. Seaming Rolls

Panel seams (Channel and Slopes) perpendicular to the hydraulic flow must be overlapped. The downstream panels will be terminated and properly anchored according to manufacturer's recommendations and placed under the upstream panel by overlapping 18".

6. Edge Treatment:

Flexamat® shall have a minimum toe-in as shown on design plans at edges perpendicular to hydraulic flow. Edges not exposed to surface sheet flow do not need to be toed if allowed by design plans and approved by the Engineer. Rather, a soil transition cover may be placed along the edge of mat to transition to landscape. Where permanent anchoring is required, e.g., installing mats on steep slopes, the cables (polypropylene grid) shall be attached to the anchoring system as indicated on the contract drawings or as recommended by manufacturer. Important areas for considering anchoring are the leading

edges, seams and overlaps.

Construction Specification 094—Contractor Quality Control

1. Scope

The work consists of developing, implementing, and maintaining a quality control system to ensure the specified quality is achieved for all materials and work performed.

2. Equipment and materials

Equipment and material used for quality control shall be of the quality and condition required to meet the test specifications cited in the contract. Testing equipment shall be properly adjusted and calibrated at the start of operations and the calibration maintained at the frequency specified.

Records of equipment calibration tests shall be available to the Engineer at all times. Equipment shall be operated and maintained by qualified operators as prescribed in the manufacturer's operating instructions and the references specified. All equipment and materials used in performing quality control testing shall be as prescribed by the test standards referenced in the contract.

All equipment and materials shall be handled and operated in a safe and proper manner and shall comply with all applicable regulations pertaining to their use, operation, handling, storage, and transportation.

3. Quality control system

The Contractor shall develop, implement, and maintain a system adequate to achieve the specified quality of all work performed, material incorporated, and equipment furnished before use. The system established shall be documented in a written plan, developed by the Contractor and approved by the Engineer. The system activities shall include the survey, material testing and inspections needed to verify the adequacy of completed work and procedures to be followed when corrective action is required. Daily records to substantiate the conduct of the system shall be maintained by the Contractor. The quality control plan shall cover all aspects of quality control and shall address, as a minimum, all specified testing and inspection requirements. The plan provided shall be consistent with the planned performance in the Contractor's approved construction schedule. The plan shall identify the Contractor's onsite quality control manager and provide an organizational listing of all quality control personnel and their specific duties. The written plan shall be submitted to the Engineer within 15 calendar days after notice of award. The Contractor shall not proceed with any construction activity that requires inspection until the written plan is approved by the Engineer.

The quality control system shall include, but not be limited to, a rigorous examination of construction material, processes, and operation, including testing of material and examination of manufacturer's certifications as required, to verify that work meets contract requirements and is performed in a competent manner.

4. Quality control personnel

Quality control activities shall be accomplished by competent personnel. A competent person is: one who is experienced and capable of identifying, evaluating, and documenting that materials and processes being used will result in work that complies with the contract and who has authority to take prompt action to remove, replace, or correct such work or products not in compliance. Off-site testing laboratories shall be certified or inspected by a nationally recognized entity. The Contractor shall submit to the Engineer, for approval, the names, qualifications, authorities, certifications, and availability of the competent personnel who will perform the quality control activities.

5. Post-award conference

The Contractor shall meet with the Engineer before any work begins and discuss the Contractor's quality control system. The Contractor and the Engineer shall develop a mutual understanding regarding the quality control system.

6. Records

The Contractor's quality control records shall document both acceptable and deficient features of the work and corrective actions taken. All records shall be on forms approved by the Engineer, be legible, and be dated and signed by the competent person creating the record.

Records shall include:

- 1) Documentation of shop drawings, including date submitted to and date approved by the Engineer, results of examinations, any need for changes or modifications, manufacturer's recommendations and certifications, if any, and signature of the authorized examiner.
- 2) Documentation of material delivered including quantity, storage location, and results of quality control examinations and tests.
- 3) Type, number, date, time, and name of individual performing quality control activities.
- 4) The material or item inspected and tested, the location and extent of such material or item, and a description of conditions observed and test results obtained during the quality control activity.
- 5) The determination that the material or item met the contract provisions and documentation that the Engineer and Contractor were notified.
- 6) For deficient work, the nature of the defects, specifications not met, corrective action taken, and results of quality control activities on the corrected material or item.

7. Reporting results

The results of Contractor quality control inspections and tests shall be communicated simultaneously in electronic .pdf format to the Engineer and Contractor immediately upon completion of the inspection or test. The original plus one copy of all records, inspections, tests performed, and material testing reports shall be submitted to the Engineer within two working days of completion. The original plus one copy of documentation of material delivered shall be submitted to the Engineer before the material is used.

8. Access

The Contractor and the Engineer shall be given free access to all testing equipment, facilities, sites, and related records for the duration of the contract.

Construction Specification CS 382—Barbed Wire Fence

All fence construction shall meet or exceed NRCS practice code 382.

1. Materials

Wire:

Use only new wire of two, twisted strands of class 3 galvanized 12.5 gauge (minimum) standard steel. If wire only has 2-point barbs, then barbs should be no farther than 4 inches apart and, if wire has 4-point barbs, then barbs would be no farther than 5 inches apart. Fence shall have five strands of barbed wire for boundary fence.

Wood Line posts:

- 1) Wood posts must be treated with a minimum of 0.4 lbs/ft³ of chromate copper arsenate (CCA-Type A, B or C), or equivalent.
- 2) Minimum 6 feet 6 inches long and 3-inch diameter.

Wood Corner, brace, and gate posts:

- 1) Wood
 - A. Wood posts must be treated with a minimum of 0.4 lb/ft³ of chromate copper arsenate (CCA-Type A, B or C), or equivalent.
 - B. Corner, brace, and gate posts must be at least 8 foot x 5 1/2"
 - C. Horizontal brace members must be at least 6 feet 6 inches x 3 inches.
 - D. Landscape timbers cannot be used for posts or brace members.
- 2) Fasteners
 - A. For wood posts, use staples that are at least 9 gauge, class 3 galvanized. Minimum length for softwoods is 1 1/2 inches and for hardwoods is 1 inch.
 - B. Use manufactured clips or minimum 14-gauge wire for steel line posts.
- 3) Gates
 - A. Gates shall be provided as shown on the plans. Gates shall be hot dipped galvanized steel with galvanized hinges and hardware.

2. Construction

Corners, Braces, Ends, and Gates:

- 1) Posts
 - A. Set posts for all fence assemblies a minimum of 42 inches deep in holes with a diameter at least 2.5X the post diameter. The top of posts should be at least 2 inches above the top wire.
 - B. Top wire height shall be an average of 46" above ground.
 - C. Backfill wooden posts by thoroughly tamping soil around the post after every 4 inches of depth.
- 2) Braces
 - A. H-braces are required for all corner, pull, end, and gate assemblies.
 - B. Anchor horizontal brace members to brace posts with a minimum 3/8 – 1/2 inches galvanized pin or 5/8" diameter rebar inserted in hole drilled in horizontal brace and upright

post at joint that penetrates the horizontal member at least 4 inches.

- C. H-braces must have a tension member consisting of two complete loops of 9-gauge smooth single strand, 12-gauge double strand, or 12.5-gauge high-tensile wire. One end of the loop is attached to the anchor (corner, end, or gate) post 4 inches above the soil surface and the other end is attached to the brace post at the same height as the top of the horizontal brace member. Twist the loops to provide rigidity to the brace assembly.
- D. Tighten tension member with a tensioner made of permanent material such as rebar, pipe, or pressure treated wood.

Corner and in-line pull assemblies:

- 1) A single inline brace assembly is required for any horizontal angle or terrain changes (> 150)
- 2) A single inline brace assembly is required when the distance from end post to end post exceeds 660 feet.
- 3) Use an H-brace assembly with two crossed tension members on fences not exceeding 660 feet and double H-brace corner assembly >660 feet.

Wood Line Posts:

- 1) The maximum distance between wood line posts is 16 feet without the use of stays between the posts.
- 2) Drive or bury wood posts at least 24 inches into the ground. The top of the post must be at least 2 inches above the top wire. If post holes are dug, backfill by tamping the soil around the post at every 4 inches depth.

Wire Spacing:

- 1) For cattle, use a minimum of four strands, or as specified on the plans, with the top wire at least 46" above the soil surface.
- 2) Equally space the wires with the bottom 16 inches above the soil surface and the top wire at least 2" below the top of wooden posts or at least 1 inch below the top of steel posts. When more than four wires are used, it is not necessary to maintain equal spacing as long as top and bottom wire positions are as above and no spacing is > 12 inches.

Fastening:

- 1) On boundary fence, attach wires to the side of the post closest receiving the most livestock pressure.
- 2) Avoid driving staples in-line with the wood grain. Place the staple parallel to the grain then rotate in the direction away from the cut face.
- 3) Pull tension on wire per manufacturer's specification and firmly attach to corner, end, gate, or pull posts.
- 4) Wires may be attached to steel posts by use of manufacturer's clips or by two turns of 14 gauge galvanized smooth wire.
- 5) Wire should be able to move freely between the fastener and the line posts.

3. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Fence Removal:

- 1) This item shall consist of removing and reinstalling existing fence as shown on plan sheets and

according to general notes on Sheet G-1.

- 2) Contractor shall flag sections of fence to be removed for Engineer approval before proceeding.
- 3) The Contractor may need to erect temporary fence for cattle control.
- 4) Fence staples shall be collected in buckets, wire rolled up and fence posts removed and legally disposed by the contractor.

Fence Construction:

- 1) Impoundment Area - This item consists of constructing and repairing perimeter fences and gates, as necessary to provide a complete perimeter fence, which are missing or were damaged or removed during construction. The perimeter fences are located at project limits and at property lines. No fences internal to the project limits will be repaired or constructed.
- 2) *Supply Canal* – This item consists of constructing and repairing fences and gates as specified on the plan at the extents of the easement for the approximately 8000’ long supply canal. No fences are proposed in these locations:
 - A. Between the farmed operations and the supply canal
 - B. Along the south side of the east/west section of the supply canal where there is an existing fence in good condition. If the existing fence is damaged during construction the Contractor shall make repairs as needed.
 - C. On the west side of the north/south section of the supply canal and existing road

Temporary Fence:

Where fence is removed or where no fence exists between the proposed construction work and pastures with grazing animals the contractor shall construct a temporary fence and maintain it for the duration of the construction to confine the animals until the permanent fence is completed.

Construction Specification 560—Access Road

1. Scope

This item shall include all plans, specifications, and construction operations required for the installation of access roads. Construction operations shall be carried out in such a manner that erosion, air, water, and noise pollution will be minimized within legal limits as established by state regulations.

The completed job shall present a workmanlike finish.

Roads and accesses shall be planned and laid out according to the plans and approved by Engineer.

2. Clearing and grubbing

All trees, stumps, roots, brush, weeds, and other objectionable material shall be removed from the area that will be required for the roadway including shoulders and ditches, and from similar areas required for side road approaches and inlet and outlet ditches. All burning shall conform to state laws and regulations. Refer to CS002 Clearing and Grubbing.

3. Construction

The roadbed shall be graded to the required elevations for subgrade preparation and that portion of the roadbed on which subgrade is to be prepared shall be loosed to a depth of 6 inches and all stones, roots and other objectionable material removed and disposed of. The subgrade shall then be thoroughly compacted with a pneumatic tired or vibratory roller. Soft spots discovered will be removed and replaced.

After completion of the subgrade, the base course will be placed; mixed as necessary to provide a homogeneous mixture; and thoroughly compacted, first with a vibratory roller and then with a general purpose roller. Compaction of embankment, subgrade or base course, shall be undertaken only when the soil moisture level is adequate to permit the require degree of compaction.

Fill material for roadbeds and embankments shall be deposited in thin layers (maximum of 9 inches) each layer and compacted with at least three passes of a vibratory roller.

Placement of the surface course shall be in accordance with sound highway construction practice for the surface material used.

Road shoulders and cut and fill slopes shall be graded smooth and stabilized in accordance with Florida NRCS conservation practice standard Critical Area Planting, Code 342 or Mulching, Code 484, as appropriate. Road edges and side slopes (including grass) should not be constructed in such a way that would result in ponded water on the road surface.

4. Shell Rock Road

Preparation:

The contractor shall complete the area to be stabilized to the lines and to a grade parallel to the finished elevation of the stabilized base before the stabilizing material is added.

Spreading and compacting Select fill base material:

After the footprint of the road has been prepared, the contractor shall place maximum of 6 inch layers of Select fill. Each layer shall be compacted with at least 3 passes of a vibratory roller.

Contractor shall continue to apply layers, compacting each until the road base reaches approximately 6” below the top of the stabilized base or as shown on the plans.

Stabilized base surface:

After base is completed the contractor shall shape the surface so that, after being compacted, it will

conform to the lines and grades for the stabilized base as determined in the field.

Spreading top layer of shell:

The contractor shall place on the completed stabilized base described above layers of shellrock to the loose depth not exceeding 6 inches per layer.

Compacting and finishing base:

After each layer spreading operations are complete, the contractor shall compact the shellrock base by rolling at least three passes with a vibratory roller. The material being compacted shall be maintained within plus or minus 2 percent of its optimum moisture content during compaction.

Additional layers of shellrock shall be added in layers as specified above until the final road surface elevations and shell rock thickness is achieved.

5. Maintenance Access

Contractor shall clear and not necessarily grub (see spraying and disking option in CS023, Foundation preparation) the footprint for the maintenance access located alongside the seepage ditch, between the fence and the seepage ditch in the impoundment area, and approximately 15' along both sides of the water supply canal in the Channel B improvements area, as shown on the drawings. The mentioned access shall be constructed by excavating and/or filling as needed, meeting the requirements specified in the respective sections (CS021 and CS023). Class C compaction is required for the maintenance access. Contractor shall grade to the specified elevations and prepare top layer to be grassed. Maintenance access is intended to be driven on for maintenance purposes only.

6. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Access Roads

- 1) This item consists of construction the following access roads:
 - A. Primary shell rock access road along east bank of Channel A, approximately 6,240' long
 - B. Shell rock access road to pump station
 - C. Select fill perimeter road around toe of impoundment berm
 - D. Maintenance accesses

Construction Specification 587 – Aluminum Structure for Water Control**1. Scope**

The work shall consist of all construction operations and furnishing materials required by design, drawings, and specifications for the complete installation of the work.

2. Location

The location of the structures shall be as shown on the drawings or as staked in the field.

3. Site and foundation preparation

Areas to be excavated and areas to be occupied by earthen embankments shall be cleared of trees, brush, tall standing vegetation, and other debris, unless otherwise specified. Objectionable materials encountered shall be removed, burned, or otherwise disposed of as specified or approved by the Engineer. It will be the responsibility of the Contractor (installer) to obtain the necessary permits for burning debris.

The foundation will be firm soil material. Any areas of muck, or other soft, unstable materials will be excavated and replaced with stable, earthfill material. Surface and ground water will be removed and diverted as needed to perform the required construction in accordance with plans and specifications. Removal of water shall be accomplished in such a manner that erosion and the transmission of sediment and other pollutants are minimized and kept within legal limits. (see specification CS011)

4. Pipe conduit installation

Pipe materials shall conform to the requirements specified on the plans, drawings, or as designated in the construction details. All appurtenances shall be of materials compatible with the pipe.

Standard band couplers are satisfactory unless otherwise specified.

Special treatment shall be provided to pipe embedded in or attached to concrete when the pipe is aluminum or aluminum-coated and aluminum-zinc alloy-coated. Potential contact surfaces shall be insulated. All aluminum, aluminum-coated, and aluminum-zinc alloy-coated pipe surfaces in contact with concrete and masonry surfaces shall be coated with two coats of a bituminous paint of the cut-back type. Placement of the pipe shall be such that direct metal-to-metal contact with other metallic materials, such as embedded steel reinforcement or water control gates, is prevented.

The pipe shall be laid to the line and grade shown on the drawings or as staked in the field. It shall be firmly and uniformly bedded throughout its entire line. It shall be loaded sufficiently during backfilling around the sides to prevent being lifted from the bedding. Heavy equipment will not be allowed over the pipe conduit until the backfill has been placed above the top surface of the structure to one-half the clear span width of the structure or 2 feet, whichever is greater.

Selected backfill material shall be placed around the conduit in layers not more than 6 inches before compaction for all structures.

See CS023 for compaction and testing requirements.

5. Earthfill placement

The completed works shall conform to the lines, grades, and elevations shown on the design, drawings, or as staked in the field within tolerances as specified on the plans.

Construction equipment shall be operated so the entire surface is traversed by not less than one tread track. The moisture content of fill material shall be adequate for obtaining the required compaction. Backfill adjacent to and on top of the structure shall be compacted by hand with at least three passes of a vibratory compactor.

The material placed in the fill shall be free of detrimental amounts of manure, sod, roots, stones more than 6 inches in diameter, and other objectionable material.

6. Pollution and workmanship

Construction operations shall be carried out so that erosion and air and water pollution are minimized and held within legal limits. All work shall be conducted in a safe, skillful, and workman- like manner.

7. Protection

A protective cover of vegetation shall be established on all exposed, sloping surfaces of the embankment. Seedbed preparation, seeding, fertilizing, mulching, sodding, and other needs shall be designated on the drawings and the Natural Resource Conservation Services' Construction Specification for Vegetative Cover.

8. Basis of acceptance

The Engineer will be notified during normal working hours on the day prior to initiating construction with additional notices designated in the construction details. Failure to notify the Engineer so that there is an opportunity to inspect the work may result in the Engineer not being able to certify that the job will meet standards and specifications.

The acceptability of the structure shall be determined by inspections to check compliance with the provisions of the plan, drawings, and this specification with respect to the design of pipe conduit, materials specified, the appurtenances, earthfill placement, and the minimum installation requirements.

9. Work Items

Aluminum Water Control Structures:

- 1) Channel A connection riser CS-1
- 2) Supply canal connection risers CS-2 through CS-8
- 3) Pump relocation riser CS-9

Construction Specification 761—Rock Riprap

1. Scope

The work shall consist of the construction of rock riprap revetments and blankets, including filter or bedding where specified.

2. Material

Rock for loose rock riprap shall conform to the requirements of Section 814, Riprap Materials, of the latest edition of the Florida Department of Transportation Standard Specifications 2010 for Riprap, Section 530. Gradation shall be as specified in Section 6. Rock for pump discharge energy dissipation shall be at least 18” in diameter. Prior to delivery of rock, the contractor shall designate in writing the source from which he intends to obtain the rock and information satisfactory to the company that the material meets the requirements of the contract. The contractor shall provide the engineer and the company free access to the source for the purpose of obtaining samples for testing.

3. Subgrade preparation

The subgrade surface on which the rock riprap, filter, bedding, or geotextile is to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. When fill to subgrade lines is required, it shall consist of approved material and shall conform to the requirements of the specified class of earthfill. Rock riprap, filter, bedding, or geotextile shall not be placed until the foundation preparation is completed and the subgrade surface has been inspected and approved.

4. Equipment-placed rock riprap

The rock riprap shall be placed by equipment on the surface and to the depth specified. It shall be installed to the full course thickness in one operation and in such a manner as to avoid serious displacement of the underlying material. The rock for riprap shall be delivered and placed in a manner that ensures the riprap in place is reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact one to another with the smaller rocks and spalls filling the voids between the larger rocks. Some hand-placing may be required to provide a neat and uniform surface. Rock riprap shall be placed in a manner to prevent damage to structures. Hand-placing is required as necessary to prevent damage to any new and existing structures.

5. Filter or bedding

The designated material shall be placed on the prepared subgrade surface of geotextile fabric as specified. Compaction of filter or bedding aggregate is not required, but the surface of such material shall be finished reasonably smooth and free of mounds, dips, or windrows.

All methods—The following provision applies to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule, is included in the payment for the item of work to which it is made subsidiary.

All payments to contractors will be made in accordance to the terms of the contract between the company and the contractor.

6. Items of work and construction details

Items of work to be performed in conformance with this specification and the construction details are:

Loose Rock Riprap

- 1) This item shall consist of furnishing and installing rock riprap required for ditch and side slope stabilization as shown on the plans.
- 2) Riprap may be carefully placed by machine to fill voids and provide uniformity. Hand- placement

of the rock may will be required adjacent to the pipes and structures. A layer of geotextile shall be installed under all rock riprap.

- 3) Riprap shall conform to the requirements set for the in the Florida Department of Transportation 2010 Standard Specification Guide for Rubble (Bank and Shore Protection), Section 530.2.2.1.

Construction Specification 2343—Geotextile Stabilization and Separation

1. General

Separation Geotextile (Subgrade CBR > 3):

- 1) This section is applicable to the use of a geotextile to prevent mixing of subgrade soil and an aggregate cover material (subbase, base, select fill, etc.).
- 2) This section may also apply to situations other than beneath pavements where separation of two dissimilar materials is required, but where water seepage through the geotextile is not a critical function.

Stabilization Geotextile (1 < Subgrade CBR < 3):

- 1) This section is applicable to the use of a geotextile in wet, saturated conditions to provide the coincident functions of separation and filtration. In some installations, the geotextile may also provide reinforcement.

2. References

- 1) American Association of State Highway and Transportation Officials (AASHTO) “Standard Specification for Geotextile Specification for Highway Applications” Designation M 288-05
- 2) AASHTO Test Standards:
 - A. T 88 – Standard Test Method for Particle Size Analysis of Soils
 - B. T 90 – Standard Test Method for Determining the Plastic Limit and Plasticity Index of Soils
 - C. T 99 – Standard Practice for Determination of the Moisture Density Relations of Soils Using a 5.5 lb hammer and 12 in drop (Standard Proctor)
- 3) American Society for Testing and Materials (ASTM):
 - A. D 123 – Standard Terminology Relating to Geotextiles
 - B. D 276 – Standard Test Method for Identification of Fibers in Textiles
 - C. D 3786 - Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics.
 - D. D 4354 - Practice for Sampling of Geosynthetics for Testing.
 - E. D 4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
 - F. D 4439 - Terminology for Geotextiles.
 - G. D 4491 - Test Methods for Water Permeability of Geotextiles by Permittivity.
 - H. D 4533 - Test Method for Index Trapezoid Tearing Strength of Geotextiles.
 - I. D 4632 - Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - J. D 4759 - Practice for Determining the Specification Conformance of Geosynthetics.
 - K. D 4751 - Test Method for Determining Apparent Opening Size of a Geotextile.
 - L. D 4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - M. D 4873 - Guide for Identification, Storage, and Handling of Geotextiles.
- 4) Federal Highway Administration (FHWA) - Geosynthetic Design and Construction Guidelines,

Publication No. FHWA HI-95-038, May 1995.

- 5) Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAI-LAP).

3. Definitions

California Bearing Ratio (CBR): The ratio of (1) the force per unit area required to penetrate a soil mass with a 19 sq cm (3 sq in) circular piston (approximately 51 mm (2 in) diameter) at the rate of 1.3 mm / min (.05 in/min). To (2) that required for corresponding penetration of a standard material.

Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

Typical Roll Value: Property value calculated from average or mean obtained from test data.

4. Submittal

Certification:

- 1) The Contractor shall provide the Owner a certificate stating the name of the geotextile manufacturer, product name, style, chemical compositions of filaments or yarns and other pertinent information to fully describe the geotextile.
- 2) The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request.
- 3) The manufacturer's certificate shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. The certificate shall be attested to by a person having legal authority to bind the Manufacturer.

Manufacturing Quality Control (MQC) test results shall be provided upon request.

5. Delivery, storage, and handling

Geotextile labeling, shipment and storage shall follow ASTM D 4873.

Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.

Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.

The protective wrapping shall be maintained during periods of shipment and storage. If the wrapping is damaged prior to installation, the outer wrap of geotextile material must be discarded before installation.

During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: Site construction damage, extended exposure to ultraviolet (UV) radiation, precipitation, chemicals that are strong acids or strong bases, flames, sparks, temperatures in excess of 71 deg C (160 deg F) and any other environmental condition that might damage the geotextile.

6. Quality assurance sampling, testing, and acceptance

Geotextile:

- 1) Geotextiles shall be subject to sampling and testing to verify conformance with this specification. Sampling for testing shall be in accordance with ASTM D 4354.
- 2) Acceptance shall be in accordance with ASTM D 4759 based on testing of either conformance samples obtained using Procedure A of ASTM D 4354, or based on manufacturer's certifications

and testing of quality control samples obtained using Procedure B of ASTM D 4354.

Sewn Seams (if required):

- 1) For seams that are to be sewn in the field, the Contractor shall provide at least a 2 meter (6 ft) length of sewn seam for sampling by the Owner before the geotextile is installed.
- 2) For seams that are sewn in the factory, the Owner shall obtain samples of the factory seams at random from a roll of geotextile that is to be used on the project.
- 3) If seams are to be sewn in both directions, samples of seams from both directions shall be provided.
- 4) For seams that are field sewn, the seams sewn for sampling shall be sewn using the same equipment and procedures as will be used for the production seams.
- 5) The seam assembly description shall be submitted by the Contractor along with the sample of the seam. The description shall include the seam type, sewing thread, and stitch density.

7. Products

Manufacturers:

- 1) Propex Inc., Chattanooga, Tennessee, 37422 USA, Phone (800) 621-1273.
- 2) Us Fabrics, Cincinnati, Ohio 45227 Phone (800)518-2290
- 3) Substitutions: Equivalent fabrics will be considered with appropriate submittals.

Equivalent Products by Manufacturer				
US Fabrics	Mirafi	Carthage Mills	Amoco (Propex)	Thrace
US 150	-	FX-44	2000	GTF 200F
US 200	500 X	FX-55	2002	GTF 200
US 250	550 X	FX-60	2004	GTF 250
US 315	600 X	FX-66	2006	GTF 300
US 4800	HP 570	FX-400MF	2044	GTF 570

Materials:

Example Material	Properties of Woven Geotextile								
	Tensile Strength	Elongation @ Break	Mullen Burst	Puncture Strength	CBR Puncture	Trapezoid Tear	Apparent Opening	Permittivity	Water Flow Rate
US Fabrics	lbs	%	psi	lbs	lbs	lbs	US Sieve	Sec ⁻¹	g/min/sf
US 150	135	12	325	65	380	55	30	0.05	4
US 200	200	15	400	90	700	75	50	0.05	5
US 250	250	15	450	100	500	90	40	0.05	4
US 315	315	15	600	120	100	120	40	0.05	4
US 4800	600 x 550	20 x 15	135 0	230	1400	230 x 200	80	0.145	15

Geotextile:

- 1) The geotextile construction shall be woven slit film polypropylene geotextile; individual slit films woven together in manner to provide dimensional stability relative to each other including selvages.
- 2) Resistant to UV degradation and biological and chemical environments normally encountered in soils.
- 3) Minimum Average Roll Values for Type III (AASHTO Class 1) (US 315) woven geotextile for paved urban roads where subgrade has a CBR of 1 to 3 and when the intended use is heavy duty haul roads and runways:

Property	Test Method	Units	Property Requirement
Grab Tensile Strength	ASTM D 4632	N (lbs)	1400 (315)
Grab Elongation	ASTM D 4632	Percent	15
Puncture Strength	ASTM D 4833	N (lbs)	667 (150)
Mullen Burst	ASTM D 3786	kPa (psi)	4650 (675)
Trapezoidal Tear	ASTM D 4533	N (lbs)	533 (120)
Apparent Opening Size	ASTM D 4751	mm (US Std. Sieve)	0.425 (40)
Permittivity	ASTM D 4491	Sec-1	0.05
Water Flow Rate	ASTM D 4491	l/min/m ² (gpm/ft ²)	160 (4)
UV Resistance (percent retained at 500 hours)	ASTM D 4355	Percent	70

Quality Control

Manufacturing Quality Control (MQC): Testing shall be performed at a laboratory accredited by GAI-LAP for tests required for the geotextile, at frequency exceeding ASTM D 4354.

Sewing Thread (if required):

- 1) Sewing thread shall consist of high strength polypropylene or polyester (Nylon shall not be used).
- 2) The thread shall be of a contrasting color to the geotextile.

8. Execution**Preparation:**

Clear, grub, and excavate/fill installation site to design grade. Remove topsoil, vegetation, and other unsuitable materials.

Soft spots and unsuitable areas shall be identified during site preparation or subsequent proof rolling. These areas shall be excavated and backfilled with select materials and compacted using normal procedures.

Installation:

The geotextile shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic.

Adjacent geotextiles rolls shall be overlapped, sewn or joined as required below:

Subgrade CBR	Minimum Overlap
Greater than 3	300 - 450 mm (12 - 18 in)
1 - 3	600 - 1000 mm (24 - 36 in)
0.5 - 1	1000 mm (36 in) or sewn
Less than 0.5	Sewn
All roll ends	1000 mm (36 in) or sewn

When sewn seams are required, the seam strength, as measured by ASTM D4632 shall be equal to or greater than 90 percent of the specified grab strength.

On curves, the geotextile may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.

Prior to covering, the geotextile shall be inspected by a certified inspector of the Owner to ensure that it has not been damaged during installation.

Damaged areas, as identified by the Owner, shall be repaired immediately by covering the damaged area with a geotextile patch that extends an amount equal to the required overlap beyond the damaged area.

The subbase shall be placed by end dumping onto the geotextile, or over previously placed subbase aggregate such that at least the minimum specified lift thickness shall be between the construction equipment tires or tracks and the geotextile at all times.

Pretensioning Geotextile:

- 1) Proof roll with heavily loaded, rubber-tired vehicle. Wheel load of truck shall be equivalent to maximum expected for site. Vehicle to make at least four passes over first lift in each area of site.
- 2) Once design aggregate has been placed, use roadway prior to paving to prestress geotextile-aggregate system in key areas.

If required, staple or pin geotextile at overlaps to maintain position during construction activities. Use 250 to 300 mm (10 to 12 in) long nails placed at minimum 15 m (50 ft) on center for parallel rolls and 1.5 m (5 ft) on center for roll ends.

Do not place overlaps along anticipated primary wheel path locations. Place overlaps at end of rolls in direction of aggregate placement with previous roll on top.

When geotextile intersects an existing pavement area, extend geotextile to edge of old system. For widening or intersecting existing roads where geotextiles have been used, anchor geotextile at roadway edge.

Compact first lift of base aggregate with a tracking dozer and then compact with smooth- drum vibratory roller to obtain minimum compacted density.

Compaction of permeable bases shall meet specified requirements. Perform construction parallel to road alignment.

Fill ruts formed during construction to maintain adequate cover over geotextile. Do not blade ruts down.

Place remaining base aggregate in lifts not exceeding 250 mm (10 in) in loose thickness and compact to specified density.

Protection:

Atmospheric exposure of the geotextile to the elements following laydown shall be limited to 14 days to prevent damage.

Equipment may operate on roadway without aggregate for geotextile installation under permeable bases if subgrade is of sufficient strength.

- 1) For extremely soft soils, use lightweight construction vehicles for access on first lift.
- 2) Limit construction vehicles in size and weight to limit rutting in initial lift to 75 mm (3 in).
- 3) If rut depths exceed 75 mm (3 in), decrease construction vehicle size or weight or increase lift thickness.

Turning not permitted on first lift of base aggregate. Construct turnouts at roadway edge to facilitate construction.

Items of work and construction details:

Items of work to be performed in conformance with this specification and the construction details are:

- 1) Optional Geotextile fabric integration into primary and secondary road bases using US Fabrics US 200 or equivalent.
- 2) Geotextile fabric under rip-rap using US Fabrics US350 or equivalent.

Construction Specification 11200 – Stormwater Pumps

1. Scope

This specification covers the design, supply and delivery of two (2) Axial Flow Pumps, drivers and accessories designed specifically for agricultural water handling applications. Contractor shall select and coordinate his work with qualified pump manufacturer as described below. The Contractor shall be responsible for the performance and quality of the completed pump station.

Owner/Engineer will not be responsible for any discrepancies or deficiencies in the final pump station due to misunderstanding, poor communication or lack of coordination between the pump manufacturer and Contractor.

2. Qualifications

The pump manufacturer shall be responsible for the proper design of the axial flow pump as defined in the contract drawings and specifications. The manufacturer shall be regularly engaged in the production of axial flow pumps and related equipment and shall be responsible for the fabrication and assembly of the pump unit. The manufacturer shall have experience with the design and manufacture of large diameter axial flow pumping systems, similar to that specified herein and shown on the contract drawings.

3. Performance test

Each pump shall be tested after installation under normal operating conditions. This test shall be conducted under the guidance of a Florida Registered Professional Engineer. A written detail testing plan shall be submitted for review by the Purchaser. The supplier shall provide four signed and sealed reports to the Engineer. The report shall develop: capacity (gpm) vs. head (ft) and performance curves. The report shall meet the requirements of SFWMD's Everglades Best Management Practices Permit Program "Flow Calibration Guidelines" dated October 1996, and as amended.

4. Operating conditions

The table provided on the design plans provided the proposed performance of the drainage pumps. It is the responsibility of the pump supplier to ensure that the pumps perform properly as specified, and if any modifications are required they are submitted to the Engineer in writing for approval.

See design plans pump location, pump performance, critical elevations and installation details. Contractor and pump manufacturer shall be responsible to provide a complete pump station which meets the pump rate and elevations requirements stated in the above table and with good workmanship and coordination between the two entities. Small changes by the pump manufacturer to the pump station design presented on the plans are expected to optimize the installation for the pumps supplied. Changes proposed should be submitted to Engineer in shop drawings for approval. The Engineer suggests a preconstruction meeting should be schedule with the Engineer, Contractor and Pump Manufacturer in attendance to review proposed plan for implementation of the drainage pump station.

The pumps performance shall be non-overloading for the design H.P. of the furnished driver. Driver and related components shall have not less than a 1.15 S.F.

5. Submittals

Submittals shall include documentation, shop drawings, and calculations but not be limited to, the following:

- 1) Guaranteed standard performance curves for each pump furnished.
- 2) Total developed head.
- 3) Efficiency.

- 4) Required brake horsepower at the bowl.
- 5) Minimum recommended submergence.
- 6) Mechanical details showing entire pump assembly, reduction gear, drive shaft, and couplings.
- 7) Layout, dimensional and cross-section drawings
- 8) Materials of construction
- 9) Coating system data
- 10) Nameplate data
- 11) Power Unit manufacture and model if applicable
- 12) Motor manufacturer and model number
- 13) Shop drawings for proposed steps, and hand rails, manhole which meet OSHA standards showing dimensions, materials, mounting methods, joint types, fasters and coatings.

6. Products

Materials - Materials not specifically described shall conform to the latest approved industry standard(s) covering appropriate class or types of materials. Material types used in the manufacture of the pumps shall conform to the following:

<u>COMPONENT</u>	<u>MATERIAL TYPE</u>	<u>SPECIFICATION</u>
Mounting Plate	HR Steel	ASTM A-36
Column & Elbow	HR Steel	ASTM A-588
Steel Plate	HR Steel	ASTM A-588
Cold Rolled Steel Bars	CR Steel	AISI/A-1018
Hot Rolled Steel Bars	HR Steel	ASTM A-36
Stainless Steel Plate	STS Steel	ASTM 304
Pipe	Schedule 80	A-53
Pump Shafting	CR Steel	ASTM A-1018
Intake Bell	HR Steel	ASTM A-588
Bearings	Bronze	ASTM B 62 or SAE 660

A-242 Carbon Steel shall be acceptable in place of A-588 where called for in specifications. All materials specification are a minimum, the Purchaser may accept equal or better substitutes at their sole discretion.

7. Pump construction

The two (2) pumps shall be of the same type with similar components and mounting.

- 1) Pump/Diffuser Bowl – The Intake Bell shall be made of ASTM A-588 steel plate, and shall be flanged for mating to the propeller wear band. Intake Bell diameter shall be no less than 1-1/2 times the impeller diameter. It shall be supported entirely by the propeller casing. It shall contain a guide hub and vanes to support a water lubricated tail bearing. The propeller wear band shall be made of ASTM A-304 or A-316 stainless steel, and shall be flanged for mating to the suction bell. It shall be machined to provide a close running tolerance to the propeller. This unit may be combined with the diffuser bowl to form a single unit. The diffuser bowl shall be made of ASTM A-588 steel plate. It shall contain a tapered diffuser cone and straightening vanes. It shall be

- welded as one piece with the propeller casing.
- 2) Propeller – The propeller and hub shall be cast, or manufactured entirely from 316 L stainless steel or bronze. The propeller blades shall be ground and polished for maximum hydraulic efficiency. For manufactured propellers with welded blades, blades shall be chamfered on both sides for full penetration welding. The periphery of the blades shall be machined for a close running fit with the impeller bowl. The complete propeller shall be properly balanced after manufacturing. The propeller shall be attached to the shaft in such a manner as to ease assembly and disassembly.
 - 3) Pump Column and Discharge Elbow - The pump column and discharge elbow shall be made of ASTM A-588 plate. The elbow shall be of long radius, with the centerline radius not less than one times the nominal pipe diameter.
 - 4) Horizontal Discharge Pipe – Size as specified on plans A-53 steel pipe.
 - 5) Flap Gate - Each horizontal buried discharge pipe shall include a flange-mounted flap gate at the discharge end. Flap gates shall be Hydro Gate cast iron Model 50C Round Opening Heavy Duty Flap Gate or equal. Hinges shall be fitted with grease fittings fabricated so that greasing can be performed safely without walking on top of the discharge pipe to access the flap gate hinges.
 - 6) Pump Shaft – The pump line shaft shall be cold rolled steel, conforming to ASTM A-108 or A-1018. It shall be sized to safely transmit the horsepower required, and to prevent vibration.
 - 7) Line Shaft Enclosure – The shaft enclosing tube shall be made of ASTM A53, Schedule 80 seamless pipe or DOM tubing, of a size to accommodate the pump line shaft and its supporting bearings.
 - 8) Bearings – Fluted bronze sleeve bearings shall be provided in the Line Shaft Enclosure tube. Bearings shall be in alignment inside the tube, spaced less than 60” apart. Bearings shall be lubricated with grease (NO OIL) from the top of the tube by means of steel grease fittings. Grease addition will be made through remote greasing lines.
 - 9) Pump Mounting Plate – The pump mounting plate shall be made of ASTM A36 Steel. It shall be of adequate thickness and strength to prevent excessive vibration and deflection. The mounting plate shall have mounting holes for anchoring the pump assembly.
 - 10) Lifting Lugs – Major pump components weighing 100 pounds or greater shall be furnished with lifting lugs to facilitate handling, and designed and arranged to allow safe handling of pump components singly or collectively as required during shipping, installation, and maintenance.
 - 11) Nuts and Bolts – Bolts used in assembling pump and its supporting members shall be 316 stainless steel coarse thread. Only hexagonal bolts and nuts shall be used.
 - 12) Name Plate – A corrosion resistant, metal nameplate shall be furnished stating the manufacturer’s name and address, pump serial number, design RPM, rated gallons per minute capacity. The nameplate shall be located in a readily visible location and suitably attached to the pump.
 - 13) Hardware – All machine bolts, nuts and cap screws shall be hex head type. Hardware and parts requiring special tool shall not be used.
 - 14) Welding – Pump and pipe welding shall be continuous and full penetration inside and out. All slag shall be removed and undercutting shall not exceed 15% of the material thickness.
 - 15) Electric Motors – Motors shall be vertically mounted on the pump by the pump manufacturer. Motors shall be 208-230V/460V, 3 Phase, 60 HZ, TEFC, T Frame. Motor manufacturer shall be Baldor, US, General Electric, or some other well recognized brand with local support and repair stations.

- 16) Drive System - The motor will be connected to the pump through a V Belt drive system. The belts shall be sufficient to convey the motor HP to the pump with at least 20% safety margin. The motor mounting shall be easily field adjusted to provide proper belt tension. Moving belts, shafts and drive components shall be shielded per OSHA standards to prevent accidental access and injury.
- 17) Staff Gauges – as specified and located on plans and shall be installed in convenient place for the operators of the pump and sluice gate stations to view gradations.
- 18) Painting – Pump interiors and exteriors shall be painted with the manufacturers paint system, or as specified. As a minimum, the pump shall be coated with bitumastic enamel equal to Zophar Tripal A coal tar enamel (minimum 6 mils), or as an option sandblasted to paint manufacturers specifications with two (2) coats (minimum 6 mils) of a high solids epoxy paint system similar to Ameron Amerlcok 400 and Amercoat 450 or approved equal. Alternate paint systems are acceptable provided that the pump manufacturer can demonstrate corrosion resistance equal to the high solids epoxy system.
- 19) Inspection –Contractor shall arrange for the inspection by the Engineer of the pump parts and related accessories and appurtenances during manufacturing to assure compliance with these specifications. The Engineer or his representative shall have the option of witnessing the pump performance testing.

8. Operation and Maintenance Manual

Contractor shall submit installation, operation and maintenance manuals (IOM Manuals) containing complete information on installation, operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, reassembly, and trouble diagnosis of the pump and its auxiliary units.

9. Warranty

As specified in the General Conditions.

10. Delivery

Contractor shall coordinate the timely delivery of the pump station equipment to the job site. Handling and storage of equipment will as recommended by the manufacturer to prevent any damage or loss. Contractor shall remain responsible for the loss mitigation, safe storage, and handling of the pump station until final acceptance by the Engineer. Any loss or damage shall be repaired or replaced by the Contractor at no cost to the Owner.

11. Quality assurance

- A. Equipment and Material incorporated into the Work - Provide products that comply with the requirements of the contract documents, undamaged, and unless otherwise indicated, unused at the time of installation. Provide products that are complete with all accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and for the intended use and effect.
- B. Standard Products - Where they are available and comply with Specifications, provide standard products of types that have been produced and used successfully in similar situations on other projects.
- C. Continued Availability - Where, because of the nature of its application, the Owner is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair or replacement, provide standard products for which the manufacturer has published assurances that the products and its parts are likely to be available to the Owner at a later date.

- D. Conform to applicable Specifications, codes, standards, and regulatory agencies.
- E. Comply with size, make, type, and quality specified or as specifically approved in writing by the Engineer.
- F. Manufactured and fabricated products:
 1. Design, fabricate, and assemble in accordance with the best engineering and shop practices.
 2. Manufacture like parts of duplicate units to standard sizes and gauges to be interchangeable.
 3. Equipment and Materials shall be suitable for service conditions intended.
 4. Equipment capacities, sizes, and dimensions indicated or specified shall be adhered to unless variations are specifically approved in writing.
 5. Two or more items of the same kind shall be identical and supplied by the same manufacturer.
- G. Do not use Equipment and Material for any purpose other than that for which it is designed or is specified.
- H. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
- I. Identification: Each item of equipment shall have permanently affixed to it a label or tag with its equipment serial number, model number, performance information, and manufacturer's name.

12. Preparation for storage

Though all Equipment and Material shall crated, packed, palletized, assembled and protected for transportation and immediate installation at the delivery site, Equipment and Material shall nevertheless be crated, packed and protected for storage for an extended period of time, which protection shall include, but not be limited to:

- J. Protection of motors, electrical equipment and machinery of all kinds against corrosion, moisture deteriorations, mechanical injury, and accumulation of dirt or other foreign matter.
- K. Protection of exposed-machined surfaces and unpainted iron and steel, as necessary, with suitable rust-preventive compounds.
- L. Protection of bearings and similar items with grease packing or oil lubrication.

13. Training

- A. On-Site Training – The pump and controls manufacturers shall provide on-site training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives. Training shall include instruction in operation, care and maintenance of the Equipment.
- B. Training Plan – The Contractor shall submit a training plan to the Engineer no less than two (2) weeks prior to the training session. Contractor's training plan shall include, but not necessarily be limited to, training manual, handouts, visual aids, and other reference materials as appropriate to the nature of the Equipment. The training plan shall be suitably bound for proper organization and easy reproduction. Seller shall furnish up to ten copies, as required by Owner, of the training plan at least two (2) weeks prior to each training session.

- C. Format and Content: Each training session shall be comprised of time spent at the specific location of the subject equipment or system but if approved, a classroom setting may be used to review documentation. As a minimum, training session shall cover the following subjects for each item of equipment or system:
1. Familiarization
 - a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
 - b. Check out the installation of the specific equipment items.
 - c. Demonstrate the unit and indicate how all parts of the specifications are met.
 - d. Answer questions.
 2. Safety
 - a. Using material previously provided, review safety references.
 - b. Discuss proper precautions and procedures related to the Equipment.
 3. Operation
 - a. Using material previously provided, review reference literature.
 - b. Explain the operating theory of the Equipment
 - c. Explain all modes of operation, including start-up, normal operation, normal shutdown, emergency operating and emergency shutdown and restart, including a discussion on system integration and electrical interlocks, if any.
 - d. Check out Owner's personnel on proper use of the Equipment. As a minimum, hands-on Equipment training for operations personnel will include:
 1. Identify location of Equipment and Equipment components
 2. Identifying piping and flow options.
 3. Identifying valves and their purpose.
 4. Identifying instrumentation:
 - a. Location of primary element.
 - b. Location of instrument readout.
 - c. Discuss purpose, basic operation, and information interpretation.
 5. Demonstrate and perform standard operating procedures.
 6. Discuss and perform the preventative maintenance activities.
 7. Discuss and perform start-up and shut-down procedures.
 8. Perform the required equipment exercise procedures.
 9. Perform routine disassembly and assembly of equipment, if applicable.
 10. Identify and review safety items and perform safety procedures, if feasible
 4. Preventive Maintenance - Using material previously provided, review preventive maintenance (PM) lists including:

- a. Reference material.
- b. Daily, weekly, monthly, quarterly, semiannual, and annual PM jobs.
- c. Show how to perform PM jobs.
- d. Show Purchaser's personnel what to look for as indicators of equipment problems.
- e. Routine preventative maintenance, including specific details on belts, seals, bearing replacement, lubrication, normal maintenance and maintenance of corrosion

protection of the Equipment and ancillary components, replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

- f. Required Equipment exercise procedures and intervals.
- g. Routine and long-term calibration procedures
- h. Routine disassembly and assembly of equipment, if applicable, for purposes such as operator inspection of equipment.
- i. Equipment inspection and troubleshooting procedures, including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.

5. Corrective Maintenance

- a. List possible problems.
- b. Discuss repairs and point out special problems.
- c. Open equipment and demonstrate procedures, where practical.
- d. Operator detection, without test instruments, of specific equipment trouble symptoms.

6. Parts

- a. Show how to use previously provided parts list and order parts.
- b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives

- a. Where to order parts: Name, address, telephone.
- b. Service problems:
 1. Who to call.
 2. How to get emergency help.

8. Operation and Maintenance Manuals

- a. Review any other material submitted.
- b. Update material, as required.

D. Video Recording: Purchaser may, at its option, provide video or digital recordings to aid in the training sessions.

Construction Specification 11210 – Stormwater Pump Relocation

1. Scope

This specification covers the relocation of one (1) Axial Flow Pump Station including drivers and accessories designed specifically for agricultural water handling applications. Contractor shall select and coordinate his work with qualified pump manufacturer as described below. The Contractor shall be responsible for the performance and quality of the completed pump station.

Owner/Engineer will not be responsible for any discrepancies or deficiencies in the final pump station due to misunderstanding, poor communication or lack of coordination between the pump manufacturer and Contractor.

2. Qualifications

The Contractor shall be responsible for the proper implementation of the removal and relocation of one (1) existing 24” axial flow pump manufactured by Creel Pump, Inc. The Contractor may contract with Creel Pump or another similarly qualified entity who is regularly engaged in the production, repair and installation of axial flow pumps and related equipment who shall be responsible for the overall project of relocating the pump station. Contractor shall submit qualifications of the company selected to coordinate the relocation and repair of the pump station to Engineer for approval.

3. Pump Removal

The Contractor shall coordinate with Highlands County and the owner of the existing 24” axial flow pump to schedule a date when the pump can be disabled for sufficient time to allow it to be updated and relocated. No work shall commence without the knowledge and approval of the pump owner. The pump station is currently in use therefore the work must be completed as expeditiously as possible without impacting the owner’s drainage operations. The pump station shall be removed entirely and relocated approximately 850’ north as shown on the plans. Any damage caused by the Contractor to the exiting pump station or its components during removal shall be his responsibility to repair or replace. Contractor is cautioned to avoid spills of fuel or petroleum products when removing the diesel engine and fuel tank.

4. Repair of Existing Pump

The existing pump will be removed and relocated per design plans and agreement with its owner. To ensure that the pump performs as originally designed and has a long service life some repairs and upgrades to the pump shall be included in this scope of work. All pump work shall be completed by the original manufacturer of the pump or an approved equal and shall include at a minimum the following items:

- 1) Replace all bolts, nuts and other fasteners removed during the moving process
- 2) New gear head shaft
- 3) New split coupling
- 4) New 4 bolt flange bearing
- 5) New pump shaft with hard coating on seals surface
- 6) New oil seals
- 7) New bottom bronze oil bearing
- 8) New Duramax marine bearing
- 9) Sand blast and epoxy (coal tar equivalent) coating
- 10) All steel parts to be installed must be primed and painted with rust resistant paint

- 11) New fuel hoses and clamps

5. Pump Installation

The intent for this scope of work is to relocate the existing pump to a new station location that meets or exceeds the current functionality, quality of workmanship, materials and safety. The replacement station shall have safety equipment upgraded to current OSHA standards for the catwalk, platform, hand rail system, belt covers, shaft covers and fuel containment systems:

- 1) The existing fuel tanks must be replaced by a double wall type tank of equivalent capacity. Contractor should arrange the fuel tank to offset the fuel filler locations to be as far as possible from the waterway.
- 2) Install new fuel hoses routed through PVC pipe to prevent incidental damage.
- 3) Construct a pressure treated wood frame building with galvanized metal exterior walls and roof, and lockable doors similar to the existing building. None of the materials from the existing building should be reused. Provide sufficient open space for air circulation.
- 4) Provide catwalk from the ditch block berm or edge of road to the pump station platform. Catwalk must have metal hand rails per OSHA standards and toe boards on both sides.
- 5) All moving parts accessible to the operator during use shall have OSHA approved covers installed.
- 6) The existing diesel engine and frame will be relocated. Any work on the engine will be by others unless the Contractor causes damage to it handling or by his negligence in which case it shall be restored or replaced at Contractor's expense.
- 7) Pump, discharge pipe, flap gate and intake screen shall be relocated without modifications other than the repairs described in Section 4. The pump critical elevations (platform top, pump intake, pump discharge, and center line drive shaft) shall match the existing station.

6. Operation and Maintenance Manual

Contractor shall submit installation, operation and maintenance manuals (IOM Manuals) containing complete information on installation, operation, lubrication, adjustment, routine and special maintenance as would normally be supplied to the owner of a new pump station by Creel Pump or the approved equal entity.

7. Warranty

Contractor shall warrant his work as specified in General Conditions. Pump repair work shall be warrantied for a period no less than 1 year from date of final acceptance.

8. Delivery

Contractor shall coordinate the timely delivery of the pump station equipment to the job site. Handling and storage of equipment will be as recommended by the manufacturer to prevent any damage or loss. Contractor shall remain responsible for the loss mitigation, safe storage, and handling of the pump station until final acceptance by the Engineer. Any loss or damage shall be repaired or replaced by the Contractor at no cost to the Owner.

Material Specification 548—Corrugated Polyethylene Pipe**1. Scope**

This specification covers the quality of polyethylene pipe and fittings as typically used for culverts and drainage systems.

2. Pipe

Corrugated polyethylene pipe shall conform to the requirements of ASTM F 405, ASTM 667, ASTM F 894, AASHTO M 252, or AASHTO M 294 for the appropriate pipe sizes and fittings.

3. Fittings

ASTM F 405 3-6 inch diameter pipe and fittings ASTM F 667 8-24 inch diameter pipe and fittings
ASTM F 894 18 to 120 inch diameter pipe and fittings AASHTO M 252 3-10 inch diameter pipe
and fittings AASHTO M 294 12-36 inch diameter pipe and fittings.

Material Specification 552—Aluminum Corrugated Pipe

1. Scope

This specification covers the quality of aluminum corrugated pipe and fittings.

2. Pipe

Aluminum corrugated pipe and fittings shall conform to the requirements of ASTM B 745, B 746, or B 790 for the specified pipe sheet thickness, shape type, fabrication methods, and the following additional requirements:

- 1) When close-riveted pipe is specified:
 - A. Pipe shall be fabricated with circumferential seam rivet spacing that does not exceed 3 inches except that 12 rivets are sufficient to secure the circumferential seams in 12-inch pipe.
 - B. Longitudinal seams that will be within the coverage area of a coupling band, the rivets shall have flat heads or the rivets and holes shall be omitted and the seams shall be connected by welding to provide a minimum of obstruction to the seating of the coupling bands.

3. Coatings

Bituminous coatings, when specified, shall conform to the requirements of ASTM A 849.

4. Coupling bands

Coupling bands are to be provided for each section of pipe. The hardware for fastening the coupling band tightly to the connecting pipe shall be fabricated to permit tightening sufficiently to provide the required joint tensile strength and, if required, water tightness without failure of its fastening.

Gaskets, if specified, are to be provided for each coupling band. The fabrication shall also be sufficient to provide the required gasket seating without warping, twisting, or bending.

Gaskets provided with connecting bands meeting requirements for special joints in erodible soil conditions shall be as specified in ASTM A 762.

5. Fittings

Fittings shall be fabricated from sheet aluminum meeting the requirements contained in ASTM B 744. The coating for fittings shall be the same as that specified for the contiguous corrugated aluminum pipe.

Fittings that are welded during fabrication shall be accomplished in a good workmanship like manner resulting in a continuous smooth surface finish. Aluminum welding electrodes used shall conform to the requirements of American Welding Society (AWS) specification AWS A5.10, "Specification for Aluminum and Aluminum Alloy Welding Rods and Bare Electrodes." Welded surfaces and adjacent surfaces damaged during welding shall be treated by removing all weld splatter. The affected surface shall be cleaned to bright metal by sand blasting, power disk sanding, or wire brushing. The cleaned area shall extend at least 0.5 inch into the undamaged section of coated area. Within 24 hours of completion of surface preparation all treated surfaces shall be painted with two coats of a chromate rich primer and allowed to fully dry before exposure to weathering conditions.

Aluminum surfaces fabricated that will have contact with steel, iron, or other metals shall be coated with a zinc-chromate primer and allowed to fully dry before final installation.

Material Specification 582—Galvanizing

1. Scope

This specification covers the quality of zinc coatings applied to iron and steel for corrosion resistance.

2. Quality

Zinc coatings shall conform to the requirements of ASTM A 123 for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel product or as otherwise specified in the items of work and construction details on the Construction Specifications.

ASTM A 123 covers both fabricated and nonfabricated products; e.g. assembled steel products, structural steel fabrications, large tubes already bent or welded before galvanizing and wire work fabricated from noncoated steel wire. It also covers steel forgings and iron castings incorporated into the pieces fabricated before galvanizing or which are too large to be centrifuged.

Material Specification 2233 – Shell Rock

1. Scope

The contractor shall provide all labor, equipment and materials to construct a base course by stabilizing the access roadbed soil material with shellrock in accordance with FDOT Standard Specifications for Road and Bridge Construction Section 285 or as specified herein, and in conformity with the lines, grades, notes and typical cross sections shown in the Drawings.

2. Shellrock Base

The installation of a shellrock base shall conform to the requirements of ASTM D1557-00, ASTM D 2922-01, and Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

3. Certifications and Testing

If the engineer deems necessary, field density tests in accordance with ASTM D 2922-01, Test for Density of Soil and Soil-Aggregate in Place by the Nuclear Method will be performed. The areas to be tested shall be determined by the engineer. Laboratory compaction tests in accordance with D1557-00-Standard Test Methods for Laboratory compaction Characteristics of Soil Using the Modified Effort (56,000 ft-lbf/cu.ft.) will also be performed. The contractor shall make the site available for testing and cooperate fully to allow tests to be taken. Failure to meet the specified density will require the contractor to recompact and retest those areas directed by the engineer.

4. Inspection and Coordination

The contractor shall provide access to the work for the engineer as requested for inspection. The Contractor shall provide 48 hours notice of its intention to begin new work activities.

5. Products

Shellrock

The contractor shall provide shellrock-stabilized base materials in accordance with FDOT Standard Specifications for Road and Bridge Construction Section 913A. With the approval of the engineer suitable shellrock material shall be obtained from approved spoil areas. The minimum acceptable density of the shellrock shall be [129] lbs/cu. ft. [NTS: Confirm the minimum acceptable density for specific project.]

Material Specification 5500—Fabricated Metalwork and Castings

1. Scope

The work of this section shall consist of furnishing all labor, materials, and equipment necessary for the installation of fabricated metalwork and castings as shown on the Drawings and specified herein.

2. Products

General:

- 2) Unless otherwise indicated, all materials shall conform to the latest issue of the following ASTM Specifications:

<u>Item</u>	<u>ASTM Specification</u>
Steel Shapes & Plates	A 36
Steel Pipe Columns	A 501 or A 53, Type EDRS, Grade B
Stainless Steel:	
Bars & Shapes	A 276, Type 316
Steel Plate, Sheet & Strip	A 167, Type 316
Bolts	A 193, Type 316, B8MN, B8M2, or B8M3
Nuts	A 194, Type 316, B8MN, B8M2, or B8M3
Aluminum, Structural Shapes & Plates	Alloy 6061-T6; conform to referenced specifications and ASTM Sections found in the Aluminum Association current Construction Manual Series
Connection Bolts for Steel Members; Use Compressible-Indicators at all Connections; Use Hardened Washers also under Head & Nut	A 325-F F 959-85 Washer Type Direct Tension F 436 (Washers)
Anchor Bolts & Nuts:	
Carbon Steel	A 307 or A 36
Stainless	A 193, Type 316
Galvanized Steel Bolts Head & Nuts	A 153, Zinc Coating for A 307 or A 36
Flat Washers (Unhardened)	F 844, Use A 153 for Zinc Coating
Threaded Bars	A 36
Connection Bolts for Aluminum	Use appropriate Stainless Steel

- 3) The miscellaneous metalwork and castings indicated on the Drawings, or required to secure the various parts together and provide a complete installation, shall be included under this section.

Anchor Bolts:

- 1) Anchor bolts for equipment and machinery, where permanently anchored into concrete, shall be stainless steel, unless otherwise shown. The diameter, length, and any bend dimensions shall be as required by the equipment or machinery manufacturer. Unless otherwise required, use inch minimum diameter as appropriate for mounting hole provided by device manufacturer or as recommended by device manufacturer and other geometry shown on the Drawings. Furnish a minimum of two nuts and a washer of the same material for each bolt. Provide sleeves as required or as shown for location adjustment.
- 2) Submerged use is defined as any connection to concrete from a point 1 foot 6 inches above the maximum water surface in a water-holding basin and any connection below that point.

- 3) Anchor bolts for other uses to anchor fabricated metalwork or structural building, or structural frame components in areas of wet use or washdown areas shall be stainless steel. Minimum size shall be as appropriate for mounting hole provided by device manufacturer or as recommended by device manufacturer and other geometry shown on the Drawings.
- 4) Fasteners for safety devices such as hand rails and equipment shields shall meet all applicable OSHA standards.

Stainless Steel Fasteners Lubricant (Anti-seizing):

Where stainless steel nuts and machined bolts, anchor bolts, concrete anchors, and all other threaded fasteners are used, Subcontractor shall apply an anti-seizing lubricant to the threads prior to making up the connections. The lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper.

Anchoring Systems for Concrete:

- 1) Wedge Anchors:
 - A. Wedge anchors shall be 100 percent 316 stainless steel and shall not be used below a point 1 foot 6 inches above the peak (maximum) water surface in any water-holding structure. See adhesive anchors or anchor bolts specified elsewhere in this Specification.
 - B. Wedge anchors shall be 316 stainless steel, stud type, stainless steel bolts, completely assembled, concrete anchors. Furnish sizes shown on Drawings. Provide ICBO (International Conference of Building Officials) or other similar building code organization recommendations regarding safe allowable design loads.
- 2) Expansion Anchors:
 - A. Expansion anchors shall not be used except in dry areas where future corrosion is not a problem unless the expansion anchors are 316 stainless steel. In the wet or damp areas, use wedge anchors as specified above or adhesive anchors in submerged conditions as hereinafter specified; 316 stainless steel expansion anchors may be used as defined for stainless wedge anchors.
 - B. Self-drilling anchors, snap-off type or flush type. Provide anchors for use with hot-dipped galvanized bolts. Non-drilling anchors shall be flush type for use with a bolt or stud type with projecting threaded stud. Provide ICBO or other similar code organizations' recommendations regarding safe allowable design loads.
- 3) Adhesive Anchors:
 - A. Adhesive anchors shall be used for anchoring metal components at or below a point 1 foot 6 inches above the peak (maximum) water surface elevations in water-holding structure.
 - B. Adhesive anchors shall be capsule anchors with 316 stainless steel stud, nuts, and washers, heavy-duty adhesive anchor rod assemblies.

Structural Steel Supports:

Provide all structural steel supports of the sizes and weights shown. All connections shall be welded, unless otherwise shown.

Bolts and Fasteners:

- 1) Bolts and fasteners not permanently embedded in concrete, but located outdoors in areas subject to the weather; chemical handling areas; equipment rooms subject to drainage, leakage, and washdown; and in galleries and trenches, shall be Type 316 stainless steel as hereinbefore specified.

- 2) Bolts for flanges of piping, valves, and other similar connections shall be as specified in other sections or as shown on the Drawings.

Grating:

- 1) All grating utilized on project shall be of aluminum, unless specifically indicated otherwise.
- 2) Gratings shall be provided with all frames, seat angles, fasteners, and other appropriate accessories as required. Metals to be embedded in concrete shall be Type 316 stainless steel.
- 3) Fasteners for anchoring grating to beam and channel flanges shall be Universal clip type with 1/4" bolts and nuts. Fasteners shall be furnished for a minimum of four, or as required, for proper support to each panel, unless otherwise noted on the Drawings.
- 4) Standard Installation clearances and tolerances shall conform to the requirements of the current Metal Bar Grating Manual published by the National Association of Architectural Metal Manufacturers.
- 5) Width of any single grating section shall not exceed 4'-0".
- 6) Grating shall be of the minimum thickness indicated on the Drawings for the various spans and shall be designed for the minimum uniform loads and concentrated loads as shown in the specified manufacturer's catalogs, unless otherwise indicated, with a maximum deflection not exceeding 1/4-inch and maximum allowable stress of 12,000 psi.
- 7) Provide angle supports as indicated. Size support angles to provide a minimum of 1-inch support for all main-bearing bars. Band all edges and cutouts.
- 8) Main bearing bars shall be of depth designated as grating thickness on the Drawings. Provide welded 3/16-inch banding for all openings and grating ends. Cross bar spacing shall be a maximum of 2-inches, unless otherwise specified. Limit lateral deflection of grating to prevent pedestrian discomfort.
 - A. All cross bars shall be flush with top of grating and shall extend downward a minimum of 50 percent of the main bar depth. Swaged cross bars shall not be used.

Lifting Lugs:

Individual equipment and/or each field disassembling part over 100 pounds in weight shall be provided with proper lifting lugs for easy handling.

Square Mesh Wire Cloth:

Wire cloth shall be Type 316 stainless steel. Size shall be 0.75-inch square mesh with 0.080-inch diameter wire, weight of 0.549 pound, per square foot, and 79.8 percent open area. Bond edges of wire cloth with rolled 316 stainless steel, 24 gauge band.

3. Execution

General:

- 1) Workmanship and finish of all metalwork specified under this section shall be the highest grade and equal to the best practice of modern shops for the respective work. Exposed surfaces shall have smooth finish and sharp, well-defined lines. Provide all necessary rabbets, lugs, and brackets so that the work can be assembled in a neat, substantial manner. Conceal fastenings where practical. Drill metalwork and countersink holes as required for attaching hardware or other materials. Fabricate metals as specified. Weld connections, except where bolting is directed. Items requiring special fabrication methods are mentioned herein. Fabrication of all other items shall be of equal quality. Methods of fabrication not otherwise specified or shown shall be adequate for the stresses and as directed by the Engineer.

- 2) Grind all exposed edges of welds smooth on walkways, guardrails, handrails, stairways, channel door frames, steel column bases, and where indicated on the Drawings. All sharp edges shall be rounded to a 1/8" minimum radius; all burrs, jagged edges, and surface defects shall be ground smooth.
- 3) Welds and adjacent areas shall be prepared such that there is (1) no undercutting or reverse ridges on the weld bead, (2) no weld spatter on or adjacent to the weld or any other area to be painted, and (3) no sharp peaks or ridges along the weld bead. All embedded pieces of electrode or wire shall be ground flush with the adjacent surface of the weld bead.
 - A. Aluminum: Fabricate aluminum as shown, and in accordance with the Aluminum Association Standards and the manufacturer's recommendations as approved. Grind smooth sheared edges exposed in the finished work.

Welding:

- 1) The technique of welding employed, appearance, quality of welds made, and the methods of correcting defective work shall conform to codes for Arc and Gas Welding in Building Construction of the AWS and AISC. Surfaces to be welded shall be free from loose scale, rust, grease, paint, and other foreign materials, except that mill scale that will withstand vigorous brushing may remain. A light film of linseed oil may likewise be disregarded. No welding shall be done when the temperature of the base metal is lower than 0 degrees Fahrenheit. Finished members shall be true to line and free from twists.
- 2) All welding operators shall be qualified in accordance with the requirements of current AWS Standard Qualification Procedure D1.1, Chapter 5, and welders of structural and reinforcing steel shall be certified for all positions of welding in accordance with such procedure. A recognized testing laboratory shall run qualification tests at the Subcontractor's expense.
- 3) All welding operators shall be subject to examination for requalification using the equipment, materials, and electrodes employed in the execution of the Contract work. Such requalification, if ordered by the Engineer, shall be done at the expense of the Subcontractor.
 - A. Aluminum: Aluminum shall be welded with Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) processes in accordance with the manufacturer's recommendations as approved, and in accordance with the recommendations of the American Welding Society contained in the Welding Handbook, as last revised. Grind smooth all exposed aluminum welds.

Installation of Fabricated Metalwork:

Install in accordance with the shop drawings, the Drawings, and these specifications. Perform field welding and erection work by skilled mechanics. Install fabricated metalwork plumb or level as applicable. The complete installations shall, in all cases, be rigid, substantial, and neat in appearance. Erect structural steel in accordance with the applicable portions of AISC Code of Standard Practice, except as modified. Install commercially manufactured products in accordance with manufacturer's recommendations as approved.

- 1) Aluminum: Erection of aluminum shall be in accordance with the Aluminum Association. Mill marking shall not be removed from concealed surfaces. Exposed surfaces not otherwise coated shall have the inked or painted identification marks removed after the material has been inspected and approved by the Engineer.

Anchor Bolts:

All anchor bolts shall be accurately located and held in place with templates at the time the concrete is poured.

Concrete Anchors:

Installation shall not begin until the concrete or masonry receiving the anchors has attained its design strength. An anchor shall not be installed closer than six times its diameter to either an edge of the concrete or masonry, or to another anchor, unless specifically detailed otherwise on the Drawings. Install in strict accordance with manufacturer's written instructions. Use manufacturer's recommended drills and equipment.

Galvanizing and Repair:

- 1) Galvanizing of steel plates, shapes, bars (and products fabricated from these items), and strip 1/8-inch thick or thicker, shall conform to ASTM A 120. Material thinner than 1/8-inch shall either be galvanized before fabrication in conformance with the requirements of ASTM A 525, Coating Designation G 210 or after fabrication, in conformance with the requirements of ASTM A 123, except that the weight of zinc coating shall average not less than 1.2 ounces per square foot of actual surface area with no individual specimen having a weight of less than 1.0 ounce. Unless otherwise provided, galvanizing shall be done before or after fabrication, for material that is thinner than 1/8-inch, at the option of the Subcontractor. Galvanizing will not be required for stainless steel, monel metal, and similar corrosion-resistant parts.
- 2) All welded areas shall be thoroughly cleaned prior to galvanizing to remove all slag or other material that would interfere with the adherence of the zinc. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating.
- 3) In like manner, galvanizing of iron and steel hardware, and nuts and bolts, shall conform to ASTM A 153. Galvanizing shall be performed after fabrication. Galvanizing of tapped holes will not be required.
- 4) Fabrication shall include all operations such as shearing, cutting, punching, forming, drilling, milling, bending, welding, and riveting.
- 5) Components of bolted assemblies shall be galvanized separately before assembly.
- 6) The minimum pitch diameter of the threaded portion of all bolts, anchor bars, or studs shall conform to ANSI B1.1, having a Class 2A tolerance before galvanizing. After galvanizing, the pitch diameter of the nuts or other threaded parts may be tapped over ANSI B1.1, Class 2B tolerance, by the following maximum amounts:

3/8-inch through 9/16-inch	0.016-inch oversize	5/8-inch through 1-inch	0.023-inch oversize
inches and larger	0.033-inch oversize		

- 7) Except for inlet grates not otherwise required to be welded, all edges of tightly contacting surfaces, where galvanizing is required, shall be completely sealed by welding before galvanizing.
- 8) Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired in accordance with SECTION 09900.

Electrolytic Protection:

Where aluminum is in contact with dissimilar metals, or to be embedded in masonry and concrete, protect surfaces. Allow paint to dry before installation of the materials. Protect painted surfaces during installation; should coating become marred, prepare and touch up surface per paint manufacturer's instructions.

Painting:

Thoroughly clean all ferrous metal items not galvanized and give a shop coating of metal primer. Preparation of surfaces and application of primer shall be in accordance with the paint manufacturer's printed directions and recommendations as approved; and in accordance with SECTION 09900, utilizing the appropriate painting system.

Preparation for Shipment:

Insofar as is practical, the items provided hereunder shall be factory assembled. The parts and assemblies that are of necessity shipped unassembled, shall be packaged and clearly tagged in a manner that will protect the materials

Material Specification 09870— Pressure Treated Lumber and Structural Members

1. Scope

The work of this section consists of furnishing pressure treated lumber and structural timber as called for in the Drawings or as specified herein, including boards for flashboard water control risers.

2. Applicable publications

The following standard specifications shall apply to the Work of this Section as indicated:

- 1) Southern Pine Inspection Bureau, Standard Grading Rules, latest edition, (SPIB).
- 2) American Society for Testing Materials (ASTM).
- 3) United States Environmental Protection Agency.
- 4) American Wood Preserves Association (AWPA).

3. General requirements

Lumber and structure timber shall be in accordance with ASTM D 1760-01 and be manufactured and graded in accordance with the current edition of the Standard Grading Rules for Southern Pine Timber, of the SPIB.

4. Component requirements

Preservative— The following pressure treated wood formulations are acceptable:

- 1) DOT Sodium Borate (SBX) [except where moisture exposure is likely]
- 2) Alkaline Copper Quaternary (ACQ-C and ACQ-D with carbonate)
- 3) Copper Azole (CBA-A and CA-B)

Treatment method— The method of treatment for all timber materials shall be in accordance with ASTM D 1760-01. Use of Chromated Copper Arsenate (CCA) treated timber is not permitted.

Additionally, use of Copper Zinc Arsenate (ACZA) treated timber is not permitted due to its extremely high corrosiveness when in contact with metal products.

Pressure treatment— Pressure treatment shall be in accordance with the requirements of American Wood Preserves Association (AWPA) Standard C1, as well as AWPA Standard C2 for lumber and AWPA Standard C9 for plywood. Each piece of pressure preservative treated shall bear the AWPA stamp, indicating point of treatment, preservative symbol, symbol of standard, dated of treatment, and moisture content after treatment.

5. Installation

Avoid milling operations that could adversely affect preservative characteristics of preservative treated wood. Treat end cuts of preservative treated wood members with field-applied end coat prior to installation. Install using stainless steel, hot-dipped galvanized or other approved fasteners for use with treated lumber and plywood.

Flash Board Risers:

1. Contractor shall supply and cut to fit 2" x 6" pressure treated lumber for each flash board riser sufficient to fill the board slots completely to the top of the riser.

Material Specification 09900— Protective Coatings

1. Scope

Summary of work. The Subcontractor shall provide coating on exterior and interior surfaces as specified throughout the Project.

Regulatory requirements. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local and regional jurisdiction. Notify the engineer of any coating specified herein that fails to conform to the requirements for the location of the project or location of application.

- 1) Lead Content: Use only coatings that are totally lead free.
- 2) Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.
- 3) Asbestos Content: Materials shall not contain asbestos.
- 4) Mercury Content: Materials shall not contain mercury or mercury compounds.
- 5) The specified maximum VOC content shall apply to the unthinned product.

2. Applicable publications

American National Standards Institute (ANSI):

A 13.1 - Scheme for the Identification of Piping Systems.

Z 53.1 - Safety Color Code for Marking Physical Hazards.

American Society for Testing and Materials (ASTM):

D4258 - Standard Practice for Surface Cleaning Concrete for Coating. D4259 - Standard Practice for Abrading Concrete.

D4260 - Standard Practice for Acid Etching Concrete.

D4261 - Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.

Society for Protective Coatings (SSPC) Surface Preparation Specifications:

SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.

SP2 - Hand Tool Cleaning: Removes loose mill scale, loose rust, loose paint and other loose foreign matter.

SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.

SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.

SP6 - Commercial Blast Cleaning: Two-thirds of each square inch free of all visible residues; remainder only light discoloration.

SP7 - Brush-Off Blast Cleaning: Removes only loose material, remaining surface tight and abraded to give anchor pattern.

SP10 - Near-White Blast Cleaning: At least 95% of each square inch shall be free of all visible residues.

SP11 - Power Tool Cleaning to Bare Metal.

3. Definitions

Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats),

inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.

- 1) Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.
- 2) If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
- 3) Concealed surfaces are generally not required to have finish-coats unless otherwise specified, but prime coat should be applied and touched up prior to concealment.
- 4) Where equipment and materials are provided with shop-applied finished coating system, only touch up is a part of field painting.
- 5) Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.
- 6) The term "DFT" means minimum dry film thickness, with no tolerance for thinner films.

4. Submittals

Submittals include, but are not limited to, the following:

- 1) Schedule of products and paint systems to be used. Schedule shall include the following information:
 - A. Surfaces for system to be applied.
 - B. Surface preparation method and degree of cleanliness.
 - C. Product manufacturer, name, and number.
 - D. Method of application.
 - E. Dry film thickness per coat of coating to be applied.
- 2) Color charts for selection and acceptance.
- 3) Product information
 - A. Manufacturer's data sheet for each product proposed
 - B. Technical and performance information that demonstrates compliance with the system performance and material requirements
 - C. Manufacturer's instructions and recommendations on surface preparation and application
 - D. Compatibility of shop and field applied coatings (where applicable)
 - E. Material Safety Data Sheet for each product used
- 4) Certification by coating manufacturers that each coating is suitable for service intended as stated on each coating system sheet.
- 5) Subcontractor shall certify in writing to the Engineer that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.
- 6) Samples
 - A. Sample of each paint, finish, and other coating material on 8-1/2 inch by 11-inch sheet metal.

Each sheet shall be completely coated over its entire surface with one coating material, type, or color.

- B. Two sets of color samples that match each color selected by the Engineer from the manufacturer's color charts. The color designation shall be shown on the back of the color sample.

5. Qualifications

Coating work shall be performed by an SSPC certified contractor having a minimum of Category QP 1 certification for work without hazardous paint removal, and Category QP 2 certification for work involving hazardous paint removal.

6. Inspection coordination

- 1) Prepainting Conference: Before field painting starts, representatives for the Subcontractor & Contractor with Engineer's personnel.
- 2) Agenda for the meeting will include details of surface preparations and coating systems to ensure understanding and agreement by all parties for compliance.
- 3) A coating report shall be completed daily by Subcontractor at each phase of the coating system starting with surface preparation. Reports shall be submitted on the form attached at end of this Section.
- 4) In the event a problem occurs with coating system, surface preparation, or application, coating applicator and coating manufacturer's technical representative shall promptly investigate the problem and submit results to Engineer.
- 5) Whenever water tightness in a water-retaining structure is dependent upon work in other sections, the Subcontractor shall assume full responsibility for water tightness of the integrated assembly. Prior to starting work, Subcontractor shall meet with installers involved and with manufacturers of all materials involved to review Drawings and Specifications to insure that materials are being used properly and details are correct. A written report of this meeting shall be submitted to the Engineer. The report shall contain at least: Meeting date and names and affiliations of those present and written statements from each installer and manufacturer of their acceptance of Drawings, Specifications and conditions, and of proposed use of their materials as proper for purposes shown.

7. Warranty

Warranty inspection. A warranty inspection may be conducted during the eleventh month following completion of coating and painting work. Subcontractor and a representative of the coating material manufacturer shall attend this inspection. All defective work shall be repaired in accordance with these specifications and to the satisfaction of the Contractor. The Subcontractor

may, by written notice to the Contractor, reschedule the warranty inspection to another date within the one year correction period or may cancel the warranty inspection altogether. If the warranty inspection is not held, the Subcontractor is not relieved of its other responsibilities under the Contract Documents.

Furnish a warranty issued jointly with the manufacturer and the applicator of the exterior and interior coating, against moisture penetration through treated surfaces for a period of five years. The warranty shall cover both the material necessary to remedy a problem and the labor and equipment to apply the material. At satisfactory completion of the work, the warranty shall be completed, signed, notarized, and delivered to the Engineer.

8. General product information

Materials furnished for each coating system must be compatible with the substrate.

Single manufacturer. All materials in each coating system shall be by the same coating manufacturer to assure compatibility of coatings.

Compatibility. When shop-painted surfaces are to be field coated, the Subcontractor shall ascertain whether finish materials will be compatible with shop coating. Coatings of uncertain composition shall be removed completely before applying new coatings

Colors.

- 1) Color of finish coatings shall match accepted color samples.
- 2) When second and finish coats of a system are of same type, Subcontractor shall tint or use an alternate color on second coat to enable visual coverage inspection of the third coat. When first and second coats only are specified and are of same or different types, tint or use an alternate color on first coat to enable visual coverage inspection of the second coat.

Include on label of material containers

- 1) Manufacturer's name, product name, and number.
- 2) Type of paint and generic name.
- 3) Color name and number.
- 4) Storage and temperature limits.
- 5) Mixing and application instructions, including requirements for precautions which must be taken.
- 6) Drying, recoat, or curing time.

Surfaces to be coated

Generic Description	Example of Surfaces	System
Steel equipment and structural steel, prime coated, normal exposure, non-immersion, interior and exterior	1. Carbon steel in fabricated equipment for machinery	S-3
Aluminum in contact with concrete or any other metal	1. Railing posts, CMP culverts	A-1

Surfaces not to be coated

- 1) Drainage pumps shall be coated by pump manufacturer and only touch up paint supplied by them will be used in the field. See construction specification CS11200.
- 2) Factory finished equipment, except for touch-up or noted otherwise.
- 3) Metal surfaces of stainless steel, bronze, aluminum, and fiberglass.
- 4) Concrete, unless listed on specific surfaces above.
- 5) Machined surfaces
- 6) Grease fittings
- 7) Glass
- 8) Equipment nameplates
- 9) Platform gratings, stair treads, door thresholds, and other walking surfaces unless listed on specific surfaces above
- 10) Concrete Floors unless listed above.

9. Delivery, storage, and handling

Manufacturer recommendations. Unless this specification requires otherwise, Subcontractor shall strictly follow the manufacturer's printed recommendations and instructions for storing and handling coating system materials.

Delivery of materials. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information. Subcontractor shall allow sufficient time for testing if required.

Storage of materials. Subcontractor shall store under conditions recommended by the Material Safety Data Sheets

- 1) All protective coating materials shall be used within the manufacturer's recommended shelf life.
- 2) Store only acceptable materials on Project site.
- 3) Provide separate area and suitable containers for storage of coatings and related coating equipment.
- 4) Dispose of used or leftover containers, thinners, rags, brushes, and rollers in accordance with applicable regulations.

10. Preparation for coating

General. All surfaces to receive protective coatings shall be clean prior to application of coatings. The Subcontractor shall examine all surfaces to be coated, and shall correct all surface defects before application of any coating material. All marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any coating application. Surfaces to be coated shall be dry and free of visible dust.

Protection of surfaces not to be coated. Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

Care shall be exercised not to damage adjacent work during blast cleaning operations. Spray painting shall be conducted under carefully controlled conditions. The Subcontractor shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.

Protection of painted surfaces. Cleaning and coating shall be coordinated so that dust and other contaminants from the cleaning process will not fall on wet, newly coated surfaces.

11. Surface preparation

General

- 1) Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed. If grease or oils are present, SSPC-SP1 must precede any other method specified. Remove surface irregularities such as weld spatter, burrs, or sharp edges, prior to specified surface preparation.
- 2) Depth of profile shall be as specified for each system, but in no instance shall it exceed one-third of the total dry-film thickness of complete system.

- 3) Prepare only those areas which will receive the first coat of the system on the same day.

Metals

- 1) The minimum abrasive blasting surface preparation shall be as indicated in the coating system sheets included at the end of this Section. Where there is a conflict between these specifications and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.
- 2) All sharp edges shall be rounded or chamfered, and all burrs, surface defects, and weld splatter shall be ground smooth prior to blast cleaning.
- 3) The type and size of abrasive shall be selected to produce a surface profile that meets the system sheet requirements for the particular coating and service conditions. Abrasives for submerged and severe service coating systems shall be clean, hard, sharp cutting crushed slag. Automated blasting systems shall not be used for surfaces that will be in submerged service. Metal shot or grit shall not be used for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned to be one with hard, sharp cutting crushed slag.
- 4) Abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.
- 5) The Subcontractor shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.
- 6) Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.
- 7) Surfaces shall be cleaned of all dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another method prior to painting.
- 8) Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.
- 9) Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.
- 10) If the required abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP2 or SSPC SP3 may be used.
- 11) Shop applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP1 before the abrasive blast cleaning work is started.
- 12) Shop primed equipment shall be solvent cleaned in the field before finish coats are applied.

Concrete and concrete masonry units

- 1) Surface preparation shall not begin until at least 30 days after the concrete or masonry has been placed.
- 2) All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC SP1 before abrasive blast cleaning.
- 3) Concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall

be abrasive blast cleaned to remove existing coatings, laitance, deteriorated concrete, and to roughen the surface equivalent to the surface of the No. 80 grit flint sandpaper.

- 4) If acid etching is required by the coating application instructions, the treatment shall be made after abrasive blasting. After etching, Subcontractor shall rinse surfaces with water and test the pH. The pH shall be between neutral and 8.
- 5) Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.
- 6) Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model DB, or equal.

12. Application

- 1) Subcontractor shall apply coatings in accordance with coating manufacturer's recommendations. Materials shall be thoroughly stirred, strained, and kept at uniform consistency during application. Coatings from different manufacturers shall not be mixed together.
- 2) Use properly designed brushes, rollers, and spray equipment for all applications.
- 3) On unprimed surfaces apply first coat of the system the same day as surface preparation.
- 4) Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The Subcontractor shall schedule such inspection with the Engineer in advance.
- 5) Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working day.
- 6) Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe painting for these areas.
- 7) Dry-film thickness of each system shall be at least as thick as the minimum specified. Maximum dry-film thickness shall not exceed the minimum more than 20% or coating manufacturer's requirements, whichever is less. Where a dry-film thickness range is specified, the thickness shall not be shall not be outside the range.
- 8) Shop and field painting shall not be applied within 3 inches of unprepared surface of any substrate such as areas to be welded or bolted.

Environmental conditions

- 1) Atmospheric temperature must be 50 degrees Fahrenheit or higher during application, unless approved in writing by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur during the curing time interval.
- 2) Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.
- 3) Relative humidity must be less than 85% and the temperature of the surface to be painted must be at least 5 degrees above the dew point.
- 4) Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.

Recoat time. In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the previously applied coating in accordance with manufacturer's recommendations.

Protection:

- 1) Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
- 2) Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
- 3) Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical equipment. Where ventilation systems must be kept in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.
- 4) Provide signs to indicate fresh paint areas.
- 5) Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers that cannot be reused in accordance with applicable regulations.
- 6) Do not remove or paint over equipment data plates, code stamps on piping, or UL fire- rating labels.

13. Inspection

- 1) Subcontractor shall provide and use a wet-film gauges to check each application approximately every 15 minutes in order to immediately correct film thickness under or over that specified.
- 2) On ferrous surfaces, measurements shall be made with one of the thickness gauges listed below. The gauge shall be calibrated on metal practically identical in composition and surface preparation to that being coated and be of substantially the same thickness, except that for measurements on metal thicker than 1/4 inch, the instrument may be calibrated on metal with a minimum thickness of 1/4 inch. When calibrating any of the gauges for making film measurements of over 3 mils, the calibrating thickness standards (shims) shall be of non-metallic composition. Where only one thickness criterion is specified, the calibrating shim thickness shall closely approximate the specified thickness, but where both thicknesses are specified, the shim's thickness shall closely approximate an average of the two. Calibrating instructions, thickness standards and, in the case of the Mikrotest gauge, a calibrating tool, should obtained from the manufacturer or supplier of the gauge.
- 3) Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.
- 4) Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.
- 5) Check temperature of the substrate at regular intervals to be certain surface is 5 degrees Fahrenheit or more above the dew point.

14. Cleaning and repairs

Remove spilled, dripped, or splattered paint from surfaces.

Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified

Electrical Specification 13300 – Pump Instrumentation and Controls – General Provisions

1. Scope

A single preapproved system supplier (Supplier) shall furnish all services and equipment defined herein and in other Specification sections as listed below under related work which shall include the following:

- 1) Furnish a dead front NEMA 4X controls panel(s) as needed to house a PLC based control and two soft start motor controls for *75 HP, 208-230/460 Volt, 3 phase, 60 Hz, TEFC, T Frame Motors. (*Contractor shall verify motor specifications with pump manufacturer before purchasing control system)
- 2) A communication link between the pump station site and some remote control/monitoring station, location to be determined later, may be required in the future but is not part of this project.
- 3) Provide two 4-20 ma liquid level monitoring with level sensors for water supply canal and stormwater pond. Level sensors shall include mounting hardware. Water level shall be calibrated to actual NAVD 88 elevation.
- 4) Provide two liquid minimum water level safety switches to be installed in each of the precast concrete pump sumps to protect pumps from damage due to clogged intake screens. Level switches shall include adjustable mounting hardware.
- 5) Provide a Programmable Logic Controller to integrate the functions of the soft start motor controllers, level sensors, motor and pump safeties and manual switches and indicator lights. The PLC shall have installed a custom program for lift station pumps with pump alternation, adjustable time delays and water level settings.
- 6) Provide TVSS for each sensor wire, for the 3 phase primary power, each soft starter, 120 VAC control wire and the PLC.
- 7) Provide one 120 VAC, 15 amp service outlet and one 120 VAC, 5 amp outlet for photocell controlled area lighting fixture.

The supplier shall provide all materials, equipment, labor and services required to achieve a fully integrated and operational system. The supplier shall design and coordinate the instrument and control system for proper operation with related equipment and materials furnished by other suppliers under other sections of these Specifications and with related existing equipment.

Auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with existing equipment or equipment provided by other suppliers under other Sections of these Specifications, shall be included whether they are shown on the instrument drawings or not.

Substitutions on functions or type of equipment specified will acceptable with submittal of shop drawings and approval by Engineer. In order to insure the interchangeability of parts, the maintenance of quality, the ease of interfacing between the various subsystems and the establishment of minimums with regard to ranges and accuracy, strict compliance with the above requirements shall be maintained. In order to insure compatibility between all equipment, it shall be the responsibility of the system supplier to coordinate all interface requirements with mechanical and electrical system suppliers and furnish any signal isolation devices that might be required.

Equipment shall be fabricated, assembled, installed and placed in proper operating condition in full conformity with detail Drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer as approved by the Engineer.

To facilitate the Owner's future operation and maintenance, products shall be of the same major

instrumentation manufacturer, with panel mounted devices of the same type and model as far as possible.

Equipment removed in the course of this work shall remain the property of the Owner. All equipment and installations shall satisfy applicable Federal, State and local codes.

Supplementing this Section, the Drawings and the related Specification sections provide additional details showing panel elevations, instrument device schedules, functional requirements of the system and interaction with other equipment.

The system supplier shall furnish start-up assistance and system check-out services.

2. Related Work

The instrument supplier shall provide all equipment and services defined in this specification.

Instrument and control systems supplied by the supplier shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications and to related existing equipment.

Review of submittals prior to final determination of related equipment shall not relieve the contractor from supplying the systems in full compliance with the specific requirements of the related equipment.

3. Qualifications

The system shall be supplied by Curry Controls Company, Lakeland Florida or equal. The control company shall have been in regular business for at least 5 years designing, fabricating, wiring and servicing custom automation and motor control systems and must have an UL approved shop. The company shall be located in Florida or have a facility within 120 miles of the job site which offers customer support, parts and service.

4. General Submittal Requirements

Submit shop drawings in accordance with GS 025. These shop Drawings shall fully demonstrate that the equipment and services to be furnished will comply with the provisions of these specifications and shall provide a true and complete record of the equipment as manufactured and delivered. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all Drawings reduced to a maximum size of 11-in by 17-in for inclusion within the binder. Separate submittals shall be made as follows:

- 1) Project Plan
- 2) Process instrumentation and controls
- 3) Digital system hardware (programmable controllers, computers, peripherals, etc.)
- 4) Digital system software
- 5) Digital specific system software applications

The project plan shall be submitted and approved before any further submittals will be accepted.

Testing Related Submittals:

- 1) Test Procedures: Submit the procedures proposed to be followed during the in shop and in field tests. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests.
 - A. Preliminary test procedure submittals: Prior to the preparation of the detailed test procedures, submit outlines of the specific proposed tests. Submittals shall include examples of the proposed forms and checklists.
 - B. Test Procedure Submittals: After the preliminary test procedure submittals have been

reviewed by the Engineer and returned stamped either "approved" or "approved as noted, confirm" submit the proposed detailed test procedures. Following this, the tests may be started.

- 2) Test Documentation: Upon completion of each required tests, document the test by submitting a copy of the signed off test procedures.

Spares, Expendables, and Test Equipment Lists Submittal - This submittal shall include for each Subsystem:

- 1) A list of, and descriptive literature for, spares, expendables and test equipment as specified below.
- 2) A separate list of, and descriptive literature for, additional spares, expendables and test equipment recommended by the System Supplier.
- 3) Provide special storage and handling instructions for spare parts if appropriate.

Process Instrumentation and Controls - This submittal shall provide complete documentation of all field instruments, control panels and other instrument and control equipment not specified to be submitted elsewhere.

- 1) Provide data sheets for each component listing all model numbers, optional and ancillary devices that are being provided.

The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information.

- A. Identification tag number per the Loop Diagrams.
 - B. Product (item) name used herein and on the Contract Drawings.
 - C. Manufacturer's complete model number.
 - D. Location of the device.
 - E. Input - output characteristics.
 - F. Range, size and graduations.
 - G. Physical size with dimensions, enclosure NEMA classification and mounting details.
 - H. Materials of construction of all components.
 - I. Instrument or control device sizing calculations where applicable.
 - J. Certified calibration data on all flow metering devices.
- 2) Provide equipment specification sheets which shall fully describe the device, the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:
 - A. Dimension, rigid-clearances or scaled drawing.
 - B. Mounting or installation details.
 - C. Connection.
 - D. Electrical power.
 - E. Materials of construction.
 - F. Environmental characteristics.
 - G. Performance characteristics.

- 3) Provide detailed loop diagrams on a single 11-in by 17-in or 8.5-in by 11-in sheet for each monitoring or control loop. The loop diagram shall show all components of the loop both analog, digital and discrete including all relays, switches, dropping resistors, etc which are being provided for proper operation. Loop numbers used shall correspond to the loop numbers indicated in the contract documents. The format shall be the Instrument Society of America, Standard for Instrument Loop Diagrams, ISA-S5.4 plus the following requirements:
 - A. On each diagram present a tabular summary of 1) the output capability of the transmitting instrument, 2) the input impedance of each receiving instrument, 3) an estimate of the loop wiring impedance based on wire sizes and approximate length used, 4) the total loop impedance, 5) reserve output capacity.
 - B. Show all interconnecting wiring between equipment, panels, terminal junction boxes and field mounted components. The diagrams shall show all components and panel terminal board identification numbers and all wire numbers. This diagram shall include all intermediate terminations between field elements and panels (e.g. terminal junction boxes). The diagrams shall be coordinated with the electrical supplier and shall bear his/her mark showing this has been done.
 - C. Show location of all devices.
 - D. Show instrument description showing type, manufacturer, model number, range, set points and operation (e.g. fail open, open on energization, normally closed, etc) as applicable.
 - E. Show all instrument loop power or instrument air requirements back to termination on terminal block or bulkhead, fuse block (including fuse size), etc, as applicable.
 - F. Show all grounding points within cabinets and panels and identify the connection point of individual components.
- 4) Provide detailed Drawings covering control panels consoles and/or enclosures which shall include:
 - A. Cabinet assembly and layout Drawings to scale. These shall include both front and interior layouts.
 - B. Material, fabrication and painting specifications.
 - C. Provide ladder type schematic diagrams for all hardwired discrete control and power circuits. Diagrams shall show all devices requiring electrical connection. Panel schematic diagrams shall identify all wire types. Relay contacts shall be referenced by line number and sheet number. Schematics shall show each circuit individually, no common schematics will be allowed.
 - D. Panel wiring diagrams showing all power connections to equipment within and on the panel, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes and grounding. This wiring diagram shall be in ladder logic format and shall reference the appropriate loop drawing for continuations or details where required. Show all wire numbers, and terminal block designations.
- 5) The submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

Digital System Hardware (Programmable Controllers, Computers, Peripherals, etc.) - This submittal shall provide complete documentation of the proposed hardware including:

- 1) A complete system block diagram(s) showing in schematic form, the interconnections between major hardware components such as; control centers, panels, power supplies, consoles, computer

and peripheral devices, telemetry equipment, local digital processors and like equipment. The block diagram shall reflect the total integration of all digital devices in the system and shall reflect any man/machine interface locations. All components shall be clearly identified with appropriate cross references to the location of each.

The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communication links.

- 2) Data sheet for each hardware component listing all model numbers, optional, auxiliary and ancillary devices that are being provided.

The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information.

- A. ID tag per the Loop Diagrams (as applicable).
 - B. Product (item) name used herein and on the Contract Drawings.
 - C. Manufacturer's complete model number.
 - D. Location of the device.
 - E. Input - output characteristics.
 - F. Range, size, and graduations.
 - G. Physical size with dimensions, enclosure NEMA classification and mounting details.
 - H. Materials of construction of all components.
 - I. Power supply device sizing calculations where applicable.
- 3) Equipment specification sheets which shall fully describe the device, the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:
 - A. Dimensions and working clearances.
 - B. Mounting or installation details.
 - C. Connection diagrams.
 - D. Electrical power requirements (volts, amps).
 - E. Materials of construction.
 - F. Environmental characteristics.
 - G. Performance characteristics.
 - 4) Detailed drawings covering control consoles and/or enclosures which shall include:
 - A. Cabinet assembly and layout Drawings to scale. These shall include both front and rear layouts.
 - B. Fabrication and painting specifications.
 - C. Color selection samples for selection by the Engineer.
 - D. Panel wiring diagrams showing all power connections to equipment within and on the enclosure, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes and grounding.
 - 5) The System Hardware submittal shall also contain all planning information, site preparation

instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

- 6) Network Analysis: A complete network analysis covering the ultimate system configuration shall be provided within 90 days of Award of Contract.

Digital System Software:

- 1) The Software Functional Design submittal shall provide a complete description of the system on a functional level. The software shall be organized into functional subsystems. The intent of the Software Functional Design submittal shall be to describe, in detail, what functions are to be performed by each subsystem. It is not the intent of this documentation to describe the individual programs that support these functions.
- 2) The Software Functional Design submittal shall include, but not be limited to, the following items for each subsystem:
 - A. Subsystem Abstract - A brief overview of the subsystem which shall describe its major functions.
 - B. Technical Description - A description of all the functions to be performed by the subsystem. This description shall indicate how the functions work from a user's standpoint.
 - C. Subsystem Structure - A diagram of the overall subsystem indicating major modules, data structures and data flow. It shall also be defined whether the function is performed in the central system, a remote unit or both.
 - D. Interface Structure - A diagram and/or description of the manner in which the subsystem interfaces with other subsystems.
 - E. Man-Machine Interface Consideration - A detailed description of all interface between the system and the operator shall be provided. All related CRT formats shall be shown.
 - F. Initialization Considerations - A description of the impact of power fail or system failover type restarts upon the subsystem shall be described.
- 3) The Software Functional Design Documentation shall also include a functional description of all support software as described in this Specification. As with the previous subsystems, this Software Functional Design submittal shall describe what functions are performed by each software support subsystem. This documentation shall describe what functional subsystems and data bases are affected by each support software subsystems.
- 4) This software submittal shall not cover the detailed control algorithms, plant reports, or process graphic displays. These shall be included in a subsequent submittal after the system supplier has met with the Engineer and Owner and developed the specifics of these for the plant.

Specific Digital System Applications

- 1) This submittal shall cover the specific plant control schemes as well as the details of the plant reports and process graphic displays that the system supplier has previously developed through meetings with the Engineer and Owner.
- 2) Any functional part of any loop that is implemented in software may either be shown on the same loop connection diagram or on a separate supplemental "loop software diagram". In either case, software diagramming shall be provided for each loop included herein. The software diagramming and the actual program shall be cross referenced and well annotated.

Symbology for software diagramming shall utilize one of the following methods. (Note this may or may not be the actual programming language used):

- A. Ladder Diagram Format - this method may be used for programmable controllers only. The use of ladder diagrams to show logic in computer or microprocessors that cannot be programmed in ladder logic is not acceptable. Ladder diagram formats which depict analog control functions or which utilize subroutines, special programming control blocks, etc, shall be further described utilizing one of the following formats (formats b through e) as is applicable.
 - B. Flow Chart Format - this method shall utilize symbology and conventions set forth in ANSI X3.5.
 - C. Binary Logic Format - this method shall utilize the symbology and conventions set forth in ISA Standard S5.2. (Latest Edition).
 - D. Structured Logic Format - this method shall utilize structured logic statements; if/and, and/or, etc.
 - E. Graphic Symbolic Representation Format - Symbolic representation of functions of digital systems shall be as set forth in ISA Standard S5.3.
- 3) Included with each diagram shall be:
- A. Brief description of the Control Function.
 - B. Listing of all scanned inputs to the control function.
 - C. A short narrative of the control strategy.
 - D. Any assumptions made in developing the program.
 - E. Listing of all outputs (i.e., AO, DO) from the control function.
 - F. Listing of all operator inputs/outputs to and from the control function. Any special CRT displays related to the function shall be illustrated. A description of the operation of any panels shall be described as it relates to the control function.
 - G. Failure contingencies shall be described in detail.
 - H. Cross references to appropriate loop drawings and other programs.
- 4) The specifics of the logs, reports and process graphic displays shall be developed by the system supplier in conjunction with the Engineer and Owner. The types and quantities are described in the Specification. The specifics of what shall appear on each and what calculations are required to support them shall be developed and submitted in final printed form for approval.

5. Reference Standards

- 1) American Society for Testing and Materials (ASTM).
 - A. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- 2) Instrument Society of America (ISA)
 - A. ISA S5.2 - Binary Logic Diagrams for Process Operations
 - B. ISA S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
 - C. ISA S5.4 - Instrument Loop Diagrams
 - D. Display Instrumentation Logic and Computer Systems
- 3) American National Standards Institute (ANSI)

A. ANSI X3.5 - Flowchart Symbols and Their Usage in Information Processing

4) National Electrical Manufacturers Association (NEMA)

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

6. Delivery, Storage, and Handling

Shipping Precautions

- 1) After completion of shop assembly, factory test and approval all equipment, cabinets, panels and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at job site.
- 2) Special instructions for proper field handling, storage and installation required by the manufacturer for proper protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in resealable plastic bags or other acceptable means of protection.

Identification:

- 1) Each component shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on the outside of the package.
- 2) A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment supplied under this Section.

Storage:

- 1) Equipment shall not be stored out-of-doors. Equipment shall be stored in dry permanent shelters including in-line equipment and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor at his/her own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such tests as directed by the Engineer. This shall be at the cost and expense of the Contractor, or the apparatus shall be replaced by the Contractor at his/her own expense.

7. Maintenance

Tools:

A complete set special tools, cables, gender adapters and PC software shall be furnished with the equipment as necessary for the Owner to operate, test, program and maintain the control systems. Standard mechanical hand tools and Windows PC Laptop will be provided by the Owner.

Test Equipment:

A list of suggested test equipment and estimated costs shall be provided to the Engineer if they are specific to the job, have value for normal operation and maintenance procedures and may not be easily or locally available.

Spare Parts

A list of suggested spare parts (including fuses) and their estimated costs shall be provided to Engineer which are specific to the job, has value for normal operation and maintenance procedures and may not be easily or locally available.

8. Instrumentation General

Type:

All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals which are established standards for the water and wastewater industries.

All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 ma dc (milliampere direct current), however, signals between instruments within the same panel or cabinet may be 1-5V dc (volts direct current), or the like.

Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed.

All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Electrical Drawings, to comply with the National Electrical Code.

All indicators and recorder readouts shall be linear in process units, unless otherwise noted.

All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent.

Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.

All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, in-so-far as possible and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

The field mounted digital system equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.

All electronic/digital equipment shall be provided with radio frequency interference protection and shall be FCC approved.

Electrical:

All equipment, except for actuated valves, shall be designed to operate on a 60 Hertz alternating current power source at a nominal 117 volts, plus or minus 10 percent, except where specifically noted. Actuated valves shall be designed to operate from 480 V, 3 phase, 60 Hertz power. All regulators and power supplied required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

9. Lightning/Surge Protection

General - Lightning/Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level and be maintenance free and self-restoring.

Instruments shall be housed in a suitable metallic case, properly grounded. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate NEMA 4 junction box coupled to the enclosure.

Power Supply - Protection of all 120 VAC instrument power supply lines shall be provided. Cabinet(s)/panel(s) and groups of field instruments regardless of location (indoor or outdoor), shall be protected by UL-listed isolation transformers and three-stage LTSS with combination gas tube and zener diode devices. Individual field instruments shall be protected by individual 120VAC three-stage LTSS devices. Transient protection shall be provided for line to line and line to ground protection. Maximum withstand ratings shall be coordinated with the electrical service entrance surge arrestors. Transformers shall be GE, SOLA, or equal. LTSS devices shall be Phoenix Contact, Joslyn, MCG Electronics, or equal.

Signal Line - All signal lines when they enter or leave a building shall be protected through the use of UL-listed two-stage LTSS devices containing gas tube surge arrestors, inductor filters, and transorb diode protectors. Panel protectors shall be track-mounted. Field protectors shall be conduit-mounted. These shall be provided at both ends of the signal lines and as close to the instruments as possible. Devices shall be Phoenix Contact, Joslyn, Rosemount, EDCO, Weidmueller, or equal.

10. Other Products

See CS 13315 for other instrumentation product specifications.

11. Control Panels, Enclosure, and Cabinets

The following Paragraphs describe general fabrication requirements of control panels, enclosures, consoles and cabinets.

- 1) Pneumatic Tubing
 - A. None used.
- 2) Wiring
 - A. All interconnecting wiring, except for electronic circuits, shall have 600 volt insulation and rated for not less than 90 degrees C.
 - B. Power distribution wiring on the line side of fuses shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 14 AWG minimum. Electronic analog circuits shall utilize 16 AWG shielded, twisted pair, cable insulated for not less than 300 volts.
 - C. Power and low voltage dc wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 12-in. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.
 - D. All wiring shall terminate in a master terminal board, rigid type and numbered. The master terminal board shall have a minimum of 25 percent spares. Terminal blocks shall be arranged

in vertical rows and separated into groups. (Power, AC control, DC signal, alarm, and graphic). Terminal blocks shall be barrier type with the appropriate voltage rating (600 volts minimum). They shall be the raised channel mounted type. Wire connectors shall be the hook fork type with non-insulated barrel for crimp type compression connection to the wire. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6-in of the side panel or adjacent terminal.

- E. All wiring to hand switches and the like which are live circuits independent of the panel's normal circuit breaker protection shall be clearly identified as such.
 - F. All wiring shall be clearly tagged and color coded. All tag numbers and color coding shall correspond to the panel wiring diagrams and loop drawings. All power wiring, control wiring, grounding and dc wiring shall utilize different color insulation for each wiring system used.
 - G. Each control loop or system shall be individually protected by fuses or breakers. All protecting devices shall be clearly labeled and located for ease of maintenance.
 - H. Provide surge protectors on all incoming power supply lines at each panel.
- 3) Equipment Mounting/Arrangement
- A. All components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Components mounting shall be oriented in accordance with the internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the drawing, specifications and supplier's data.
 - B. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc, required to maintain the NEMA rating of the panel.
- 4) Nameplates
- A. All panels shall be supplied with suitable nameplates which identify the panel and individual devices as required.
- 5) Painting
- A. All sections shall be descaled, degreased, filled, ground and finished. The enclosure when fabricated of steel shall be finished with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel and FRP panels will not require a paint finish.
- 6) Freestanding Vertical Panels, Wall or Unistrut Mounted Cabinets, or Computer Consoles
- A. All assemblies shall be Underwriters Laboratories (UL) listed and approved.
 - B. The instrumentation shall be housed in a dust-proof and waterproof NEMA 4X, Type 304, 14 Gauge stainless steel enclosure powder coated white, with a 304 stainless steel, lockable three-point handle-type latching mechanism. All exterior hardware and hinges shall be stainless steel.
 - C. A 14 gauge aluminum back-panel will be provided to mount all electrical control devices. All interior electrical control components mounted on the back-panel will be secured using stainless steel machine screws 8-32 minimum size. Heavier items including the RTU, control

power transformer and items in excess of 10 pounds will be secured with 1/4"-20 stainless steel machine screws. Screw anchor nuts will be permanently installed in the sub-panel using cadmium plated steel knurled threaded inserts AKV Model AKS7 or equal. No self-tapping sub-panel tapped screws will be used.

- D. All wiring to the control devices within the RTU panel will be harnessed and permanently attached to the panel using welded 8-32 studs and stud mounted cable ties. Stick on tie wrap fasteners are not acceptable. Wiring will be supported every 8 inches minimum. This panel will be grounded via a 10-32 stud located in the bottom hinged side and bonded to the enclosure and ground buss.
- E. There shall be a permanently affixed document pocket on the interior side of the exterior enclosure door to include a laminated wiring diagram, and bill of materials.
- F. No devices or equipment shall be mounted to the top of the control panel enclosure, exclusive of radio antenna.
- G. The enclosure, sub-panel, and dead front operator panel will all be painted with heat fused polyester powder, electrostatically applied paint on a phosphatized base. The enclosure will be white, inside and outside. The interior panels will be silver-tek bronze.
- H. All components will be able to operate at -22 F or lower to 140 F and higher at 95% humidity
- I. Panels shall be provided with full length rear doors or front access doors as shown on the panel details. Full length rear access door shall be not greater than 24-in in width. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments. All doors shall be mounted with strong, continuous, piano type hinges and be provided with lockable door handles and three point latches.
- J. Approximate size and equipment layout is shown on the panel details.
- K. Print storage pockets shall be provided on the inside of each panel. Its size shall be of sufficient size to hold al of the prints required to service the equipment. Reduced drawings shall be provided to be stored in these pockets.

12. General Installation

Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all information relevant to the placing of process control work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

The instrumentation loop diagrams indicate the intent of the interconnection between the individual instruments. Any exceptions should be noted. Two complete sets of approved shop drawings shall be kept at the job site during all on-site construction. Both sets shall be identically marked up to reflect any modifications made during field installation or start-up. All markings shall be verified and initialed by the Engineer or his/her designated representative.

Following completion of installation and the operational readiness test, one set of the marked up drawings shall be provided to the Engineer, the other retained by the supplier for incorporation of the mark-ups into final as-built documentation.

The instrumentation installation details on the Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the Drawings, the American Petroleum Institute (API) Recommended Practice 550 shall be followed as applicable.

All work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising therefrom.

All equipment used in areas designated as hazardous shall be designed for the Class, Group and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the supplier shall bear full responsibility for such violations and assume all costs arising there from.

Unless specifically shown in the Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing and blow down service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors and shut-off valves.

Field instruments requiring power supplies shall be provided with local electrical shutoffs and fuses as required.

Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

The system supplier shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the system supplier shall be required to ship his/her material in sections sized to permit passing through restricted areas in the building. The system supplier shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).

The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground point be employed for each shield.

Lifting rings from cabinets/assemblies shall be removed. Hole plugs shall be provided for the holes of the same color as the cabinet.

The system supplier, acting through the Contractor, shall coordinate the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval. He/She shall be responsible to insure that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to insure a satisfactory functioning installation.

13. Test (General)

The supplier shall test all equipment at the factory prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the supplier shall be tested at the factory as a single fully integrated system.

As a minimum, the testing shall include the following:

- 1) Unwitnessed Factory Test (UFT).
- 2) Operational Readiness Tests (ORT).
- 3) Functional Demonstration Tests (FDT).
- 4) 30-Day Acceptance Tests

Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

All tests shall be conducted in accordance with prior Engineer- approved procedures, forms and checklist. Each specific test to be performed shall be described and a space provided after it for signoff by the appropriate party after its satisfactory completion.

Copies of these signoff test procedures, forms and checklists will constitute the required test documentation.

Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation. Define these simulations techniques in the test procedures.

The Contractor shall require the supplier to coordinate all of his/her testing with him, all affected Subcontractors and the Owner.

The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved Test Procedures.

The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

No equipment shall be shipped until the engineer has received all test results and approved the system is ready for shipment.

The supplier shall furnish the services of servicemen, all special calibration and test equipment and labor to perform the field tests.

14. Unwitnessed Factory Tests (UFT)

The entire system except for primary elements, final control elements, and field mounted transmitters shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions and control devices/functions. All panels, consoles and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, Specifications and Drawings.

During the tests all digital system hardware and software shall be operated for at least five days continuously without a failure to verify the system is capable of continuous operation.

15. Operational Readiness Tests (ORT)

General: Prior to startup and the Functional Acceptance Test, the entire system shall be certified (inspected, tested and documented) that it is READY for operation.

Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and these Specifications.

- 1) The Loop/Component Inspections and Tests shall be implemented using Engineer-approved forms and checklists.
 - A. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment and calibration. These reports shall include the following information and check off items with spaces for signoff by the system supplier:
 1. Project Name.
 2. Loop Number.

3. Tag Number for each component.
 4. Check offs/signoffs for each component.
 - Tag/identification
 - Installation
 - Termination - wiring
 - Termination - tubing
 - Calibration/adjustment
 5. Check offs/signoffs for the loop.
 - Panel interface terminations
 - I/O interface terminations
 - I/O signal operation
 - Inputs/outputs operational: received/sent, processed, adjusted
 - Total loop operation
 6. Space for comments.
- B. Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry and a space for signoff by the system supplier:
1. Project Name.
 2. Loop Number.
 3. Component Tag Number of I/O Module Number.
 4. Component Code Number Analog System.
 5. Manufacturer (for Analog system element).
 6. Model Number/Serial Number (for Analog system).
 7. Summary of Functional Requirements. For example:
 - For Indicators and Recorders: Scale and chart ranges
 - For Transmitters/Converters: Scale and chart ranges
 - For Computing Elements: Function
 - For Controllers: Action (direct/reverse) control modes (PID)
 - For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL)
 - For I/O Modules: Input or output
 8. Calibrations; for example:
 - For Analog Devices: Required and actual inputs and outputs at 0, 10, 50 and 100 percent of span, rising and falling.
 - For Discrete Devices: Required and actual trip points and reset points.
 - For Controllers: Mode settings (PID).

- For I/O Modules: Required and actual inputs or outputs for 0, 10, 50 and 100 percent of span, rising and falling.
9. Space for comments.
 10. Space for signoff by the system supplier.
- 2) The Contractor shall require the system supplier to maintain the Loop Status Reports and Components Calibration sheets at the jobsite and make them available to the Engineer/Owner at any time.
 - 3) These inspections and tests do not require witnessing. However, the Engineer will review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Tests. Any deficiencies found shall be corrected.

16. Functional Acceptance Test

Prior to startup and the Functional Acceptance Test, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the operational readiness tests.

Once the facility has been started up and is operating, a witnessed Functional Acceptance Test shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.

Loop-specific and non-loop-specific tests shall be the same as specified under Factory Demonstration Tests except that the entire installed system shall be tested and all functions demonstrated.

Updated versions of the documentation specified to be provided for during the Factory Tests shall be made available to the Engineer at the jobsite both before and during the tests. In addition, one copy of all O & M Manuals shall be made available to the Engineer at the jobsite both before and during testing.

The daily schedule specified to be followed during the Factory Tests shall also be followed during the Functional Acceptance Testing.

The system shall operate for a continuous 100 hours without failure before this test will be considered successful.

17. 30-Day Acceptance Test

After completion of the Operational Readiness Tests, the System Supplier shall be responsible for operation of the entire system for a period of 30 consecutive days, under conditions of full plant process operation, without a single non-field repairable malfunction.

During this test, plant operating and supplier personnel shall be present as required. The supplier is expected to provide personnel for this test who have an intimate knowledge of the hardware and software of the system.

While this test is proceeding, the Owner shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes.

Any malfunction during the tests shall be analyzed and corrections made by the system supplier. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

Any malfunction, during this 30 consecutive day test period, which cannot be corrected within 24 hours of occurrence by the Supplier's personnel, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction.

Upon completion of repairs, by the system supplier, the test shall be repeated as specified herein. In the event of rejection of any part or function, perform repairs or replacement within 90 days.

All data base errors must be corrected prior to the start of each test period. The 30 day test will not be considered successful until all data base is correct.

The total availability of the system shall be greater than 99.5 percent during this test period. Availability shall be defined as "Avail. = ((Total Time-Down Time) ÷ Total Time) x 100".

Down times due to power outages or other factors outside the normal protection devices or backup power supplies provided, shall not contribute to the availability test times above.

Upon successful completion of the 30 day operation test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the one year warranty period shall commence.

18. Training

Contractor shall provide onsite training as recommended by manufacturer. Training shall be conducted by a qualified manufacturer representative for up to 16 hours.

The cost of training programs to be conducted with Owner's personnel shall be included in the Contract price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

The supplier shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

The supplier shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.

The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.

All training schedules shall be coordinated with, and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

19. Warranty/Preventative Maintenance

A written maintenance contract executed by the supplier shall be provided to the Owner for on-site warranty and preventive maintenance services. This maintenance contract shall include all labor, parts, and emergency calls providing on-site response within 24 hours, to provide complete system maintenance for a period of one year after the date of final acceptance of the system.

20. Control System Diagrams and Details

To assist the system supplier in determining the scope of work, a series of loop diagrams and details are provided. Unless specifically stated otherwise, the system supplier shall be responsible for providing all instrumentation, control equipment and auxiliary devices necessary to perform the functions specified herein and as shown and described on these diagrams. Any auxiliary devices such as lightning/surge protectors, relays, timers, signal isolators, signal boosters, etc, which are necessary for complete operation of the system, or to perform the functions specified shall be included, whether or not they are specifically shown or tabulated on the loop diagrams.

The intent of the loop diagrams is to describe in as much detail as possible, the hardware, software and functional requirements of a process measurement or control system. They are not intended to convey requirements for conduit and wiring between panels or system components. This information is included in appropriate electrical specifications and Drawings.

Electrical Specification 13315 – Pump Instrumentation and Controls - Products**1. Scope**

This section covers the furnishing, installation, and services for the following major systems, panels and subassemblies:

- 1) Control/Monitoring Systems
 - A. One PLC based control system.
- 2) Two soft start motor controls.
- 3) Two Level sensors and two-level switches. Refer to Instrumentation General Provisions, ES 13300.

2. Related Work

Refer to ES 13300 for General Provisions Refer to ES 13330 for PLC Software

3. Submittals

Refer to ES 13300.

4. Reference Standards

Refer to ES 13300.

5. Quality Assurance

Refer to ES 13300.

6. Maintenance and Test Equipment

Refer to ES 1330

7. Field Mounted Instruments**Weighted Float Type Level Switches:**

- 1) Type:
 - A. The switch assembly shall be weighted and suspended on its own cable.
 - B. Mercury switch
- 2) Functional/Performance:
 - A. Temperature Rating - 0 to 50 degrees C
 - B. Contact Rating - Up to 250V AC/DC, and 8 amps AC, 5 amps DC.
 - C. Contact Arrangement - Form C contact which is field selectable normally open or closed.
 - D. Angular Operating Differential - 20 degrees.
 - E. Vertical Operating Differential - 1/2-inch.
- 3) Physical:
 - A. Contact - Sealed mercury switch housed in a chemical-resistant polypropylene casing.
 - B. Flexible Support Cable - Synthetic three wire cable, minimum 19 AWG wire.
 - C. Specific Gravity - Match to fluid being measured.
- 4) Options/Accessories Required:

- A. Provide flexible support cable of sufficient length to ensure no splice or connection is required in the basin.
 - B. Provide junction box inside the stilling well for connection of cable.
 - C. Provide stainless steel supports/mounting accessories as required.
 - D. Support bracket with adjustable clamp for setting switch height.
- 5) Manufacturers:
- A. FLYGT Model ENH-10.
 - B. Or equal.

4-20 ma Liquid Level Sensors:

- 1) Type:
 - A. The Level Sensor assembly shall be field mounted in a PVC wet well specifically provided for the sensor
 - B. 4-20 ma submersible sensor
- 2) Functional/Performance:
 - A. Temperature Rating - 0 to 50 degrees C
- 3) Physical:
 - A. Contact - Sealed housed in a chemical-resistant polypropylene or stainless steel casing.
 - B. Flexible Support Cable - Synthetic wire cable, minimum 19 AWG wire.
- 4) Options/Accessories Required:
 - A. Provide flexible support cable of sufficient length to ensure no splice or connection is required in the basin.
 - B. Provide junction box inside the stilling well for connection of cable.
 - C. Provide stainless steel supports/mounting accessories as required.
 - D. Support bracket with adjustable clamp for setting sensor height.
- 5) Manufacturers:
 - A. FLYGT or equal.

8. Miscellaneous Panel Components

Pilot Type Indicating Lights:

- 1) Type:
 - A. Heavy duty oil tight type which utilizes a low voltage lamp.
- 2) Functional/Performance:
 - A. Units shall be provided with low voltage lamps suitable for the voltage supplied. Lights supplied with 120V AC power shall have integral reduced voltage transformers.
 - B. Lamps shall be replaceable from the front of the unit.
- 3) Physical:
 - A. Lens color shall be as indicated on the instrument device schedule. Lens shall be approximately 1-1/4-in in diameter.

- B. Provide legend faceplates engraved to indicate the required function of each device.
 - C. Units shall be rated NEMA 13 for indoor panels. Units located outdoors or indicated to be weatherproof shall be rated NEMA 4X.
- 4) Manufacturers:
- A. Square D
 - B. Micro switch
 - C. Allen Bradley
 - D. General Electric

Rotary Hand Switches and Pushbuttons:

- 1) Type:
- A. Control devices shall be heavy duty oil tight type with stackable contact blocks.
- 2) Functional/Performance:
- A. Provide contact arrangement and switching action as required for the control system specified.
- 3) Physical:
- A. For 120V AC service provide contacts rated 10 amps at 120V AC, for 24V DC service provide silver sliding contacts rated 5 amps at 125V DC, for electronic (millivolt/ milliamp) switching provide contacts rated lamp at 28V DC.
 - B. Pushbuttons shall have flush type operators. Selector switches shall have knob or wing lever operators.
 - C. Units shall be rated NEMA Type 13 for indoor service. Units located outdoors or indicated to be weatherproof shall be rated NEMA 4X.
 - D. Provide legend plates denoting switch/pushbutton position/ function.
- 4) Options/Accessories Required:
- A. Provide lock-out-pushbuttons, key-operators, etc, as indicated on the instrument device schedule.
 - B. Provide make-before-break bridging contacts where required.
- 5) Manufacturers:
- A. Square D
 - B. Micro switch
 - C. Allen Bradley
 - D. General Electric

Square Type Selector Switches and Multilight Indicators:

- 1) Type:
- A. Selector switches and indicators shall be of the illuminated, multiple lamp, oil tight type with square shape display windows and removable contact blocks.
- 2) Functional/Performance:
- A. Provide contact arrangement as required for the control system specified.
- 3) Physical:

- A. For 120V AC service provide contacts rated 10 amps at 120V AC, for 24V DC circuits provide silver sliding contacts rated 5 amps at 125V DC, for electronic (Millivolt/ Milliamp) switching duty provide gold plated sliding contacts rated lamp at 28V DC.
 - B. Units shall be approximately 2-1/2-in square and shall be divided into as many as four separate lightable quadrants.
 - C. Indicating lights used with 120 volt control power shall be provided with an integral transformer to reduce the voltage.
 - D. Provide legend plates, color inserts and cover plates to indicate the required function.
- 4) Manufacturers:
- A. Square D
 - B. Micro switch type CMC

Industrial Relays and Time Delays

- 1) Type:
 - A. Industrial heavy duty relays.
- 2) Functional/Performance:
 - A. Contact arrangement/function shall be as required to meet the specified control function specified.
 - B. Contacts shall be rated 10 amps continuous at 600 volts.
 - C. Relays shall be provided with convertible contact blocks.
 - D. Pneumatic time delay relays shall be used on time delays less than 180 seconds and shall be adjustable.
 - E. Solid state time delay relays shall be used on time delays between 180 seconds and one-hour.
- 3) Options/Accessories Required:
 - A. Provide all mounting rails, etc, that are required.
- 4) Manufacturers:
 - A. Square D
 - B. Allen Bradley

General Purpose Relays and Time Delays

- 5) Type:
 - A. Units shall be of the general purpose plug-in type.
- 6) Functional/Performance:
 - A. Coil voltage shall match supply voltage.
 - B. Contact arrangement/function shall be as required to meet the specified control function.
 - C. Mechanical life expectancy shall be in excess of 10 million.
 - D. Duty cycle shall be rated for continuous operation.
 - E. Units shall be provided with integral indicating light to indicate if relay is energized.
 - F. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.

- G. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.
- 7) Physical:
 - A. For 120V AC service provide contacts rated 10 amps at 120V AC, for 24V DC service provide contacts rated 5 amps at 28V DC, for electronic (milliamp/millivolt) switching applicator provide gold plated contacts rated for electronic service.
 - B. Relays shall be provided with dust and moisture resistant covers.
- 8) Options/Accessories Required:
 - A. Provide mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
 - B. Provide mounting rails/holders as required.
- 9) Manufacturers (or equal):
 - A. Square D
 - B. Eagle signal controls
 - C. Allen Bradley
 - D. Potter & Brumfield

Signal Relay Switches (Current Trips)

- 1) Type:
 - A. Solid state electronic type.
- 2) Functional/Performance:
 - A. Input - 4-20 mA
 - B. Output - Isolated contact output, double pole double throw, rated 5 amps at 120V AC.
 - C. Accuracy - 0.1 percent.
 - D. Protection - Provide RFI protection.
 - E. Deadband - Adjustable between 0.1 and 5.0 percent of span.
 - F. Set point Adjustment - Provide graduated dial for each alarm set point from 0 to full scale. Alarms shall be adjustable to trip on rising or falling input signal.
 - G. Repeatability - Trip point repeatability shall be at least 0.1 percent of span.
- 3) Physical:
 - A. Mounting - Suitable for mounting in an enclosure or high density instrument rack.
- 4) Options/Accessories Required:
 - A. Mounting rack or general purpose enclosure as required.
- 5) Manufacturers (or equal):
 - A. Moore Industries
 - B. Rochester Instrument Systems
 - C. Acromag Inc.

Signal Isolators/Boosters/Converters

- 1) Type:

- A. Solid state electronic type.
- 2) Functional/Performance:
 - A. Accuracy - 0.15 percent.
 - B. Inputs - Current, voltage, frequency, temperature, or resistance as required.
 - C. Outputs - Current or voltage as required.
 - D. Isolation - There shall be complete isolation between input Circuitry, output circuitry, and the power supply.
 - E. Adjustments - Zero and span adjustment shall be provided.
 - F. Protection - Provide RFI protection.
- 3) Physical:
 - A. Mounting - Suitable for mounting in an enclosure or instrument rack.
- 4) Options/Accessories Required:
 - A. Mounting rack or general purpose enclosure as required.
- 5) Manufacturers (or equal):
 - A. Moore Industries
 - B. Rochester Instrument Systems
 - C. Acromag Inc.

Signal Selectors, Computation, and Conditioning Relays

- 1) Type:
 - A. Solid state electronic type.
- 2) Functional/Performance:
 - A. Inputs - 4-20 mA
 - B. Outputs - 4-20 mA
 - C. Protection - Provide RFI protection.
 - D. Operation - The relay shall multiply, add, subtract, select, extract the square root, or perform the specified conditioning/computation function required. All inputs shall be able to be individually rescaled and biased as required.
 - E. Isolation - All inputs, outputs, and power supplies shall be completely isolated.
 - F. Accuracy - 0.35 percent of span.
 - G. Adjustments - Multiturn potentiometer for zero, span, scaling, and biasing.
- 3) Physical:
 - A. Mounting - Suitable for mounting in an enclosure or instrument rack.
- 4) Options/Accessories Required:
 - A. Mounting rack or general purpose enclosure as required.
- 5) Manufacturers:
 - A. Moore Industries

- B. Rochester Instrument Systems
- C. Acromag Inc.

Intrinsically Safe Relays

- 1) Type:
 - A. Relays shall be of the solid state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe usage in hazardous areas.
- 2) Options/Accessories Required:
 - A. Relays shall match power supply provided.
 - B. Relays shall be located in non-hazardous areas.
- 3) Manufacturers (or equal):
 - A. Consolidated Electric
 - B. Gems Safe-Pak
 - C. Warrick Controls
 - D. R. Stahl, Inc.

9. Soft Start Motor Controls

Each *75 HP electric pump motor shall be operated and protected by a solid state soft start motor starter. (*Contractor shall verify motor HP and specifications with pump manufacturer before purchasing control system.)

The soft start shall consist of hardwire I/O and an interface compatible with the proposed PLC.

Soft start shall be suitable for a 120V single phase control power supply. It also shall be provided with a main circuit breaker and TVSS.

Manufacturer: Square D or equal

10. Programmable Logic Controllers

The pump control station will include a Programmable Logic Controller (PLC). The PLC will accumulate data generated by: level sensors, level switches, and run time meter. The PLC will instruct the pump soft start controllers to perform operations according to a custom program.

PLC and other low voltage controls may be mounted in the same enclosure as the motor soft starters or in a separate enclosure, as safety standards and design efficiency permit.

PLC shall be Square D, Omron or Allen-Bradley MicroLogix or equal with Ethernet port and associated I/O hardware.

11. Execution – General

Instrumentation and accessory equipment shall be installed in accordance with specification Section 13300 and as specified herein.

Unless specifically shown otherwise in the Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves.

All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adapters, and shut-off valves.

Field instruments requiring power supplies shall be provided with local electrical shut-offs and fuses as required.

The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment, but in no case shall more than one ground point be employed for each shield.

Lifting rings shall be removed from all panels and assemblies once in position. Plugs of the same color as the panel shall then be installed in the holes.

The supplier shall coordinate the installation, placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval.

The supplier shall ensure that all field wiring for power and signal circuits are in accordance with best industry practice, and provide for all necessary system grounding to insure a satisfactory functioning installation.

Electrical Specification 13330 – Pumps Instrumentation and Controls – PLC Software

1. Scope

This section covers the furnishing program logic for the PLC controller located at the inflow pump station.

2. Definitions

This section refers to several sensors which are referred to by letter for clarity. The sensors are defined in the table below.

Sensor ID	Sensor Location	Measures	Type
A	PVC Wet Well	Inflow Canal Water Supply Level	Analog
B	Inside Sluice Gate Precast Pump	Stormwater Pond Water Level	Analog
C	Inside Pump 1 Precast Sump	Minimum Water Level Sensor	Float Switch
D	Inside Pump 2 Precast Sump	Minimum Water Level Sensor	Float Switch

The PLC program will have time delays to provide smooth operation and to prevent damage to the motors. A summary of the delays are provided in the table below.

Delay ID	PLC Time Range	Beginning Program Time Value	Time Units	Description
1	0-9999	300	Seconds	Sensor A start pump signal – Lead Pump
2	0-9999	300	Seconds	Sensor A start pump signal – Lag Pump
3	0-9999	60	Seconds	Sensor A stop pump signal – Lead Pump
4	0-9999	60	Seconds	Sensor A stop pump signal – Lag Pump
5	0-9999	10	Seconds	Sensor B run enable pumps signal
6	0-9999	120	Seconds	Sensor B stop pumps signal
7	0-9999	10	Seconds	Sensor C stop pump signal
8	0-9999	60	Seconds	Sensor C enable pump restart signal
9	0-9999	10	Seconds	Sensor D stop pump signal
10	0-9999	60	Seconds	Sensor D enable pump restart signal

3. Related Work

Refer to ES 13300 and 13315.

4. Submittals

Programmer must demonstrate to the Engineer the functionality of the proposed PLC program prior to installing on the PLC units.

5. Reference Standards

Refer to ES 13300.

6. Quality Assurance

Refer to ES 13300.

7. Maintenance and Test Equipment

Any special equipment and software necessary for the continued operation, monitoring and maintenance of the PLC's and the pump control program will be included as part of this contract with no extra charges incurred to the Owner including PC software and connection cables for standard Windows PC laptop (supplied by Owner.)

8. Program Logix – Duplex Pump Control

The control logic discussion assumes that the PCL logic use standard duplex pump control logic for two pump down (dewatering) pumps. Typical for this type of software are the following functions:

- 1) Pump start alternation
- 2) Pump alternation for run time
- 3) Alternating or parallel pump operation based on level conditions and program settings
- 4) Adjustable time delays to provide smooth operation
- 5) Pump short cycling protection
- 6) Hand-Off-Auto coordination
- 7) Restart options after safety shutdown
- 8) Indicator lights for time delays, safety shutdown and pump operation
- 9) Bypass a pump which has been taken off line by safeties
- 10) Log and display run time hours for each pump
- 11) Log faults and provide fault resolution

Lead pump will be the first to start when the water level reaches the required level, Lag pump will start if water level continues to rise to second start level, typically 6" above lead pump.

9. Program Logix – PLC Software Development

The control equipment designer and programmer of the PLC should coordinate with the Engineer by meeting with him through internet software or in person prior developing the PVC software.

The Engineer envisions the PLC software to be a standard duplex pump control product with only minor adjustments to the programming being required to fit the specifics of the proposed pump station.

Electrical Specification 16050 – Basic Materials and Methods

1. Scope

Summary of Work: The Contractor shall furnish all labor, equipment and material for installation of the electrical hardware as described herein and as shown on the Drawings.

The provisions of this Section apply to all electrical specifications, except for those covered by sections ES 13300, ES 13315 and ES 13330.

Concrete, excavation, backfill, and steel reinforcement required for encasement, installation, or construction of the work of the various sections of the electrical specifications is included as a part of the work under the respective sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.

The Contractor shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required by the Drawings. Contractor shall also be responsible for field verifying the available space in substation switchboards to integrate new power circuit breakers. Costs for this work shall be included in the Contractor's original bid amount.

2. Applicable publications

- 1) NEC (NFPA 70) National Electrical Code 2015 Edition
- 2) NETA International Electrical Testing Association – Acceptance Testing Specifications
- 3) NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum)
- 4) Local Building Codes and Standards

3. Submittals

The Contractor shall provide the following for shop drawing submittals:

- 1) Complete material lists stating manufacturer and brand name of each item or class of material.
- 2) Shop Drawings for all grounding work not specifically indicated.
- 3) Front, side, rear elevations, and top views with dimensional data.
- 4) Location of conduit entrances and access plates.
- 5) Component data.
- 6) Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers.
- 7) Method of anchoring, seismic requirements, weight.
- 8) Types of materials and finish.
- 9) Nameplates.
- 10) Temperature limitations, as applicable.
- 11) Voltage requirement, phase, and current, as applicable.
- 12) Front and rear access requirements.
- 13) Test reports.
- 14) Grounding requirements.
- 15) Catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material. Catalog data sheets shall be stamped to indicate the project name,

applicable Section and paragraph, model number, and options. This information shall be marked in spaces designated for such data in the company's stamp.

Shop Drawings shall be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed shall be crossed out or deleted from Shop Drawings.

Materials and equipment schedules: The Contractor shall deliver to the Engineer within 30 days of the commencement date in the Notice to Proceed, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

Record drawings: The Contractor shall show invert and top elevations and routing of all duct banks and concealed below-grade electrical installations. Buried electrical conduits shall be located by showing the horizontal distance to two fixed structures at the start of the conduit installation, the end of the conduit installation, and for every conduit change of direction. In addition, circuit schematic drawings and wiring drawings shall show all field changes. Layout drawings shall show all equipment location changes. Record drawings shall be prepared and be available to the Engineer.

Where test reports are indicated, proof of design test reports for mass-produced equipment shall be submitted with the Shop Drawings, and factory performance test reports for custom-manufactured equipment shall be submitted and be approved prior to shipment. Field test reports shall be submitted for review prior to Substantial Completion.

4. Responsibilities

The Contractor shall contact the serving utility and verify compliance with requirements before construction. The Contractor shall coordinate schedules and payments for work by all utilities.

Electrical service shall be as indicated and be as required by the serving utility.

The Contractor shall verify and provide all service conduits, fittings, transformer pad, grounding devices, and all service wires not provided by the serving utility. The Contractor shall verify with the utility the exact location of each service point and type of service, and shall pay all charges levied by the serving utilities as part of the work.

Permits shall be obtained and inspection fees shall be paid according to the terms of the contract between the Owner and the Contractor.

The Contractor shall pay all connection and turn-on service charges required by the utility company.

The Contractor shall be responsible for factory and field tests required by the electrical specifications, by the Engineer and other authorities having jurisdiction. The Contractor shall furnish necessary testing equipment and pay costs of tests, including all replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.

5. Inspection coordination

The Contractor shall provide access to the work for the Engineer as requested for inspection. The Contractor shall provide 48 hours notice of its intention to begin new work activities.

6. Products

1) General:

- A. The Contractor shall provide equipment and materials that shall be new, shall be listed by UL, or by an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction, and shall bear the UL label or other certification where these requirements apply. Equipment and materials shall be the products of experienced and reputable manufacturers in the industry. Similar

- items in the work shall be products of the same manufacturer. Equipment and materials shall be of heavy duty industrial grade.
- B. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.
- C. On devices indicated to display dates, the year shall be displayed as 4 digits.

2) Signage:

- A. Electrical Equipment
 - 1. Each piece of electrical equipment shall be legibly marked to indicate its purpose unless the purpose is indicated by the location and arrangement.
- B. Warning Signs
 - 1. 115 to 600 Volts nominal, or less. – Entrances to rooms and other guarded locations or enclosures that contain live parts shall be marked with conspicuous signs prohibiting unqualified persons to enter.
 - 2. All buildings, rooms or enclosures containing exposed live parts or exposed conductors operating at 600 volts nominal, or less, shall be lockable. Permanent and conspicuous warning signs shall be provided reading as follows: DANGER – HIGH VOLTAGE – KEEP OUT.
 - 3. Outside branch circuits and feeders – for 600 volts nominal, or more – Warning signs shall be posted in plain view where unauthorized persons might come in contact with live parts – "WARNING – HIGH VOLTAGE – KEEP OUT"
- C. Isolating Switches – Isolating switches not interlocked with an approved circuit interrupting device shall be provided with a sign warning against opening them under load.

7. Area designations

- 1) General:
 - A. Raceway system enclosures shall comply as mentioned herein.
 - B. Electric work specifically indicated in sections within any of the Specifications shall comply with those requirements.

AREA	NEMA ENCLOSURE CLASSIFICATION						Notes
	1	3R	4X	7	9	12	
Air Condition Space	√						
Non A/C Space Interior		√	√			√	Or as directed by project drawings
Outdoor Application		√	√				Or as directed by project drawings

2) Materials Requirements

- A. NEMA 4X enclosures shall be 316 stainless steel.

- B. NEMA 7 enclosures shall be cast aluminum where used with aluminum conduit; cast iron when used with galvanized steel conduit.
- C. NEMA 1, 3R, and 12 enclosures shall be steel coated with ANSI 61 grey paint. NEMA 4X, 7, and 9 shall not be coated.

8. Mounting hardware

1) Miscellaneous Hardware

- A. Threaded rods for trapeze supports shall be continuous threaded, 3/8-inch diameter minimum. Utilize hot dipped galvanized steel for dry indoor non process areas and 316 stainless steel for “wet,” “damp,” or “corrosive” areas.
- B. Strut for mounting of conduits and equipment shall be 316 stainless steel or hot dipped galvanized as specified on project drawings. Where contact with concrete or dissimilar metals may cause galvanic corrosion, suitable non-metallic insulators shall be utilized to prevent such corrosion.
- C. Wall-mounted panels that weigh more than 500 pounds shall be provided and mounted with steel support pedestals. Transformers hung from 4-inch stud walls and weighing more than 300 pounds shall have auxiliary floor supports.

2) Bolts and Anchors

- A. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolt material, anchor bolts and cap screws shall be in accordance with the following
 - 1. Structural connections: ASTM A 307, Grade A or B, hot-dip galvanized
 - 2. Anchor Bolts: ASTM A 307, Grade A or B, or ASTM A 36, hot-dip galvanized
 - 3. High strength bolts where indicated: ASTM A 325
- B. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.
 - 1. All buried locations.
 - 2. All submerged locations.
 - 3. All locations subject to seasonal or occasional flooding.
 - 4. Inside hydraulic structures below the top of the structure.
 - 5. Inside buried vaults, manholes, and structures which do not drain through a gravity sewer or to a sump with a pump.
 - 6. All chemical handling areas.
 - 7. Inside trenches, containment walls, and curbed areas.
 - 8. Locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.
- C. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for

submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

1. Anti-seizure lubricant shall be classified as acceptable for potable water use by the NSF.
2. Anti-seizure lubricant shall be odorless, non-toxic, weather-proof, teflon based, with operating temperatures up to 475 deg F.

D. Indoors Finished Areas Service:

1. Expanding-Type Anchors: Expanding-type anchors if indicated or permitted, shall be 18-8 stainless steel split expansion ring with threaded stud bolt body and integral cone expander, nut and washer. Plated carbon steel, hot-dipped galvanized carbon steel, type 304 stainless steel or type 316 stainless steel anchor bodies, as identified in the drawings or other notations.

9. Electrical identification

Nameplates: Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock. Each shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style with no characters smaller than 1/4-inch high.

Conductor and Equipment Identification: Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place.

10. Execution

General:

Incidentals: The Contractor shall provide all materials and incidentals required for a complete and operable system, even if not required explicitly by the Specifications or the Drawings. Typical incidentals are terminal lugs not furnished with vendor supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor furnished equipment to connect with other equipment indicated in the Contract Documents.

- 1) Field Control of Location and Arrangement: The Contractor shall determine the exact locations in the field based on the physical size and arrangement of equipment, finished elevations, and other obstructions. The Drawings indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Locations on the Drawings, however, shall be followed as closely as possible.
 - A. Where conduit development drawings or "home runs" are shown, the Contractor shall route the conduits in accordance with the indicated installation requirements. Routings shall be exposed or encased as indicated, except that conduit in finished areas shall be concealed unless specifically indicated otherwise. Conduits encased in a slab shall be sized for conduit OD to not exceed one-third of the slab thickness and be laid out and spaced to not impede concrete flow.
 - B. Conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms as indicated. Where the Drawings do not indicate exact locations, such locations shall be determined by the Engineer. Lighting fixture locations shall be adjusted slightly as necessary prior to installation to avoid obstructions and to minimize shadows.
 - C. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the

Contractor's responsibility to provide all lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated. Wiring shall be #12 AWG minimum, and conduits shall be 3/4-inch minimum (exposed) and 1-inch minimum (encased). Where circuits are combined in the same raceway, the Contractor shall derate conductor ampacities in accordance with NEC requirements.

- 2) Workmanship: Materials and equipment shall be installed in strict accordance with printed recommendations of the manufacturer. Installation shall be accomplished by workers skilled in the work. Installation shall be coordinated in the field with other trades to avoid interference.
- 3) Protection of Equipment and Materials: The Contractor shall fully protect materials and equipment against damage from any cause. Materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. Moving parts shall be kept clean and dry. The Contractor shall replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections as part of the work.
- 4) Incoming utility power equipment shall be provided in conformance with the utility's requirements.
- 5) Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 FR 1926, as applicable), state building standards, and applicable local codes and regulations.

Core drilling:

- 1) The Contractor shall perform core drilling required for installation of raceways through concrete walls and floors. Locations of floor penetrations, as may be required, shall be based on field conditions. Verify all core drilling locations based on equipment actually furnished as well as exact field placement. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the Engineer prior to any core drilling activities.

Concrete housekeeping pads:

- 1) Concrete housekeeping pads shall be provided for indoor floor standing electrical equipment. Housekeeping pads for equipment, including future units, shall be 4 inches nominal above surrounding finished floor or grade and 4 inches larger in both dimensions than the equipment, unless otherwise indicated.
- 2) Concrete housekeeping curbs shall be provided for all conduit stub-ups in indoor locations that are not concealed by equipment enclosures. Such curbing shall be 4 inches nominal above finished floor or grade.

Equipment identification: Equipment and devices shall be identified as follows:

- 1) Nameplates shall be provided for all panelboards, control and instrumentation panels, starters, switches, and pushbutton stations. In addition to nameplates, control devices shall be equipped with standard collar-type legend plates.
- 2) Control devices within enclosures shall be identified as indicated. Identification shall be similar to the subparagraph above.
- 3) Toggle switches which control loads out of sight of switch and all multi-switch locations of more than 2 switches shall have inscribed finish plates clearly indicating the load.
- 4) Where shown on the drawings, name tags shall be inscribed with the equipment name and tag number.
- 5) The Contractor shall furnish typewritten circuit directories for panelboards; circuit directory shall

accurately reflect the devices/equipment connected to each circuit breaker.

Cleaning:

- 1) The Contractor shall thoroughly clean the electrical work before final acceptance. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. Oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Touch-up paint shall be applied to scratches on panels and cabinets. Electrical cabinets or enclosures shall be vacuum-cleaned.

Electrical Specification 16110 – Raceways, Boxes, Fittings, and Supports

1. Scope

Furnish and install complete raceway systems as shown on the Drawings and as specified herein. This specification applies to all electrical work except those covered by sections CS 13300, CS 13315, and CS 13330.

2. Applicable publications

- 1) NEC (NFPA 70) National Electrical Code.
- 2) NETA International Electrical Testing Association - Acceptance Testing Specifications.
- 3) NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum).
- 4) Local Building Codes and Standards.
- 5) ASTM A47 - Standard Specification for Ferric Malleable Iron Castings
- 6) ASTM 1011 - Standard Specification for Steel. Sheet and Strip, Hot-Rolled, Carbon, Structural, High - Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- 7) ASTM 635 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Commercial Steel, Drawing Steel, Structural, High - Strength Low Alloy, High - Strength Low Alloy with Improved Formability, Hot-Rolled, General Requirements for D2000 Standard Classification System for Rubber Products in Automotive Applications
- 8) ASTM D 2564-02 - Solvent Cements for Poly Vinyl Chloride Plastic Piping Systems
- 9) UL 508 - Industrial Control Equipment
- 10) UL 514A - Metallic Outlet Boxes
- 11) UL 514B - Fittings for Cable and Conduit
- 12) UL 886 - Standard for Safety for Outlet Boxes and Fittings for use in Hazardous (Classified) Locations
- 13) UL 1059 - Terminal Blocks
- 14) UL 6 - Standard for Safety for Rigid Metal Conduit - Tight
- 15) UL 360 - Standard for Liquid Tight Flexible Steel Conduit
- 16) ANSI C80.1 revision 94 – Standard for Rigid Steel Conduit - Zinc Coated
- 17) UL 5B - Strut-Type Channel Raceways and Fittings

3. Shop drawings

Complete catalog cuts of all raceways, fittings, boxes, supports, and mounting hardware, marked to show proposed materials and finishes.

Complete catalog cuts of all pullboxes, manholes, and handholes, marked where applicable to show proposed materials and finishes

Dimensioned layout drawings of all cable tray routings, including elevations.

Dimensioned layout drawings of all conduit racks and trapeze type hangers including elevations.

4. Responsibilities

Unless otherwise hereinafter specified, or shown on the Drawings, all boxes shall be metal.

Combination expansion-deflection fittings shall be used where exposed or embedded conduits cross

structure expansion joints.

All conduit, fittings and accessories shall be UL listed and labeled.

Furnish sizes of conduit, fittings and accessories as indicated, specified or as required by Electrical Codes and Standards.

5. Inspection coordination

The Subcontractor shall provide access to the work for the Engineer as requested for inspection. The Subcontractor shall provide 48 hours notice of its intention to begin new work activities.

6. Materials

Rigid Galvanized Steel (RGS) Conduit:

- 1) Rigid steel conduit shall be mild steel, hot-dip galvanized inside and out.
- 2) Rigid steel conduit shall be manufactured in accordance with ANSI C80.1 - Rigid Steel Conduit, Zinc Coated, and UL-6.
- 3) Each conduit length shall be threaded on both ends with threads protected.

Rigid Non-Metallic Conduit:

- 1) Rigid non-metallic conduit shall be Schedule 40 PVC, UV resistant.
- 2) Rigid non-metallic conduit shall be manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit.

Electrical Metallic Tubing (EMT):

- 1) Electrical metallic tubing shall be hot-dipped galvanized steel. EMT conduit shall only be allowed in office or control room areas which are considered air conditioned interior space.

Liquidtight Flexible Conduit:

- 1) Liquidtight flexible conduit shall be constructed of a flexible galvanized metal core with a sunlight resistant thermoplastic outer jacket. Utilize liquid tight flexible conduit with spiral enclosed copper bonding conductors for conduit sizes 1 1/4 inches and smaller.
- 2) Liquidtight flexible conduit shall be manufactured in accordance with UL-360 - Steel Conduits, Liquid-Tight Flexible.
- 3) Fittings used with flexible conduit shall be of the screw-in type.

Flexible Couplings:

- 1) Flexible couplings shall be of heavy-duty construction, water tight, and have electrical conductivity equal to rigid conduit. 3/4" - 2" shall have an inner brass core with insulating liner, outer bronze braid. 2 1/2"-4" shall have inner stainless steel core with insulating liner, outer stainless steel braid. Couplings shall be in compliance with UL Standard 886 and conform to ASTM A47-77, Grade 32510.

Boxes and Fittings:

- 1) Terminal boxes, junction boxes, pull boxes, etc. shall be sheet steel unless otherwise shown on the Drawings. Boxes shall be galvanized and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14-gauge metal and covers shall not be less than 12-gauge metal. Covers shall be gasketed and fastened with stainless steel screws.
- 2) Cast iron boxes and fittings shall be galvanized with cast galvanized covers and corrosion proof screws. Cast and malleable iron fittings for use with metallic conduit shall be the threaded type

with five full threads

- 3) In outdoor areas, conduit shall be terminated in raintight hubs. In other than outdoor areas, sealed locknuts and bushings shall be used.
- 4) Conduit, fittings, and boxes in hazardous locations shall be suitable for the Class and Division indicated.
- 5) Floor boxes shall be of the round or rectangular cast metal type. Boxes shall be watertight and cover frames shall be adjustable. Box covers shall finish flush with finished floor surface. Boxes shall be located as directed by the District and/or as indicated on the Drawings. Necessary gaskets, sealing compound, plugs, or devices shall be provided for the complete installation.
- 6) Steel elbows and couplings shall be hot-dipped galvanized. Joints shall be taped.
- 7) Electrical metallic tubing fittings shall be of the rain-tight, concrete-tight, compression type.

Outlet Boxes:

- 1) Construction: Outlet boxes shall be Zinc-coated or cadmium-plated sheet steel boxes of a class to satisfy the condition at each outlet except where unilet or conduit bodies are required. They shall be knockout type with knockouts removed only where necessary to accommodate the conduit entering. Square cornered, straight-sided gang boxes, 4-inch octagon concrete rings and 4 inch octagon hung ceiling boxes with bars, may be folded type. All other boxes shall be one-piece, deep-drawn.
- 2) Size: All boxes shall be of sufficient size to accommodate the required number and sizes of conduits, wires and splices in accordance with NEC requirements, but not smaller than size shown or specified. Special purpose boxes shall be sized for the device or application indicated.
- 3) Fixture Studs: 3/8 inch malleable-iron fixture studs shall be used in outlet boxes for ceiling lighting fixtures and interior-bracket lighting fixtures, other than lamp receptacles and drop cords.
- 4) Exposed: Screw-joint type boxes, with gasketed weatherproof covers shall be used in locations exposed to the weather.
- 5) Tile Boxes: Boxes rectangular in shape with square corners and straight sides shall be used for receptacles and switches mounted in furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls. Install without plaster rings.
- 6) Wall-mounted Switch, Receptacle, and Signal Boxes: Shall be, unless otherwise noted or specified, not less than 4 inches square by 2 inches deep for two devices, and multigang boxes for more than two devices. Boxes for switches and receptacles on unfinished walls may be screw-joint type with covers to fit the devices.
- 7) Wall-mounted Telephone Outlet Boxes: Shall be 4 inches square by 2 inches deep, unless otherwise noted on the Drawings.
- 8) Light Fixture Boxes: Shall be 4 inch diameter by 2 inch deep, minimum, for ceiling and interior bracket fixtures with concealed conduits. Plaster covers for bracket fixtures shall have 3-inch diameter openings. Screw-joint boxes with canopy seat shall be used for ceiling and interior bracket fixtures with exposed conduits.
- 9) Grounding Terminal: Provide a grounding terminal in each box containing a green equipment ground conductor, or serving motors, lighting fixtures, or receptacles. Grounding terminal shall be green-colored, washer-in-head, machine screw or grounding bushing.

Pullboxes:

- 1) Pullboxes shall be minimum NEC size requirements unless larger box is noted, as specified for

outlet boxes with blank cover for pullboxes with internal volume not more than 150 cubic inches, and as specified for cabinets for pullboxes with internal volume over 150 cubic inches, except covers to have some thickness as box with corrosion resistant screw or bolt attachment.

PVC Fittings:

- 1) Fittings for use with rigid non-metallic conduit shall be PVC, solvent welded type.
- 2) Provide watertight field-applied coat of all weather PVC solvent cement compound with viscosity and wet film thickness recommended as required for installation of non-metallic conduit and fittings. The cement compound shall be furnished by the conduit manufacturer. PVC solvent cement shall meet the requirements of ASTM D 2564-02, "Solvent Cements for Poly Vinyl Chloride Plastic Piping Systems".

Stainless Steel Boxes:

- 1) Stainless steel boxes shall be used with RGS conduit and where indicated.
- 2) Stainless steel boxes shall be NEMA 4X, Type 316 as indicated in specification SECTION 16050.
- 3) Stainless steel shall be minimum 14-gauge thickness, with a brushed finish.
- 4) Doors shall have full length stainless steel piano hinges. Non-hinged boxes are not acceptable.

Terminal Cabinets:

- 1) Interiors shall be so designed that control relays and terminal blocks can be replaced or added without disturbing adjacent units. Each cabinet shall be furnished with a minimum of 30% spare terminals.
- 2) All interiors shall be completely factory assembled with control relays, terminal blocks, insulating barriers, etc. All 120 volt AC and DC terminal blocks shall be isolated from each other by insulating barriers or separate enclosures.
- 3) All wiring within the cabinets shall be grouped together in harnesses and secured to the structure.
- 4) For terminal block specification refer to ES 16120.
- 5) Boxes shall be made from 14 gauge galvanized steel and shall be of sufficient size to provide a minimum of 4 inches of wiring space on all sides and between adjacent terminal blocks. A minimum two-inch spare shall be provided between control relays. A minimum of four mounting studs shall be provided on each cabinet. Cabinets shall be furnished without knockouts. Holes for raceways shall be drilled on the job.
- 6) A single hinged door shall cover the front of each terminal cabinet. Doors shall have a neoprene gasket, vault type handle, three-point catch and lock. Two keys will be supplied for each lock. All locks shall be keyed alike.
- 7) All exterior and interior steel surfaces of the cabinets shall be properly cleaned and finished with gray over a rust-inhibiting phosphatized coating conforming to ANSI A55.1. The finish paint shall be of a type to which field applied paint will adhere.
- 8) Cabinets shall be painted 14 gauge or 16 gauge steel with 14 gauge steel doors, seams continuously welded and ground smooth, no holes or knockouts, with latch kit hardware. Cabinets shall conform to UL 508, File No. E61997, Type 12 and Type 13, NEMA/EEMAC Type 12 and Type 13.

Conduit Mounting Hardware:

- 1) Conduit supports shall be one hole galvanized malleable iron pipe straps with galvanized clamp backs and nesting backs where required.

- 2) Ceiling hangers shall be adjustable galvanized carbon steel pipe hangers. Straps or hangers of plumbers perforated tape shall not be acceptable. Hanger rods shall be 3/8 inch minimum galvanized all-thread rod and shall meet or exceed ASTM A193B7. Trapeze, rod type hangers shall not be loaded in excess of 500 pounds per rod. Where loading exceeds this value, rigid frames shall be provided.
- 3) Racks shall be constructed from framing channel. Channels and all associated hardware shall be steel, hot dipped galvanized after fabrication of the channel. Field cuts shall be painted with zinc rich paint. Channels attached directly to building surfaces shall be 14-gauge minimum material 1 5/8 inch wide by 13/16 inch depth. All other channels shall be 12-gauge minimum 1 5/8 inch wide by 1 5/8 inch minimum depth. Racks shall be designed to limit deflection to 1/200 of span length. All exposed ends of framing channel shall be covered with manufacturer's standard plastic inserts.

7. Cable trays

Cable tray systems shall be composed of straight sections, curved sections, fittings, and accessories as defined in the latest NEMA Standards publication VE-1 - Ventilated Cable Tray.

- 1) The cable tray and fittings shall be hot-dip galvanized after fabrication, aluminum or stainless steel.
- 2) Cable tray shall be ladder type with 6, 9, 12, or 24-inch spacing with ventilated trough or solid trough. Tray sizes shall have 3, 4, 5 or 6-inch minimum usable load depth as indicated on project drawings.
- 3) Loading capacities shall meet NEMA weight classification with a safety factor of 1.5.

8. Manholes and handholes

Manholes and pullboxes shall be precast, light duty, heavy duty or extra heavy duty of square, rectangular, or round configurations with loading capacities as shown on the drawings.

- 1) Traffic covers shall be traffic type, H-20 loading, except as indicated otherwise. Manhole and pullbox covers shall be identified as "Electric" by raised letters cast into the covers. Manhole frames and covers shall be heavy duty, frost-tight, water-tight neoprene gasketed frame, solid lids and inner lids.
- 2) Manholes shall have frost-proof and water-tight grey iron frames and covers with solid lids and inner lids with 28-inch clear openings. Covers and lids shall be bolted to cast-in-place steel frames with corrosion resistant hardware. Covers shall be cast-iron and shall have pick- holes.

Manholes and pullboxes shall be equipped with pulling-in irons opposite and below each ductway entrance.

PVC ductbank conduits shall be provided with end bells. Brackets and 60-inch concrete inserts shall be provided in manholes as required for racking wiring through manholes.

9. Duct banks

Underground ducts shall be Schedule 40 PVC, unless otherwise noted.

Ducts shall be arranged as shown on the drawings and encased in concrete. Variations from the standard duct bank configurations will be considered by the Engineer on a case by case basis if needed to clear obstacles or provide adequate cover. Concrete shall have 3,000 psi compressive strength conforming to CS 031/34M.

Ductbanks shall contain a No. 4/0 bare stranded copper ground wire. The ground wire shall be continuous through the ductbank and terminate at power distribution equipment and grounding grid.

Identification Tape: Continuous lengths of underground warning tapes shall be installed 12-inches above and parallel to all ductbanks. Tape shall be 6-inches wide polyethylene with foil backing film imprinted "CAUTION - ELECTRIC UTILITIES BELOW."

10. Preparation

- 1) The Subcontractor shall provide suitable protection for conduit risers against damage during construction.
- 2) The Subcontractor shall cap ends of all conduits before concrete is poured.
- 3) The Subcontractor shall install pull cord and cap all conduits after cleaning where conduits are to be left empty by this Contract.
- 4) The Subcontractor shall carefully ream ends of all conduit lengths after cutting to eliminate sharp burrs.
- 5) The Subcontractor shall clean out all conduits before pulling wire.
- 6) The Subcontractor shall clean out all conduits immediately after concrete work is finished.

11. Installation

- 1) No conduit smaller than 3/4-inch electrical trade size shall be used, nor shall any have more than three 90° bends in any one run. Pull boxes shall be provided as required per references listed in section 1.02.
- 2) No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.
- 3) The ends of all conduits shall be tightly plugged to exclude dust and moisture while under construction.
- 4) Conduit supports shall be spaced at intervals of 8 feet or less, as required to obtain rigid construction.
- 5) Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-inch diameter.
- 6) Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete inserts of the spot type shall be provided.
- 7) All conduits on exposed work shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduits shall be run perfectly straight and true.
- 8) No unbroken run shall exceed 300 feet in length. This length shall be reduced by 75-feet for each 90° elbow.
- 9) Conduits terminating in pressed steel boxes shall have double lock nuts and insulated bushings.
- 10) Conduits terminating in gasketed enclosures shall be terminated with conduit hubs.
- 11) Conduit wall seals shall be used for all conduits penetrating walls below grade or other locations shown on the Drawings.
- 12) Liquid-tight, flexible metal conduit shall be used for all motor terminations and other equipment where vibration is present.

- 13) Conduit stubouts for future construction shall be provided with threaded PVC end caps at each end.
- 14) All wiring shall be run in raceway unless indicated otherwise.
- 15) Raceways shall be installed between equipment as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be accomplished with tools designed for this purpose. Factory elbows shall be utilized wherever possible.
- 16) Where raceway routings are indicated on plan views, follow those routings to the extent possible.
- 17) Where raceways are indicated but routing is not shown, such as home runs or on conduit developments and schedules, raceway routings shall be the Subcontractor's choice and in strict accordance with the NEC and customary installation practice. Raceway shall be encased, exposed, concealed, or under floor as indicated, except that conduit in finished areas shall be concealed unless specifically indicated otherwise.
- 18) Underground raceways shall be installed between manholes, handholes, and pullboxes as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be fabricated with tools designed for this purpose. Factory elbows shall be utilized wherever possible. Continuous lengths of underground warning tapes shall be installed 12-inches above and parallel to all underground conduits. Tape shall be 6-inches wide polyethylene with foil backing film imprinted "CAUTION – ELECTRIC UTILITIES BELOW."
- 19) Routing shall be adjusted to avoid obstruction. Coordinate between trades prior to installation of raceways. Lack of such coordination shall not be justification for extra compensation, and removal and re-installation to resolve conflicts shall be by the Subcontractor as part of the work.
- 20) Exposed raceways shall be installed parallel or perpendicular to structural beams.
- 21) Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.
- 22) Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, suitable insulating means shall be provided to prevent such corrosion.
- 23) Holes:
 - A. The Subcontractor shall provide the required insert materials and holes for all openings in new work completely bonded, curbed, flashed and finished off in an approved manner, whether in concrete, steel grating, metal panels or roofs. Resulting seal shall prevent smoke and gas penetration and adhere to Lloyds Register Standards Certificate Numbers SVG/F93/468, SVG/F93/469 and SVG/F93/470 and applicable UL Standards. Insert materials shall be of one of the following type:
 1. Non-shrinking grout applied to continuously fill annular space between pipe and wall opening. The resulting seal shall serve as an isolator of fire, weather and gaseous conditions.
 2. Fire rated, Ozone and Ultra-Violet radiation resistant, two-part silicone room temperature vulcanizing (RTV) foam.
 - B. The Subcontractor shall core-drill all holes required in existing building work using a dustless method.
- 24) The Subcontractor shall place grout or foam as specified, in the following locations:
 - A. All holes in concrete wall, floor and roof slabs after installation of conduit.

- B. Wall entrances where conduit enters the building or vaults from exterior underground.
- 25) The Subcontractor shall install fire and smoke stop fittings at all conduit penetration of fire rated walls, ceilings and floors.

12. Conduit

Exposed conduit shall be Rigid Schedule 40 PVC, unless indicated otherwise:

- 1) In areas with chlorine or acid, schedule 40 PVC shall be utilized.
- 2) In lime or ferric chloride areas, rigid aluminum conduit shall be utilized
- 3) In Class I, Div. I or Div. II hazardous locations, rigid aluminum conduit shall be utilized.

Where conduit emerges from concrete encasement, a PVC Schedule 40 elbow shall be utilized for transition from the concrete (utilize PVC Coated, RGS elbow for analog control conduits). Conduit shall emerge from the concrete perpendicular to the surface whenever possible.

Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4-inch for concrete not exposed to weather or in contact with the ground.

Conduits passing through a slab, wall, or beam shall not impair significantly the strength of the construction.

Conduits embedded within a slab, wall, or beam (other than those merely passing through) shall satisfy the following:

- 1) Conduits with their fittings embedded within a column shall not displace more than 4 percent of the gross area of cross section.
- 2) Conduits shall not be larger in outside dimension than one third the overall thickness of slab, wall, or beam in which embedded.
- 3) Conduits shall not be spaced closer than 3 outside diameters on centers

Conduit shall be placed so that cutting, bending, or displacing reinforcement from its proper location will not be required.

Threads shall be coated with a conductive lubricant before assembly.

Joints shall be tight, thoroughly grounded, secure, and free of obstructions in the pipe. Conduit shall be adequately reamed to prevent damage to wires and cables during installation. Strap wrenches and vises shall be used to install conduit to prevent wrench marks on conduit. Conduit with wrench marks shall be replaced.

Wherever possible, conduit runs shall slope to drain at one or both ends of run. Wherever conduit enters substructures below grade, the conduit shall be sloped to drain water away from the structure.

Installation of rigid steel conduit through a core-drilled hole in an exterior wall below grade shall utilize a modular sealing device.

Each conduit shall be identified at each end with a permanent non-corrosive metal marker. Designation shall be pressure stamped into the tag. The conduit identification shall be designated circuit number as shown.

13. Supports

The Subcontractor shall construct metal framing strut systems with sufficient rigidity to hold all mounted equipment and material in permanent and neat alignment. All channels, fittings and hardware of the strut assemblies shall be as per contract drawings and specifications and shall not exceed load requirements in UL classification 5B, NEC Article 352 and applicable NEMA and ASTM standards.

Utilize galvanized material for interior non-corrosive and air conditioned spaces and stainless steel or aluminum, for outdoor or corrosive environments.

Design supports to provide 1/4-inch space between equipment housings and walls or columns upon which they are mounted.

After Power Tool Cleaning, paint all welds, field cuts and damaged areas with one manufacturer type of primer and paint. Utilize organic zinc-rich primer at 3 mils dry film thickness.

All screws, nuts, bolts, pipe clamps and other anchoring materials for struts and framing shall be stainless steel.

All outdoor supports shall be constructed to meet wind load requirements of the site as set forth in structural specifications or/and contract drawings.

14. Outlet boxes

Installation: Unless otherwise specified or shown on the drawings, outlet boxes shall be flush mounted, and the front edges of the boxes or plaster covers shall be flush with the finished wall or ceiling line; or, if installed in walls and ceilings of incombustible construction, not more than 1/4 inch back of same. Mount boxes with the long axes of devices vertical, unless otherwise specified. A multiple of box extensions and/or covers will not be permitted. Install in a rigid and satisfactory manner with suitable metal bar hangers, box cleats, adjustable box hangers, etc. Use wood screws on wood, expansion shields on masonry and machine screws on steelwork.

Mounting Heights: The mounting height of a wall-mounted outlet box shall be construed to mean the height from the finished floor to the horizontal center line of the cover plate. On exposed tile, block, or brick constructions, mount outlet boxes at the nearest bed joint to the mounting height indicated. Verify heights with the Engineer.

Wall-mounted Switch, Receptacle and Signal Outlets: On columns, pilasters, etc., mount so the centers of the columns are clear for future installation of partitions. Install outlet boxes near doors or windows close to the trim. Install according to architectural drawings, unless other locations are approved by the Engineer.

Back-to-back: Outlets shown on the drawings "back-to-back" are to be installed with a minimum of 6 inches lateral separation between outlets. "Through-the-wall" type boxes are not permitted.

15. Fixture connections

Recessed or surface light fixtures in lay-in or accessible ceilings shall be connected with minimum 1/2 inch flexible metallic conduit, 4 to 6 feet long, with grounding provisions.

16. Ductbanks

Ductbanks shall be installed in accordance with the criteria below:

- 1) Duct shall be assembled using high impact non-metallic spacers and saddles to provide conduits with vertical and horizontal separation. Plastic spacers shall be set every 5-feet. The duct array shall be anchored every 5-feet to prevent movement during placement of concrete.
- 2) The duct shall be laid on a grade line of at least 3-inches per 100-feet, sloping towards pullboxes or manholes. Duct shall be installed and pullbox and manhole depths adjusted so that the top of the concrete envelope is a minimum of 18-inches below grade and a minimum of 24-inches below roadways.
- 3) Changes in direction of the duct envelope by more than 10° horizontally or vertically shall be accomplished using bends with a minimum radius 24 times the

duct diameter.

- 4) Duct couplings shall be staggered a minimum of 6-inches.
- 5) The bottom of trench shall be of select backfill or sand.

Each bore of the completed ductbank shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct. After passing of the mandrel, a wire brush and swab shall be drawn through. Spare raceways that are not indicated to contain conductors shall have a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.

Duct entrances shall be grouted smooth; ducts shall be terminated with flush end bells. Sections of pre-fabricated manholes and pullboxes shall be assembled with waterproof mastic and shall be set on a 12-inch bed of gravel as recommended by the manufacturer or as required by field conditions.

Ductbank penetration through walls of manholes, pullboxes, and building walls below grade shall be watertight.

Concrete encased ductbank shall terminate at building foundations. When duct enters the building with a concrete slab on grade foundation, duct shall not be encased, but shall transition to rigid steel conduits at the edge of the slab.

17. Buried conduits, yard areas

The Subcontractor shall place PVC schedule 40 conduit where indicated on project drawings. Make all joints watertight per requirements of section 2.01.J.2.

Bury conduits a minimum of 24 inches below finish grade unless indicated otherwise. Slope conduit away from conduit risers where possible.

Maintain 6-inch separation from underground piping.

Use long radius bends at all risers unless indicated otherwise.

After trench bottom has been excavated to elevation, lay conduit. Backfilling shall be as specified in CS 023.

Provide watertight seal around wires where conduit terminates in pull box.

Empty service entrance conduits shall be PVC Schedule 40, or as otherwise required by serving utility.

Electrical Specification 16120 – Wires and Cables

1. Scope

This section includes furnishing and installing (including terminations) of all electrical wire, cable and accessories except where it conflicts with sections CS 13300 or CS 13315.

2. Applicable publications

- 1) NEC (NFPA 70) National Electrical Code 2002 Edition.
- 2) UL 83 – Thermoplastic Insulated Wires and Cables
- 3) NETA International Electrical Testing Association – 1999 Acceptance Testing Specifications

3. Submittals

The Subcontractor shall submit Shop Drawings in accordance with Subcontractor Submittals.

4. Testing

Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements of 1999 NETA ATS Section 7.3.2. Factory test results shall be submitted to Engineer prior to shipment of cable. The following field tests shall be the minimum requirements:

- 1) Power cable rated at 600 VAC shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
- 2) Field testing shall be done after cables are installed in the raceways.
- 3) Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the Engineer for review and acceptance.
- 4) Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

Continuity Test: Control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cables in service.

5. Inspection coordination

The Subcontractor shall provide access to the work for the Engineer as requested for inspection. The Subcontractor shall provide 48 hours notice of its intention to begin new work activities.

6. Warranty

Any cable which fails either the megohmmeter or continuity test after installation shall be replaced by the Subcontractor at no cost to the Contractor.

7. Materials

Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. All conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

Low voltage wire and cable:

- 1) Power and Lighting Wire
 - A. Wire rated for 600 volts in duct or conduit for all power and lighting circuits shall be Class B Type THHN or THWN, polyvinyl chloride rated at 90° C in dry locations, 75° C in wet locations, meeting the requirements of UL 83.
 - B. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
 - C. Conductors for branch circuits as defined in Article 100 of the NEC, shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
- 2) Control Wire
 - A. Control wire in duct or conduit shall be the same type as power and lighting wire indicated above.
 - B. Control wiring shall be No.14 AWG.
 - C. Control wires at panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations.
- 3) Instrumentation Cable
 - A. Instrumentation cable shall be rated at 600 volts.
 - B. Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color coded polyethylene: black-red for two-conductor cable and black-red- white for three-conductor cable.
 - C. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 16 AWG stranded tinned copper drain wire, and a PVC outer jacket with a thickness of 0.048-inches.

Connectors:

- 1) Cable connectors shall be designed and sized for specific cable being connected.
- 2) Solderless, pressure-type connectors shall be constructed of non-corrodible tin-plated copper.
- 3) All connectors shall have a current-carrying capacity equal to or greater than the cable being connected.
- 4) Application tooling for connectors shall contain die or piston stops to prevent over- crimping and cycling or pressure relief to prevent under-crimping. Dies of all application tooling shall provide dot or wire size coding for quality control verification. All tooling shall be manufactured by the connector manufacturer.
- 5) Compression connectors shall be threaded split bolt type of high strength copper alloy. Pressure type, twist-on connectors will not be acceptable.
 - A. Pre-insulated fork tongue lugs shall be nylon terminals with vinyl insulation. Insulators shall have funnel entry.
 - B. General purpose insulating tape shall be high temperature (105° C) tape, with a dielectric strength of 1,150 V/mil of polyvinyl material.
- 6) Power Connectors (10 AWG and Smaller) 600V and Below:

- A. Power connectors shall be spring wire type.
- 7) Power Connectors (Sizes 8-4 AWG) 600V and Below:
 - A. Non-insulated ring-tongue type.
 - B. Ring tongue sized to match terminal stud size.
 - C. Brazed barrel seam.
 - D. Application tooling designed to crimp the wire barrel (conductor grip) with a one- step crimp.
- 8) Control, Instrument and Specialty Cable Connectors:
 - A. Tin-plated copper.
 - B. Vinyl or nylon pre-insulated ring-tongue type. (Spade lugs will not be permitted).
 - C. Sized to match terminal study size.
 - D. Have insulation grip sleeve to firmly hold to cable insulation.
 - E. Insulation grip sleeve shall be funneled to facilitate wire insertion and prevent turned-back strands.
 - F. Application tooling designed to crimp the wire barrel (conductor grip) and the insulation grip sleeve with a one-step crimp.

Terminal blocks:

- 1) For Mounting in Terminal Boxes:
 - A. Designed and sized for the cables being terminated.
 - B. Phenolic block rated 600 volts.
 - C. Binding screw-type terminals for power cables and straight-strap stud terminals for control and instrument cables.
 - D. Rated current carrying capacity equal to or greater than the cable being terminated.
 - E. Marking strip.
- 2) For Mounting in Cabinets, Panels, Control Boards, Etc.:
 - A. Designed and sized for the cables being terminated.
 - B. Terminal blocks shall be tubular screw type with pressure plates and shall be rated 600 V AC/DC, less than 55 A rated minimum.

Cable identification tags: Refer to ES 16050 for appropriate conductor identification material.

8. Execution

General: The Subcontractor shall provide and terminate all power, control, and instrumentation conductors except where indicated.

Installation: Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.

Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.

Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned

out to terminals.

Single conductor cable in cable trays shall be No. 1/0 or larger and shall be of a type listed and marked for use in cable trays. Tray cable smaller than 1/0 shall be multi-conductor, with outer jacket.

9. Splices and terminations

Wire taps and splices shall be properly taped and insulated according to their respective classes.

In general, there shall be no cable splices in underground manholes or pullboxes. If splices are necessary, the cables shall be brought aboveground and terminated in a NEMA 4X, stainless steel terminal or splice cabinet on a concrete pad. Splices in underground manholes and pullboxes may be made only with the approval of the Engineer.

Stranded conductors shall be terminated directly on equipment box lugs making sure that all conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

Excess control and instrumentation wire shall be properly taped and terminated as spares.

1) Control Wire and Cable

- A. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
- B. In junction boxes, motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips.

2) Instrumentation Wire and Cable

- A. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4-20 mA system.
- B. Two- and three-conductor shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pullboxes. Such cable runs shall have only one splice per conductor.

3) Power Wire and Cable

- A. All 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the Subcontractor.
- B. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of two layers of varnished cambric tape overtaped with a minimum of two layers of high temperature tape.

10. Cable Identification

General: Wires and cables shall be identified for proper control of circuits and equipment and to reduce maintenance effort.

Identification numbers: The Subcontractor shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to all conductors having common terminals and shall be shown on "as built" drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control Conductor" shall be defined as any conductor used for alarm, annunciator, or signal purposes.

- 1) Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The

instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.

- 2) All 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The 480/277-volt system conductors shall be color coded as follows: Phase A - Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs.
- 3) General purpose AC control cables shall be red. General purpose DC control cables shall be blue.
- 4) Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
- 5) Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

Electrical Specification 16450 – Grounding

1. Scope

The Subcontractor shall provide the electrical grounding system, complete and operable, in accordance with the Contract Documents. Including but not limited to the building grounding grid, the grounding rod system and ground riser extension to electrical equipment. All grounding components and installation shall meet local building codes.

The requirements of ES 16050 – Basic Materials and Methods apply to this Section.

2. Applicable publications

- 1) NEC Article 250 – Grounding.
- 2) UL 467 - Standard for Safety Grounding and Bonding Equipment.
- 3) IEEE, 837 – 1989 Standard for Qualifying Permanent Connections Used in Substation Grounding.
- 4) IEEE 81-1983 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
- 5) AWWA C210 – 1997 Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
- 6) NETA (International Acceptance Testing Specifications)

3. Definitions

Low Voltage Grounded System (600V or less): A low voltage grounded system is a system where the local power supply is a transformer with the transformer secondary grounded.

The first disconnecting means on the load side of this transformer shall provide the point where the neutral conductor is grounded.

The neutral shall be connected to the Equipment Grounding Circuit Conductor only at one point which is within the enclosure of the disconnecting means.

The Grounding Electrode Conductor or the Equipment Grounding Circuit Conductor shall not be used as the neutral.

4. Shop drawings

Manufacturer's product information for connections, clamps, grounding rods and grounding system components, showing compliance with the requirements of this Section must be submitted prior to commencement of work.

5. Responsibilities

The Subcontractor shall not conceal or cover any ground connections until the Engineer or his authorized representative has established that every grounding connection conforms to the Contract Documents and has given the Subcontractor written confirmation.

6. Testing

Measure and test the ground impedance in accordance with IEEE Standard 81 after installation but before connecting the electrode to the remaining grounding system. Verify all ground potentials on plan drawings and submit to the Engineer for final approval.

Test the grounding system per 2017 NETA ATS section 7.13.

7. Inspections coordination

The Subcontractor shall provide access to the work for the Engineer as requested for inspection. The Subcontractor shall provide 48 hours notice of its intention to begin new work activities.

8. Products

Components of the grounding electrode system shall be manufactured in accordance with ANSI/UL 467 - Standard for Safety Grounding and Bonding Equipment, and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.

Grounding Electrode System:

- 1) Grounding loop conductors shall be bare annealed copper conductors suitable for direct burial. Conductors shall be at least #4/0 unless indicated otherwise.
- 2) Ground Rods
 - A. Unless indicated otherwise, the ground rod shall be a minimum of 3/4-inch in diameter, 20-foot long with pointed end to facilitate driving, and have a uniform covering of electrolytic copper metallurgically bonded to a rigid steel core. The copper to steel bond shall be corrosion resistant. The rod length shall be clearly stamped near the top of the rod.
 - B. Conform to ANSI/UL 467.
 - C. Sectional type joined by threaded copper alloy couplings.
- 3) Buried cable-to-cable and cable-to-ground rod connections shall be made using exothermic welds or compression connectors suitable for direct burial.
- 4) Exposed grounding connectors shall be of the compression type (connector to cable), made of high copper alloy, and be manufactured specifically for the particular grounding application.
- 5) Grounding conductor to grounding rods shall be done by thermal bonding.
- 6) Equipment Grounding Circuit Conductors
 - A. These conductors shall be the same type and insulation as the load circuit conductors. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
 - B. Present in all raceways. The conduit system is not an allowable equipment ground.
 - C. Cable to equipment ground lugs shall be compression type, bolted to the equipment with silicon bronze bolts and lock washers.

Epoxy Coatings:

- 1) All underground grounding connections shall be coated with epoxy paint as specified herein.
- 2) Coating shall be of Polyamide Epoxy with high build corrosion resistance. Resulting coat shall conform to the performance requirements of AWWA C 210.

9. Wire, cable, and raceway grounding

Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material as well as in each raceway with parallel feeder run.

Size as given on the conduit schedule and in accordance with the NEC-Article 250.

Provide the duct bank ground system indicated, including, trenching, splices, ground rods, and connections to equipment and structures.

Grounding Wires and Cables:

- 1) Install using as few joints as possible.
- 2) Protect against abrasion by several wrappings of rubber tape at all points where cable leaves concrete in exposed areas.
- 3) Suitably protect cable against damage during construction.
- 4) Replace or suitably repair cable if damaged by anyone before final acceptance.

10. Grounding boxes, motors, and electrical equipment

Provide a separate grounding conductor for each motor and connect at motor box. Do not use bolts securing motor box to frame or cover for grounding connectors.

Provide a grounding type bushing for secondary feeder conduits which originate from the secondary section of each MCC section, switchboard, or panelboard.

Individually bond these raceways to the ground bus in the secondary section.

Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.

Interconnect the secondary switchgear neutral bus to the ground bus in the secondary switchgear compartment only at service entrance point or after a transformer.

11. Grounding systems

Embedded Ground Connectors:

- 1) The connection shall be made in accordance with the manufacturer's instructions.
- 2) Lay in bottom of trench or in other excavations at least 18 inches below finished grade.
- 3) Maintain clearance of at least 12 inches from all underground metal piping or structures, except where connections thereto are specifically indicated.
- 4) Duct Bank Ground: A grounding conductor shall be embedded in every duct bank as indicated.

Ground Ring:

- 1) Furnish trenching and materials necessary to install the ground ring as indicated.
- 2) Bonding conductor shall be in direct contact with the earth and be of the size indicated.
- 3) Minimum burial depth 36-inches or as indicated on the Drawings, whichever is greater.
- 4) Re-compact disturbed soils to original density in 6-inch layers.

Ground Rods:

- 1) Ground rods forming an individual ground array shall be equal in length.
- 2) The Subcontractor shall install rods as indicated by driving and not by drilling or jetting.
- 3) The Subcontractor shall drive rods into unexcavated portion of the earth where possible.
- 4) In excavated areas, the Subcontractor shall drive grounding rods after compaction and backfill is completed.
- 5) The Subcontractor shall drive to a depth such that top of rods will be approximately 18 inches below final grade, or subgrade, and connect main grid ground cable thereto.

12. Shield grounding

Shielded instrumentation cable shall have its shield grounded at one end only unless Shop Drawings indicate the shield will be grounded at both ends.

The grounding point shall be at the control panel or otherwise at the receiving end of the signal carried by the cable.

Termination of shield drain wire shall be on its own terminal screw.

All terminal screws shall be jumpered together using manufactured terminal block jumpers.

Connection to the ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.