Subsurface Soil Exploration and Geotechnical Engineering Evaluation
Manhole MH 72-02 and Lift Station #73
New Smyrna Beach, Florida

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March 19, 2021
File No. 21-23-5218

Utilities Commission, City of New Smyrna Beach
200 Canal Street
New Smyrna Beach, Florida 32168

Attention: Ms. Dana Hale, P.E.

Subject: Subsurface Soil Exploration and
Geotechnical Engineering Evaluation
Manhole MH 72-02 and Lift Station #73
Sugarmill Subdivision
New Smyrna Beach, Florida
Purchase Order No.: PO00017231
Task No. 003

Dear Ms. Hale:

As requested, we have completed a shallow subsurface soil exploration for the subject project. The purposes of performing this exploration were to evaluate the general subsurface conditions at the existing manhole and lift station locations and to provide recommendations for replacement of the structures. In addition, we have estimated the normal seasonal high groundwater level at the boring locations. This report documents our findings and presents our engineering recommendations.

SITE LOCATION AND DESCRIPTION

Our field exploration program was performed at two sites within the existing Sugarmill residential subdivision located in New Smyrna Beach, Volusia County, Florida (Section 10, Township 17 South, Range 33 East). One of the sites is the existing Manhole MH 72-02 location within the intersection of Club House Boulevard and Beach Fern Court. The second site is the existing Lift Station #73 location north of and adjacent to the intersection of Red Maple Way and Red Maple Court. The general site locations are shown superimposed on the New Smyrna Beach, Florida, U.S.G.S. quadrangle map presented as Figure 1.

The existing Manhole MH 72-02 structure is located within the asphalt pavement near the center of the Club House Boulevard and Beach Fern Court intersection. Apparent settlement of the manhole structure and the asphalt pavement around the manhole structure was noted during our field exploration program. Properties to the east of the intersection are developed with single-family residences and undeveloped property is located west of the intersection.

The existing Lift Station #72 facility is located immediately north of the Red Maple Way and Red Maple Court intersection in a grassed area. A tall hedge and areas associated with the Sugar Mill Golf Course are located north of and adjacent to the lift station facility. Based on information provided by the client, the wet well structure associated with the lift station has settled.
PROPOSED CONSTRUCTION

It is our understanding that the proposed construction includes installation of a new manhole structure to replace the existing Manhole MH 72-02. We have assumed that the new manhole structure will be placed on shallow spread foundations no deeper than approximately 15 feet below the existing top of pavement surface.

Additionally, it is our understanding that the project includes possibly installing a wet well structure at the Lift Station #73 site. We have assumed that the new precast concrete wet well will be founded no deeper than 30 feet below the existing ground surface and that the wet well will be installed using the conventional braced excavation method with dewatering as necessary.

REVIEW OF SOIL SURVEY MAPS

Based on the 1980 Soil Survey for Volusia County, Florida, as prepared by the U.S. Department of Agriculture Soil Conservation Service, the Manhole MH 72-02 site is located in an area mapped as the “Placid fine sand, depressional” soil series. The Lift Station #73 site is located in an area mapped as the "St. Lucie fine sand, 0 to 8 percent slopes" soil series. A description of these soil types, as obtained from the Soil Survey, is provided below.

Placid fine sand, depressional (#48):

“Placid fine sand, depressional” is a very poorly drained, nearly level soil that occurs in wet depressions. A representative soil profile consists of sand to a depth of 80 inches. The water table is within a depth of 12 inches for more than 6 months in most years. The soil is generally covered with standing water for as much as 6 months annually.

St. Lucie fine sand, 0 to 8 percent slopes (#62)

“St. Lucie fine sand, 0 to 8 percent slopes” is an excessively drained, nearly level to moderately sloping soil on dunelike ridges and isolated knolls. A representative soil profile consists of gray and white sand to a depth of 80 inches. The water table is always below a depth of 72 inches and is usually below 120 inches.

FIELD EXPLORATION PROGRAM

The field exploration program included performing one Standard Penetration Test (SPT) boring near both the existing Manhole MH-72-02 (Boring TH-1) and Lift Station #73 (Boring TH-2). SPT Boring TH-1 was advanced to a depth of 20 feet below the pavement surface and Boring TH-2 was advanced to a depth of 35 feet below existing ground surface using the methodology outlined in ASTM D-1586. A summary of this field procedure is included in the Appendix.

Soil samples recovered during performance of the borings were visually classified in the field and representative portions of the samples were transported to our laboratory in sealed sample jars. The groundwater level at the boring locations was measured during drilling. Upon completion of drilling the borings were grouted with neat cement grout.

The locations of the borings are schematically illustrated on the Boring Location Plans included as Figures 2 and 3. These boring locations were determined in the field by estimating distances.
from existing site features and other points of reference. The locations of the borings should be considered accurate only to the degree implied by the method of measurement used.

LABORATORY PROGRAM

Representative soil samples obtained during our field sampling operation were packaged and transferred to our laboratory for further visual examination and classification. The soil samples were visually classified in general accordance with the Unified Soil Classification System (ASTM D-2488). The resulting soil descriptions are shown on the soil boring profiles presented on Figures 4 and 5.

In addition, we conducted seven percent fines analyses on selected soil samples obtained from the borings. The results of these tests are presented adjacent to the sample depth on the boring profiles on Figure 5.

GENERAL SUBSURFACE CONDITIONS

General Soil Profile

The results of the field exploration and laboratory programs are graphically summarized on the soil boring profiles presented on Figures 4 and 5. The stratification of the boring profiles represents our interpretation of the field boring logs and the results of laboratory examinations of the recovered samples. The stratification lines represent the approximate boundary between soil types. The actual transitions may be more gradual than implied.

The results of Boring TH-1 indicate the following general soil profile below the pavement and base material at the Manhole MH 72-02 location:

<table>
<thead>
<tr>
<th>Depth Below Ground Surface (ft.)</th>
<th>Soil Description (Unified Soil Classification)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1.5</td>
<td>Fine sand with silt (SP-SM) with shell</td>
</tr>
<tr>
<td>1.5 to 12.5</td>
<td>Very loose fine sand (SP)</td>
</tr>
<tr>
<td>12.5 to 17.5</td>
<td>Loose fine sand (SP)</td>
</tr>
<tr>
<td>17.5 to 20</td>
<td>Medium dense fine sand (SP)</td>
</tr>
</tbody>
</table>

The results of Boring TH-2 the following general soil profile at the Lift Station #73 location:

<table>
<thead>
<tr>
<th>Depth Below Ground Surface (ft.)</th>
<th>Soil Description (Unified Soil Classification)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 9</td>
<td>Loose fine sand (SP)</td>
</tr>
<tr>
<td>9 to 27.5</td>
<td>Medium dense fine sand (SP)</td>
</tr>
<tr>
<td>27.5 to 35</td>
<td>Loose silty fine sand (SM)</td>
</tr>
</tbody>
</table>
The above soil profiles are outlined in general terms only. Please refer to Figures 4 and 5 for soil profile details.

**Groundwater Level**

The groundwater level was measured in the boreholes on the day drilled. As shown on Figure 5, the groundwater level was encountered in Borings TH-1 and TH-2 at depths of approximately 5.1 and 4.3 feet below the existing pavement surface or ground surface, respectively. Fluctuations in groundwater levels should be anticipated throughout the year primarily due to seasonal variations in rainfall and other factors that may vary from the time the borings were conducted.

**NORMAL SEASONAL HIGH GROUNDWATER LEVEL**

The normal seasonal high groundwater level each year is the level in the August-September period at the end of the rainy season during a year of normal (average) rainfall. The water table elevations associated with a flood would be much higher than the normal seasonal high groundwater level. The normal high water levels would more approximate the normal seasonal high groundwater levels.

The seasonal high groundwater level is affected by a number of factors. The drainage characteristics of the soils, the land surface elevation, relief points such as drainage ditches, lakes, rivers, swamp areas, etc., and distance to relief points are some of the more important factors influencing the seasonal high groundwater level.

In addition to evaluating the conditions above, we have reviewed annual precipitation data available from the Melbourne Office of the National Weather Service. Based on this data, the annual rainfall to date in Volusia County is approximately 4.2 inches, which is approximately 2 inches below normal for this time of year.

Based on our interpretation of the site conditions using our boring logs, we estimate the normal seasonal high groundwater level at the locations of the borings conducted at the project sites to be approximately 3 feet above the groundwater level measured at the time of our field exploration.

**ENGINEERING EVALUATION AND RECOMMENDATIONS**

**General**

Based on observations made by the Client, Manhole MH 72-02 has settled. During our field exploration program, we observed that the top of the manhole structure and the pavement areas surrounding the manhole structure had apparently settled. The results of Boring TH-1 drilled in close proximity to the existing manhole structure indicate a very loose to loose soil profile in the top approximate 17.5 feet. It is likely that the very loose soil conditions encountered at this location have contributed to the manhole structure and pavement settlement that has occurred.

During the replacement of the manhole structure, the very loose to loose soils present around the existing manhole structure will need to be excavated and placed back around the new manhole structure in compacted lifts in accordance with the recommendations presented in subsequent sections of this report.
Based on the results of Boring TH-2 drilled near the existing Lift Station #73 facility, no obvious soil conditions that would be expected to cause the settlement of the wet well structure were encountered in the boring. As a result of the settlement of both Manhole MH 72-02 and the wet well structure associated with Lift Station #73, it is our understanding that the Client is considering replacing both structures. Geotechnical recommendations for the replacement of both structures are presented in the following sections of this report.

The results of our exploration indicate that, after the site preparation procedures recommended in this report, the existing soils are suitable for supporting the proposed new manhole and wet well structures. Shallow spread and/or mat foundations should provide adequate support for the manhole and wet well structures.

A positive head should be maintained in the wet well to prevent a quick condition from occurring in the excavation bottom. A quick condition is defined as a condition where the soil in the bottom of the excavation has zero contact stress between the soil particles due to an overwhelming upward hydraulic gradient, and the soil structure breaks up. The bottom of the excavation can fail by heaving under this condition. In addition, "sinkholes" could occur around the perimeter of the excavation if a quick condition occurs in the bottom of the excavation. We note that if a quick condition occurs during wet well installation, the soil parameter estimates presented below may not be valid.

Presented below are our recommendations for various soil parameters that may be used for wet well design and our recommendations for site preparation during construction of the manhole and wet well structures. There are alternate installation techniques for which some of the following recommendations would not apply. If a wet well installation technique other than installation in a dewatered excavation is planned, we should be retained to review the proposed methods. We can then modify our recommendations as appropriate.

**Buoyancy**

Permanent structures submerged below the water table will be subject to uplift forces caused by buoyancy. The components resisting this buoyancy include: 1) the total weight of the structure divided by an appropriate factor of safety; 2) the buoyant weight of soil overlying the structure; and 3) the shearing forces that act on shear planes that radiate vertically upward from the edges of the structure to the ground surface. The allowable unit shearing resistance may be determined by the following formula:

\[
\text{Allowable Unit Shearing Resistance, } F = K_o \gamma_m h(2/3 \tan \phi)/S.F. \text{ (above groundwater table)}
\]

\[
\text{Allowable Unit Shearing Resistance, } F = K_o \left[ \gamma_m h_w + \gamma_b (h-h_w) \right] (2/3 \tan \phi)/S.F. \text{ (below groundwater table)}
\]

Where:

- \(F\) = unit shearing resistance (psf)
- \(K_o\) = coefficient of earth pressure at rest = 0.5
- \(\gamma_m\) = unit weight of moist soil = 110 pcf
- \(\gamma_b\) = buoyant unit weight of soil = 50 pcf
- \(h\) = vertical depth (feet) below grade at which shearing resistance is determined
Manhole MH 72-02 and Lift Station #73
File No. 21-23-5218

\[ h_w = \text{vertical depth (feet) below grade to groundwater table} \]
\[ \phi = \text{angle of internal friction of the soil} = 30 \text{ degrees} \]
\[ \text{S.F.} = \text{safety factor} = 2 \]

The values given for the above parameters assume that the sides of the structure are in intimate contact with the surrounding soil, and that the ground level within 15 feet of the structure is relatively flat.

**At-Rest Earth Pressures Acting on Embedded Structures**

Lateral loads acting on the embedded structure will include at-rest earth pressures as well as hydrostatic pressures and surcharge loads. The lateral earth pressure will be a function of both the soil unit weight (submerged or moist) and the depth below ground surface. The following equation can be used to determine the lateral at-rest earth pressure:

\[
\sigma_h = K_o \gamma_m h \text{ (above groundwater table)} \\
\sigma_h = K_o [\gamma_m h_w + \gamma_b (h - h_w)] \text{ (below groundwater table)}
\]

Where:
\[
\sigma_h = \text{lateral earth pressure (psf)} \\
K_o = \text{coefficient of at rest earth pressure (0.5) (this value assumes that the backfill is lightly compacted yet not overcompacted)} \\
\gamma_m = \text{effective moist unit weight of soil = 110 pcf for compacted moist soil above the water table.} \\
\gamma_b = \text{buoyant unit weight of soil = 50 pcf for saturated soil below the water table.} \\
h = \text{vertical depth (feet) below grade at which lateral earth pressure is determined} \\
h_w = \text{vertical depth (feet) below grade to groundwater table}
\]

For design, an appropriate factor of safety should be applied to the lateral earth pressure calculated using the above equation. Lateral pressure distributions determined in accordance with the above do not include hydrostatic pressures or surcharge loads. Where applicable, they should be incorporated in the design.

**Excavation and Backfilling**

Based on the soil conditions encountered during the field exploration, we anticipate that the soils encountered in the borings performed within the project areas and presented on Figures 4 and 5 can be excavated with standard earth moving equipment, (i.e., front-end loaders and backhoes).

The bottom of the manhole and wet well excavations should be compacted to achieve a density of at least 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value for a depth 1 foot below the bottom of the excavation. Any overexcavated areas should be backfilled with suitable fill soil as outlined below in the “Suitable Backfill Material and Compaction of Backfill Soils” section of this report.

Excavation and backfilling should be performed “in the dry”. Therefore, extensive dewatering will be necessary to lower the groundwater level 2 to 3 feet below the bottom of the excavation and
compaction surfaces. Dewatering of the excavations is discussed in a subsequent section of this report.

The excavations should be safely braced to prevent injury to personnel or damage to equipment. Temporary safe slopes should be cut at a minimum in accordance with OSHA, 29 CFR Part 1926 Final Rule, Excavations Requirements. Flatter slopes should be used if deemed necessary. Surcharge loads should be kept at least 5 feet from excavations and spoil piles adjacent to excavations should be sloped no steeper than 2.0H to 1.0V. Provisions for maintaining workman safety within excavations is the sole responsibility of the Contractor.

**Suitable Backfill Material and the Compaction of Backfill Soils**

All backfill soil should be free of organic materials, such as roots and vegetation. We recommend using backfill with less than 12 percent by dry weight of material passing the U.S. Standard No. 200 sieve size. The fine sand and fine sand with silt (Strata Nos. 1 and 2 without roots, as shown on Figures 4 and 5) are suitable for use as backfill soil and, with proper moisture control, should densify using conventional compaction methods. Soils with more than 12 percent passing the No. 200 sieve (Stratum No. 3) can be used in some applications, but will be more difficult to compact due to their inherent nature to retain soil moisture.

All structural backfill should be placed in level lifts not to exceed 12 inches in uncompacted thickness. Each lift should be compacted to at least 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value. The backfilling and compaction operations should continue in lifts until the desired elevation(s) is achieved. If hand-held compaction equipment is used, the lift thickness should be reduced to no more than 6 inches.

Backfill placed adjacent to the structure walls should consist of granular soils that are free draining and relatively free of fines. The backfill within 5 feet of the structure walls should be placed in lifts and compacted with hand-held compactors to between 95 and 98 percent of the modified Proctor (ASTM D-1557) maximum dry density value. Overcompaction of the backfill should be avoided since it could cause excessively large earth pressures to develop against the walls. Heavy equipment should be kept at least 5 feet away from the walls.

**Foundation Support by Shallow Foundations and Foundation Compaction Criteria**

For both the new manhole structure and the new wet well structure, excavate the foundation to the proposed bottom of footing elevation and, thereafter, verify the in-place compaction for a depth of 1 foot below the footing bottom. If necessary, compact the soils at the bottom of the excavation to at least 95 percent of the modified Proctor maximum dry density (ASTM D-1557) for a depth of 1 foot below the footing bottom. Based on the existing soil conditions and, assuming the above outlined compaction criteria are implemented, an allowable soil bearing pressure of 1,500 pounds per square foot (psf) may be used in the design of the structure foundation. This bearing pressure should result in foundation settlement within tolerable limits (i.e., 1 inch or less).

**Dewatering**

If the control of groundwater is required to achieve the necessary excavation, filling, compaction, and any other earthwork, sitework, and/or foundation subgrade preparation
operations required for the project, the actual method(s) of dewatering should be determined by the contractor. Dewatering should be performed to lower the groundwater level to depths that are adequately below excavations and compaction surfaces. Adequate groundwater level depths below excavations and compaction surfaces vary depending on soil type and construction method, and are usually 2 feet or more. Dewatering solely with sump pumps may not achieve the desired results.

QUALITY ASSURANCE

We recommend establishing a comprehensive quality assurance program to verify that all site preparation and foundation construction is conducted in accordance with the appropriate plans and specifications. Materials testing and inspection services should be provided by Ardaman & Associates.

In-situ density tests should be conducted during backfilling activities and below all foundations to verify that the required densities have been achieved. In-situ density values should be compared to laboratory Proctor moisture-density results for each of the different natural and fill soils encountered. During the density testing at each structure, each 12-inch (maximum) lift of backfill should be tested.

Finally, we recommend inspecting and testing the construction materials for the foundations and other structural components.

CLOSURE

The analyses and recommendations submitted herein are based on the data obtained from the soil borings presented on Figures 2 through 5. This report does not reflect any variations which may occur away from the soil boring locations. The nature and extent of the variations away from the borings may not become evident until during construction. This report does not include an evaluation of the environmental (ecological or hazardous/toxic material related) condition of the site and subsurface.

This report has been prepared for the exclusive use of the Utilities Commission, City of New Smyrna Beach in accordance with generally accepted soil and foundation engineering practices. In the event any changes occur in the design, nature, or location of the proposed structures, we should review the applicability of conclusions and recommendations in this report.

We are pleased to be of assistance to you on this phase project. When we may be of further service to you or should you have any questions, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 59595

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DMC/JPM/dk

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SECTION 10
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OBTAINED FROM U.S.G.S. QUAD MAP: NEW SMYRNA BEACH, FLORIDA

SITE LOCATION MAP

SUBSURFACE SOIL EXPLORATION
MANHOLE MH 72-02 AND LIFT STATION #73
NEW SMYRNA BEACH, FLORIDA

DRAWN BY: TAT CHECKED BY: DATE: 3/9/21
FILE NO. 21-5218 APPROVED BY: FIGURE: 1
LEGEND

SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP-SM)
3. SILTY FINE SAND (SM)

COLORS

A. LIGHT BROWN TO BROWN
B. GRAYISH-BROWN
C. LIGHT GRAY TO GRAY

TH STANDARD PENETRATION TEST (SPT) BORING
N STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
WOH SAMPLER ADVANCED BY STATIC WEIGHT OF HAMMER AND RODS ONLY
–200 NATURAL MOISTURE CONTENT IN PERCENT (ASTM D-2216)
G GROUNDWATER LEVEL MEASURED ON DATE DRILLED

SP,SP-SM UNIFIED SOIL CLASSIFICATION SYSTEM
SM,SC,CH

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>BLOW COUNT &quot;N&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY LOOSE</td>
<td>0 TO 4</td>
</tr>
<tr>
<td>LOOSE</td>
<td>4 TO 10</td>
</tr>
<tr>
<td>MEDIUM DENSE</td>
<td>10 TO 30</td>
</tr>
<tr>
<td>DENSE</td>
<td>30 TO 50</td>
</tr>
<tr>
<td>VERY DENSE</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER’S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED. GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR.

SOIL PROFILES LEGEND

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
MANHOLE MH 72–02 AND LIFT STATION #73
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21–5218
APPENDIX

Standard Penetration Test Procedure
STANDARD PENETRATION TEST

The standard penetration test is a widely accepted test method of *in situ* testing of foundation soils (ASTM D 1586). A 2-foot long, 2-inch O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 30 inches. The number of blows needed for each 6 inches of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch increments of penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual examination and classification of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load.

The tests are usually performed at 5-foot intervals. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is a bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, NX-size flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid.

Representative split-spoon samples from the soils at every 5 feet of drilled depth and from every different stratum are brought to our laboratory in air-tight jars for further evaluation and testing, if necessary. Samples not used in testing are stored for 30 days prior to being discarded. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed, if necessary, and backfilled.