Professional Service Industries, Inc.
1280 Trumbull Avenue, Girard, OH 44420
(330) 759.0288 (P)

October 6, 2022

**CT Consultants, Inc.**
3875 Embassy Parkway, Suite 200
Akron, OH 44333

Attention: Mr. Eric Fallon, PE

Re: Geotechnical Engineering Exploration Report
**Sanitary Siphon Replacement**
E McGaffney Street
Lowellville, Ohio
**PSI Project No. 01393755**

Dear Mr. Fallon,

Per your request, Professional Service Industries, Inc. (PSI) is pleased to submit this Geotechnical Engineering Services Report for the above referenced project. Included in this presentation are the results of the subsurface exploration and recommendations concerning the design and construction of the new pump station and force main.

After the plans and specifications are complete, PSI should review the final design and specifications in order to verify that the earthwork and recommendations are properly interpreted and implemented. **It is considered imperative that the geotechnical engineer and/or its representative be present during foundation installation and earthwork operations to observe the field conditions with respect to the design assumptions and specifications. PSI will not be held responsible for interpretations and field quality control observations made by others.**

Respectfully submitted,
**PROFESSIONAL SERVICE INDUSTRIES, Inc.**

Scott Hynes
Branch Manager

A. Veeramani, P.E.
Director/Principal Consultant

**Subsurface Exploration Report**

**For the Proposed**

**Sanitary Siphon Replacement**
**E McGaffeny Street**
**Lowellville, Ohio**

**Prepared for**

**CT Consultants, Inc.**
**3875 Embassy Parkway, Suite 200**
**Akron, Ohio 44333**

**Prepared by**

**Professional Service Industries, Inc.**
**1280 Trumbull Avenue**
**Girard, OH 44420**

**PSI Project No. 01393755**

Scott Hynes
Branch Manager

Alagaiya Veeramani, P.E.
Principal Consultant

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# 1 PROJECT INFORMATION

## 1.1 PROJECT AUTHORIZATION

This report presents the results of a geotechnical subsurface exploration and evaluation conducted for CT Consultants, Inc. in connection with the proposed pump station to be located between E McGaffney St. and E Jackson St., and force main that will run between the new pump stations and the existing Wastewater Treatment Plant on East Water Street in the Village of Lowellville, Mahoning County, Ohio. PSI's services for this project were performed in accordance with PSI Proposal No. 0139-364807R1, dated May 27, 2022. Authorization to perform this exploration and analysis was in the form of a Purchase Order from CT Consultants, Inc., dated May 31, 2022.

## 1.2 PROJECT DESCRIPTION

Project information was obtained from Mr. Eric Fallon, PE with CT Consultants, Inc on January 25, 2022, and Mr. Ryan Schuster, PE with CT Consultants, Inc on May 5, 2022, along with your request for proposal and proposed boring location plan. PSI understands that this project includes the construction of a new pump/lift station and a new force main. The planned pump/lift station is located between E McGaffney St. and E Jackson St., on a parcel owned by the Village of Lowellville, and will extend to a depth of about 25-feet below existing surface grades. The new force main will be horizontally drilled beneath the Mahoning River, and will connect to the existing Wastewater Treatment Plant, located at 600 East Water Street, Lowellville, Ohio.

The geotechnical recommendations presented in this report are based on the available project information, the proposed pump station and force main location on the site and the subsurface materials described in this report. If any of the information we have been given or have assumed is incorrect, please contact us so that we may amend the recommendations presented accordingly. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

## 1.3 PURPOSE AND SCOPE OF SERVICES

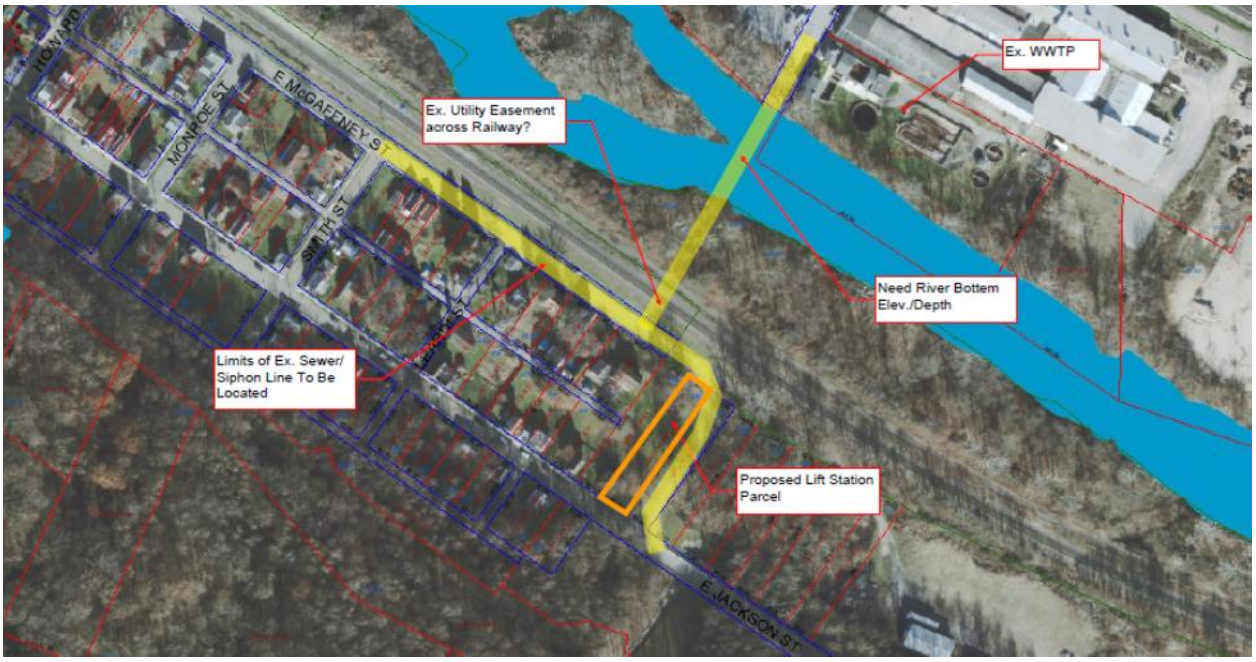
The purpose of this study was to explore the subsurface conditions at the site and to prepare recommendations for site preparation, and construction considerations for the proposed pump station and force main. Our scope for this service included a project site reconnaissance, drilling and sampling two (2) test borings, completing a laboratory testing program, and submitting an engineering analysis and evaluation of the subsurface soils encountered.

The scope of services for the geotechnical exploration did not include an environmental assessment for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors, colors or unusual or suspicious items or conditions are strictly for the information of the client. PSI's scope also did not include any service to investigate or detect the presence of moisture, mold, or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence or the amplification of the same. The Client should be aware that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. The Client should also be aware that site conditions are outside of PSI's control, and that mold amplification will likely occur, or continue to occur, in the presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or reoccurrence of mold amplification.

# 2 SITE AND SUBSURFACE CONDITIONS

## 2.1 SITE LOCATION AND DESCRIPTION

The project site for the proposed pump/lift station is located on the south side of the Mahoning River, between E McGaffney Street and E Jackson Street and consists of an open grass area. The force main will be horizontally drilled beneath the Mahoning River, and will connect to the existing Wastewater Treatment Plant, located at 600 East Water Street, Lowellville, Ohio. The project area is shown below:




Based on the available topographic plan and site observations, the site has elevation differences of up to 20-feet between the two boring locations, with an overall elevation difference of approximately 35-feet. We recommend that any existing utility lines be checked and marked prior to construction activities.

## 2.2 SUBSURFACE CONDITIONS

The subsurface conditions at the site were explored with a total of two (2) test borings. The test borings were drilled to a depth of about 23 ½ to 27 feet below the existing surface grades. The approximate boring locations are shown on the Boring Location Plan presented in the *Appendix* of this report. The locations and depths for the test borings were selected by CT Consultants, Inc. The borings were located in the field by PSI relative to existing site features and adjusted if necessary, based on site accessibility and the presence of below ground utilities.

The borings were advanced utilizing 3¼ inch inside diameter, hollow-stem auger drilling methods. Soil samples were routinely obtained during the drilling process. Selected soil samples were later tested in the laboratory to obtain soil material properties for construction considerations for the proposed sanitary sewer. Drilling, sampling, and laboratory testing was accomplished in general accordance with ASTM procedures.

The types of subsurface materials encountered in the test borings have been visually classified. The results of the visual classifications, Standard Penetration tests, moisture contents and water level observations are presented on

the boring logs in the *Appendix* of this report. Representative samples of the soils were placed in sample jars and are now stored in the laboratory for further analysis, if requested. Unless notified to the contrary, all samples will be disposed of after 60 days following the date of this report.

SURFACE: The ground surface at boring location B-1 consisted of a 6-inch layer of topsoil and grass, while the surface at boring B-2 consisted of FILL soil comprised of sandy silty clay with gravel and concrete fragments. The thickness and composition of the surface materials should be expected to vary throughout the proposed construction area.

FILL: At boring location B-2 the ground surface consisted of FILL soil comprised of sandy silty clay with gravel and concrete fragments, overlying silty sand with slag Fill, and foundry sand. The FILL materials extended from existing surface grades to a depth of about 8-feet.

NATURAL SOILS: Beneath the topsoil surface cover and FILL in boring B-2, natural soils were encountered to depths between 9 ½ to 22-feet below existing surface grades. The natural soils encountered were classified as Sandy Silty Clay (CL-ML), and Silty Sand (SM), with varying amounts of gravel and rock fragments in general accordance with the Unified Soil Classification System (USCS). The standard penetration N-values generally indicate consistencies of firm to stiff within the cohesive soils, and very loose to medium dense compactness within the granular soils. Please note that cobble-to-boulder sized rock are common within the natural glacial soil deposits.

WEATHERED ROCK: The areas bottommost formation encountered consisted of highly weathered Sandy Shale and sandstone. The Shale was encountered at depths between 9 ½ and 22-feet below existing surface grades. Rock coring was performed at boring B-1 in general accordance with ASTM D2113.

The subsurface description is of a generalized nature provided to highlight the major strata encountered. The boring logs included in the *Appendix* should be reviewed for specific information at the individual boring locations. The stratifications shown on the boring logs represent the conditions only at the actual test positions. Variations may occur and should be expected between the boring locations. The stratifications represent the approximate boundary between the subsurface materials, and the transition may be gradual or not clearly defined.

## 2.3 GROUNDWATER LEVEL MEASUREMENTS

Groundwater was encountered during drilling activities at test boring locations B-2 at a depth of about 14 feet below existing surface grades. No groundwater was encountered in boring B-1 during or at the completion of drilling activities. For safety reasons, the boreholes were backfilled upon completion and therefore, long term ground water measurements were not made. Longer times may have been required to stabilize groundwater levels within the boreholes.

Please note that the granular soils and soil rock interface observed at this site can discharge significant quantities of groundwater into excavations for undercuts and utilities. It should also be noted that the groundwater levels at this site, as well as perched water levels and volumes, will fluctuate significantly based on variations in rainfall, snowmelt, evaporation, surface run-off and other related hydrogeologic factors. The groundwater levels in boreholes are often not representative of the actual groundwater level because the boreholes remained open for a relatively short time. To obtain longer-term measurements, it is necessary to install groundwater level observation wells or piezometers. The water level measurements presented in this report are the levels that were measured at the time of PSI's field activities.

# 3 EVALUATION AND RECOMMENDATIONS

It is recommended that PSI be retained to provide observation and testing of construction activities involving earthwork and related activities of this project. PSI cannot accept responsibility for any conditions which deviate from those described in this report, nor for the performance of the sanitary sewer system if not engaged to also provide construction observation and testing for this project.

## 3.1 GEOTECHNICAL DISCUSSION

Three (3) potentially significant geotechnical-related issues exist at this site which may affect the performance of the proposed pump station and force main construction or could adversely impact construction activities.

1. Weathered rock was encountered at a depth as shallow as 9 ½ feet below existing site grades at the pump station location, boring B-1. The pump station is planned to extend to a depth of about 25-feet below surface grades. Extensive rock excavation will be required to reach the planned depth of the pump station.

2. Groundwater was encountered during drilling operations at a depth of 14-feet in boring B-2. The force main is to be directionally bored under the Mahoning River, given the sites proximity to the Mahoning River, groundwater seepage is anticipated within the bore pit excavation.

3. The natural soils at this site are very sensitive to changes in moisture content and can exhibit a loss of stability when subjected to site grading and construction traffic, especially during wet weather conditions. Subgrade soils that are destabilized by construction activity would need to be excavated and replaced or stabilized insitu via chemical modification. Additionally, aeration and drying of the wetter fine-grained soils may be required during site grading and compacting activities. If grading and compaction activities take place during a wet or cold season of the year, lime stabilization (or other form of chemical modification) may be necessary to expedite site grading and achieve the required level of soil compaction.

## 3.2 EXCAVATION SUPPORT

Based on the site plan provided by CT Consultants, Inc., the proposed pump station will be bearing within the area's natural soil and rock formations at anticipated invert depths ranging from 10 to 25-feet below current surface grades. In view of the results of the test boring operations, laboratory test studies, analysis, and provided information, consideration should be given to the following factors in the design and installation of the proposed sewer line.

The proposed sewer line installation will be located adjacent to existing commercial properties. Therefore, based on the locations of the proposed sewer lines and as per OSHA excavation regulations, open cut excavation is possible up to a maximum depth of about twenty 20-feet. The excavation slopes should follow OSHA guidelines for **type 'C'** soils. However, due to close proximity of the existing roadway and shallow ground water levels encountered during field drilling, temporary excavation support along with dewatering system will be required. The contractor or specialty subcontractor should be responsible to design and install the required system. For the various subsurface formations encountered, the following soil parameters may be adopted for determining lateral earth pressures:

| Type of Soil | Unit Weight (pcf) | Effective Strength | Undrained Shear Strength |
|---|---|---|---|
| Cohesive Soils (CL-ML) | 120 | $\phi = 24°$, C' = 100 | $\phi = 0°$, C = 1,500 psf |
| Granular Soils (SM & SP) | 120 | $\phi = 30°$, C' = 100 | $\phi = 32°$, C = 0 psf |
| Weathered Shale/Sandstone | 140 | $\phi$' = 35°, C' = 0 psf | $\phi = 0°$, C = 7,500 psf |

The design groundwater depth should be determined based on the actual groundwater conditions encountered in the field during construction.

### 3.3 FOUNDATION RECOMMENDATIONS – LIFT STATION

The test borings, laboratory test results, the proposed construction and analysis indicate that the proposed lift station structure will bear approximately 25-feet below existing surface grades and can be supported by a mat/slab foundation, bearing on the areas weathered rock formation, or a leveling course of #57 crushed gravel/stone placed over the rock.

The following table illustrates the foundation recommendation for the individual structures:

| PROPOSED STRUCTURE | RECOMMENDATIONS | REMARKS |
|---|---|---|
| Pump Station (Boring B-1) | **Recommended Foundation:** Rigid Mat/Slab Foundation<br>**Allowable rock bearing pressure:** 8,000 psf<br>**Anticipated Total settlements:** 0.5" | Provide leveling course of #57 crushed stone or concrete "mud mat". |

### 3.4 LIFT STATION – BELOW GRADE WALLS

Below-grade wet well walls should be designed to resist lateral earth pressures. Lateral earth pressure is developed from the soils present within a wedge formed by the vertical below-grade pump station and valve vault walls and an imaginary line extending up and away from the bottom of the wall at an approximate 45° angle. The lateral earth pressures are determined by multiplying the vertical applied pressure by the appropriate lateral earth pressure coefficient K. If the walls are rigidly attached to the structure and not free to rotate or deflect at the top, such as for this lift station, PSI recommends designing the walls for the "at-rest" lateral earth pressure condition using $K_o$. An "equivalent fluid" pressure can be substituted by multiplying the at-rest earth pressure coefficient times the total effective weight of the soil. Where a saturated "equivalent fluid" pressure is needed, the effective unit weight (total unit weight minus unit weight of water) should be multiplied times the appropriate K-factor and the unit weight of water added to that resultant.

In the case of the lift station where water pressures will be exerted on the below-grade wall structure below the prevailing water levels, the saturated value should be used below the water level. For native soil used as backfill, an equivalent fluid pressure of 70 and 100 pounds per square foot should be used above and below the water level, respectively. Where granular material is used as backfill in the backfill zone as described above, an equivalent fluid pressure of 50 and 85 pounds per square foot should be used above and below the water level, respectively.

## 3.5 UPLIFT CONSIDERATIONS

The results of the test borings indicate that no ground water was encountered during drilling operations at B-02. However, it must be recognized that, over a time period, the backfill against any below grade structures will be saturated. Under this circumstance, it is possible that the bottom slab will be subjected to hydrostatic uplift, which should be considered in the design. Uplift may be resisted by assuring that the dead load of the proposed structure counterbalances the buoyant forces with an appropriate factor of safety. Sufficient waterproofing and water stops should be used to prevent in-flow seepage into the pump station and valve vault.

## 3.6 DIFFICULT ROCK EXCAVATION CONSIDERATIONS

Based on our field exploration, most of the in-place soils should generally be excavatable using conventional excavation equipment, such as scrapers, front end loaders, bulldozers, etc. However, the area for the pump station will likely encounter weathered rock or bedrock such as indicate in Boring B-1.

Materials having SPT resistances greater than 50 blows per foot will require pre-loosening with heavy equipment in order to achieve excavation. PSI anticipates that the upper couple feet of weathered rock surface will be rippable, but impact hammers or other methods may be needed to remove more competent underlying rock particularly for any necessary trench excavations below the weathered rock surface.

For the purposes of this report, we recommend that subsurface materials causing auger refusal or having SPT N-values in excess of 50 blows per 3 inches of penetration be considered unrippable rock. Disagreements often arise relative to the excavatability of materials in the transition zone between soil and rock. Therefore, we recommend that the project specification stipulate that excavation materials are considered “unclassified” and provide contractors the information from the geotechnical borings to aid their estimates.

If excavation materials will be classified, we suggest the contract documents include unit rock excavation prices. To reduce potential ambiguities, we suggest the contract documents define general rock excavation as:

> Material that cannot be dislodged and excavated with a single-tooth ripper drawn by a crawler tractor having a draw bar pull rated at not less than 56,000 pounds (Caterpillar D8R or equivalent) and occupying an original volume of at least one cubic yard. Additionally, trench rock excavation should be defined as material that cannot be excavated with a backhoe having a bucket curling force rated at not less than 45,000 pounds (Caterpillar 330D L or equivalent) and occupying an original volume of at least ½ cubic yard. If the Contractor elects to use equipment with power ratings that exceed the minimum power ratings described in this section, then rock should be defined based on the actual equipment used.

Excavation of weathered rock, cobble/boulder rock, or bedrock is typically much more difficult within confined excavations—such as, footings, utility trenches, etc. Jackhammering or blasting is generally required for removing these materials at or below the level that auger refusal is encountered. If blasting is required, we recommend conducting a pre-blast condition survey by a registered land surveyor of the surrounding structures that may be impacted by the blasting and the performance of vibration monitoring during blasting. A pre-blast survey will help to establish the existing condition and integrity of the surrounding structures prior to commencement of construction activities. Collecting the actual pre-existing and post-construction conditions will help reduce the possibility of future damage claims. Following blasting, a post-blast survey should be performed to assess damage possibly caused by the blasting activities.

If blasting is required, care should be taken to avoid significant over-blasting, as this may damage adjacent structures and the underlying rock, thereby reducing the load bearing capability of the rock and resulting in increased settlement potential as the rock "settles" back in place. If blasting is utilized, all loose rock and rock fragments should be cleaned out of the excavations prior to placement of structural fill, reinforcement steel, or concrete, particularly within foundation excavations or other load bearing areas. Also, if blasting is utilized, the excavation of the rock should be done in accordance with 29 CFR Part 1926 Subpart U, Blasting and the Use of Explosives, prepared by the United States Department of Labor, Occupational Safety and Health Administration (OSHA).

## 3.7 BACKFILL OPERATIONS

Backfill required against the below grade structure should consist of native soil or granular materials. The backfill is to be placed on a controlled lift-by-lift basis. Individual fill lifts are to be of maximum 8-inch loose measure thickness, and each individual lift is to be adjusted in moisture content to within plus or minus 2 percent of the optimum moisture content as determined by ASTM D-698. The fill materials are to be systematically compacted, such that an in-place density of at least 98 percent of the maximum laboratory density as determined by the above-referenced ASTM method is achieved.

## 3.8 EARTHQUAKE AND SIESMIC DESIGN CONSIDERATIONS

The 2017 International Building Code requires a site class for the calculation of earthquake design forces. This class is a function of soil type (i.e., depth of soil and stratum types). Based on the depth to rock and the estimated shear strength of the soil at the boring locations, **Site Class "C"** is recommended. The USGS-NEHRP probabilistic ground motion values near Latitude 41.032024° and Longitude –80.532605° are as follows:

| Period (seconds) | 2% Probability of Event in 50 years * (%g) | Site Coefficients | Max. Spectral Acceleration parameters | Design Spectral Acceleration Parameters | |
|---|---|---|---|---|---|
| 0.2 ($S_s$) | 15.1 | $F_a$ = 1.2 | $S_{ms}$ = 0.181 | $S_{Ds}$= 0.121 | $T_0$= 0.104 |
| 1.0 ($S_1$) | 5.6 | $F_v$ = 1.7 | $S_{m1}$ = 0.095 | $S_{D1}$= 0.063 | $T_s$= 0.521 |

The Site Coefficients, $F_a$ and $F_v$ were interpolated from IBC 2017 Tables 1613.3.3(1) and 1613.3.3(2) as a function of the site classifications and the mapped spectral response acceleration at the short ($S_s$) and 1 second ($S_1$) periods

# 4 CONSTRUCTION CONSIDERATIONS

## 4.1 GROUNDWATER CONTROL

Groundwater was encountered during field drilling operations in boring B-2, at a depth of about 14 feet below the existing surface grade. Therefore, ground water will be encountered during the lift station/force main excavations. Furthermore, the force main will cross under the Mahoning River, groundwater seepage is to be expected. Accordingly, a dewatering system should be designed by a professional engineer and installed by a dewatering contractor experienced in the project area, such that the groundwater is always controlled and maintained at an elevation of at least 2 feet below the excavation bottom. Every effort should be made to keep the excavations dry if water is encountered.

## 4.2 EXCAVATIONS

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P." This document was issued to better ensure the safety of workers entering trenches or excavations. It is mandated by this federal regulation that all excavations, whether they be utility trenches, basement excavations or foundation excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced. If they are not followed closely, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person" as defined in "CFR Part 1926," should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

If the excavations are left open and exposed to the elements for a significant length of time, desiccation of the clays may create minute shrinkage cracks which could allow large pieces of clay to collapse or slide into the excavation. Materials removed from the excavation should not be stockpiled immediately adjacent to the excavation, as this load may cause a sudden collapse of the embankment.

We are providing this information solely as a service to our client. PSI is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

## 4.3 SILTATION CONTROL

The Clean Water Act implemented in 1990 includes a federal permit program called the National Pollutant Discharge Elimination System (NPDES). This program requires that projects sites in excess of 1 acre or are part of a development which exceeds 1 acre be covered under a permit. This typically includes the development of a storm water pollution prevention plan (SWPPP) as well as period inspections (typically once a week plus after significant rainfall). PSI is available to assist with these services.

## 4.4 WEATHER CONSIDERATIONS

The soils encountered at this site are known to be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. Care should be exercised during the grading operations at the site. The traffic of heavy equipment, including heavy compaction equipment, may very well create pumping and a general deterioration of those soils in the presence of water. Therefore, construction, if at all possible, should be performed during a dry season. A layer of crushed stone may be required to allow the movement of construction traffic over the site during the rainy season. The contractor should maintain positive site drainage and if wet/pumping conditions occur, the contractor will be responsible to over excavate the wet soils and replace them with a properly compacted structural fill.

# 5 GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. Site exploration identifies actual subsurface conditions only at those points where samples are taken. A geotechnical report is based on conditions that existed at the time of the subsurface exploration. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding sections constitute PSI's professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and referenced during this evaluation, and PSI's experience in working with these conditions.

# 6 REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by **Mr. Eric Fallon, PE with CT Consultants, Inc**. If there are any revisions to the plans for the proposed sanitary sewer project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be retained to determine if changes in the recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the geotechnical recommendations for the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are complete, it is recommended that PSI be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and recommendations are properly interpreted and implemented. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of CT Consultants, Inc. and the Village of Lowellville, for the specific application to the **Sanitary Siphon Replacement** project, located in the Village of Lowellville, Mahoning County, Ohio.

# APPENDIX

## SITE VICITY PLAN

## BORING LOCATION PLAN

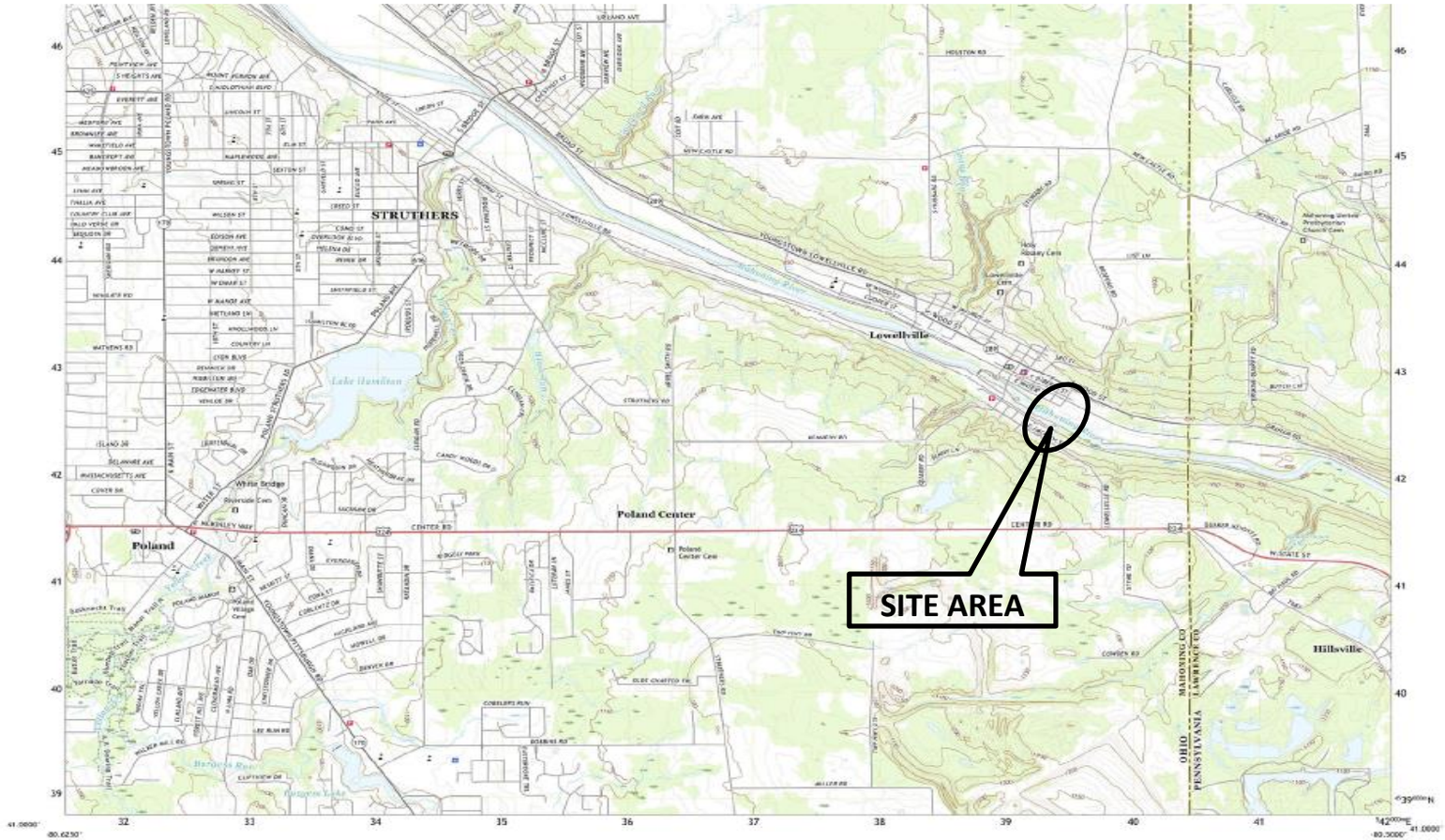
## BORING LOGS

## GRAIN SIZE GRAPH

## GENERAL NOTES

## USCS SOIL CLASSIFICATION CHART

Professional Service Industries, Inc.




NORTH

Produced by the United States Geological Survey

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

RDAS CLASSIFICATION

CAMPBELL, OH, PA
2019

intertek psi

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phone 330-759-0288 fax 330-759-0923

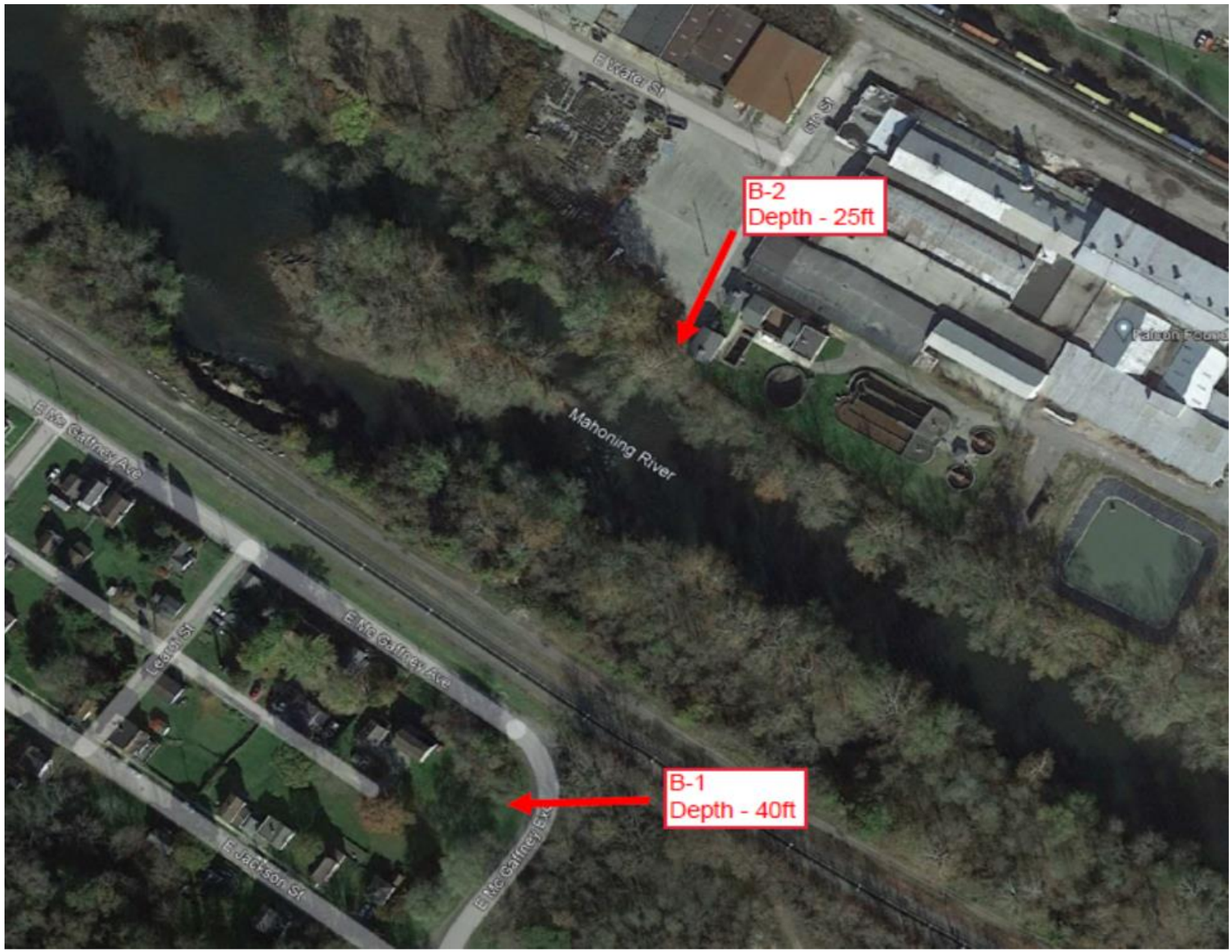
## Site Vicinity Plan

**PROJECT NO. : 01393755**

**PROJECT: Sanitary Siphon Replacement**

**LOCATION: E McGaffney Street**
**Lowellville, Ohio**

Professional Service Industries, Inc.

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## Boring Location Plan

**PROJECT NO. : 01393755**

**PROJECT:** Sanitary Siphon Replacement

**LOCATION:** E McGaffeny Street
Lowellville, OH

# BORING B-1

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 6/23/22 | **DRILL COMPANY:** | Ridgeway Drilling |
| **DATE COMPLETED:** | 6/23/22 | **DRILLER:** P. Posedly | **LOGGED BY:** J. Mellinger |
| **COMPLETION DEPTH** | 27.0 ft | **DRILL RIG:** | D50 Truck |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 831 ft | **SAMPLING METHOD:** | 2-in SS |
| **LATITUDE:** | | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | | **EFFICIENCY** | N/A |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | Scott Hynes |

**REMARKS:**

**Water**

| | |
|---|---|
| While Drilling | Not Encountered |
| Upon Completion | Not Encountered |
| Delay | N/A |

**BORING LOCATION:**
Pump Station

| Elevation (feet) | Depth, (feet) | Graphic Log | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | STANDARD PENETRATION TEST DATA (N in blows/ft) / STRENGTH, tsf | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 830 | 0 | | | 1 | 12 | **6" Topsoil**<br>Firm, moist, brown, **Sandy Silty Clay**, trace gravel | CL-ML | 3-4-3-3<br>N=7 | 14 | | |
| | 5 | | | 2 | 14 | Loose to Medium Dense, moist, brown, **Silty Sand with Gravel** | SM | 4-5-6<br>N=11 | 11 | | |
| 825 | | | | 3 | 12 | | | 4-3-3<br>N=6 | 9 | | |
| | | | | 4 | 0 | *8.5 - 10.0': No Sample Recovery* | | 50/2" | 5 | >> | |
| | 10 | | | | | Highly Weathered, brown to gray, **Shale** | | | | | |
| 820 | | | | 5 | 6 | | | 41-50/2" | 3 | >> | |
| | 15 | | | | | Weathered, gray, thinly bedded, **Sandstone** | | | | | |
| 815 | | | | 6 | 1 | | | 50/1" | | >> | |
| | 20 | | | | | | | | | | |
| 810 | | | | 7 | 75 | Slightly Weathered, moderately fractured, gray, **Siltstone with clay seams** | | | | >> | |
| | 25 | | | | | Slightly Weathered, moderately fractured, gray, thinly bedded, **Sandstone** | | | | | |
| 805 | | | | | | Auger Refusal @ 20'<br><br>Core Data:<br>Run 20' to 27'<br>Recover 90%<br>Longest Piece 11"<br>RQD 20%<br>UC 4,680 psi<br><br>End of Boring @ 27' | | | | | |

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0


Professional Service Industries, Inc.
1280 Trumbull Avenue
Girard, OH 44420
Telephone: (330) 759-0288


**PROJECT NO.:** 01393755
**PROJECT:** Sanitary Siphon Replacement
**LOCATION:** E McGaffney St.
Lowellville, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

# BORING B-2

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 6/23/22 | **DRILL COMPANY:** | Ridgeway Drilling |
| **DATE COMPLETED:** | 6/23/22 | **DRILLER:** P. Posedly | **LOGGED BY:** J. Mellinger |
| **COMPLETION DEPTH** | 23.7 ft | **DRILL RIG:** | D50 Truck |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 811 ft | **SAMPLING METHOD:** | 2-in SS |
| **LATITUDE:** | | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | | **EFFICIENCY** | N/A |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | Scott Hynes |

**REMARKS:**

**Water**

| | |
|---|---|
| While Drilling | 14 feet |
| Upon Completion | N/A |
| Delay | N/A |

**BORING LOCATION:**
Bore Pit

| Elevation (feet) | Depth, (feet) | Graphic Log | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % |
|---|---|---|---|---|---|---|---|---|---|
| 810 | 0 | | | 1 | 11 | *Fill*: Moist, brown and black, **Sandy Silty Clay with Gravel**, concrete fragments | CL-ML | 7-11-11-5<br>N=22 | 11 |
| | | | | 2 | 5 | *Fill*: Moist, black, **Silty Sand with Slag** | SM | 2-7-3<br>N=10 | 27 |
| 805 | 5 | | | 3 | 4 | *Fill*: Moist, brown and red, **Foundary Sand** | SP | 1/18"<br>N=0 | 18 |
| | | | | 4 | 15 | Loose, moist, brown, **Sandy Silt with Gravel** | SM | 4-3-2<br>N=5 | 30 |
| 800 | 10 | | | | | | | | 20 |
| | | | | 5 | 12 | Loose, wet, gray, **Silty Sand with Shale fragments** | SM | 3-2-2<br>N=4 | 13 |
| 795 | 15 | | | | | | | | 12 |
| | | | | 6 | 14 | Stiff, moist, gray, **Sandy Silty Clay with Gravel** | CL-ML | 4-4-6<br>N=10 | |
| 790 | 20 | | | 7 | 2 | Moderately Hard, gray, highly weathered, **Sandy Shale** | | 50/2" | >> |

Auger Refusal @ 23' 8"

Water Encountered @ 14'

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

Additional Remarks


intertek psi
Professional Service Industries, Inc.
1280 Trumbull Avenue
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**PROJECT NO.:** 01393755
**PROJECT:** Sanitary Siphon Replacement
**LOCATION:** E McGaffney St.
Lowellville, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
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Phone: (330) 759-0288
Fax: (330) 759-0923

**Report No: MAT:01393755-1-S1**
**Issue No: 1**



# Material Test Report

**Client:** CT CONSULTANTS INC. **CC:**
3875 EMBASSY PARKWAY, SUITE 200
AKRON, OH 44333-1798

**Project:** PUMP STATION - LOWELLVILLE
LOWELVILLE, OH

Approved Signatory: Scott Hynes (Department Manager)
Date of Issue: 10/6/2022

## Sample Details

| | |
|---|---|
| **Sample ID:** | 01393755-1-S1 |
| **Client Sample ID:** | |
| **Date Sampled:** | 06/23/22 |
| **Sampled By:** | Ralph Roth |
| **Specification:** | D422/T88 Part. Size Analysis (Set #1) |
| **Supplier:** | |
| **Source:** | |
| **Material:** | |
| **Sampling Method:** | Split Spoon |
| **Soil Description:** | Silty SAND with Gravel (SM) |
| **General Location:** | B-1 |
| **Location:** | 6.0 - 7.5 |

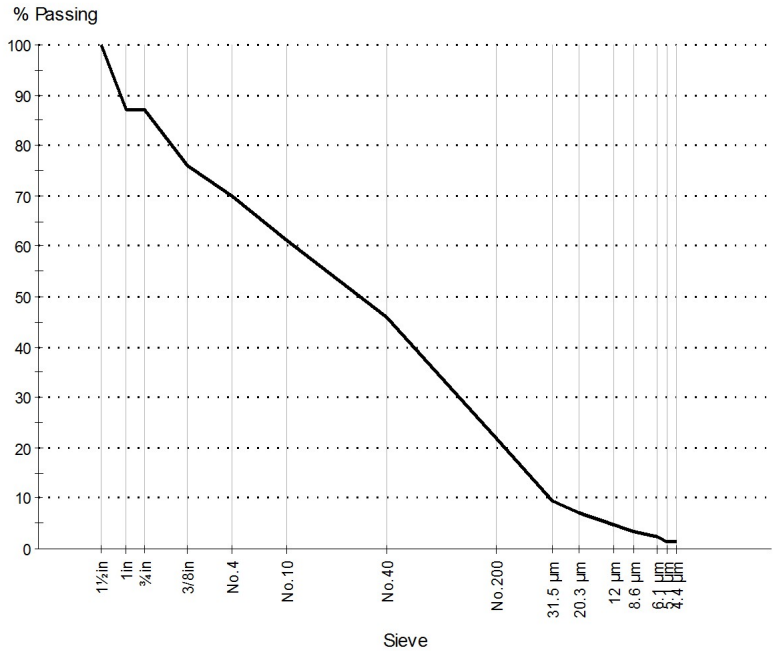
## Sample Description:

Silty SAND with Gravel (SM)

## Atterberg Limit:

**Liquid Limit:** 19
**Plastic Limit:** 16
**Plasticity Index:** 3

## Particle Size Distribution




| COBBLES | GRAVEL | | SAND | | | FINES | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| (0.0%) | (12.7%) | (17.3%) | (9.4%) | (14.9%) | (23.9%) | (20.6%) | (1.2%) |

## Grading: ASTM D 422

**Date Tested:** 7/7/2022
**Tested By:** Ralph Roth

| Sieve Size | % Passing | Limits |
|---|---|---|
| 1½in (37.5mm) | 100 | |
| 1in (25.0mm) | 87 | |
| ¾in (19.0mm) | 87 | |
| 3/8in (9.5mm) | 76 | |
| No.4 (4.75mm) | 70 | |
| No.10 (2.0mm) | 61 | |
| No.40 (425µm) | 46 | |
| No.200 (75µm) | 22 | |
| 31.5 µm | 9.3 | |
| 20.3 µm | 7.0 | |
| 12.0 µm | 4.6 | |
| 8.6 µm | 3.5 | |
| 6.1 µm | 2.3 | |
| 5.1 µm | 1.2 | |
| 4.4 µm | 1.2 | |

**D85:** 16.7502 **D60:** 1.8038 **D50:** 0.6423
**D30:** 0.1337 **D15:** 0.0465 **D10:** 0.0330
**Cu:** 54.59 **Cc:** 0.30

Professional Service Industries, Inc.
1280 Trumbull Avenue
Girard, OH 44420

Phone: (330) 759-0288
Fax: (330) 759-0923

**Report No: MAT:01393755-1-S1**
**Issue No: 1**



# Material Test Report

**Client:** CT CONSULTANTS INC. **CC:**
3875 EMBASSY PARKWAY, SUITE 200
AKRON, OH 44333-1798

**Project:** PUMP STATION - LOWELLVILLE
LOWELVILLE, OH

Approved Signatory: Scott Hynes (Department Manager)
Date of Issue: 10/6/2022

## Sample Details

**Sample ID:** 01393755-1-S1
**Client Sample ID:**
**Date Sampled:** 06/23/22
**Sampled By:** Ralph Roth
**Specification:** D422/T88 Part. Size Analysis (Set #1)
**Supplier:**
**Source:**
**Material:**
**Sampling Method:** Split Spoon
**Soil Description:** Silty SAND with Gravel (SM)
**General Location:** B-1
**Location:** 6.0 - 7.5

## Other Test Results

| Description | Method | Result | Limits |
|---|---|---|---|
| Group Symbol | ASTM D 2487 | SM | |
| Group Name | | Silty sand with gravel | |
| Tested By | | Ralph Roth | |
| Date Tested | | 7/7/2022 | |
| Dispersion device | ASTM D 422 | Dispersant by hand | |
| Dispersion time (min) | | | |
| Shape | | | |
| Hardness | | | |
| Approximate maximum grain size | ASTM D 4318 | | |
| Material retained on 425µm (No. 40) (%) | | | |
| Method of Removal | | | |
| Grooving Tool Type | | | |
| Specimen preparation method | | | |
| Drying Method | | | |
| Special selection process | | | |
| Rolling Method for PL | | Hand | |
| As Received Water Content (%) | | | |
| Liquid Limit Device Type | | Mechanical | |
| Liquid Limit | | 19 | |
| Plastic Limit | | 16 | |
| Plasticity Index | | 3 | |
| Liquid Limit Procedure | | One-point (B) | |
| Tested By | | Ralph Roth | |
| Date Tested | | 7/7/2022 | |

## Comments

N/A

Professional Service Industries, Inc.
1280 Trumbull Avenue
Girard, OH 44420

Phone: (330) 759-0288
Fax: (330) 759-0923

**Report No: MAT:01393755-1-S2**
**Issue No: 1**



# Material Test Report

**Client:** CT CONSULTANTS INC. **CC:**
3875 EMBASSY PARKWAY, SUITE 200
AKRON, OH 44333-1798

**Project:** PUMP STATION - LOWELLVILLE
LOWELVILLE, OH

Approved Signatory: Scott Hynes (Department Manager)
Date of Issue: 10/6/2022

## Sample Details

| | |
|---|---|
| **Sample ID:** | 01393755-1-S2 |
| **Client Sample ID:** | |
| **Date Sampled:** | 06/23/22 |
| **Sampled By:** | Ralph Roth |
| **Specification:** | D422/T88 Part. Size Analysis (Set #1) |
| **Supplier:** | |
| **Source:** | |
| **Material:** | |
| **Sampling Method:** | Split Spoon |
| **Soil Description:** | Silty SAND (SM) |
| **General Location:** | B-2 |
| **Location:** | 8.5 - 10.0 |

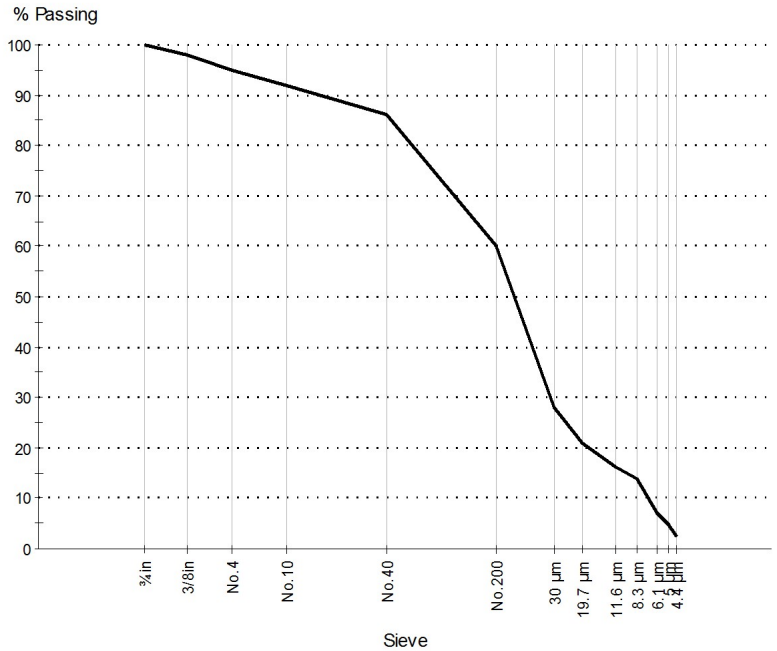
## Sample Description:

Silty SAND (SM)

## Atterberg Limit:

**Liquid Limit:** 30
**Plastic Limit:** 26
**Plasticity Index:** 4

## Particle Size Distribution




## Grading: ASTM D 422

**Date Tested:** 7/7/2022
**Tested By:** Ralph Roth

| Sieve Size | % Passing | Limits |
|---|---|---|
| ¾in (19.0mm) | 100 | |
| 3/8in (9.5mm) | 98 | |
| No.4 (4.75mm) | 95 | |
| No.10 (2.0mm) | 92 | |
| No.40 (425µm) | 86 | |
| No.200 (75µm) | 60 | |
| 30.0 µm | 27.9 | |
| 19.7 µm | 20.9 | |
| 11.6 µm | 16.3 | |
| 8.3 µm | 13.9 | |
| 6.1 µm | 7.0 | |
| 5.0 µm | 4.6 | |
| 4.4 µm | 2.3 | |

| COBBLES | GRAVEL | | SAND | | | FINES | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| (0.0%) | (0.0%) | (5.4%) | (2.4%) | (5.9%) | (26.0%) | (55.7%) | (4.6%) |

**D85:** 0.3976 **D60:** 0.0750 **D50:** 0.0564
**D30:** 0.0319 **D15:** 0.0097 **D10:** 0.0070
**Cu:** 10.75 **Cc:** 1.94

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Fax: (330) 759-0923

**Report No: MAT:01393755-1-S2**
**Issue No: 1**



# Material Test Report

**Client:** CT CONSULTANTS INC.
3875 EMBASSY PARKWAY, SUITE 200
AKRON, OH 44333-1798

**CC:**

**Project:** PUMP STATION - LOWELLVILLE
LOWELVILLE, OH

Approved Signatory: Scott Hynes (Department Manager)
Date of Issue: 10/6/2022

## Sample Details

**Sample ID:** 01393755-1-S2
**Client Sample ID:**
**Date Sampled:** 06/23/22
**Sampled By:** Ralph Roth
**Specification:** D422/T88 Part. Size Analysis (Set #1)
**Supplier:**
**Source:**
**Material:**
**Sampling Method:** Split Spoon
**Soil Description:** Silty SAND (SM)
**General Location:** B-2
**Location:** 8.5 - 10.0

## Other Test Results

| Description | Method | Result | Limits |
|---|---|---|---|
| Group Symbol | ASTM D 2487 | ML | |
| Group Name | | Sandy silt | |
| Tested By | | Ralph Roth | |
| Date Tested | | 7/7/2022 | |
| Dispersion device | ASTM D 422 | Dispersant by hand | |
| Dispersion time (min) | | | |
| Shape | | | |
| Hardness | | | |
| Approximate maximum grain size | ASTM D 4318 | | |
| Material retained on 425µm (No. 40) (%) | | | |
| Method of Removal | | | |
| Grooving Tool Type | | | |
| Specimen preparation method | | | |
| Drying Method | | | |
| Special selection process | | | |
| Rolling Method for PL | | Hand | |
| As Received Water Content (%) | | | |
| Liquid Limit Device Type | | Mechanical | |
| Liquid Limit | | 30 | |
| Plastic Limit | | 26 | |
| Plasticity Index | | 4 | |
| Liquid Limit Procedure | | One-point (B) | |
| Tested By | | Ralph Roth | |
| Date Tested | | 7/7/2022 | |

## Comments

N/A

# GENERAL NOTES

## SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

## DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
RC: Rock Core
TC: Texas Cone
BS: Bulk Sample
PM: Pressuremeter
CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

## SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
$N_{60}$: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
$Q_u$: Unconfined compressive strength, TSF
$Q_p$: Pocket penetrometer value, unconfined compressive strength, TSF
w%: Moisture/water content, %
LL: Liquid Limit, %
PL: Plastic Limit, %
PI: Plasticity Index = (LL-PL),%
DD: Dry unit weight, pcf
▼,▽,▼ Apparent groundwater level at time noted

## RELATIVE DENSITY OF COARSE-GRAINED SOILS

| Relative Density | N - Blows/foot |
|---|---|
| Very Loose | 0 - 4 |
| Loose | 4 - 10 |
| Medium Dense | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | 50 - 80 |
| Extremely Dense | 80+ |

## ANGULARITY OF COARSE-GRAINED PARTICLES

| Description | Criteria |
|---|---|
| Angular: | Particles have sharp edges and relatively plane sides with unpolished surfaces |
| Subangular: | Particles are similar to angular description, but have rounded edges |
| Subrounded: | Particles have nearly plane sides, but have well-rounded corners and edges |
| Rounded: | Particles have smoothly curved sides and no edges |

## GRAIN-SIZE TERMINOLOGY

| Component | Size Range |
|---|---|
| Boulders: | Over 300 mm (>12 in.) |
| Cobbles: | 75 mm to 300 mm (3 in. to 12 in.) |
| Coarse-Grained Gravel: | 19 mm to 75 mm (¾ in. to 3 in.) |
| Fine-Grained Gravel: | 4.75 mm to 19 mm (No.4 to ¾ in.) |
| Coarse-Grained Sand: | 2 mm to 4.75 mm (No.10 to No.4) |
| Medium-Grained Sand: | 0.42 mm to 2 mm (No.40 to No.10) |
| Fine-Grained Sand: | 0.075 mm to 0.42 mm (No. 200 to No.40) |
| Silt: | 0.005 mm to 0.075 mm |
| Clay: | <0.005 mm |

## PARTICLE SHAPE

| Description | Criteria |
|---|---|
| Flat: | Particles with width/thickness ratio > 3 |
| Elongated: | Particles with length/width ratio > 3 |
| Flat & Elongated: | Particles meet criteria for both flat and elongated |

## RELATIVE PROPORTIONS OF FINES

| Descriptive Term | % Dry Weight |
|---|---|
| Trace: | < 5% |
| With: | 5% to 12% |
| Modifier: | >12% |

# GENERAL NOTES

(Continued)

## CONSISTENCY OF FINE-GRAINED SOILS

| $Q_U$ - TSF | N - Blows/foot | Consistency |
|---|---|---|
| 0 - 0.25 | 0 - 2 | Very Soft |
| 0.25 - 0.50 | 2 - 4 | Soft |
| 0.50 - 1.00 | 4 - 8 | Firm (Medium Stiff) |
| 1.00 - 2.00 | 8 - 15 | Stiff |
| 2.00 - 4.00 | 15 - 30 | Very Stiff |
| 4.00 - 8.00 | 30 - 50 | Hard |
| 8.00+ | 50+ | Very Hard |

## MOISTURE CONDITION DESCRIPTION

| Description | Criteria |
|---|---|
| Dry: | Absence of moisture, dusty, dry to the touch |
| Moist: | Damp but no visible water |
| Wet: | Visible free water, usually soil is below water table |

## RELATIVE PROPORTIONS OF SAND AND GRAVEL

| Descriptive Term | % Dry Weight |
|---|---|
| Trace: | < 15% |
| With: | 15% to 30% |
| Modifier: | >30% |

## STRUCTURE DESCRIPTION

| Description | Criteria |
|---|---|
| Stratified: | Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick |
| Laminated: | Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick |
| Fissured: | Breaks along definite planes of fracture with little resistance to fracturing |
| Slickensided: | Fracture planes appear polished or glossy, sometimes striated |
| Blocky: | Cohesive soil that can be broken down into small angular lumps which resist further breakdown |
| Lensed: | Inclusion of small pockets of different soils |
| Layer: | Inclusion greater than 3 inches thick (75 mm) |
| Seam: | Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample |
| Parting: | Inclusion less than 1/8-inch (3 mm) thick |

## SCALE OF RELATIVE ROCK HARDNESS

| $Q_U$ - TSF | Consistency |
|---|---|
| 2.5 - 10 | Extremely Soft |
| 10 - 50 | Very Soft |
| 50 - 250 | Soft |
| 250 - 525 | Medium Hard |
| 525 - 1,050 | Moderately Hard |
| 1,050 - 2,600 | Hard |
| >2,600 | Very Hard |

## ROCK BEDDING THICKNESSES

| Description | Criteria |
|---|---|
| Very Thick Bedded | Greater than 3-foot (>1.0 m) |
| Thick Bedded | 1-foot to 3-foot (0.3 m to 1.0 m) |
| Medium Bedded | 4-inch to 1-foot (0.1 m to 0.3 m) |
| Thin Bedded | 1¼-inch to 4-inch (30 mm to 100 mm) |
| Very Thin Bedded | ½-inch to 1¼-inch (10 mm to 30 mm) |
| Thickly Laminated | 1/8-inch to ½-inch (3 mm to 10 mm) |
| Thinly Laminated | 1/8-inch or less "paper thin" (<3 mm) |

## ROCK VOIDS

| Voids | Void Diameter |
|---|---|
| Pit | <6 mm (<0.25 in) |
| Vug | 6 mm to 50 mm (0.25 in to 2 in) |
| Cavity | 50 mm to 600 mm (2 in to 24 in) |
| Cave | >600 mm (>24 in) |

## GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

| Component | Size Range |
|---|---|
| Very Coarse Grained | >4.76 mm |
| Coarse Grained | 2.0 mm - 4.76 mm |
| Medium Grained | 0.42 mm - 2.0 mm |
| Fine Grained | 0.075 mm - 0.42 mm |
| Very Fine Grained | <0.075 mm |

## ROCK QUALITY DESCRIPTION

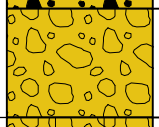
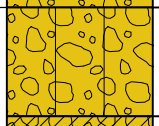
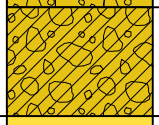
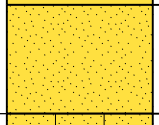
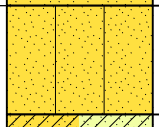
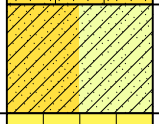
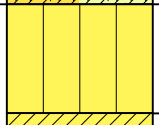
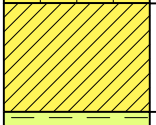
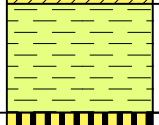
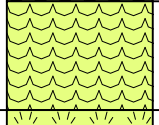
| Rock Mass Description | RQD Value |
|---|---|
| Excellent | 90 -100 |
| Good | 75 - 90 |
| Fair | 50 - 75 |
| Poor | 25 -50 |
| Very Poor | Less than 25 |

## DEGREE OF WEATHERING

| | |
|---|---|
| Slightly Weathered: | Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact. |
| Weathered: | Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife. |
| Highly Weathered: | Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife. |

# SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

| MAJOR DIVISIONS | | | SYMBOLS GRAPH | SYMBOLS LETTER | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS<br>MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | GRAVEL AND GRAVELLY SOILS<br>MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | CLEAN GRAVELS (LITTLE OR NO FINES) |  | GW | WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | | |  | GP | POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | | GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES) |  | GM | SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES |
| | | |  | GC | CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES |
| | SAND AND SANDY SOILS<br>MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE | CLEAN SANDS (LITTLE OR NO FINES) |  | SW | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | |  | SP | POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES |
| | | SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) |  | SM | SILTY SANDS, SAND - SILT MIXTURES |
| | | |  | SC | CLAYEY SANDS, SAND - CLAY MIXTURES |
| FINE GRAINED SOILS<br>MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE | SILTS AND CLAYS | LIQUID LIMIT LESS THAN 50 |  | ML | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | | |  | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | |  | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| | SILTS AND CLAYS | LIQUID LIMIT GREATER THAN 50 |  | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS |
| | | |  | CH | INORGANIC CLAYS OF HIGH PLASTICITY |
| | | |  | OH | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS |
| HIGHLY ORGANIC SOILS | | |  | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |

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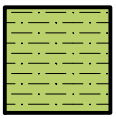
# Graphic Symbols for Materials and Rock Deposits

CONCRETE
Portland Cement Concrete

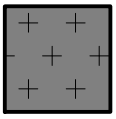
BITUMINOUS CONCRETE



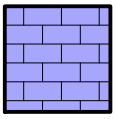
CLAYSTONE

COAL
Coal, Anthracite Coal

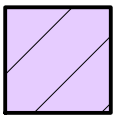
CONGLOMERATE/BRECCIA
Conglomerate, Breccia



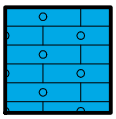
IGNEOUS ROCK
Anorthsite, Basalt, Metabasalt, Diabase (Gabbro), Gabbro, Granite/Granodionite, Homfels, Pegmatite, Rhyolite/Metarhyolite



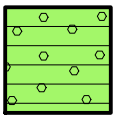
LIMESTONE
Limestone, Dolomite



METAMORPHIC ROCK
Amphibolite, Gneiss, Marble, Phyllite, Quartzite, Schist, Serpentinite, Slate

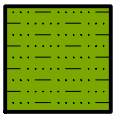


CHERT

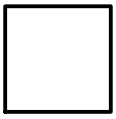


SANDSTONE
Sandstone, Orthoquarzite (Sandstone)

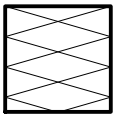
SHALE



SILTSTONE



NO RECOVERY



VOID

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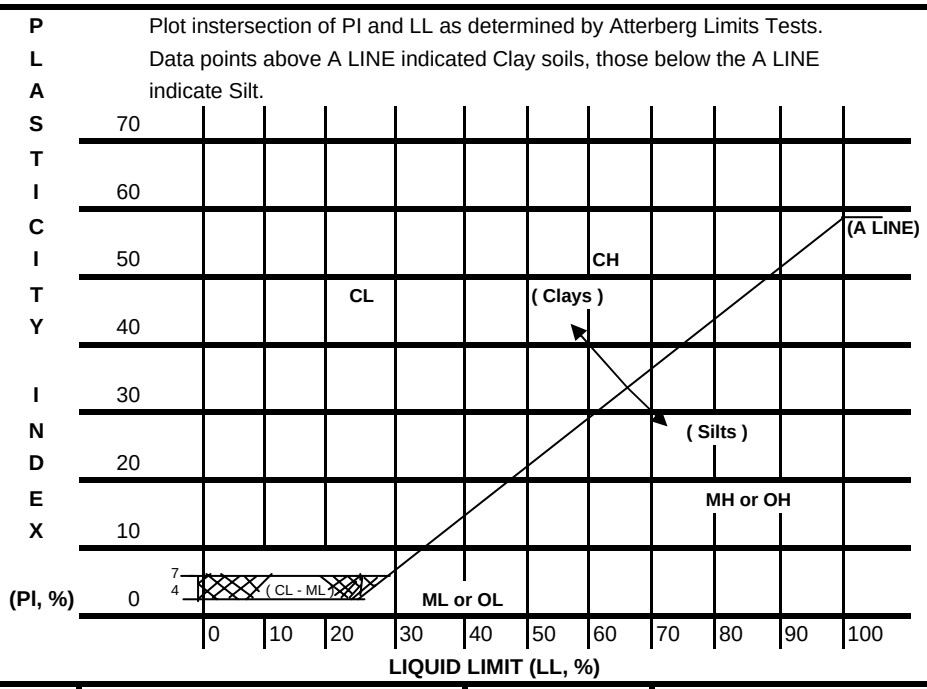
**United Soil Classification System**
**ASTM Designation D - 2487**

psi Information To Build On
Engineering • Consulting • Testing

**Based upon percentage of material passing No. 200 sieve classify as:**

| | |
|---|---|
| **Less than 5%** | **GW, GP, SW, SP** |
| **More than 12%** | **GM, GC, SM, SC** |
| **5% to 12%** | **Borderline, use dual symbols** |




| | | | | | |
|---|---|---|---|---|---|
| **Coarse Grained Soils** (More than half of is larger than No. 200 sieve) | **Gravels (More than 50% retained on No.4 sieve)** | **GW** | **Well graded gravels, gravel-sand mixtures, little or no fines** | $C_u = \frac{D_{60}}{D_{10}} > 4$ | $1 < C_c = \frac{[D_{30}]^2}{D_{10} * D_{60}} < 3$ |
| | | **GP** | **Poorly graded gravels, gravel-sand mixtures, little or no fines** | **Does not meet all requirements for GW** | |
| | | **GM** | **Silty gravels, gravel-sand-silt mixtures** | **below A Line, PI < 4** | **in shaded area 4 < PI < 7 Dual Symbols** |
| | | **GC** | **Clayey gravels, gravel-sand-clay mixtures** | **above A Line, PI > 7** | |
| | **Sands (More than 50% passing a No. 4 sieve)** | **SW** | **Well graded sands, gravelly sands, little or no fines** | $C_u = \frac{D_{60}}{D_{10}} > 6$ | $1 < C_c = \frac{[D_{30}]^2}{D_{10} * D_{60}} < 3$ |
| | | **SP** | **Poorly graded sands, gravelly sands, little or no fines** | **Does not meet all requirements for SW** | |
| | | **SM** | **Silty sands, sand-silt mixtures** | **below A Line, PI < 4** | **in shaded area 4 < PI < 7 Dual Symbols** |
| | | **SC** | **Clayey sands, sand-clay mixtures** | **above A Line, PI > 7** | |
| **Fine Grained Soils** (More than half of material is smaller than No. 200 sieve) | **Silts & Clays (LL less than 50)** | **ML** | **Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity** | | |
| | | **CL** | **Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays** | | |
| | | **OL** | **Organic silts and organic silty clays of low plasticity** | | |
| | **Silts & Clays (LL greater than 50)** | **MH** | **Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, plastic silts** | | |
| | | **CH** | **Inorganic clays of high plasticity fat clays** | | |
| | | **OH** | **Organic clays of medium to high plasticity** | | |
| | **Highly Organic Soil** | **Pt** | **Peat and other highly organic soils** | | |

# Proposed Pump Station & Force Main

**Latitude, Longitude: 41.032024, -80.532605**


| | |
|---|---|
| **Date** | 7/15/2022, 8:53:00 AM |
| **Design Code Reference Document** | ASCE7-10 |
| **Risk Category** | II |
| **Site Class** | C - Very Dense Soil and Soft Rock |

| Type | Value | Description |
|---|---|---|
| $S_S$ | 0.151 | $MCE_R$ ground motion. (for 0.2 second period) |
| $S_1$ | 0.056 | $MCE_R$ ground motion. (for 1.0s period) |
| $S_{MS}$ | 0.181 | Site-modified spectral acceleration value |
| $S_{M1}$ | 0.095 | Site-modified spectral acceleration value |
| $S_{DS}$ | 0.121 | Numeric seismic design value at 0.2 second SA |
| $S_{D1}$ | 0.063 | Numeric seismic design value at 1.0 second SA |

| Type | Value | Description |
|---|---|---|
| SDC | A | Seismic design category |
| $F_a$ | 1.2 | Site amplification factor at 0.2 second |
| $F_v$ | 1.7 | Site amplification factor at 1.0 second |
| PGA | 0.079 | $MCE_G$ peak ground acceleration |
| $F_{PGA}$ | 1.2 | Site amplification factor at PGA |
| $PGA_M$ | 0.095 | Site modified peak ground acceleration |
| $T_L$ | 12 | Long-period transition period in seconds |
| SsRT | 0.151 | Probabilistic risk-targeted ground motion. (0.2 second) |
| SsUH | 0.169 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration |
| SsD | 1.5 | Factored deterministic acceleration value. (0.2 second) |
| S1RT | 0.056 | Probabilistic risk-targeted ground motion. (1.0 second) |
| S1UH | 0.06 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration. |
| S1D | 0.6 | Factored deterministic acceleration value. (1.0 second) |
| PGAd | 0.5 | Factored deterministic acceleration value. (Peak Ground Acceleration) |
| $C_{RS}$ | 0.894 | Mapped value of the risk coefficient at short periods |
| $C_{R1}$ | 0.926 | Mapped value of the risk coefficient at a period of 1 s |

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