C88
CB/FILE
04457 2000

**DUNKELBERGER ENGINEERING & TESTING, INC.**
*Geotechnical • Materials Testing/Inspection • Environmental*

Kimley-Horn & Associates
4431 Embarcadero Drive
West Palm Beach, Florida 33407

October 21, 2002
Project No. 02-11-1300

Attention: Mr. Mark D. Miller, P.E ... *via fax and U.S. Mail*

Subject: ***Geotechnical Services***
**New Clearwell Structure**
**Indian River County Utilities**
**South RO Plant**
**Indian River County, Florida**

Gentlemen:

## INTRODUCTION

Pursuant to your authorization, Dunkelberger Engineering & Testing, Inc. has completed geotechnical services in accordance with the contract agreement dated September 25, 2002. This report presents the methods of study, factual data from the field exploration and laboratory examination of the subsoils, geotechnical engineering evaluations, and recommendations for design and construction.

## PROJECT CONSIDERATIONS

We understand the proposed construction will consist of a new clearwell structure and post-treatment modifications consisting of a scrubber and blower structure for the existing South RO Water Treatment Plant in Indian River County. The scrubber and blower structures will be 25 feet high and will be founded on a grade level slab. The clearwell structure will have plan dimensions of 40 feet by 30 feet with its bottom about 4 to 5 feet below the existing grade level.

The scrubber/blow slab and clearwell structure will both be constructed with reinforced cast-in-place concrete. We have assumed that the maximum foundation contract stress below area loaded slabs will not exceed 1,000 pounds per square foot (psf) and the maximum contact stress below shallow strip footings will not exceed 2,500 psf.

523A N.W. Enterprise Drive • Port St. Lucie, Florida 34986
Phone: (772) 343-9787 • Fax: (772) 343-9404
E-mail: detpsl@bellsouth.net
State of Florida Board of Professional Engineers Authorization No. 6870

## GEOTECHNICAL SCOPE OF WORK

### Field Exploration

The subsurface conditions in the proposed structure areas were explored utilizing two (2) Standard Penetration Test (SPT) borings each drilled to 25 feet beneath the existing ground surface. The borings were drilled with truck-mounted machinery employing mud rotary procedures. Samples of the in-place materials were recovered at frequent vertical intervals using a standard split-barrel driven with a 140-pound hammer freely falling 30 inches (the SPT after ASTM D 1586). Boring locations are presented on Sheet 1.

### Laboratory Examination

Samples recovered from the borings were placed in moisture-proof containers and returned to our laboratory for visual examination and classification in accordance with the Unified Soil Classification System (ASTM D 2487).

### Engineering Evaluation and Report

Factual data from the field and laboratory work was evaluated with respect to the proposed construction to develop recommendations for foundation design and related construction. This report summarizes the data, analysis and recommendations.

## SUBSURFACE CONDITIONS

### Stratigraphy

The SPT borings show the subsurface soils to the depth of interest to be sands. In general, the subsoils consist of a surficial layer of relatively clean sand over dark colored, weakly cemented sand (hardpan) followed by relatively clean sand to the terminal depths of exploration at 25 feet. Generalized stratigraphic data and descriptions are listed below.

| Stratum No. | Depth Interval (feet) | Material Description | *Condition* |
|---|---|---|---|
| 1 | 0.0 – 1.0 | Gray fine SAND, upper 12 inches with roots (SP) | Loose |
| 2 | 1.0 – 3.0 | Dark brown fine SAND, slightly silty, weakly cemented, organic stained (SP-SM) (Hardpan) | Medium dense |
| 3 | 3.0 – 25.0 | Light brown to brown fine SAND, trace silt to slightly silty (SP, SP-SM) | Medium dense to dense |

Detailed graphical representations of the subsurface stratigraphy are presented on Sheet 1. The SPT data indicates the subsoils are loose to medium dense in terms of relative density.

**Groundwater**

Groundwater levels were measured in the borings at the time of drilling (October 1, 2002). The depth to the water table was 3.1 and 3.5 feet below the ground surface at TB-1 and TB-2, respectively. These groundwater levels are representative of conditions at the time of their measurement. Groundwater levels will fluctuate above and below these levels in response to rainfall, drainage, and other such conditions.

## SITE GEOTECHNICAL SUITABILITY

The results of this subsurface study indicate the site is suitable for the planned construction from a geotechnical viewpoint. The proposed structures may be supported on conventional shallow foundations (i.e., spread footings and/or mats) following normal site preparation and densification of the subsoils. Ground improvement by roller compaction must be performed carefully owing to the proximity of the new construction areas to existing plant structures.

Groundwater levels are relatively shallow at the project site, and therefore must be considered in both design and construction. Excavations below grade will bottom in relatively clean sands, and below the water table. As such, the cuts will need to be carefully dewatered and braced to enable safe underground works, while protecting the integrity of existing structures.

## BUILDING FOUNDATIONS

**Foundation Soil Preparation**

In order to provide for uniform foundation soils with adequate shearing strength and minimal compressibility, we recommend that the scrubber and blower structure footprints are prepared in the manner described below.

1. Clear the building pad areas of any vegetation existing at the time of construction. Currently, the site is covered with mowed grass. Grub the stripped ground surface and remove roots that are concentrated or of diameter greater than 1/4-inch.

2. Once the clearing and grubbing is complete, the footprints of the proposed structures should be roller compacted. Owing to the presence of nearby existing structures, surface compaction of the areas should be performed using a compactor that is modest in size, such as a 1-ton (static weight) WACKER W-74 walk-behind vibratory drum roller. The soil

densification should encompass the entire structure footprint plus a perimeter margin which extends at least 5 feet beyond the maximum outside lines of the structure footprint. Each section of subgrade should be subjected to multiple, overlapping (minimum of 20 percent overlap) coverages of the compactor as it operates at its maximum vibrational frequency and normal walking speed. Compaction should continue until no additional settlement is visually discernible at the subgrade surface. In no case, however, should any section of subgrade receive less than 10 passes of the compaction equipment. Density control should be exercised in the upper 12 inches of the proof-rolled subgrade. Soils in this interval should be compacted to not less than 95 percent of the ASTM D 1557 maximum dry density.

3. Structural fill needed to raise the pads to proposed subgrade elevations should consist of sands with not more than 10% passing the U.S. Standard No. 200 sieve. The structural fill should be placed in thin lifts (12-inch thick loose measure), near the optimum moisture content for compaction, and be uniformly compacted to a firm and stable condition and to at least 95 percent of the ASTM D 1557 maximum dry density.

4. Detrimental impacts of vibration induced stresses to nearby structures may be lessened through the excavation of a vibration isolation trench that extends to depth of two feet below the water table and is located between the existing and proposed structures.

**Building Foundation Support**

The proposed scrubber and blower structures may be supported on shallow foundation systems. It is anticipated that monolithic thickened edge slabs will be used to support these buildings. Thickened edge portions of the slabs should bottom at least 12 inches below the adjacent exterior grade, and have a minimum width of 16 inches. As such, the footings should be designed for an allowable bearing pressure of 2,500 pounds per square foot (psf). The thickened edge portion of the footing should be well reinforced to resist the moments that result from eccentric loading.

Foundations designed and constructed in accordance with these recommendations are expected to sustain tolerable total and differential settlements. Owing to the granular nature of the profile components, settlement should occur rapidly and be virtually complete by the end of the construction period.

## CLEARWELL STRUCTURE

**Excavations and Dewatering**

The materials found in the borings can be excavated using conventional earthmoving equipment. Below grade excavations should be made in accordance with all applicable State and Federal

requirements. Per the Occupational Safety and Health Administration (OSHA) 29 CFR Part 1926, Sub-part P- "Excavations," the subsoils at the site fall within the Type C criteria. We expect dry excavation sideslopes to be stable when cut on a 2:1 slope (horizontal:vertical). We recommend that the contractor exercise extreme caution in any decision to place men and equipment in unbraced excavations, particularly when wetted, and/or subjected to surcharge loads as well as vibrational forces.

Considering the measured groundwater depths and the anticipated cut requirements, it is expected that excavations for the proposed clearwell structure will require dewatering to enable construction in a dry condition. Where this is the case, groundwater levels should be maintained at least 24 inches below the excavation bottom. The dewatering means and methods should be determined by the contractor. However, we expect that the dewatering may be accomplished by pumping from wells, wellpoints or sumps, or a combination thereof.

The proposed excavations will bottom roughly 4 to 5 feet below finished grades. Soils found in the borings at this depth consist of relatively clean sands. We recommend the following parameters be used in the design:

| | |
|---|---|
| Moist Soil Unit Weight | 120 pounds per cubic foot |
| Buoyant Soil Unit Weight | 55 pounds per cubic foot |
| Angle of Internal Friction | 30 degrees |
| Earth Pressure Coefficients | |
| Active, Ka - | 0.33 |
| Passive, Kp - | 3.00 |
| At-Rest, Ka - | 0.50 |

**Foundation Support**

The proposed clearwell structure may be supported on a reinforced concrete mat foundation that is designed for an allowable soil contact pressure of 1,000 pounds per square foot. We recommend the foundation concrete be cast upon the existing granular soils that are compacted to at least 95 percent of maximum density (ASTM D 1557) to a depth of at least 12 inches. Alternatively, the upper 12 inches of foundation soils may be over-excavated and replaced with washed gravel that meets the size requirements of FDOT No. 57 stone.

**Structure Backfill**

Soils placed adjacent to the structures' exterior walls should consist of sands (ASTM D 2487) containing not more than 10% passing the U.S. Standard No. 200 sieve. Backfill should be placed in loose lifts not more than in 12-inch thick (maximum). To avoid developing excessive lateral earth pressures, only light-weight walk-behind compaction equipment should be used within 5 feet of the wall face. Backfill soils should be compacted to 95 percent of the ASTM D

1557 maximum dry density. Materials from the excavation are expected to meet the requirements for structure backfill.

**Lateral Earth Pressures**

Stresses on buried structure walls should be based upon the at-rest condition, and the lateral earth pressure parameters listed above. As such, lateral earth pressures should be calculated using equivalent fluid pressures of 60 pounds per square foot per foot depth (psf/foot) above the water table and 30 psf/foot below the water table. These pressures are in addition to surcharge and/or hydrostatic pressures that may be acting on the structure walls.

**Uplift Considerations**

Design of the below-grade components of the structure should account for the position of the groundwater. The design must account for hydrostatic uplift forces acting on the base. Those forces would be resisted by a combination of structure dead weight and the weight of the soil backfill overlying the foundation edges. Total and buoyant soil unit weights of 120 and 55 pcf, respectively, should be used for design.

## LIMITATIONS OF STUDY

DET has completed a subsurface study in connection with the new clearwell structure and post-treatment modifications to be constructed at the South RO Water Treatment Plant in Indian River County, Florida. The objectives of the study were to evaluate the subsurface conditions existing in the proposed structure areas and to provide recommendations for foundation design and related construction. DET warrants that the factual data, recommendations and professional advice provided herein are based on recognized practices in the disciplines of soil mechanics, foundation engineering and engineering geology. No other warranties are expressed or implied.

____oOo____

We trust that the information presented in this report is clear and understandable. Should it require any clarification or amplification, however, please feel free to contact us.

Very truly yours,

**DUNKELBERGER ENGINEERING & TESTING, INC.**

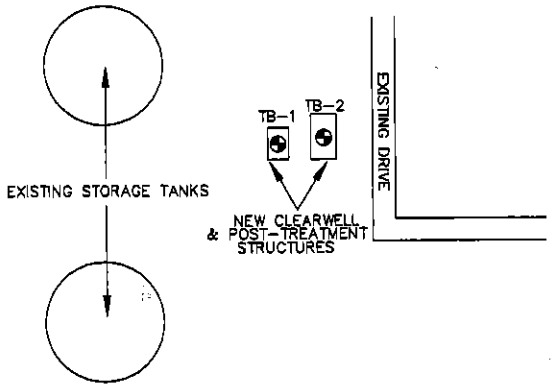
Hieu H. Huynh, E.I.
Staff Engineer

Craig E. Dunkelberger, P.E.
Vice President
FL Registration No. 49932
10/22/02

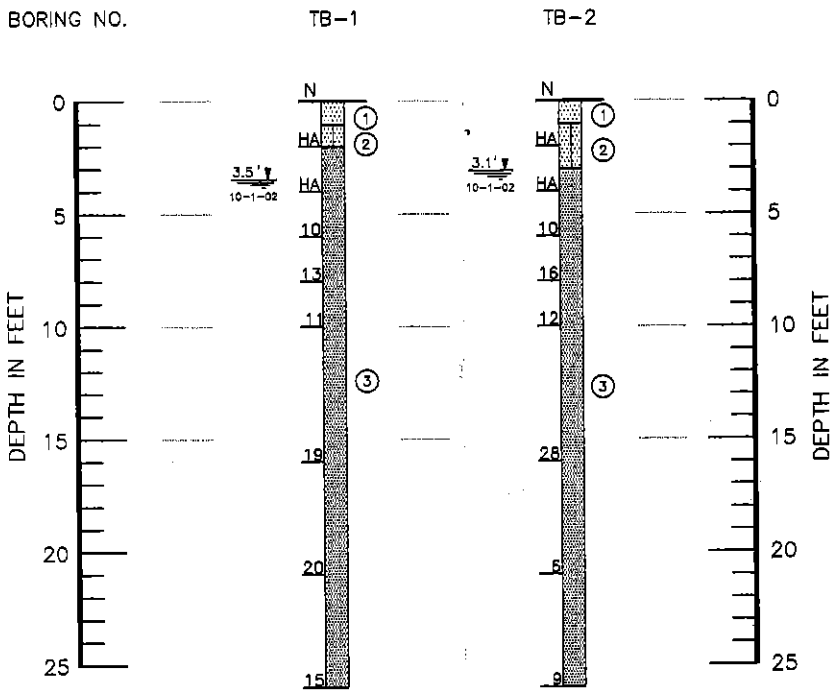
1300rpt
HHH/CED/pg

Attachment: Boring Locations and Subsurface Profiles

cc: Addressee (2)




BORING LOCATION PLAN
N.T.S.




SUBSURFACE PROFILES
Scale: 1" = 5'

LEGEND

① Gray fine SAND, upper 12 inches with roots (SP)

② Dark brown fine SAND, slightly silty, weakly cemented, organic stained (SP-SM) (Hardpan)

③ Light brown to brown fine SAND, trace silt to slightly silty (SP, SP-SM)

SP – Unified Soil Classification System Group Symbol (ASTM D 2487)

TB-1 – Standard Penetration Test (SPT) Boring location and number

3.5' ▽ 10-1-02 – Depth of groundwater (feet) & date measured

N – Indicates the number of blows of a 140 pound hammer, freely falling a distance of 30 inches, required to drive a 2-inch diameter sampler 12 inches (ASTM D 1586)

HA – Hand Auger to 4 feet in order to avoid possible conflict with underground utilities

NOTES

(1) Borings were drilled on October 1, 2002, using a Central Mine Equipment (CME 55) drilling rig.

(3) Strata boundaries are approximate and represent soil strata at each test hole location only. Soil transitions may be more gradual than implied.

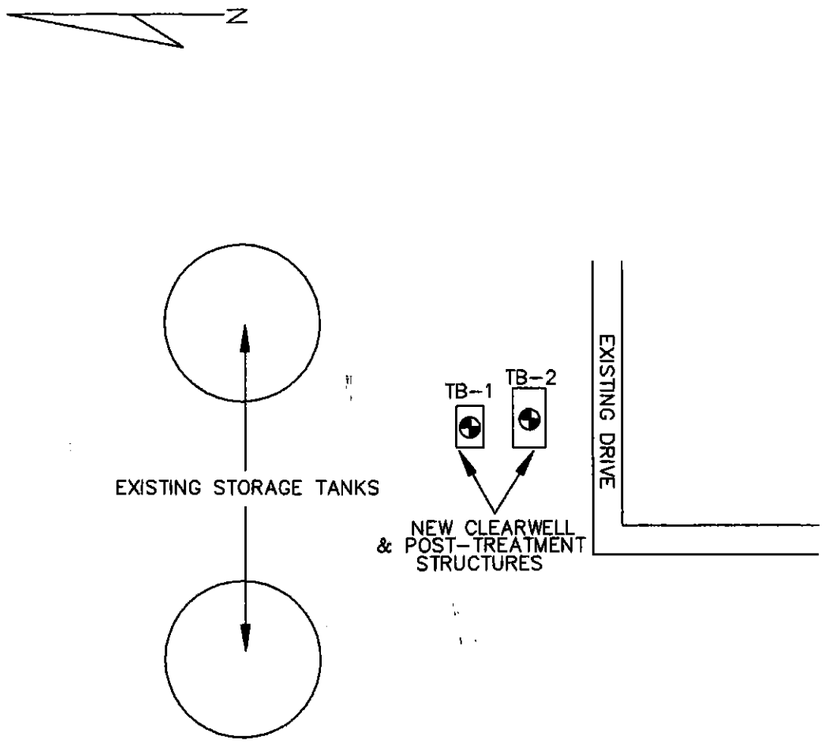
(4) Groundwater depths shown on the subsurface profiles represent groundwater surfaces on the dates shown. Groundwater level fluctuations should be anticipated throughout the year.

| | |
|---|---|
| DRAWN | JD |
| CHECKED | HHH |
| APPROVED | CED |
| SCALE | AS SHOWN |
| REVISED | |

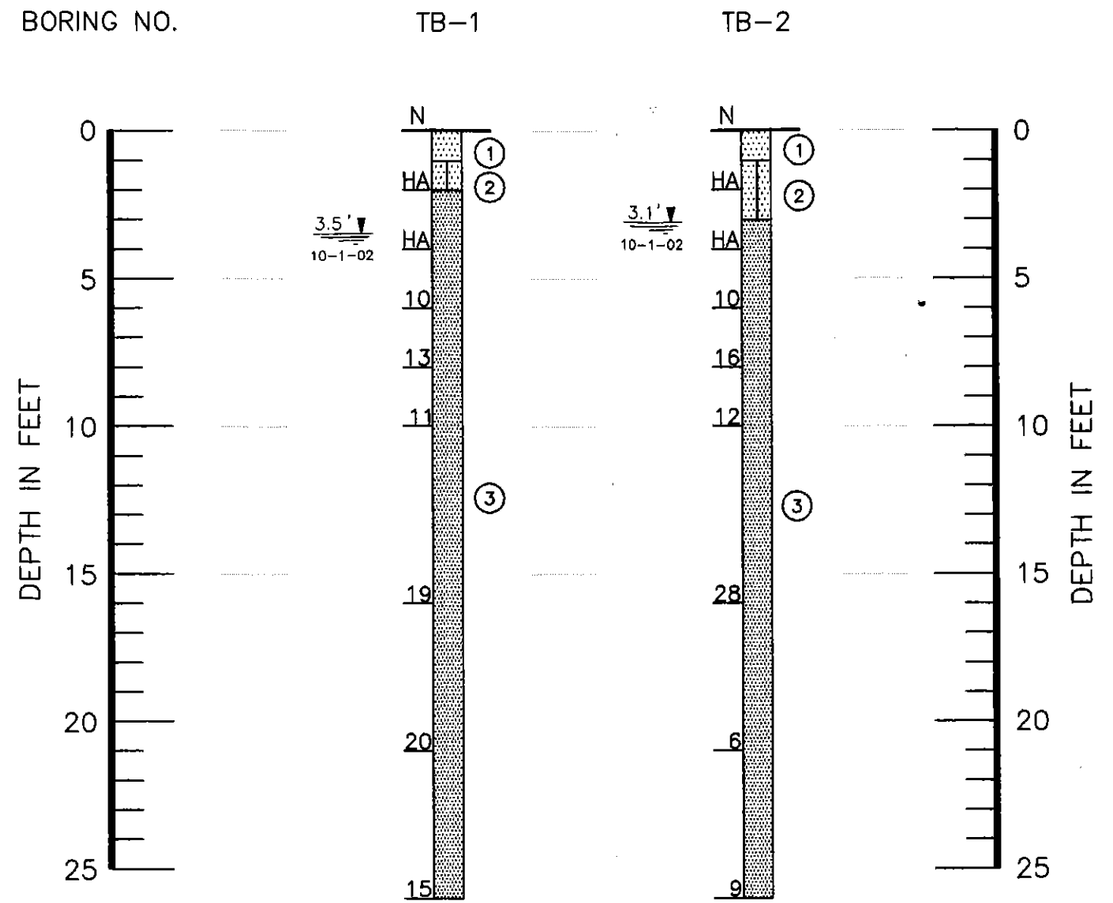
BORING LOCATIONS & SUBSURFACE PROFILES
NEW CLEARWELL STRUCTURE
INDIAN RIVER COUNTY UTILITIES
INDIAN RIVER COUNTY, FLORIDA

DUNKELBERGER ENGINEERING & TESTING, INC.
Geotechnical • Materials Testing/Inspection • Environmental

| DATE | PROJ. NO. | SHEET |
|---|---|---|
| 10-2-02 | 02-11-1300 | 1 |




BORING LOCATION PLAN
N.T.S.




SUBSURFACE PROFILES
Scale: 1" = 5'

LEGEND

① Gray fine SAND, upper 12 inches with roots (SP)

② Dark brown fine SAND, slightly silty, weakly cemented, organic stained (SP–SM) (Hardpan)

③ Light brown to brown fine SAND, trace silt to slightly silty (SP, SP–SM)

SP – Unified Soil Classification System Group Symbol (ASTM D 2487)

TB–1 – Standard Penetration Test (SPT) Boring location and number

3.5' / 10–1–02 – Depth of groundwater (feet) & date measured

N – Indicates the number of blows of a 140 pound hammer, freely falling a distance of 30 inches, required to drive a 2–inch diameter sampler 12 inches (ASTM D 1586)

HA – Hand Auger to 4 feet in order to avoid possible conflict with underground utilities

NOTES

(1) Borings were drilled on October 1, 2002, using a Central Mine Equipment (CME 55) drilling rig.

(3) Strata boundaries are approximate and represent soil strata at each test hole location only. Soil transitions may be more gradual than implied.

(4) Groundwater depths shown on the subsurface profiles represent groundwater surfaces on the dates shown. Groundwater level fluctuations should be anticipated throughout the year.

| | |
|---|---|
| DRAWN | JD |
| CHECKED | HHH |
| APPROVED | CED |
| SCALE | AS SHOWN |
| REVISED | |

BORING LOCATIONS & SUBSURFACE PROFILES
NEW CLEARWELL STRUCTURE
INDIAN RIVER COUNTY UTILITIES
INDIAN RIVER COUNTY, FLORIDA

DUNKELBERGER ENGINEERING & TESTING, INC.
Geotechnical • Materials Testing/Inspection • Environmental

| DATE | PROJ. NO. | SHEET |
|---|---|---|
| 10–2–02 | 02–11–1300 | 1 |