SUBSURFACE INVESTIGATION AND GEOTECHNICAL REPORT

FOR

LOUDOUN COUNTY
SOLID WASTE MANAGEMENT FACILITY
PUMP STATION
LOUDOUN COUNTY, VA

GEOPRO PROJECT GP-10502-001

SUBMITTED TO:

MR. AFAN AREF, P.E.
SOLID WASTE SERVICES, LLC
11706 BOWMAN GREEN DRIVE
RESTON, VA 20190

JULY 15, 2019
REVISED SEPTEMBER 18, 2019
Mr. Afan Aref, P.E.
Solid Waste Services, LLC
11706 Bowman Green Drive
Reston, VA 20190

Re: Loudoun County Solid Waste Management Facility (LCSWMF) Pump Station
Loudoun County, Virginia Subsurface Investigation and Geotechnical Engineering Study Report
GeoPro Project No : GP 10502-001

Dear Mr. Aref:

GeoPro has completed the authorized subsurface exploration and revised geotechnical report for the above referenced site.

The recommendations presented in this report are intended for use by your office and for the use of other design professionals involved with the design and development of this specific project described herein.

GeoPro appreciates the opportunity to be of professional service during this preliminary phase of the project, and we look forward to working with you during the final design and construction. Should you have any questions concerning this geotechnical report, please contact us.

Respectfully Submitted,

GeoPro, LLC

Alan Troup, C.P.G.
Project Manager

Jeff S. Paik, P.E.
Principal Engineer
TABLE OF CONTENTS

1.0 INTRODUCTION .............................................................................................................. 1
  1.1 SCOPE OF WORK ........................................................................................................... 1
  1.2 SITE LOCATION AND DESCRIPTION ......................................................................... 1
  1.3 PROJECT DESCRIPTION .............................................................................................. 2

2.0 METHODOLOGY ........................................................................................................... 2
  2.1 SUBSURFACE INVESTIGATION ................................................................................... 2
  2.2 LABORATORY TESTING .............................................................................................. 3

3.0 RESULTS ....................................................................................................................... 4
  3.1 SITE GEOLOGY AND SOIL MAPPING ......................................................................... 4
  3.2 SUBSURFACE OBSERVATIONS .................................................................................. 6
  3.3 GROUNDWATER CONDITIONS ................................................................................. 7
  3.4 LABORATORY TEST RESULTS .................................................................................. 7

4.0 GEOTECHNICAL RECOMMENDATIONS ....................................................................... 8
  4.1 SUITABILITY OF ONSITE SOILS ............................................................................... 8
  4.2 UNDERGROUND UTILITIES ...................................................................................... 9
  4.3 EARTHWORK ............................................................................................................. 10
  4.4 FOUNDATION SUPPORT RECOMMENDATIONS ...................................................... 11
  4.5 VALVE VAULT WALL ................................................................................................ 13
  4.6 UNDERGROUND STORAGE TANKS ......................................................................... 14

5.0 CLOSING REMARKS ................................................................................................... 15
  5.1 ADDITIONAL SERVICES ............................................................................................ 15
  5.2 LIMITATIONS ............................................................................................................ 15

FIGURES
  Site Vicinity Map ............................................................................................................. Figure 1
  Soils Map ...................................................................................................................... Figure 2
  Geology Map ................................................................................................................ Figure 3

APPENDICES
  Boring Location Plan and Test Boring Logs ................................................................. Appendix I
  Laboratory Test Results ................................................................................................. Appendix II
1.0 Introduction

GeoPro, LLC has completed a subsurface exploration and geotechnical engineering study at a property located in Loudoun County, Virginia and referenced herein as “LCSWMF – Pump Station”. The work was authorized by Mr. Afan Aref, P.E. of Solid Waste Services, LLC as an assessment of the subsurface conditions across the site to aid design of the proposed pump station.

1.1 Scope of Work

In accordance with our proposal, our scope of services for LCSWMF-Pump Station included drilling two (2) soil test borings, designated as SB-1 and SB-2, to characterize subsurface conditions for the proposed structure, performing limited laboratory testing of recovered soil samples, performing engineering analysis, and preparing a geotechnical report.

1.2 Site Location and Description

The subject site is located in Leesburg, Loudoun County, Virginia within the southeast portion of the Loudoun County Solid Waste Management Facility (LCSWMF), also referred to as the Loudoun County Landfill and identified by Loudoun County PIN 278491882. The site is bound to the east by Evergreen Mills Rd (Route 621), to the south and west by The Woods Road (Rt. 771), and to the north by private residential properties.

The proposed area of development is located with an existing west to east oriented valley swale with an existing channel along the axis. Elevation at the site varies from approximately EL. 340 in the southwest to EL. 328 in the east in the vicinity of the exiting channel. Prior to development of the LCSWMF and construction of the existing gravel/rip-rap lined channel within the existing valley swale, streamflow included a natural minor tributary stream of Goose Creek. Past and present stream flow within the proposed area of development within the LCSWMF is in the west to east direction along topography. The stream channel exits LCSWMF under Evergreen Mills Road within a concrete conspan under Evergreen Mills Road where it joins another minor tributary approximately 700 feet west of the eastern boundary of the LCSWF before meandering in a southeast direction to join Goose Creek.
1.3 Project Description

The project consists of the design of a proposed pump station within the existing LCSWMF for the purpose of pumping landfill leachate. We understand that the proposed pump station is to be located approximately 600 feet to the west of Evergreen Mills Rd. (Rt. 621) and to the northwest of the existing facility construction access road and southwest of the existing stormwater management sedimentation basin SB-4. Based on existing drawings provided by the client, we understand that the proposed pump station will consist of three underground storage tanks with 12 ft diameter and 54 ft -4 in length, a force main (FM) for transportation of landfill leachate with associated aboveground and underground utility infrastructure, emergency generator and aboveground odor control tank.

2.0 METHODOLOGY

2.1 Subsurface Investigation

GeoPro performed a recent subsurface exploration that included two (2) test borings, identified as Borings SB-1 and SB-2, located near the existing culvert and within the proposed pump station, respectively. Borings SB-1 and SB-2 were advanced to depths of 40 ft and 20 ft below the ground surface, respectively. The boring locations were located and staked by the client. The locations of the test borings are shown on the Boring Location Plan presented in Appendix I of this report.

The test borings were drilled with a CME550 ATV drill rig utilizing 2-1/4 inch inside diameter hollow-stem augers. The soil borings included performing the Standard Penetration Tests (SPT) at pre-determined intervals in general accordance with ASTM D1586-84. The Standard Penetration Test employs a two-inch outside diameter, split-barrel sampler driven 18-inches into the ground by a 140-pound hammer with a free fall of 30 inches. The number of blows required to drive the sampler the second and third six-inch intervals is recognized as the standard penetration resistance or the
N-value of the soil at the specified depth of sampling and is indicated for each sample on the boring logs. This value can be used to provide a quantitative indication of the in-place relative density of non-cohesive soils or the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

The soils encountered were visually classified in the field in general accordance with the ASTM D2488 procedures. The soil samples were placed in sealed jars and transported to our office in Chantilly, Virginia for further examination by a GeoPro geotechnical engineer and laboratory testing purposes.

Groundwater observations were made during the drilling of the test borings by a visual examination of recovered samples from the standard penetration tests, auger cuttings, and water marks on the split-barrel sampler and drill rods. Further, groundwater readings were made upon the completion of each boring and at the end of the day. Specific observations and soil descriptions recorded during the subsurface exploration are detailed on the individual field logs that are presented in Appendix I of this report.

Soil samples were recovered from the test borings using the split spoon sampler in conjunction with performing the Standard Penetration Test.

### 2.2 Laboratory Testing

The purpose of the laboratory testing program was to evaluate the engineering and index properties of the subsurface soils and to assist in soil classification and relative strength evaluations. Representative soil samples were obtained at various depth intervals within each of the test borings for laboratory testing and analysis. These samples were divided into groups of similar samples according to color and visual classification. Representative soil samples from each group were then classified according to the Unified Soil Classification System (USCS) described in ASTM D2487, based on the laboratory test results.
The laboratory-testing program was performed in general accordance with applicable American Society of Testing and Materials (ASTM) Standard Test Procedures. The laboratory test program included the test methods listed below.

- Moisture Content of Soils  
  ASTM D2216
- Grain Size Distribution  
  ASTM D422
- Atterberg limits (Liquid Limit, Plastic Limit, and Plasticity Index)  
  ASTM D4318

Moisture content determinations were performed in order to verify the in-situ moisture contents of the subsurface soils encountered. The grain size distribution tests were performed to assist in soil classification (i.e., gravel, sand, silt or clay). Atterberg Limit tests were performed in order to evaluate the plasticity characteristics of the encountered subsurface soils and to assist in soil classification. The results of the laboratory classification test reports are provided in Appendix II.

All soil samples will be stored at our office where they will be available for inspection for a period of 60 days from the date of this report, after which time they will be discarded, unless instructed otherwise in writing.

3.0 RESULTS

3.1 Site Geology and Soil Mapping

The site is mapped as part of the Culpeper Basin. The Culpeper Basin is a structural trough filled with Mesozoic sedimentary and igneous rocks of late Triassic to early Jurassic age extending from about Madison Hills, Virginia to Frederick, Maryland. At this site location, the principal rock type is mapped as the upper Lower Jurassic to Upper Goose Creek Member of the Catharpin Creek Formation (JTrCg) as per the 2006 Geologic Map of Loudoun County, Virginia, as captured in Figure 3, Geology Map. Bedrock belonging to JTrCg consists of lenticular conglomerate and interbedded pebbly/gravelly sandstone. The conglomerate is typically reddish brown to grayish green, thickly bedded to massive with subrounded pebbles and cobbles consisting of quartzite, greenstone, metasiltstone, gneiss, vein quartz with
minor carbonate in a medium to coarse grained arkosic (red) sandstone matrix. The contact between JTrCg and the interbedded sandstone, siltstone, and conglomerate of the Catharpin Creek Formation proper (JTrC) is approximately at and along Evergreen Mills Road. The higher elevations of LCSWMF above the proposed pump station site are mapped as underlain by a surficial layer of Late Quaternary to Holocene lag gravel (Qlg) consisting of cobbles and gravel of rounded rock similar in composition to the clasts in the underlying conglomerate (JTrCg) bedrock. The natural soils below the topsoil consist of residual soils derived from the in-place weathering of the underlying sedimentary bedrock.

The residual soils overlying conglomerate rock are generally low to medium plasticity sandy lean clay, sandy silt, clayey gravel, and silty gravel. All soil types typically contain gravel to cobble sized mixed conglomerate clasts (rock fragments) as residual from partial weathering of underlying conglomerate bedrock. Many areas of the Culpeper Basin are noted for seasonal shallow groundwater due to the shallow depth to bedrock and low permeability residual soils, particularly in the vicinity of floodplains and tributary streams, in which the latter case applies to the subject project site.

Based on the Interpretive Guide to the Use of Soils Maps of Loudoun County, Virginia, the onsite soils are mapped as Manassas silt loam (14B, Class II), Leedsville cobbly silt loam (70B and 70C, Class I) and Albano silt loam (79A, Class IV), shown on Figure 2, Soils Map, and the Boring Location Plan. The Albano silt loam (79A) is mapped as located over most of the proposed pump station site, including within the existing valley swale along existing lined channel (former tributary stream), and is classified as very poor potential for development due to flooding, seasonal perched water tables, and shallow groundwater overall. Albano silt loam (79A) is a hydric soil type typical of wetlands and streams in Loudoun County. Albano silt loam has the potential to contain organics and highly plastic cohesive soil material along with deeply weathered residual profiles, principally along the axes of existing or former stream channels and/or channel wetlands. The Albano silt loam is located adjacent to and within the flood plain of the existing east-to-west-flowing minor tributary stream in the extreme southern portion of the site. The remaining soil types are Class I and II soils which are considered favorable for development with few problems related to groundwater,
flooding, or workability of soil materials.

3.2 Subsurface Observations

The Boring Logs presented in Appendix I represent our interpretation of the subsurface conditions based on observations performed during the drilling operations, visual examination of the soil samples by a geotechnical engineer, as well as a review of geologic data. The lines designating the interfaces between various strata on the Boring Logs represent the approximate strata boundaries. The actual transitions between strata may be more gradual than shown. All data should be considered accurate only at the exact test boring locations.

The soils encountered in the test borings appear to be generally consistent with regional geologic information. Test borings indicate the following generalized soil strata underlying the proposed pump station.

**Stratum I: Existing FILL**

Existing FILL consisted of sandy silt and sandy lean clay containing rock fragments and roots. Ground surface was covered with 6-inch thick crushed stones. Existing fill was encountered at the surface and extended to depths of 5 to 6 ft below grade. SPT N values were in the range of 16 to 34, indicating medium to dense density. Relatively high blow counts were obtained near the surface due to crushed stones.

**Stratum II: Residual Soils**

Stratum II consists of fine-grained residual soils comprised predominantly of red brown and brown sandy SILT (ML) and sandy Lean CLAY (CL) with varying amounts of weathered rock fragments included subrounded conglomerate clasts. Silty GRAVEL (GM) and silty SAND (SM) were also encountered in Boring SB-1, likely representative of less weathered or more rocky conglomerate material with lower percentage of fine-grained matrix. These soils extended to a depth of 40 ft, the maximum depth of boring. SPT N values were in the range of 7 to 26, indicating generally stiff consistency for fine-grained cohesive material and medium density for granular, silty GRAVEL material.
For more detailed and specific information at each boring location refer to the Boring Logs in Appendix I.

3.3 Groundwater Conditions

Groundwater readings were performed during and upon completion of each soil boring. Groundwater was detected approximately at depths of 14.0 ft to 17.5 ft below grade or El 321 to El 322.5 ft. The groundwater readings and associated cave-in depths are recorded on the Boring Logs in Appendix I.

The groundwater condition at the proposed site is expected to be significantly influenced by surface runoff and rainfall flowing into the existing channel (former tributary stream) within the proposed pump station footprint and portions of proposed force main alignment, and the nearby but unconnected stormwater management sedimentation basin. Groundwater levels are expected to fluctuate seasonally and more frequently as a consequence of precipitation events and affected by runoff, infiltration, and nearby construction activity within or adjacent to the existing valley terrain of the proposed pump station site. Therefore, the groundwater levels encountered during construction or during the operational life of the pump station may differ from and vary highly from those recorded at our two test boring locations during the subsurface investigation.

3.4 Laboratory Test Results

The results of the laboratory tests indicate that the natural soils tested classify as silty GRAVEL with sand (GM) and Lean CLAY with sand (CL). The individual laboratory test data sheets are presented in Appendix II and presented in applicable boring logs. A summary of the laboratory test results that include soil classification and Atterberg limits is listed in the following table.
4.0 GEOTECHNICAL RECOMMENDATIONS

The recommendations outlined in this report are based on the subsurface exploration and laboratory testing analysis, as well as the information provided to us by Solid Waste Services, LLC and Wastewater Management, Inc. The primary factors that will affect the proposed development include groundwater and relatively loose sand at the footing subgrade of the proposed wet well.

4.1 Suitability of Onsite Soils

Existing FILL
Existing FILL is probably due to site grading work during construction of the adjacent stormwater management facilities. Documentation records the placement and/or compaction of existing FILL are unavailable. Any evaluation of the suitability of existing FILL for reuse as backfill material for the proposed pump station will be made at a later date.

Residual Soils
The cohesionless and low to moderate plasticity residual soils of Stratum II, silty SAND (SM), silty GRAVEL (GM) and SILT (ML) are generally suitable for use as structural fill for pad support, pavement areas and backfill over site utilities. Lean CLAY (CL) encountered in Boring SB-2 is not suitable for the structural fill.

Unsuitable Material
Unsuitable soils having a liquid limit value greater than 40 and plasticity index value greater than 14 to include Elastic SILT (MH) and Fat CLAY (CH) are known to exhibit
high shrink-swelling and plastic behavior. When encountered during site grading, these high plasticity materials should be excavated and removed from the remaining suitable soils.

All borrow materials, including the fine-grain fraction of (SM–SC) type soils, shall be tested for classification and shrink/swell characteristics prior to their use as structural fill or backfill material.

Some soils may be wet or dry of the optimum moisture required for compaction; therefore, scarifying and drying by spreading and aerating or the use of a water truck during construction and prior to their reuse as compacted structural fill or backfill should be expected.

4.2 Underground Utilities

Groundwater may be encountered during excavation of 12 inch PVC pipes connected to the wet well at El 322. Temporary dewatering measures may be necessary during construction and should consist of sump pits and continuous pumping.

Temporary excavations greater than four (4) feet should be properly shored or sloped away from the excavation with a minimum grade of 1.5H:1V. If sloping of temporary trenches and pits is not desired, then trench boxes should be utilized. All excavations shall be performed in accordance with the OSHA and VOSHA regulations.

Where plastic or expansive soils are encountered at the pipe subgrade, a minimum 6-inch granular bedding should be provided below the pipe system to provide uniform support and promote drainage. When hand-held tampers are used to compact the backfill materials, 1-feet thickness shall be reduced to not more than 6 inches to ensure achieving a compacted wedge between the pipe and the bedding layer. Backfill for utilities shall consist of approved structural fill and shall be compacted to at least 95% of the maximum dry density as determined in accordance with the specifications set forth in ASTM D698 (Standard Proctor). Backfill materials for use in utility trenches shall meet the material requirements of Section 4.3.3 of this report.
4.3 Earthwork

4.3.1 Subgrade Preparation

After the excavation is made to the final level of each structure, we recommend that the exposed subgrade be verified by the geotechnical engineer. Soft or loose areas should be removed, as directed by the geotechnical engineer, prior to placement of new fill or stone base.

Since loose sand and fill may be present at the subgrade, undercutting may be required at some local areas.

4.3.2 Structural Fill Material

All structural fill material, whether on-site or imported from an off-site source, shall be tested for suitability and quality prior to its use as fill or backfill. We recommend that the material be tested to determine particle gradation, plasticity and maximum dry density. The following standard tests should be performed to determine the above properties of all structural fill material:

<table>
<thead>
<tr>
<th>Test</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Gradation</td>
<td>ASTM D422</td>
</tr>
<tr>
<td>Plasticity</td>
<td>ASTM D4318</td>
</tr>
<tr>
<td>Standard Proctor</td>
<td>VTM-1, ASTM D698</td>
</tr>
</tbody>
</table>

Structural fill material shall consist of quality, low plasticity, free of organic soil that classify as GW, GP, GM, GC, SW, SP, SC, SM, ML in accordance with ASTM D2487 and shall have a maximum of 30% retained on a standard ¾-inch sieve and a maximum of 70% passing a U.S. Standard No. 200 sieve. Proposed structural fill shall be tested to ensure that the material has liquid limit value less than or equal to 40 and plasticity index value less than 14 for building areas; and 45 and 20, respectively, for pavement areas.

All fill material shall be free of ice, snow, organic material, construction debris, rock sizes greater than 4 inches, expansive soils, or other deleterious material.
4.3.3 Structural Fill Placement and Testing

Structural fill materials for the concrete pads and pavement area shall be placed in no greater than 8-inch loose lifts and compacted to at least 95% of the maximum dry density as determined in accordance with specifications set forth in ASTM D698 (Standard Proctor). Fills greater than 8 feet in thickness shall be compacted to at least 98% of the maximum dry density to limit differential settlement.

To ensure proper compaction efforts, field density determinations shall be performed in accordance with specifications set forth in ASTM D6938 (nuclear method) or D1556 (sand cone method). Compaction tests should be performed on every lift of fill placed. The moisture content of the fill being placed shall be within 2 percentage points of the optimum moisture content of the material.

All earthwork shall be monitored on a full-time basis by a qualified inspector, acting under the guidance of a Professional Engineer, registered in the Commonwealth of Virginia.

4.4 Foundation Support Recommendations

4.4.1 Wet Well

The proposed HDPE wet well will be 6 ft in internal diameter and 22 ft in height. Two submersible pumps will be installed at the bottom of the well and two 12 inch PVC pipes will be connected at El 322 in southwest and northwest. Drain tiles with 4 inch diameter will also be installed at El 335. A 1.5 ft thick concrete footing is planned to support the wet well.

Considering the proposed bottom elevation of El 316.5, medium stiff sandy silt underlain by loose silty sand is expected to be present at the footing subgrade. Medium stiff silt and loose sand are not considered suitable for support of the proposed wet well due to anticipated excessive settlement. It is recommended that footing subgrade be undercut by minimum 2 ft and the undercut be replaced by No. 57 stone. Footings founded on No. 57 stone may be designed for a soil bearing
4.4.2 Valve Vault

A concrete valve vault is planned next to the wet well. Internal width and length of the proposed valve vault are 8 ft and 12 ft, respectively. Concrete wall thickness is assumed one foot. Considering the bottom elevation of El 330, stiff to very stiff sandy silty of natural origin is expected to be present at the bottom of the valve vault.

Stiff to very stiff silt is suitable for support of the proposed valve vault. It is recommended to place minimum 8 inch of compacted 21A or 21B stones as the subbase for the valve vault. Soil bearing capacity of 2,500 psf is recommended for the subbase underlain by very stiff silt.

4.4.3 Concrete Pads

An odor control chemical tank, a generator and electrical equipment will be installed around the proposed valve vault. Although design information of concrete pads for the above structure is not available at the time of this reporting, we assumed that the proposed concrete pads may be designed with turn down footings. Based on the site layout plan and information from the test borings, it is anticipated that the proposed turn down footings will be supported on the existing fill. Turn down footings directly on existing fill which contains clay layer with organic material are not considered feasible for support of the above structure due to excessive differential settlement.

It is recommended that existing fill be undercut to the natural soils and the undercut be replaced with structural fill with granular material. A soil bearing pressure of 3,000 psf may be designed for the concrete pads installed on structural fill.

The use of the above specified uniform allowable bearing capacity will minimize the total settlement to one (1) inch or less with differential settlement of less than one-half (1/2) inch or less in accordance with standard engineering practices.
Proper construction procedures should be followed to maintain the quality of the footing excavations. Footing subgrades should be protected from precipitation, seepage, surface run-off and frost. We recommend that the footings be cast the same day of excavation.

4.4.4 Dewatering

Groundwater should be expected within excavations of the proposed wet well and permanent dewatering system is recommended during construction and operation of the pump station.

The contractor should be responsible for designing, permitting, and constructing dewatering system using accepted and professional methods consistent with current industry practice to maintain the groundwater level below bottom of the proposed wet well.

The dewatering system should be of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow work to be installed in a dry condition (i.e., no standing water) that maintains stability of the subgrade soils.

4.5 Valve Vault Wall

4.5.1 Lateral Earth Pressures

Since the vault walls are to receive unbalanced backfill, we recommend that the vault walls be designed to resist lateral earth pressures. According to IBC 2012, an equivalent fluid pressure of 60H (psf) is recommended for the wall design, provided that porous backfill is to be placed.

4.5.2 Backfill

Soils classified as SM, SC, SP, SW or more granular soils in accordance with ASTM D-2487 are considered suitable for backfill. The on-site excavated silty sand (SM) and silty gravel (GM) of Stratum II may be reused for backfill.
Backfill should be compacted to 95 percent per ASTM D-698. A hand-operated tamper should be used for compaction of backfill within 5 ft from the wall to avoid over stressing.

4.6 Underground Storage Tanks

Three (3) 40,000 gallon fiberglass storage tanks will be installed in the south portion of the pump station. Each tank is 12 ft in diameter and 54 ft-4 in in length. Bottom elevation of the tanks is planned at El 324, which is from 15.5 ft to 16 ft below the final ground surface of El 339.5 to El 340.0. Center to center spacing between the tanks is 15 ft.

4.6.1. Deadman Anchoring System

Deadman anchoring systems are designed to prevent the underground storage tank from floating out of the ground during periods of high groundwater. Deadman anchors consist of minimum 12 inch thick reinforced concrete beams that run the full length of the tanks. Tank anchoring calculations (buoyancy calculations) are to be performed by the manufacturer with calculations achieved with water estimated to the top of the tank. Corrosion protection is recommended for all anchors.

4.6.2. Subgrade Preparation

Stiff sandy SILT of natural origin is expected to be present at the subgrade of the proposed tanks. Subgrade shall be field verified by the certified geotechnical engineer. If unsuitable soil exists at the subgrade, filter fabric is recommended to be installed on the bottom and sides of the tank pit. Filter fabric must be placed before the bedding and backfill is in place.

Pea gravel which has grain size from 1/8” to 3/4” with no more than 3 percent passing a 3/8” sieve is recommended for bedding and backfill material. Minimum one foot thickness of bedding is considered suitable for support of the proposed tanks. Bedding shall be compacted before the tanks are placed.
Based on our investigation and test results, the design bearing capacity of 2,500 psf is considered suitable and recommended for the foundation design.

5.0 CLOSING REMARKS

5.1 Additional Services

We recommend that GeoPro, LLC be retained to monitor the construction activities and to verify that the field conditions are consistent with the findings of our investigation. If significant variations are encountered or if the design is altered, GeoPro, LLC should be notified and given the opportunity to evaluate potential impacts to the geotechnical recommendations of this report.

The quality control testing and geotechnical engineering consulting services provided during or to support the construction phase of this project shall include:

1. Observing and documenting undercutting of unsuitable soils and inspect the subgrade for foundation and any paved areas;
2. Performing laboratory testing of material proposed for use as structural fill;
3. Performing compaction testing during the placement of approved structural fill material;

5.2 Limitations

This preliminary report has been prepared by GeoPro, LLC, exclusively for the specific subject project. The work has been performed in accordance with generally accepted engineering principles and practices. No other warranty, expressed or implied, is made.

The interpretations and recommendations submitted in this report are based in part upon the subsurface data obtained from the borings. The nature and extent of variations between the field test locations may not become evident until
construction begins. Any changes in the nature or design of the proposed development should be reviewed against the conclusions and recommendations contained herein and the conclusions modified or verified in writing. We recommend that we be provided an opportunity to review the geotechnical aspects of the final design and specifications for compliance with our report. If significant variations are encountered or if the design is altered, GeoPro, LLC should be notified and given the opportunity to evaluate potential impacts to the geotechnical recommendations of this report. In no case can we assume responsibility for misinterpretation of our recommendations.
FIGURES
ACCORDING TO THE INTERPRETIVE GUIDES TO THE USE OF SOILS MAPS FOR LOUDOUN COUNTY, THE SITE CONTAINES CLASS IV SOILS

14B: Manassas silt loam - Class II
70B: Leedsville cobbly silt loam (3-8% slopes) – Class I
70C: Leedsville cobbly silt loam (8-15% slopes) - Class I
79A: Albano silt loam - Class IV
APPENDIX I

Boring Location Plan
Test Boring Logs
GeoPro, LLC
4515 Daly Dr.
Suite D
Chantilly, Virginia 20151
Phone: (703) 774-3304

LCSWMF-PUMP STATION
LOUDOUN COUNTY, VIRGINIA
BORING LOCATION PLAN

APPENDIX 1
PROJ. #GP-10502-001

SCALE: NO SCALE

SOIL TABLE

<table>
<thead>
<tr>
<th>NO.</th>
<th>SOIL NAME</th>
<th>GROUP</th>
<th>CLASS</th>
<th>SLOPE (%)</th>
<th>K FACTOR</th>
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<tr>
<td>14B</td>
<td>MANASSAS SILT LOAM</td>
<td>B</td>
<td>II</td>
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<td>70B</td>
<td>LEEDSVILLE COBBLY SILT LOAM</td>
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<td>I</td>
<td>3-8</td>
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<tr>
<td>70C</td>
<td>LEEDSVILLE COBBLY SILT LOAM</td>
<td>B</td>
<td>I</td>
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<td>79A</td>
<td>ALBANO SILT LOAM</td>
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<tr>
<td>35</td>
<td>Brown, Sandy SILT with rock fragments and quartz fragments, trace mica, stiff, wet</td>
<td>ML</td>
<td></td>
<td></td>
<td>9</td>
<td>3 4 6</td>
</tr>
<tr>
<td>40</td>
<td>Bottom Of Boring at 40.0 ft.</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>4 5 8</td>
</tr>
</tbody>
</table>
**PROJECT NAME:** LCSWFM-Pump Station

**BORING NUMBER:** SB-2

**PROJECT NUMBER:** GP-10502-001

**ELEVATION (FT):** (est.) 338.5

---

**WATER LEVELS**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>DEPTH</th>
<th>CAVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-07-2019</td>
<td>11:20</td>
<td>17.5'</td>
<td></td>
</tr>
</tbody>
</table>

**ENCOUNTERED:**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>DEPTH</th>
<th>CAVED</th>
<th>DATE START:</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-07-2019</td>
<td>11:20</td>
<td>17.5'</td>
<td></td>
<td>06-07-2019</td>
</tr>
</tbody>
</table>

**UPON COMPLETION:**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>DEPTH</th>
<th>CAVED</th>
<th>DATE FINISH:</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-07-2019</td>
<td>11:20</td>
<td>17.5'</td>
<td></td>
<td>06-07-2019</td>
</tr>
</tbody>
</table>

**SHORT TERM:**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>DEPTH</th>
<th>CAVED</th>
<th>DATE START:</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-07-2019</td>
<td>11:30</td>
<td>Dry</td>
<td>12.5'</td>
<td>06-07-2019</td>
</tr>
</tbody>
</table>

**EQUIPMENT:** CME550 ATV

---

**LONG TERM:**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>DEPTH</th>
<th>CAVED</th>
<th>DATE FINISH:</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-07-2019</td>
<td>12:10</td>
<td>Dry</td>
<td>12.5'</td>
<td>06-07-2019</td>
</tr>
</tbody>
</table>

**REVIEWER:** L.M./A.T.

---

**DEGREES:**

<table>
<thead>
<tr>
<th>ELEV (FT)</th>
<th>DEPTH (FT)</th>
<th>GRAPHIC LOG</th>
<th>USCS</th>
<th>DESCRIPTION / CLASSIFICATION OF MATERIALS</th>
<th>MC(%)</th>
<th>SAMPLE #</th>
<th>TYPE</th>
<th>BLOWS</th>
<th>SPT N</th>
<th>Atterberg Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6&quot; Crushed Stone</td>
<td>FILL- Brown, Sandy SILT with roots and rock fragments, hard to stiff, moist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>335</td>
<td>330</td>
<td>325</td>
<td>320</td>
<td>23.3 Red brown, Sandy Lean CLAY with rock fragments and quartz fragments, stiff, moist</td>
<td>23.3</td>
<td>3</td>
<td>S</td>
<td>7</td>
<td>10</td>
<td>Plastic Limit</td>
</tr>
<tr>
<td>330</td>
<td>325</td>
<td>320</td>
<td>20</td>
<td>24.3 Red brown, Sandy SILT with rock fragments and lean clay layers, stiff, moist</td>
<td>24.3</td>
<td>4</td>
<td>S</td>
<td>5</td>
<td>6</td>
<td>Plastic Limit</td>
</tr>
<tr>
<td>325</td>
<td>320</td>
<td>315</td>
<td>20</td>
<td>Wet below 17.5ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plastic Limit</td>
</tr>
<tr>
<td>320</td>
<td>315</td>
<td>310</td>
<td>15</td>
<td>Bottom Of Boring at 20.0 ft.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plastic Limit</td>
</tr>
</tbody>
</table>

**SPT N Values**

<table>
<thead>
<tr>
<th>SPT N</th>
<th>Atterberg Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Limit</td>
<td>Liquid Limit</td>
</tr>
<tr>
<td>SPT N Values</td>
<td>Plastic Limit</td>
</tr>
</tbody>
</table>

---

**NOTES:**
APPENDIX II

Soil Classification Charts
Laboratory Test Results
### SOIL CLASSIFICATION CHART

(ASTM D-2487)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests\(^A\)  

<table>
<thead>
<tr>
<th>Coarse-Grained Soils</th>
<th>Fine-Grained Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravels More than 50% retained on No. 200 sieve</td>
<td>Silts and Clays 50 % or more passes the No. 200 sieve</td>
</tr>
<tr>
<td>Sands 50 % or more of coarse fraction retained on No. 4 sieve</td>
<td>Liquid limit less than 50</td>
</tr>
</tbody>
</table>

#### Gravelly Soils

- Gravels with 5 to 12 % fines require dual symbols:
  - GW-GM: well-graded GRAVEL with silt
  - GW-GC: well-graded GRAVEL with clay
  - GP-GM: poorly graded GRAVEL with silt
  - GP-GC: poorly graded GRAVEL with clay

- Sand with 5 to 12 % fines require dual symbols:
  - SW-SM: well-graded SAND with silt
  - SW-SC: well-graded SAND with clay
  - SP-SM: poorly graded SAND with silt
  - SP-SC: poorly graded SAND with clay

#### Clean Sands

- Clean Gravels Cuv ≥ 4 and 1 ≤ Cc ≤ 3\(^F\)  
- Less than 5% fines Cuv < 4 and/or 1 > Cc > 3\(^F\)  
- Gravels with Fines Cuv ≥ 4 and 1 ≤ Cc ≤ 3\(^F\)  
- More than 12% fines Cuv < 4 and/or 1 > Cc > 3\(^F\)

#### Silts and Clays

- Silts and Clays
  - Inorganic: PI > 7 and plots on or above "A" line\(^E\)  
  - Organic: PI < 4 or plots below "A" line\(^E\)  
- Liquid limit - oven dried
  - Liquid limit - not dried

- Liquid limit - oven dried
  - Liquid limit - not dried

#### Organics

- Highly Organic Soils: Primarily organic matter, dark in color, and organic odor
- Primarily organic matter, dark in color, and organic odor

---

\(^A\) Based on the material passing the 3-in. (75mm) sieve.

\(^B\) If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

\(^C\) Gravels with 5 to 12 % fines require dual symbols:
  - GW-GM: well-graded GRAVEL with silt
  - GW-GC: well-graded GRAVEL with clay
  - GP-GM: poorly graded GRAVEL with silt
  - GP-GC: poorly graded GRAVEL with clay

\(^D\) Sand with 5 to 12 % fines require dual symbols:
  - SW-SM: well-graded SAND with silt
  - SW-SC: well-graded SAND with clay
  - SP-SM: poorly graded SAND with silt
  - SP-SC: poorly graded SAND with clay

\(^E\) Cu = D_{60} / D_{10}  

\(^F\) Cc = (D_{90}^2 / (D_{10} \times D_{60}))

\(^G\) If fines classify as CL-ML, use dual symbol GC-ML, or SC-ML.

\(^H\) If fines are organic, add “with organic fines” to group name.

\(^I\) If soil contains ≥ 15 % gravel, add “with gravel” to group name.

\(^J\) If Atterberg limits plot in hatched area, soil is a CL-ML, silty CLAY.

\(^K\) If soil contains 15 to 29 % plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

\(^L\) If soil contains ≥ 30 % plus No. 200, predominantly sand, add “sandy” to group name.

\(^M\) If soil contains ≥ 30 % plus No. 200, predominantly gravel, add “gravely” to group name.

\(^N\) PI ≥ 4 and plots on or above “A” line.

\(^O\) PI < 4 or plots below “A” line.

“Some” indicates presence of negligible amount of material.

---

### RELATIVE DENSITY AND CONSISTENCY TABLE

The Standard Penetration Resistance values (N-values) and DCP values are used to describe the relative density of coarse-grained soils and the consistency of fine-grained soils as follows:

#### Cohesionless Soil

<table>
<thead>
<tr>
<th>N-value</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>Very Loose</td>
</tr>
<tr>
<td>5 - 10</td>
<td>Loose</td>
</tr>
<tr>
<td>11 - 24</td>
<td>Medium Dense</td>
</tr>
<tr>
<td>25 - 50</td>
<td>Dense</td>
</tr>
<tr>
<td>51+</td>
<td>Very Dense</td>
</tr>
</tbody>
</table>

#### Cohesive Soil

<table>
<thead>
<tr>
<th>N-value</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
<td>Very Soft</td>
</tr>
<tr>
<td>2 - 4</td>
<td>Soft</td>
</tr>
<tr>
<td>5 - 8</td>
<td>Medium Stiff</td>
</tr>
<tr>
<td>9 - 15</td>
<td>Stiff</td>
</tr>
<tr>
<td>16 - 30</td>
<td>Very Stiff</td>
</tr>
<tr>
<td>31 – 60</td>
<td>Hard</td>
</tr>
<tr>
<td>61+</td>
<td>Very Hard</td>
</tr>
</tbody>
</table>

---

GeoPro, LLC
**Material Description**

Brown Silty Gravel with Sand

**Atterberg Limits**

<table>
<thead>
<tr>
<th>PL</th>
<th>LL</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>32</td>
<td>4</td>
</tr>
</tbody>
</table>

**Coefficients**

<table>
<thead>
<tr>
<th>D90</th>
<th>D85</th>
<th>D60</th>
<th>D30</th>
<th>D15</th>
<th>Cc</th>
<th>AASHTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.9214</td>
<td>13.0784</td>
<td>1.4428</td>
<td>0.1616</td>
<td>Cc</td>
<td>A-4(0)</td>
<td></td>
</tr>
</tbody>
</table>

**Classification**

USCS = GM

**Remarks**

MC = 20.6%

---

**Location:** SB-1  
**Sample Number:** S4  
**Depth:** 8.5'-10.0'  
**Date:** 6/17/19
**Material Description**
Brown Lean Clay with Sand

**Atterberg Limits**
- PL = 22
- LL = 33
- PI = 11

**Coefficients**
- D_{90} = 0.2188
- D_{10} = 0.1056
- D_{50} = 0.1
- C_{u} = 1
- C_{c} = 1

**Classification**
- USCS = CL
- AASHTO = A-6(8)

**Remarks**
MC = 23.3%

---

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>PERCENT FINER</th>
<th>SPEC.*</th>
<th>PASS? PERCENT (X=NO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#4</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#10</td>
<td>98.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#20</td>
<td>95.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#40</td>
<td>93.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#60</td>
<td>90.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#100</td>
<td>87.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#200</td>
<td>81.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Location:** SB-2  
**Sample Number:** S3  
**Depth:** 5.0'-6.5'  
**Date:** 6/17/19
<table>
<thead>
<tr>
<th>Boring #</th>
<th>Sample #</th>
<th>Depth</th>
<th>Tare #</th>
<th>Tare Weight</th>
<th>Tare &amp; Wet Soil</th>
<th>Tare and Dry Soil</th>
<th>% Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SB-1</td>
<td>S3</td>
<td>5.0-6.5'</td>
<td>L27</td>
<td>20.64</td>
<td>106.95</td>
<td>102.00</td>
</tr>
<tr>
<td>2</td>
<td>SB-1</td>
<td>S4</td>
<td>8.5-10'</td>
<td>T19</td>
<td>8.80</td>
<td>214.69</td>
<td>179.97</td>
</tr>
<tr>
<td>3</td>
<td>SB-1</td>
<td>S5</td>
<td>13.5-15.0'</td>
<td>L40</td>
<td>20.83</td>
<td>87.36</td>
<td>75.15</td>
</tr>
<tr>
<td>4</td>
<td>SB-2</td>
<td>S3</td>
<td>5.0-6.5'</td>
<td>T7</td>
<td>8.74</td>
<td>230.77</td>
<td>188.84</td>
</tr>
<tr>
<td>5</td>
<td>SB-2</td>
<td>S4</td>
<td>8.5-10'</td>
<td>L44</td>
<td>20.40</td>
<td>91.29</td>
<td>77.45</td>
</tr>
<tr>
<td>6</td>
<td>SB-2</td>
<td>S5</td>
<td>13.5-15.0'</td>
<td>L9</td>
<td>20.84</td>
<td>99.29</td>
<td>83.54</td>
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</tbody>
</table>