EXHIBIT 24

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January 19, 2017

W1199 GEOTECHNICAL RPT
(REVISED)

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Attention: Scott Rose

SUBJECT: Geotechnical Investigation
Camas Project-Based Learning High School
5780 NW Pacific Rim Blvd
Camas, Washington

At your request, GRI has completed a geotechnical investigation for the proposed Camas Project-Based Learning (PBL) High School in Camas, Washington. The Vicinity Map, Figure 1, shows the general location of the site. The investigation was conducted to evaluate subsurface conditions at the site and to develop recommendations for design and construction of the site development including; earthwork, seismic design criteria, foundations, slab-on-grades, retaining walls, pavements, and stormwater facilities. Our investigation included a review of available geologic and geotechnical information for the site, subsurface explorations, laboratory testing, and engineering analyses. This report describes the work accomplished and summarizes our conclusions and recommendations for design and construction of the proposed high school.

The following reports were reviewed to assist in our investigation:

"Phase I Foundation Investigation, RCA/Sharp Microelectronics Facility, Camas, Washington," dated August 2, 1985; prepared by L. R. Squier Associates, Inc. for Shimizu America Corporation.

"Geotechnical Exploration for Phase I, Proposed Shimizu/RSM Project, Camas, Washington," dated October 1985; prepared for CH2M Hill IDC/Shimizu by CH2M Hill.

PROJECT DESCRIPTION

The proposed development will include a two-story, steel-framed high school building that is approximately 420 ft long and 130 ft wide. As shown on Figure 2, the proposed high school building will be located in the north-central portion of the project site. The planned top of slab for the first floor of the school is at elevation 489 ft and existing site grades within the school footprint range between 479 and 490 ft, necessitating fills of up to 10 ft to establish site grades within the building area. Based on information provided by DLR Group, we understand that the maximum building column loads will be on the order of 350 kips and that maximum tolerable total and differential settlement will be 1 in. and 3/4 in. between adjacent footings, respectively.

Asphalt concrete (AC) parking areas and access drives are planned for the south and west of the school. Up to 18 school busses will access the high school and middle school staff parking lot twice daily. Heavy vehicle use in the remaining parking lots will be limited to occasional heavy vehicles such as garbage trucks and emergency vehicles. We understand that construction of the school will start in the spring of 2017 with the school being operational for the 2018 / 2019 school year.

We also understand that three stormwater detention facilities will be constructed for the project and that the base of these facilities will be located within 5 to 10 ft of adjacent site grades. One pond is planned west of the parking lot with a maximum design water level of 447 ft and one pond is planned northeast of the proposed school and about 35 ft from the crest of an approximate 2H:1V (Horizontal:Vertical) fill slope and will have a maximum design water level of 479.32. A third pond is planned for the area south of the bus / unloading area. As currently envisioned, this pond will have two ponding sections separated by a weir. The east side of this pond will have a maximum design water elevation of 483.5 ft while the west side of this pond will have a maximum water elevation of 479.5 ft.

All elevations referenced in this report refer to the National Geodetic Vertical Datum of 1929 (NGVD 29), unless otherwise noted.

SITE DESCRIPTION

General

The Camas PBL High School is planned for a relatively flat portion of the former Sharp Laboratories property at 5780 NW Pacific Rim Boulevard in Camas, Washington. The subject property is bounded to the east by the existing Sharp Laboratory building; to the south and west by Sharp Drive, SE Payne Rd, SE 40th Street, NW 18th Avenue, and residential developments; and to the north by undeveloped and a heavily forested slope and NW Pacific Rim Boulevard. In the flatter portion of the property, site grades slope downwards to the west and north from about elevation 500 ft at the southeast corner of the site to about elevation 470 ft. The ground surface slopes downward below the flatter portion of the project site at grades between 3H:1V and 4H:1V to about elevation 375, at which point the grades further flatten out to about elevation 325 ft along NW Pacific Rim Boulevard.

The Camas PBL middle school is located in the southeast corner of the property. Asphalt paved parking areas are located to the south and west of the PBL middle school. Two stormwater ponds and undeveloped, brush-covered property are located further to the west of the western parking lot. Based on our review of aerial photographs available on the Clark County webpage, a series of small buildings were located on this portion of the property until at least the mid-1980s.

The proposed high school will be located to the northwest of the PBL middle school. Fill, likely associated with the development of the Sharp Laboratories facility, has been placed within this portion of the site and partially extends over the 3H:1V to 4H:1V slope along the west and north side of the site. Based on a site plan included in the L.R. Squier geotechnical report, site grades within this portion of the site were situated between elevation 470 and 490 ft. Existing site grades range from elevation 479 to 490 ft, indicating that upwards of 20 ft of fill has been placed over this portion of the site. Documentation of fill placement in this area has not been provided to us.

SUBSURFACE CONDITIONS

Geology

Based on our review of published geologic maps (Evarts and O'Connor, 2008), near surface conditions at the site consist of basaltic andesite rock correlated with the Volcanic Rocks of the Boring Lava Field. This rock was sourced by a volcanic vent on the west side of Prune Hill. The upper portion of the Boring Lava is locally decomposed to a stiff to hard, silty residual soil that grades to gravel-size fragments of very soft to soft, decomposed to moderately weathered basalt. Medium hard to hard, slightly weathered basalt is present below the residual soils. Fill soil associated with past site development is present at the location of the proposed high school building and in the western portion of the site.

General

Subsurface materials and conditions at the site were investigated between August 29 and September 2, 2016, with four borings, designated B-1 through B-4, and nine test pits, designated TP-1 through TP-8 and TP-7A. Subsurface conditions were further explored on December 19, 2016, with four additional test pits, designated TP-9 through TP-12. The borings were advanced to depths of 32.5 to 53 ft, and the test pits were advanced to depths of 8 to 15 ft. The locations of the explorations advanced for this study are shown on the Site Plan, Figure 2. A detailed discussion of the field exploration and laboratory testing program for this investigation are described in Appendix A. Logs of the borings and test pits are shown on Figures 1A through 4A and Figures 5A through 11A, respectively. The terms and symbols used to describe the soil and rock encountered in the test pits and borings are defined in Tables 1A and 2A and the attached legend. The results of laboratory testing are summarized in Table 3A, and graphical representations are provided on Figures 12A through 16A.

Infiltration Testing

Four small-scale pilot infiltration tests were attempted at the base of test pits TP-3, TP-5, TP-6, and TP-7A and at depths of 10.5, 9.25, 9.75, 9.5 ft, respectively. Approximately 12-in. of water was added to the base of the excavation and the water level was continuously monitored for several hours. During the time period monitored, the water level in the test pits remained constant. On-site stormwater disposal is not recommend for this site.

Soils

For the purpose of discussion, the soils disclosed by the explorations have been grouped into the following categories based on their physical characteristics and engineering properties:

1. **FILL(Building Area)**
2. **FILL(West Site)**
3. **FILL (Northeast Detention Pond Site)**
4. **SILT (Residual Soil)**
5. **Silty SAND and Silty GRAVEL (Residual Soil)**
6. **BASALT**

A detailed description of each soil unit and a discussion of groundwater conditions at the site are provided below. A 5- to 6-in.-thick, heavily rooted zone was typically encountered at the ground surface across the site.

1. FILL (Building Area). Fill was encountered to depths of 17.5, 7.5, 10, and 3 ft in borings B-1 through B-4 and to the maximum depths explored, about 10.5 ft, in test pits TP-1 through TP-3. Each of these explorations was made near the footprint of the proposed high school. The building area fill typically consists of silt with some clay and trace fine-grained sand. Fine roots, wood debris, organics, and grass were encountered throughout the fill and gravel and cobbles were also encountered at select locations and depths. Based on SPT N-values between 2 and 15 blows/ft and Torvane shear strength values between 0.35 and 0.90, the relative consistency of the silt fill is soft to stiff, and is typically medium stiff to stiff. The natural moisture content of the silt fill ranges from 16 to 45%. The results of Atterberg limits determinations on two samples of the silt indicate that the soil has a liquid limit (LL) of between 28 and 32% and a plasticity index (PI) of about 6%. Two one-dimensional consolidation tests were completed on representative samples of the silt. The silt typically exhibits a relatively low compressibility in the existing range of overburden stresses and a moderate compressibility in overburden stresses in excess of the existing overburden stresses. The results of the Atterberg limits and one-dimensional consolidation tests of the fill are provided on Figures 12A, 13A, and 15A.

Medium dense, gravel fill was encountered to a depth of about 3 ft in boring B-4. The gravel fill is silty, and contains some fine- to coarse-grained sand.

2. Fill (Northeast Detention Pond Site). Fill was encountered at the ground surface in test pits TP-10 through TP-12, which were made within the planned footprint of the northeast detention facility. The fill extends to depths of between 4 and 8 ft and consists of silt with a trace of clay and variable sand content up to some. Scattered subangular to subrounded gravel and cobbles were encountered at select locations and depths within the fill. Based on observations during digging, the relative consistency of the fill in this portion of the site is medium stiff to stiff. The fill has a natural moisture content of the fill encountered in the northeast detention pond varies from 20 to 27%.

3. FILL (West Site). Fill was encountered at the ground surface in test pits TP-4, TP-7, and TP-7A, which were advanced in the western portion of the site near the location of some demolished historical buildings. The fill extends to the maximum depth explored, about 10.5 ft, in test pit TP-4, to refusal on basalt rock at a depth of 8 ft in test pit TP-7, and to a depth of about 8 ft in test pit TP-7A. The fill encountered in the western portion of the site typically consists of silt with trace to some clay, trace to some fine-grained sand, and trace subrounded and subangular gravel. Cobbles and boulders up to 3 ft in diameter were encountered in test pit TP-4 from between 1.5 and 3.5 ft and throughout the fill in test pits TP-7 and TP-7A. The fill contains fine roots and grass, and the fill encountered below 6 ft in test pits TP-7 and TP-7A contains debris, including dimensional lumber, steel pipe, and plastic. Based on Torvane shear strength values of 0.4 to 0.6 tsf, the relative consistency of the fill observed in the west side of the site is medium stiff to stiff. The fill encountered in this portion of the site has a natural moisture content of between 18 and 30%.

4. SILT (Residual Soil). Residual soil consisting of silt was encountered from 17.5 to 34 ft in boring B-1, from 7.5 ft to 32 ft in boring B-2, from 10 to 31 ft in boring B-3, from 3 to 25 ft in boring B-4, from the ground surface to about 10 ft (the maximum depth explored) in test pit TP-5, from the ground surface to about 8 ft in test pit TP-6, from 8 to 9 ft in test pit TP-7A, from 3 to 10.5 ft (maximum depth explored) in test pit TP-8, from the ground surface to 15 ft (maximum depth explored) in test pit TP-9, from 8 to 15 ft (maximum depth explored) in test pit TP-10, from 4 to 14 ft (maximum depth explored) in test pit TP-11, and from 6 to 12 ft (maximum depth explored) in test pit TP-12. The upper portion of the residual soils is typically brown mottled gray and rust and contains trace to some fine-grained sand and some clay. The deeper residual silt soils are typically red mottled black, clayey, and contain a trace of fine-grained sand and variable gravel content up to gravelly. Up to 10-in.-diameter Basalt cobbles were observed in test pit TP-5 below about 6 ft, in test pit TP-9 below about 4 ft and in test pit TP-11 below about 10 ft. A 16-in.-diameter basalt boulder was encountered in test pit TP-12 at a depth of about 10 ft. Based on SPT N-values of 0 to 26 blows/ft, Torvane shear strength values of between 0.20 and 0.85, and the results of unconfined compressive strength tests completed by L. R. Squires, the residual silts are soft to very stiff and are typically stiff to very stiff.

The natural moisture content of the residual silt ranges from 16 to 67, with the higher moisture contents typically corresponding to the deeper, more clayey residual silt soils. The results of Atterberg limits determinations on two samples of the clayey silt indicate that the clayey silts have a liquid limit (LL) of between 72 and 77% and a plasticity index (PI) of between 26 and 33%. Two one-dimensional consolidation tests were completed on representative samples of the residual silt. The testing indicates that the residual silt is moderately to heavily overconsolidated and exhibits a relatively low compressibility in the pre-consolidated range of stresses and a moderate to high compressibility in the normally consolidated range of stresses. The results of the Atterberg limit and one-dimensional consolidation tests of the residual silts are provided on Figures 12A, 14A, and 16A.

5. Silty GRAVEL and Silty SAND (Residual Soil). Residual soil consisting of silty, angular basalt gravel with some fine- to coarse-grained sand was encountered in boring B-1 from 34 to 38 ft and from 42 to 48 ft, in boring B-2 from 32 to 39 ft, in boring B-4 from 25 to refusal on basalt at 33.5 ft, and in test pit TP-6 from 8 to 10.5 ft (maximum depth explored). Based on SPT N-values of between 32 and more than 50 blows for 6 in. of sampler penetration, defined as refusal conditions, the silty gravel is dense to very dense. The silty gravel has a natural moisture content of 40 to 49%.

Silty sand with trace to some angular basalt gravel was encountered in boring B-3 from 31 ft to refusal on basalt at 32.5 ft. Based on a SPT N-value of 73 blows/ft, the relative density of the silty sand is very dense. The silty sand has a natural moisture content of about 49%.

6. BASALT. Basalt was encountered in boring B-1 at depths of between 38 and 42 ft and 48 to 53 ft (maximum depth explored), in boring B-2 from 39 to 50.2 ft (maximum depth explored), and in TP-7A from 9 to 10 ft (maximum depth explored). Borings B-3, B-4, and test pit TP-7 were terminated when encountering basalt at depths of 32.5, 33.5, and 8 ft, respectively. The basalt observed in test pit TP-7A is soft to medium to medium hard (R2 to R3) and slightly to moderately weathered. The basalt observed in borings B-1 and B-2 is typically medium hard to very hard (R3 to R5) and is slightly weathered to fresh. Rock core recovery ranged from 40 to 100 percent and the RQD ranges from 6 to 76%. Photographs of the basalt obtained from the borings are provided in Appendix B.

Groundwater

Groundwater was encountered in test pit TP-8 at a depth of about 9 ft (elevation 480 ft). Groundwater was also measured at a depth of 32 ft (elevation 457) in boring B-1, which was drilled using mud-rotary drilling techniques and was left open for about 24 hours to allow the water level to stabilize. All other borings were completed using mud-rotary drilling techniques, which do not permit the measurement of groundwater levels. L.R. Squier Associates installed a piezometer in boring B-7 located near the west portion of the proposed school. The groundwater in this piezometer was measured at elevation 457.2 ft on July 18, 1985. We anticipate that the groundwater level will fluctuate in response to seasonal precipitation and that perched groundwater could approach the ground surface during periods of sustained wet weather.

CONCLUSIONS AND RECOMMENDATIONS

General

Subsurface explorations made for this investigation and for nearby projects indicate the site is typically mantled with stiff to very stiff, residual silts that are underlain by basalt. Up to 17.5 ft of fill was observed at the location of the proposed high school building. Fill was also observed in the western portion of the site in the footprint of future parking areas and in the northeast corner of the site at the location of the proposed detention facility. Groundwater was observed at a depth of 8 ft in test pit TP-8 and at a depth of 32 ft in boring B-1. During periods of wet weather, we anticipate that perched groundwater may approach the ground surface.

The near-surface soils at the site contain an appreciable amount of silt and fine-grained sand and are considered to be moisture-sensitive. Earthwork activities will be most efficiently accomplished during the warm, dry summer to early-fall months when the moisture content of the site soils can be more easily controlled near-optimum. The use of granular haul roads or work pads should be anticipated, especially if construction extends into the wetter portions of the year. The existing fill will not provide suitable support of the proposed building loads. In our opinion, the structural loads of the proposed buildings can be supported by either conventional spread footings placed on ground improvement or on structural fill placed extending to the underlying residual silts (i.e. complete removal of existing fill).

The following sections of this report provide our conclusions and recommendations earthwork, seismic design criteria, slab-on-grades, lateral earth pressures, and pavements. Evaluation of the need for a liner for the west and northeast detention pond is also provided.

Earthwork

Demolition, Stripping, and Work Pads. All debris from the demolition of existing pavement and utilities should be removed from the site. Excavations required to remove existing improvements, including underground utilities, should be backfilled with structural fill. Surface vegetation and other organic materials within the limits of new fills, buildings, and other structures, such as pavements and sidewalks, should be stripped. Based on the conditions observed in our explorations, we anticipate a stripping depth of around 4 to 6 in. will be required to remove light vegetation and organics. In currently undeveloped portions of the sites, deeper stripping and grubbing depths should be anticipated to remove the stumps and roots larger than about 1/2 in. associated with the larger trees and shrubs present on the site. The strippings will not be suitable for structural fill and should only be used in landscape areas or removed from the site.

Following site stripping, the exposed subgrade in areas to receive structural fill or other improvements should be evaluated by a qualified geotechnical engineer. Any soft areas or areas of unsuitable material should be overexcavated to firm undisturbed soil and backfilled as described below in the Structural Fill section of this report. Due to the presence of fill and localized zones of soft silt, it should be anticipated that some overexcavation of the subgrade will be required.

Due to the moisture-sensitive nature of the silty soils that mantle the site, site preparation and earthwork phases of this project will be accomplished most efficiently during the dry, summer months. However, if construction is to proceed during the wet months of the year, or if wet ground conditions exist, we recommend making all excavations using large hydraulic excavators (backhoes) equipped with smooth cutting edges, in lieu of scrapers and/or bulldozers, to prevent softening of the subgrade soils. Also, the contractor should plan the earthwork operations such that no construction equipment, i.e., bulldozers, dump trucks, etc., traffic the exposed silty soils. This will require the placement of imported granular fill for a working pad and/or haul roads as the excavation progresses. If the subgrade is disturbed during construction, soft, disturbed soils should be overexcavated to firm soil and backfilled with clean, granular materials.

In our experience, granular haul roads and work pads generally require a minimum of 18 to 24 in. of relatively clean, fragmental rock to support construction traffic. If the subgrade is particularly soft, it may be advisable to place a woven stabilization fabric such as Mirafi 600X, or equivalent, on the exposed subgrade prior to placement and compaction of the granular work pad.

The test pits disclosed debris and near-surface boulders and rock fragments up to 3 ft in diameter. It should be anticipated that these materials may be encountered during earthwork activities.

Structural Fill. The existing ground surface within limits of the proposed high school building footprint is irregular, and in some locations up to 10 ft of structural fill may be required to establish planned site grades for the building. Grading plans for the remainder of the site have not been provided to us. As design continues, GRI should review the impact of fills placed adjacent to the 3H:1V to 4H:1V slope located north of the proposed building. At a minimum and for preliminary planning purposes only, the toe of any proposed fill slope should be setback a minimum of 20 ft from the crest of slopes on the north and west side of the site.

On-site or imported, organic-free soils approved by the geotechnical engineer may be used to construct structural fills. However, the onsite soil is fine-grained and sensitive to moisture content and should only be placed during the dry, summer and early fall months. Organics and debris should also be removed from the onsite fill soils if they will be used as structural fill on the project. If construction is to proceed during the wet, winter and spring months, fills should be constructed using imported, relatively clean, granular materials.

All fill placed for buildings, paved areas, sidewalks, and hardscape areas should be installed as compacted, structural fill. In general, approved, organic-free, fine-grained soils used to construct structural fills should be placed in 9-in.-thick (loose) lifts and compacted using segmented-pad rollers to at least 95% of the maximum dry density, as determined by ASTM D698. Fill placed in landscaped areas should be compacted to about 90% of the maximum dry density, as determined by ASTM D698. At the time of compaction, the moisture content of silt soil should be controlled to within 3% of the optimum moisture content as determined by ASTM D698. It has been our experience that it is difficult to adequately compact wetter soils. If the fill is compacted at a moisture content wetter than recommended, pronounced pumping and rutting of the material will occur under the wheels or treads of construction equipment. The pumping and rutting are indications that the fill material is too wet, relatively weak and compressible, and may require replacement.

Imported granular material used to construct structural fills or work pads during wet weather should consist of material up to 6-in. maximum size and with not more than about 5% passing the No. 200 sieve (washed analysis). Care should be taken during compaction of the initial lift of granular soil placed over the silt subgrade to avoid disturbance of the subgrade. The first lift of imported fill material placed over the silt subgrade should range from 12 to 18 in. thick (loose) and should be compacted with a medium-weight (48-in.-diameter drum), smooth, steel-wheeled, vibratory roller until well keyed. Subsequent lifts of granular fill should not exceed 12 in. and should be compacted to a density not less than 95% of the maximum dry density as determined by ASTM D698. Smaller lift thicknesses may be required if walk-behind plate compactors, jumping jacks, or small vibratory rollers are used to compact granular structural fill.

Where fills are to be placed on existing slopes steeper than about 5H:1V, the area to be filled should be terraced or benched to provide a relatively level surface for fill placement. Typical benching requirements are illustrated on Figure 3. Final graded slopes of native soils or structural fill should be no steeper than 2H:1V. Structural fill should be placed and compacted a minimum of 2 ft beyond the final slope configuration and then trimmed back to final grade.

Seeps or springs that emerge on cut slopes may require drainage provisions depending on the actual conditions observed during construction. These provisions could include French drains, drainage blankets, and subdrains (possibly placed in utility trenches), to collect and remove water.

Fill Settlement. For the purpose of our settlement evaluation, we have assumed fills on the order of 5 to 10 ft in height may be needed to achieve final site grades within the footprint of the proposed school. Larger fills may be needed to achieve site grades at other locations at the site. We estimate total settlement due to placement of 10 ft of fill will be less than 1 in. We anticipate the majority of this settlement will occur within three to four months following placement of the fill. We recommend that any mass grading to raise site grades be accomplished early in the construction schedule to allow the majority of settlement associated with fill placement to occur prior to installation of utilities, hardscapes, and buildings. Where the fills are greater than 10 ft thick, we recommend that the completion of settlement be evaluated by monitoring several survey points on the surface of the finished structural fill prior to constructing settlement sensitive improvements. The survey data should be evaluated by GRI.

Utility Excavations. We understand that utility trench excavations associated with the proposed improvements will generally be less than about 10 ft deep and will primarily encounter properly compacted new structural fill, existing medium stiff to stiff silt fill, and stiff to very stiff residual silt. In our opinion, compacted structural fill or the existing medium stiff to stiff silt fill would be classified as a Type C soil according to the most recent Occupational Safety and Health Administration (OSHA) regulations. Stiff to very stiff residual soils would classify as a Type B soil according to OSHA regulations. In our opinion, these materials can be excavated with conventional excavation equipment. Boulders, up to 3 ft in diameter, were observed in the test pits advanced for this study. The contractor should be prepared to handle oversize materials, if encountered in the fill.

Medium hard to hard (R2 to R3) basalt that is slightly to moderately weathered was observed at a depth of about 8 to 9 ft in test pits TP-7 and TP-7A, which were advanced in the western portion of the site. We anticipate that rock excavation methods such as chipping, drilling and splitting, or blasting will be required for excavations extending into the basalt.

We anticipate that relatively small groundwater inflows will be encountered within the silt soils across the majority of the site, particularly if utility construction takes place during the dry summer months. Dewatering across the majority of the site can most likely be accomplished by pumping from sumps. If groundwater is encountered within utility excavations, it will be necessary to overexcavate the trench bottom to permit installation of a granular working blanket to reduce bottom instability and facilitate pumping from sumps. We estimate the required thickness of the granular working blanket will be on the order of 1 ft, or as required to maintain a stable trench bottom, depending on the conditions exposed in the trench and the effectiveness of the contractor's dewatering efforts. The thickness of the granular blanket must be evaluated on the basis of field observations during construction. We recommend the use of relatively clean, free-draining material, such as 2- to 4-in.-minus crushed rock, for this purpose. If the ground is extremely soft, it may be necessary to install a woven geotextile fabric, such as Mirafi 500X (or equivalent), over the subgrade prior to placing the granular blanket.

All backfill placed in utility trench excavations within the limits of paved areas or in future improvement areas should consist of sand, sand and gravel, or crushed rock with a maximum size of up to 2½ in. and with not more than 5% passing the No. 200 sieve (washed analysis). The granular backfill should be placed in 12-in.-thick lifts (loose) and compacted using vibratory plate compactors or tamping units to at least 95% of the maximum dry density as determined by ASTM D698. Thicker lifts may be appropriate if hoe-mounted vibratory compactors are used. Flooding or jetting the backfilled trenches with water to achieve the recommended compaction should not be permitted.

Seismic Considerations

We understand the proposed improvements will be designed in conformance with the 2015 *International Building Code* (IBC), which references the American Society of Civil Engineers (ASCE) *Minimum Design Loads for Buildings and Other Structures* (ASCE 7-10). The IBC design methodology uses two spectral response parameters, S_S and S_1, corresponding to periods of 0.2 and 1.0 second, to develop the Risk-Targeted Maximum Considered Earthquake (MCE_R) response spectrum. The spectral response parameters were obtained from the U.S. Geological Survey (USGS) Hazard Response Spectra Curves for the coordinates of 45.5936° N latitude and 122.4621° W longitude (USGS, 2008a). The S_S and S_1 parameters identified for the site are 0.93 and 0.38 g, respectively. These spectral response parameters are adjusted for Site Class with the 0.2 and 1.0 second period site coefficients, F_a and F_v, based on the soil profile in the upper 100 ft. Based on the conditions observed in the borings completed for this study, the site would classify as Site Class E (Soft Clay Soil). For Site Class E, a value of 0.98 should be used for site coefficient F_a and 2.46 should be used for site coefficient F_v. The design-level response spectrum is calculated as two-thirds of the Site Class-adjusted MCE_R spectrum.

Based on the types of the soils present at the site, it is our opinion that the risk of liquefaction, liquefaction-induced settlement and lateral spreading is low. Geologic literature indicates the inferred northwest-southeast-trending Portland Hills fault is about 10 miles southwest of the site, and the Lacamas Lake fault zone is about 2 miles northeast of the site (USGS, 2008b). Given the relatively low level of activity associated with these fault zones, the risk of ground rupture at the site is low during the expected design life of the proposed improvements unless occurring on an unknown or unmapped fault. The risk of tsunami and/or seiche at the site is absent.

Foundation Support

General. Based on our conversation with DLR Group, we understand that the maximum building column loads will be on the order of 350 kips and that maximum tolerable total and differential settlement will be 1-in. and 3/4-in. between adjacent footings, respectively. The borings and test pits advanced for this study disclosed up to 17.5 ft of fill under the proposed footing subgrade. The history of fill placement is not available to us and the fill includes fine roots, wood debris, organics, and grass. Our analysis indicates that the existing fill soils are compressible and will provide poor support of shallow foundations. Consequently, it our opinion that foundation support for the building can be most-economically provided by conventional column-type and continuous spread footings founded on ground improvement such as engineered aggregate piers. Overexcavation and replacement of undocumented fill may also be an option and is discussed below.

Engineered Aggregate Piers. Engineered aggregate pier foundations are a proprietary system; the suitability of the engineered aggregate pier foundation system should be evaluated by GeoPier Foundation Company, Geotech Foundation Company - West, Hayward-Baker, or another contractor/designer of engineered aggregate pier foundations. In general, an engineered aggregate pier foundation system consists of drilling a shaft with or without casing and backfilling the excavation with crushed rock while compacting with a compaction mandrel. The installation of the engineered aggregate piers may be somewhat challenging due to the presence of undocumented fill soils, cobbles and boulders, zones of relatively soft silt, and the potential for encountering shallow perched groundwater. As a result, it would be prudent for the aggregate pier contractor to assume that casing will be required to retain the overburden soils in some, if not all, of the pier locations.

We recommend engineered aggregate piers extend through the fill and a minimum of 5 ft into the underlying residual soils. The actual pier depth will need to be designed by the foundation contractor based on the footing bearing pressure and settlement information presented below.

The aggregate pier foundation contractor should evaluate the soil conditions at the site and determine the length, spacing, and diameter of aggregate piers that can provide a suitable bearing pressure while limiting settlement to less than 1 in. of total settlement and 3/4-in. of differential settlement at the design dead plus live load. Based on our experience and our discussions with a local engineered aggregate pier contractor/designer, we anticipate that an allowable bearing pressure for this type of system at this site will range from 4,000 to 6,000 psf. However, further analysis will be required by the specialty contractor to provide the actual maximum allowable bearing capacity.

We recommend establishing shallow spread and continuous footings supported by aggregate pier foundations at a minimum depth of 1.5 ft below the lowest adjacent finished grade. The footing width should not be less than 4 ft for isolated column footings and 2 ft for continuous wall footings. Excavations for all foundations should be made with a smooth-edged bucket and should be examined by the geotechnical engineer. This includes confirming the engineered aggregate piers are exposed in the foundation bottom.

Horizontal shear forces can be resisted partially or completely by frictional forces developed between the base of wall or spread footings and the underlying soil and by soil passive resistance. The total frictional resistance between the footing and the soil is the normal force times the coefficient of friction between the soil and the base of the footing. We recommend an ultimate value of 0.40 for the coefficient of friction for footings cast on engineered aggregate piers or crushed rock. The normal force is the sum of the vertical forces (dead load plus real live load). If additional lateral resistance is required, passive earth pressures against embedded footings can be computed on the basis of an equivalent fluid having a unit weight of 250 pcf in soil. This design passive earth pressure would be applicable only if the footing is cast neat against undisturbed soil, or if backfill for the footings is placed as granular structural fill. This value also assumes the ground surface in front of the foundation is horizontal, i.e., does not slope downward away from the toe of the footing.

Subgrade Overexcavation Option. Building or retaining wall loads can also be supported on a subgrade that has been overexcavated to the underlying residual silt soil and replaced with compacted crushed rock structural fill to the limits indicated on Figure 4. Alternatively, all of the fill soils within the building footprint could be overexcavated and replaced with structural fill as discussed in the Earthwork section of this report. Excavations for all footings should be made using a smooth-edged bucket. Prior to placing the structural fill, the geotechnical engineer should observe the base of the overexcavation to confirm that the fill soils have been adequately removed. Soft, loose, or otherwise unsuitable soils, if encountered at the base of the footing overexcavation, should be removed to firm subgrade material and replaced with structural fill. Based on the conditions observed in our borings, the depth of overexcavation could extend from between 3 and 17.5 ft.

Footings placed on structural fill should meet the minimum embedment depth and footing sizes described in the section of this report titled *Engineered Aggregate Piers*. Footings established on structural fill extending to the residual silt soils can be designed to impose an allowable soil bearing pressure of 2,500 psf. This value applies to the total of dead load plus frequently and/or permanently applied live loads and can be increased by one-third for the total of all loads; dead, live, and wind or seismic. We estimate the total settlement of spread footings supporting column loads of up to 350 kips or wall loads less than 10 kips/ft will be about 1 in. We estimate that differential settlements will be about one-half of the total settlement. Our experience indicates these settlements will occur rapidly, with the majority of the settlement occurring during construction.

Recommendations for resistance to lateral loads are provided in the section of this report titled *Engineered Aggregate Piers*.

Slab-on-Grade Floors

Slab-on-grade floors that are established at or above adjacent final site grades should be underlain by a minimum 8-in.-thick granular base course. To provide a capillary break between the silty subgrade and the floor, the base course material should consist of open-graded, angular, crushed rock up to 1$^{1}/_{2}$ in. in size with no more than about 2% passing the No. 200 sieve (washed analysis). Crushed rock meeting the gradation requirements for Gravel Backfill for Drains in Section 9-03.12(4) of the Washington State Department of Transportation (WSDOT) Standard Specifications is suitable for this purpose. The base course material should be installed in a single lift and compacted until well keyed using a minimum of four passes with a medium- to heavy-weight vibratory roller. To facilitate compaction of the granular base and limit contamination from construction activities prior to placing the concrete slab, it may be desirable to replace the upper 2 in. of the open-graded base course material with 3/4-in.-minus crushed rock having less than 5% passing the No. 200 sieve (washed analysis). Where the potential for damp slab surfaces is not a concern, the slabs may be underlain by an 8-in. thickness of 3/4-in.-minus, angular, crushed rock having less than 5% passing the No. 200 sieve (washed analysis).

In moisture-sensitive floor areas, such as those to be covered with vinyl flooring or carpet, or where moisture-sensitive material may be stored directly on the concrete floor slab, it may be prudent to install a suitable vapor-retarding membrane beneath slab-on-grade floors. Vapor-retarding membranes should be installed in accordance with the manufacturer's recommendations.

Based on the subsurface explorations, non-engineered fill will be encountered in a portion of the building floor slab area. Structural fill will be present at the planned slab-on-grade subgrade elevation. Non-engineered fill encountered in floor slab areas should be overexcavated to a minimum depth of 2 ft below the crushed rock elevation and replaced with properly compacted structural fill. In our opinion, for the design of the slabs on grade, it is appropriate to assume a coefficient of subgrade reaction, k, of 150 pci for point loading.

Retaining Walls

Design lateral earth pressures for retaining walls depend on the drainage condition behind the wall and the ability of the wall to yield. We recommend that foundation drainage be provided behind the retaining walls. The two possible conditions regarding the ability of the wall to yield include the at-rest and active earth pressure cases. The at-rest earth pressure case is applicable to a wall that is relatively rigid and laterally supported at the top and bottom and therefore is unable to yield. The active earth pressure case is applicable to a wall that is capable of yielding slightly away from the backfill by either sliding or rotating about its base.

Assuming the top of the backfill will be horizontal and the backfill will be completely drained, yielding (active) and non-yielding (at-rest) walls with a maximum height less than 10 ft can be designed on the basis of a hydrostatic pressure based on an equivalent fluid unit weight of 35 and 55 pcf, respectively. Additional lateral pressures due to surcharge loadings in the backfill area, such as vehicle traffic and/or adjacent footings, can be estimated using the guidelines provided on Figure 5.

To account for seismic loading, the Mikola and Sitar method (2013) was used to develop lateral earth pressures on permanent embedded structures. Using this method, the static lateral earth pressures should be increased by an equivalent fluid unit weight of 11 pcf for yielding walls and 21 pcf for non-yielding walls with a level back slope. This results in a triangular distribution with the resultant acting at 1/3H up from the base of the wall, where H is the height of the wall in feet. The lateral force induced by an earthquake is in additional to the lateral earth pressures acting on the wall during static conditions.

We recommend that a foundation drainage system be provided behind all retaining walls. A typical drainage system for retaining walls is shown on Figure 6. Wall backfill material should meet the requirements of structural fill provided earlier of this report and should and be compacted to about 95% of the maximum dry density according to ASTM D698. Overcompaction of the backfill should be avoided. Heavy compactors and large pieces of construction equipment should be kept a minimum distance of 5 ft from any embedded wall to avoid the buildup of excessive lateral pressures. Compaction close to walls should be accomplished using hand-operated, vibratory plate compactors.

Pavement Design

We understand that parking areas and access lanes will be paved with asphalt concrete pavement. We understand that the project plans include a designated bus loading and unloading area that can accommodate up to 18 busses at a time. In developing our recommended pavement section, we have assumed a 20-year pavement design period. In the bus loading and unloading area, we have assumed a total of 36 passes with a fully loaded bus per day every weekday and that the busses include a 12 kip front axle and a 24 kip rear axle. For drive aisles and access roads, we have assumed a total of 10 heavy vehicles (i.e., school busses, garbage trucks, delivery trucks, etc.). Based on our experience with similar projects and subgrade materials, we recommend the following pavement sections as detailed in Table 1.

Table 1: RECOMMENDED PAVEMENT SECTIONS FOR VEHICLE DRIVE AISLES AND PARKING AREAS

	AC Thickness, in.	CRB Thickness, in.
Bus Loading and Unloading Area	5	12
Drive Aisles and Access Roads	4	8
Vehicle Parking Area (Truck Restricted Areas)	3	8

A woven geotextile fabric should be placed beneath the crushed rock base (CRB) for all pavement sections.

The recommended pavement sections should be considered minimum thicknesses, and it should be assumed some maintenance will be required over the life of the pavement. The sections are based on the assumption that pavement construction will be accomplished during the dry season and after construction of the building has been completed. If wet-weather or wet-ground pavement construction is considered, it will likely be necessary to increase the thickness of CRB to support construction equipment and protect the subgrade from disturbance. The indicated sections are not intended to support extensive construction traffic, such as loaded dump trucks and concrete trucks. Pavements subject to construction traffic may require repair.

For the recommended sections, drainage is an essential aspect of pavement performance. We recommend all paved areas be provided with positive drainage to remove surface water and water within the CRB. This will be particularly important in cut sections or at low points within the paved areas, such as at catch basins. Effective methods to prevent saturation of the CRB materials include providing weep holes in the sidewalls of catch basins, subdrains in conjunction with utility excavations, and separate trench drain systems.

To provide quality materials and construction practices, we recommend the pavement work conform to WSDOT standards. Prior to placing CRB, all planned pavement areas should be proof rolled with a fully loaded 10-cy dump truck and observed by a qualified geotechnical engineer. Any soft areas detected by the proof rolling should be overexcavated to firm ground and backfilled with compacted structural fill.

Detention Facility Liner Evaluation

General. We understand that three stormwater detention facilities are planned as part of the proposed improvements. The western and northern detention facilities are planned on or adjacent to sloping ground. GRI completed a seepage and slope stability analysis in order to evaluate the need for a liner for each of these facilities. Additional discussions regarding the conditions at the west and north detention facilities are provided below.

- **West Detention Facility.** This detention facility is planned for the western portion of the site on ground that is sloping downward to the north at about 6.5H:1V. The base of the detention facility is situated between elevation 441 and 442 ft and the design maximum water level in the facility is planned for elevation 447 ft. Based on the conditions observed in test pit TP-9, which was advanced within the proposed footprint of the facility, subsurface conditions at the location of the relatively pond primarily consist of silt with some sand, gravel- and cobble-sized pieces basalt. Groundwater was not encountered within the maximum elevation explored, about elevation 438 ft.

- **North Detention Facility.** This detention facility is planned in a grass-covered area northeast of the proposed Camas PBL High School. The ground surface at the pond site is currently situated between about elevation 475 and 485 ft. The detention facility is located about 35 ft from the crest of an approximate 2H:1V fill slope that partially extends over a 3H:1V to 4H:1V native slope. The base of this detention facility is planned for elevation 476 ft and the design maximum water level in the facility is planned for elevation 479.3 ft. Test pits TP-10 through TP-12 were advanced within the footprint of this facility. Subsurface conditions consist of up 4 to 6 ft of silt fill underlain by residual silt. Groundwater was not encountered within the maximum elevation explored, about elevation 438 ft.

Seepage Evaluation. The groundwater module of the Slide Version 7.009 software developed by Rocscience, Inc. of Toronto, Ontario was used to estimate the impact to the groundwater table that may occur if the water levels in the detention facilities are kept at their maximum level for an extended period of time (i.e., steady-state conditions). Basic inputs for the models included the existing and proposed topography and the subsurface conditions as disclosed in the field exploration program advanced for this study. The permeability used in the seepage evaluation was estimated based on our experience with similar soils. We assumed a permeability of 10^{-5} cm/sec for the west detention facility where the subsurface conditions primarily consist of silt with some sand, gravel, and cobble-sized basalt pieces. For the fill and silt residual soils observed at the north detention facility, a lower permeability of 10^{-7} cm/sec was used. For both the north and west detention facilities and for steady-state conditions, our seepage analysis indicates that a groundwater mound may develop below each of the facilities and that groundwater seepage may emerge on the slope below the facilities.

Slope Stability Evaluation. The stability of the slopes below the detention facilities were estimated using the Slide software and the same model (i.e., slope configuration and subsurface profile) that was used in our seepage evaluation. For both the north and west detention facility, the strength of the soil was conservatively modeled using a drained friction angle of 30°. The steady-state groundwater level used estimated in the seepage analysis was used in our slope stability evaluation. Our analysis indicates that the slope located below the west detention facility has a factor of safety of about 1.4 during static conditions while the slope located below the north detention facility has a factor of safety of less than 1.0. Computed factors of safety less than 1.0 indicate instability and lateral movement will likely occur.

Liner Recommendations. Based on the results of our seepage and stability evaluation, it is our opinion that the north detention facility should be lined. If this facility is not lined, there is a significant risk of seepage and slope instability, which may undermine the access road located to the north of proposed facility. Our analysis indicates that a liner is not necessary for the west facility, as long as occasional seepage in the slope below the pond is tolerable. Based on the location of the southern pond located south of the bus loading / unloading facility, it is our opinion that a liner is not necessary for this pond.

DESIGN REVIEW AND CONSTRUCTION SERVICES

We welcome the opportunity to review and discuss construction plans and specifications for this project as they are being developed. In addition, GRI should be retained to review all geotechnical-related portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in our report. In addition, to observe compliance with the intent of our recommendations, design concepts, and the plans and specifications, we are of the opinion that all construction operations dealing with earthwork and foundations should be observed by a GRI representative. Our construction-phase services will allow for timely design changes if site conditions are encountered that are different from those described in our report. If we do not have the opportunity to confirm our interpretations, assumptions, and analyses during construction, we cannot be responsible for the application of our recommendations to subsurface conditions that are different from those described in this report.

LIMITATIONS

This report has been prepared to aid the project team in the design of this project. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects of the project relevant to site preparation and earthwork and design and construction of foundation and floor support, embedded walls, and pavements. In the event that any changes in the design and location of the project elements as outlined in this report are planned, we should be given the opportunity to review the changes and to modify or reaffirm the conclusions and recommendations of this report in writing. No geotechnical investigations were completed within the footprint of the west and northeast stormwater facilities. Additional site investigations and engineering analysis should be completed prior to completing final design of these stormwater facilities.

The conclusions and recommendations submitted in this report are based on the data obtained from the borings and test pits made at the locations indicated on Figure 2 and from other sources of information discussed in this report. In the performance of subsurface investigations, specific information is obtained at specific locations at specific times. However, it is acknowledged that variations in soil conditions may exist between exploration locations. This report does not reflect any variations that may occur between these explorations. The nature and extent of variation may not become evident until construction. If, during construction, subsurface conditions differ from those encountered in the explorations, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Please contact the undersigned if you have any questions regarding this report.

Submitted for GRI,

WESLEY SPANG
STATE OF WASHINGTON
35875
REGISTERED
PROFESSIONAL ENGINEER

Renews 11/2017

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This document has been submitted electronically.

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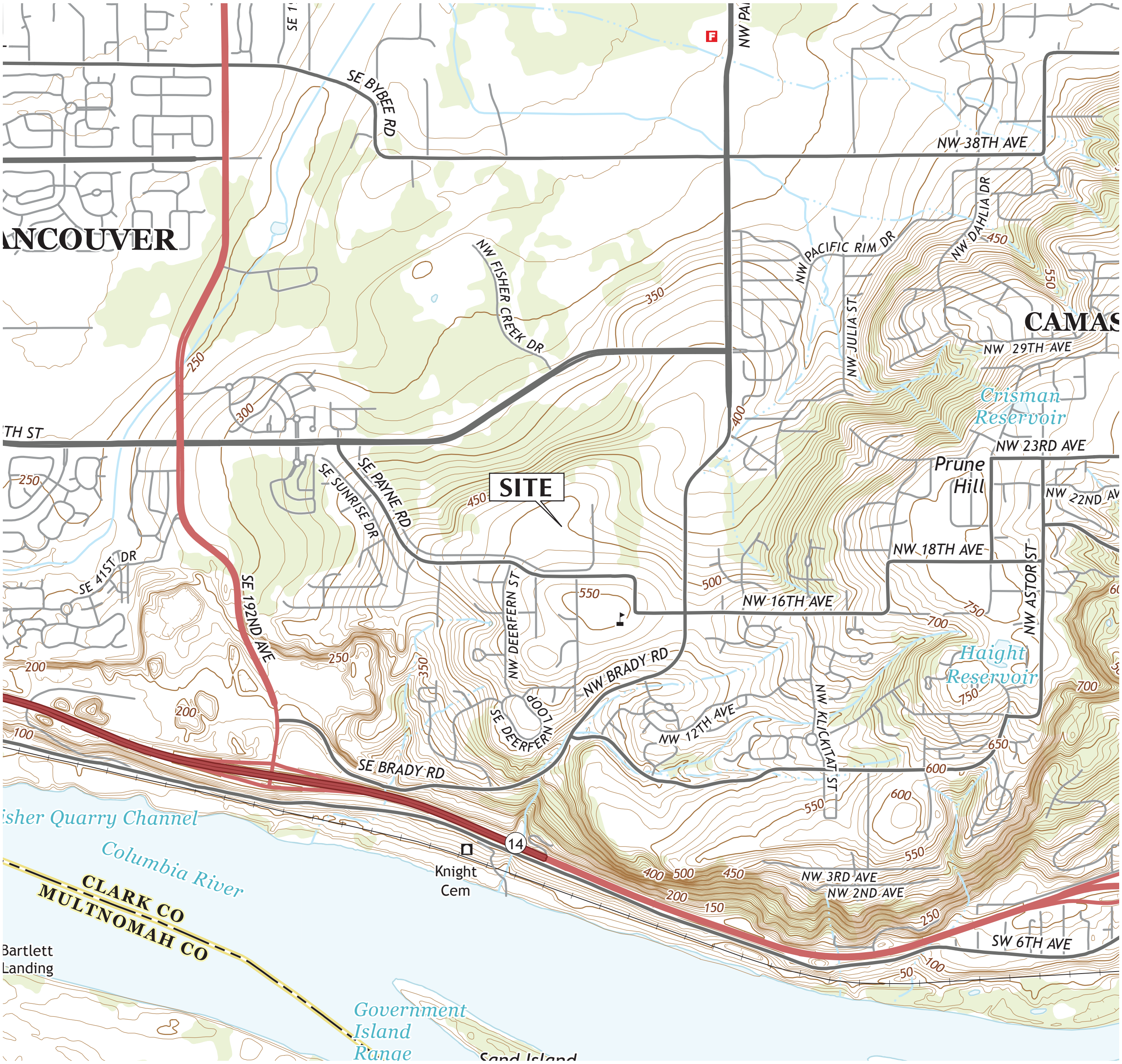

USGS TOPOGRAPHIC MAP
CAMAS, WASHINGTON (2013)

North

0 1/2 1 MILE

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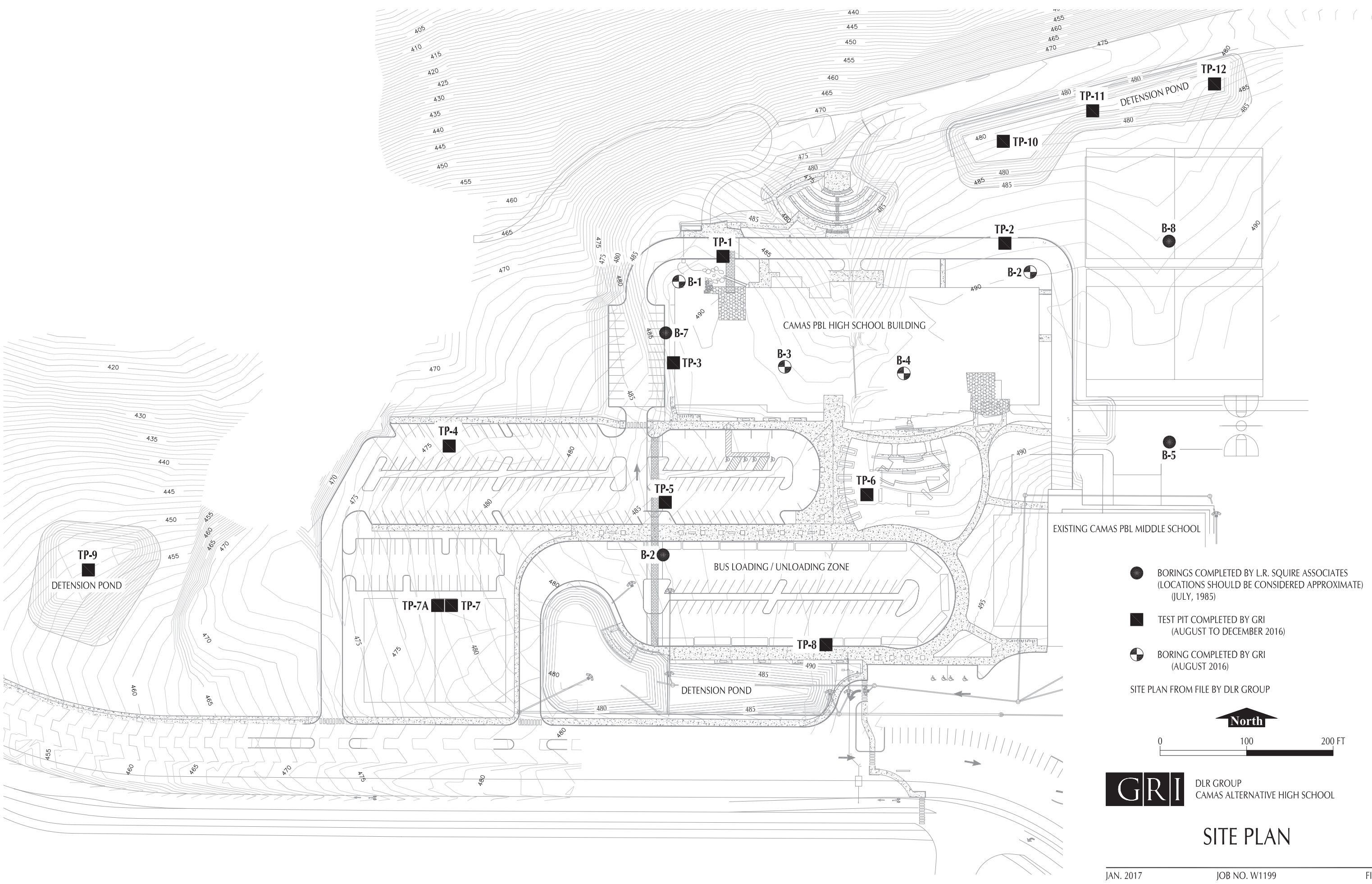
VICINITY MAP

JAN. 2017 JOB NO. W1199 FIG. 1



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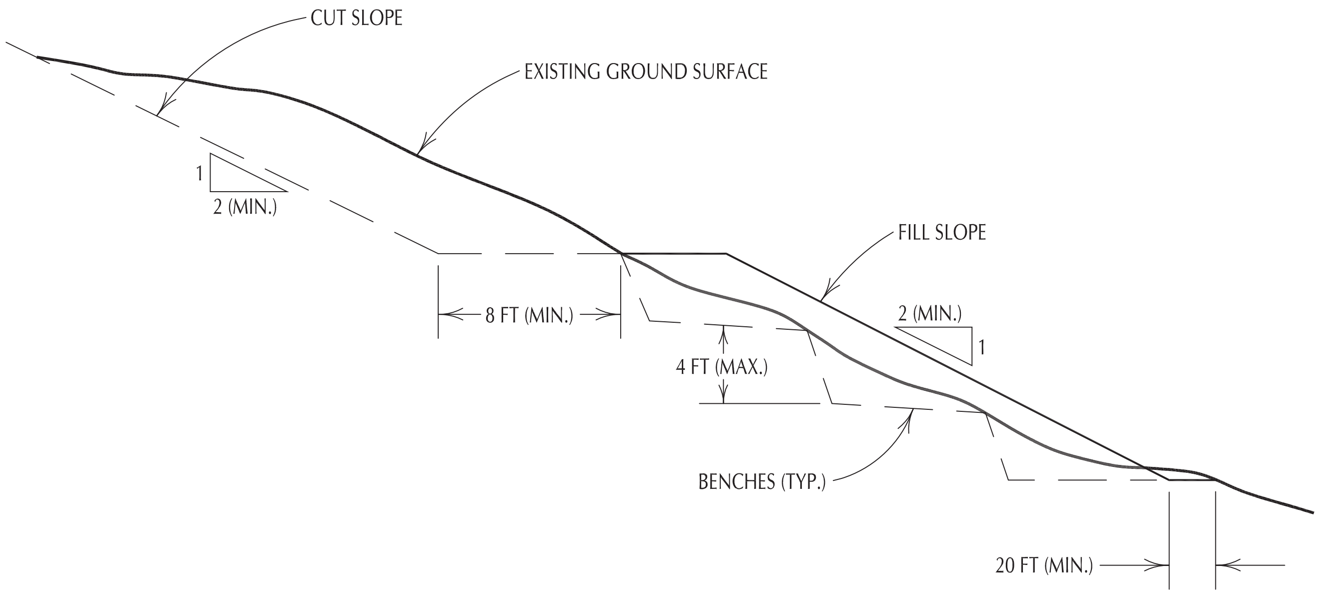
SITE PLAN

JAN. 2017 JOB NO. W1199 FIG. 2



NOT TO SCALE

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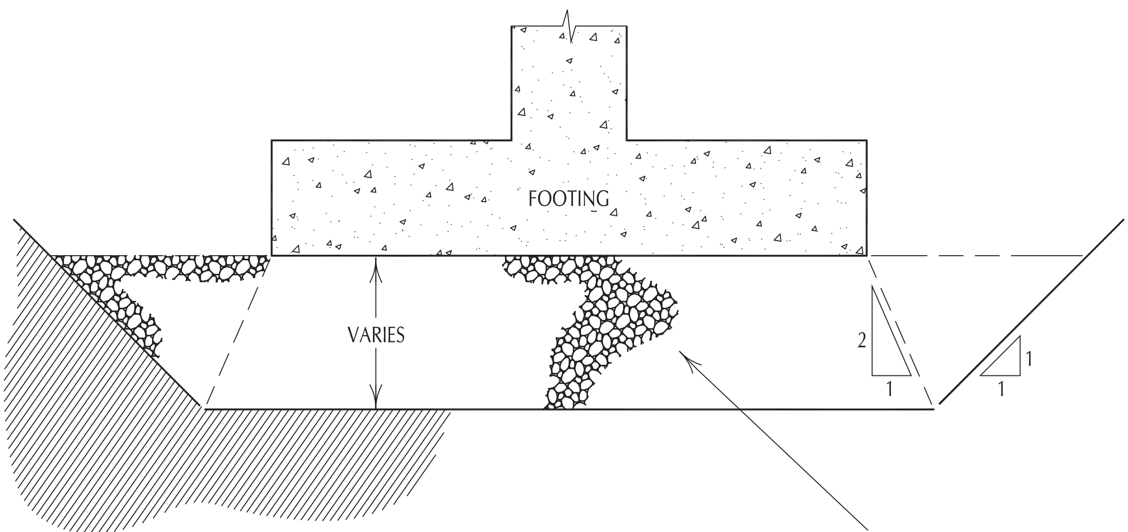
TYPICAL DETAIL FOR FILLING ON SLOPES

JAN. 2017 | JOB NO. W1199 | FIG. 3



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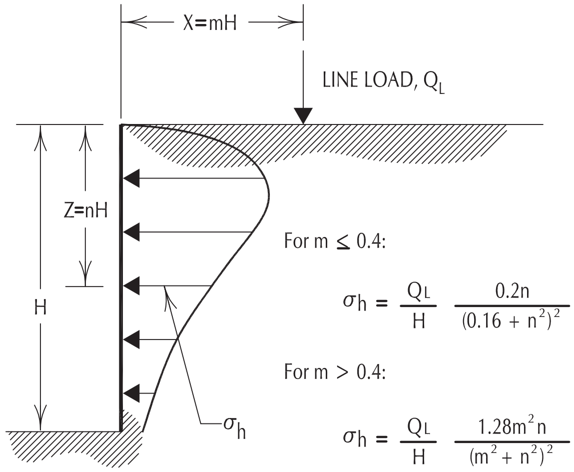
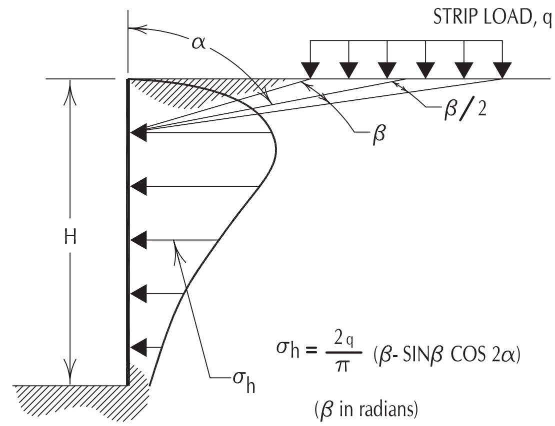
FOOTING OVEREXCAVATION DETAIL

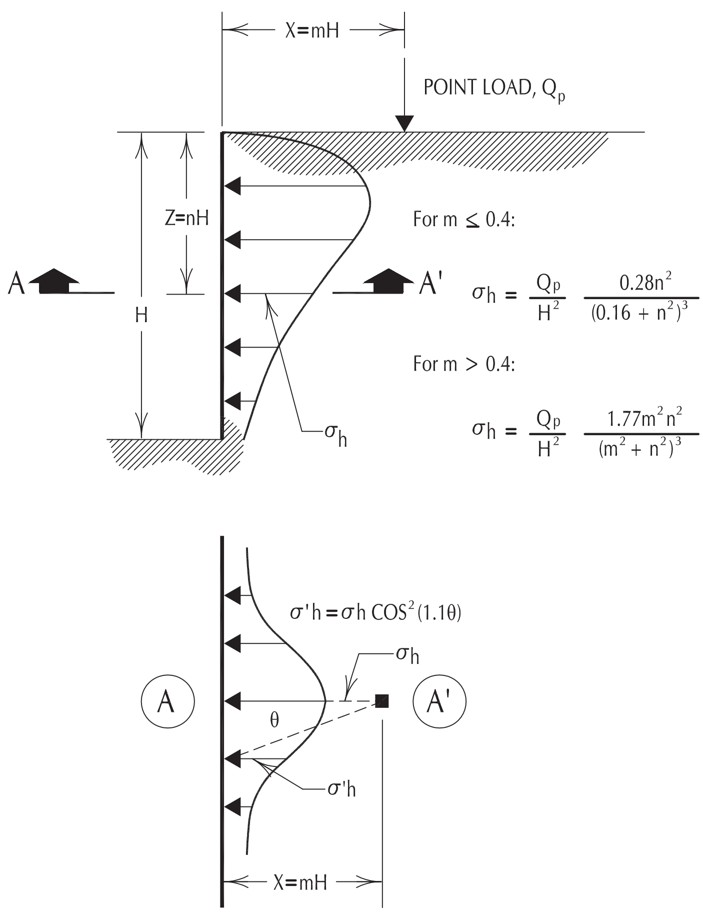
JAN. 2017 | JOB NO. W1199 | FIG. 4



LINE LOAD PARALLEL TO WALL



STRIP LOAD PARALLEL TO WALL



DISTRIBUTION OF HORIZONTAL PRESSURES

VERTICAL POINT LOAD

NOTES:

1. THESE GUIDELINES APPLY TO RIGID WALLS WITH POISSON'S RATIO ASSUMED TO BE 0.5 FOR BACKFILL MATERIALS.
2. LATERAL PRESSURES FROM ANY COMBINATION OF ABOVE LOADS MAY BE DETERMINED BY THE PRINCIPLE OF SUPERPOSITION.

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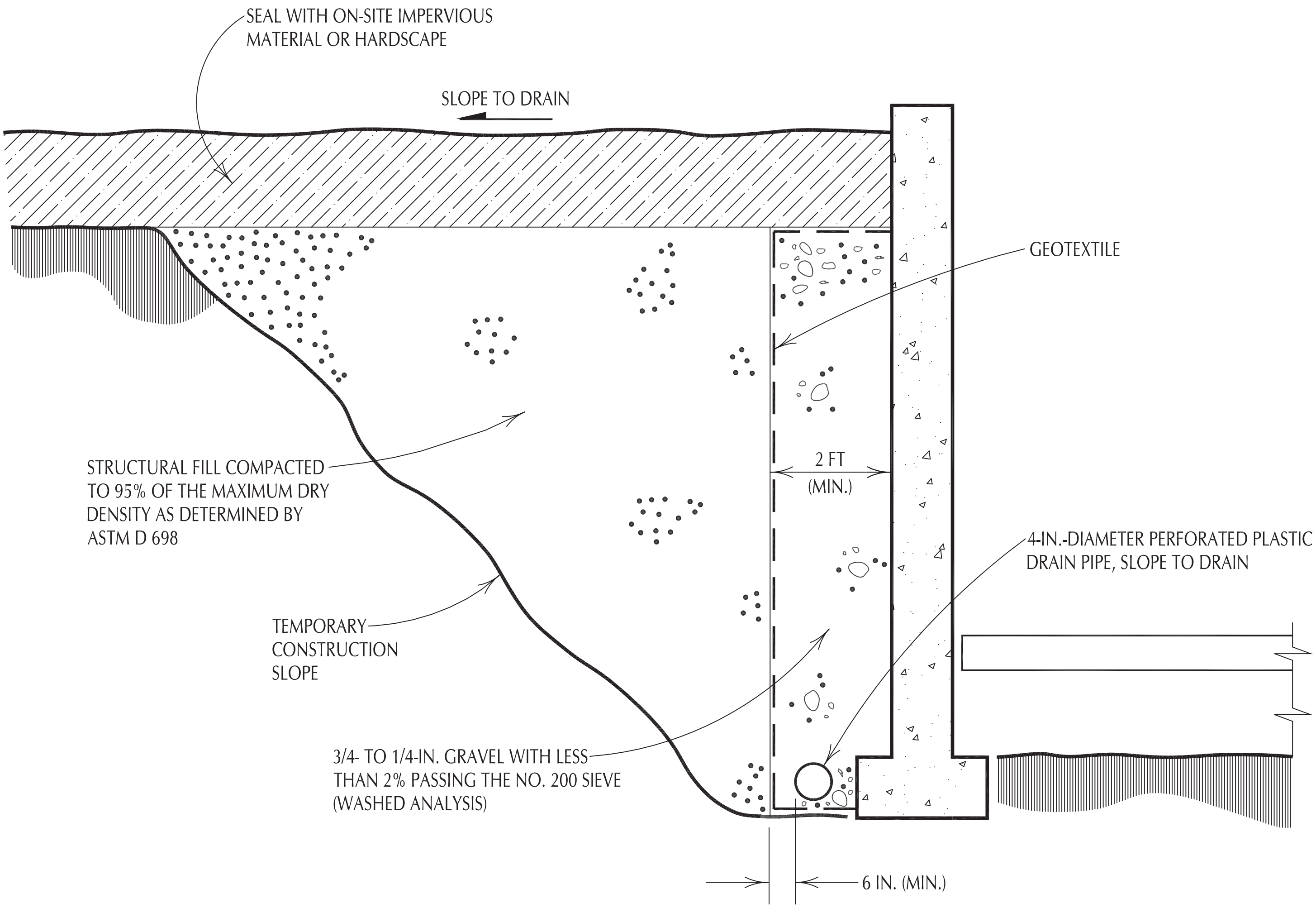
SURCHARGE-INDUCED LATERAL PRESSURE

JAN. 2017 | JOB NO. W1199 | FIG. 5



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TYPICAL SUBDRAINAGE DETAIL

JAN. 2017 | JOB NO. W1199 | FIG. 6

APPENDIX A

Field Explorations and Laboratory Testing

APPENDIX A

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS

Subsurface materials and conditions at the site were investigated between August 29 and 31, 2016 with four borings, designated B-1 through B-4; between August 29 and September 2, 2016, with 9 test pits, designated TP-1 through TP-8 and TP-7A; and on December 19, 2016, with four additional test pits, designated TP-9 through TP-12. The locations of the explorations made for this study are shown on the Site Plan, Figure 2. The field exploration work was directed by an experienced geotechnical engineer from GRI, who maintained a detailed log of the materials disclosed during the course of the work and obtained samples at frequent samples of the depth.

The borings were completed using mud-rotary and rock coring techniques with a CME 75, truck-mounted drill rig supplied and operated by Hard Core Drilling, Inc. of Dundee, Oregon under subcontract to GRI. The borings were advanced to depths of 32.5 and 53 ft below the ground surface. Disturbed samples were obtained from the borings at 2.5-ft intervals in the upper 15 to 20 ft and 5-ft intervals of depth below this depth using standard split-spoon sampler. At the time of sampling, the Standard Penetration Test (SPT) was conducted. This test consists of driving a standard split-spoon sampler into the soil a distance of 18 in. using a 140-lb, automatic hammer dropped 30 in. The number of blows required to drive the sampler the last 12 in. is known as the standard penetration resistance, or N-value. The N-values provide a measure of the relative density of granular soils, such as sand, and the relative consistency, or stiffness, of cohesive soils, such as silt. The split-spoon samples were carefully examined in the field and representative portions were saved in airtight jars. Relatively undisturbed samples of fine-grained, cohesive soils were obtained by pushing 3-in.-O.D. Shelby tubes into the undisturbed soil a maximum distance of 24 in. using the drill rig or the excavator bucket. The soils exposed in the ends of the Shelby tubes were examined and classified in the field. After classification, the tubes were sealed with rubber caps and tape to preserve the natural moisture content of the soils. All samples were returned to our laboratory for further examination and testing.

Rock Coring was performed in borings B-1 and B-2 using wireline drilling techniques and cored using an HQ diamond core bit attached to a split-core barrel. The rock core samples were classified in the field, the percentage of rock core recovered and the Rock Quality Designation (RQD), an index for determining the relative number of fractures and amount of softening or alteration of the rock mass, were calculated for each core sample. The samples were placed into core boxes and returned to our laboratory for further examination and testing. Photographs of the rock core collected are provided in Appendix B.

Test pits TP-1 through TP-8 and TP-7A were advanced to depths of between 8 and 10.5 ft using a track-mounted excavator owned and operated by Dan J. Fischer Excavating, Inc. of Forest Grove, Oregon. Test pits TP-9 through TP-12 were advanced to depths of between 12 and 15 ft using a track-mounted excavator owned and operated by Scott Lee Excavating, Inc. of Battle Ground, Washington. Disturbed samples of the soils obtained from the test pits were examined in the field and saved in airtight jars for further examination in our laboratory. The test pit excavations were backfilled with the excavated materials, and the backfill was graded to match the adjacent ground surface. Minimal compactive effort was applied to the backfill.

Logs of the borings and test pits are provided on Figures 1A through 4A and Figures 5A through 11A, respectively. Each log presents a descriptive summary of the various types of materials encountered in the boring and notes the depth at which the materials and/or characteristics of the materials change. To the right of the descriptive summary, the numbers and types of samples are indicated. Further to the right, natural moisture content, Torvane shear strength, and Atterberg limits are shown. N-values, rock coring intervals, run lengths, percent core recovered, and RQDs are also summarized on the boring logs. Measured groundwater depths and other observations are noted on the far right of the logs. The terms used to describe the soil and rock encountered in the explorations are defined in Tables 1A and 2A and the attached legend.

LABORATORY TESTING

General

Soil and rock samples obtained from the explorations were returned to our laboratory for examination and testing. The physical characteristics were noted, and the field classifications were modified where necessary. The laboratory program included determinations of natural moisture content, washed sieve analyses, Atterberg limit determinations, Torvane shear strengths, one-dimensional consolidation tests, and dry unit weights. The following paragraphs describe the testing program in more detail.

Natural Moisture Content

Natural moisture content determinations were made in conformance with ASTM 2216. The results are shown on the exploration logs, Figures 1A through 11A, and are summarized in Table 3A.

Grain Size (Washed-Sieve Analysis)

Washed sieve analyses were performed on selected samples to determine the percentage of material passing the No. 200 sieve. The test is performed by taking a sample of known dry weight and washing it over a No. 200 sieve. The material retained on the sieve is oven-dried and weighed, and the percentage of material passing the No. 200 sieve is calculated. The test results are provided on Figures 9A through 11A and are summarized in Table 3A.

Atterberg Limits

Atterberg limits tests were performed on four representative samples of the fine-grained soil in substantial conformance with ASTM D4318. The test data is summarized in Table 3A; on the boring logs, Figures 1A through 4A; and are shown graphically on Figure 12A.

Torvane Shear Strength

The approximate undrained shear strength of relatively undisturbed fine-grained soil samples was determined using a Torvane shear device. The Torvane is a hand-held apparatus with vanes that are inserted into the soil. The torque required to fail the soil in shear around the vanes is measured using a calibrated spring. The results of the Torvane shear tests are summarized on Figures 1A through 9A.

Dry Unit Weight

The dry unit weight of four undisturbed samples was determined in the laboratory in accordance with ASTM D2937 by cutting a cylindrical specimen of soil from a Shelby tube sample. The dimensions of the specimen were carefully measured, the volume calculated, and the specimen weighed. After oven-drying, the specimen was reweighed and the water content calculated. The dry unit weight was then computed.

The dry unit weights are summarized in Table 3A and are also presented on the boring logs, Figures 1A through 4A.

One-Dimensional Consolidation

One-dimensional consolidation testing was performed on select samples of relatively undisturbed fine-grained soil from the Shelby tubes in accordance with ASTM D2435 to obtain data on the compressibility characteristics and stress history of the soil. The results of testing on four samples are summarized on Figures 13A through 16A in the form of a curve showing effective stress versus percent strain. The initial moisture content and dry unit weight of each sample are provided on the figures.

Table 1A

GUIDELINES FOR CLASSIFICATION OF SOIL

Description of Relative Density for Granular Soil

Relative Density	Standard Penetration Resistance (N-values) blows per foot
very loose	0 – 4
loose	4 – 10
medium dense	10 – 30
dense	30 – 50
very dense	over 50

Description of Consistency for Fine-Grained (Cohesive) Soils

Consistency	Standard Penetration Resistance (N-values) blows per foot	Torvane or Undrained Shear Strength, tsf
very soft	0 - 2	less than 0.125
soft	2 - 4	0.125 - 0.25
medium stiff	4 - 8	0.25 - 0.50
stiff	8 - 15	0.50 - 1.0
very stiff	15 - 30	1.0 - 2.0
hard	over 30	over 2.0

Grain-Size Classification

Boulders:
> 12 in.

Cobbles:
3 - 12 in.

Gravel:
1/4 - 3/4 in. (fine)
3/4 - 3 in. (coarse)

Sand:
No. 200 - No. 40 sieve (fine)
No. 40 - No. 10 sieve (medium)
No. 10 - No. 4 sieve (coarse)

Silt/Clay:
pass No. 200 sieve

Modifier for Subclassification

Adjective	Primary Constituent SAND or GRAVEL	Primary Constituent SILT or CLAY
	Percentage of Other Material (by weight)	
trace:	5 - 15 (sand, gravel)	5 - 15 (sand, gravel)
some:	15 - 30 (sand, gravel)	15 - 30 (sand, gravel)
sandy, gravelly:	30 - 50 (sand, gravel)	30 - 50 (sand, gravel)
trace:	< 5 (silt, clay)	*Relationship of clay and silt determined by plasticity index test*
some:	5 - 12 (silt, clay)	
silty, clayey:	12 - 50 (silt, clay)	

Table 2A: GUIDELINES FOR CLASSIFICATION OF ROCK

RELATIVE ROCK WEATHERING SCALE

Term	Field Identification
Fresh	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric. Decomposition extends up to 1 in. into rock.
Moderately Weathered	Rock mass is decomposed 50% or less. Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Predominantly Decomposed	Rock mass is more than 50% decomposed. Rock can be excavated with geologist's pick. All discontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed	Rock mass is completely decomposed. Original rock "fabric" may be evident. May be reduced to soil with hand pressure.

RELATIVE ROCK HARDNESS SCALE

Term	Hardness Designation	Field Identification	Approximate Unconfined Compressive Strength
Extremely Soft	R0	Can be indented with difficulty by thumbnail. May be moldable or friable with finger pressure.	< 100 psi
Very Soft	R1	Crumbles under firm blows with point of a geology pick. Can be peeled by a pocket knife and scratched with fingernail.	100 - 1,000 psi
Soft	R2	Can be peeled by a pocket knife with difficulty. Cannot be scratched with fingernail. Shallow indentation made by firm blow of geology pick.	1,000 - 4,000 psi
Medium Hard	R3	Can be scratched by knife or pick. Specimen can be fractured with a single firm blow of hammer/geology pick.	4,000 - 8,000 psi
Hard	R4	Can be scratched with knife or pick only with difficulty. Several hard hammer blows required to fracture specimen.	8,000 - 16,000 psi
Very Hard	R5	Cannot be scratched by knife or sharp pick. Specimen requires many blows of hammer to fracture or chip. Hammer rebounds after impact.	> 16,000 psi

RQD AND ROCK QUALITY

Relation of RQD and Rock Quality

RQD (Rock Quality Designation), %	Description of Rock Quality
0 - 25	Very Poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Terminology for Planar Surface

Bedding	Joints and Fractures	Spacing
Laminated	Very Close	< 2 in.
Thin	Close	2 in. – 12 in.
Medium	Moderately Close	12 in. – 36 in.
Thick	Wide	36 in. – 10 ft
Massive	Very Wide	> 10 ft

Table 3A

SUMMARY OF LABORATORY RESULTS

Sample Information						Atterberg Limits			
Location	Sample	Depth, ft	Elevation, ft	Moisture Content, %	Dry Unit Weight, pcf	Liquid Limit, %	Plasticity Index, %	Fines Content, %	Soil Type
B-1	S-1	2.5	486.5	23	--	--	--	--	FILL
	S-2	5.0	484.0	36	--	--	--	--	FILL
	S-4	9.5	479.5	37	--	--	--	--	FILL
	S-5	12.8	476.2	33	87	--	--	--	FILL
	S-5	14.2	474.8	34	--	32	6	--	FILL
	S-6	14.5	474.5	30	--	--	--	--	FILL
	S-7	17.5	471.5	26	--	--	--	--	SILT
	S-8	20.0	469.0	49	--	--	--	--	Clayey SILT
	S-9	25.0	464.0	54	--	--	--	--	Clayey SILT
	S-10	27.0	462.0	63	--	--	--	--	Clayey SILT
	S-10	28.3	460.7	50	73	77	33	--	Clayey SILT
	S-11	30.0	459.0	59	--	--	--	--	Clayey SILT
B-2	S-1	2.5	487.5	22	--	--	--	--	FILL
	S-2	5.0	485.0	22	--	--	--	--	FILL
	S-3	7.5	482.5	25	--	--	--	--	SILT
	S-4	10.0	480.0	35	--	--	--	--	Clayey SILT
	S-5	12.5	477.5	45	--	--	--	--	Clayey SILT
	S-6	15.0	475.0	54	--	--	--	--	Clayey SILT
	S-7	20.0	470.0	53	--	--	--	--	Clayey SILT
	S-8	25.0	465.0	63	--	--	--	--	Clayey SILT
	S-9	30.0	460.0	67	--	--	--	--	Clayey SILT
	S-10	35.0	455.0	40	--	--	--	--	Silty GRAVEL
B-3	S-1	2.5	486.0	25	--	--	--	--	FILL
	S-2	5.7	482.8	34	84	28	6	--	FILL
	S-3	7.0	481.5	27	--	--	--	--	FILL
	S-4	10.0	478.5	24	--	--	--	--	SILT
	S-5	12.5	476.0	41	--	--	--	--	Clayey SILT
	S-6	15.0	473.5	49	--	--	--	--	Clayey SILT
	S-8	21.2	467.3	58	--	--	--	--	Clayey SILT
	S-9	25.0	463.5	52	--	--	--	--	Clayey SILT
	S-10	30.0	458.5	49	--	--	--	--	Clayey SILT
	S-10	31.0	457.5	49	--	--	--	--	Silty SAND
B-4	S-1	2.5	487.0	17	--	--	--	--	FILL
	S-1	3.3	486.3	17	--	--	--	--	Clayey SILT
	S-2	5.0	484.5	23	--	--	--	--	Clayey SILT
	S-3	7.5	482.0	24	--	--	--	--	Clayey SILT
	S-4	10.0	479.5	35	--	--	--	--	Clayey SILT
	S-5	12.5	477.0	49	--	--	--	--	Clayey SILT
	S-6	15.6	473.9	58	66	72	26	--	Clayey SILT
	S-7	17.0	472.5	54	--	--	--	--	Clayey SILT

Table 3A

SUMMARY OF LABORATORY RESULTS

Sample Information						Atterberg Limits			
Location	Sample	Depth, ft	Elevation, ft	Moisture Content, %	Dry Unit Weight, pcf	Liquid Limit, %	Plasticity Index, %	Fines Content, %	Soil Type
B-4	S-8	20.0	469.5	58	--	--	--	--	Clayey SILT
	S-10	25.5	464.0	49	--	--	--	--	Silty GRAVEL
TP-1	S-1	2.0	486.0	16	--	--	--	--	FILL
	S-2	4.0	484.0	21	--	--	--	--	FILL
	S-3	6.0	482.0	23	--	--	--	--	FILL
	S-4	8.0	480.0	30	--	--	--	--	FILL
	S-5	10.0	478.0	30	--	--	--	--	FILL
TP-2	S-1	2.0	486.5	16	--	--	--	--	FILL
	S-2	4.0	484.5	20	--	--	--	--	FILL
	S-3	6.0	482.5	28	--	--	--	--	FILL
	S-4	8.0	480.5	23	--	--	--	--	FILL
	S-5	10.0	478.5	24	--	--	--	--	FILL
TP-3	S-1	1.0	487.0	24	--	--	--	--	FILL
	S-2	2.0	486.0	26	--	--	--	--	FILL
	S-3	3.0	485.0	28	--	--	--	--	FILL
	S-4	5.0	483.0	45	--	--	--	--	FILL
	S-5	7.0	481.0	25	--	--	--	--	FILL
	S-6	10.0	478.0	23	--	--	--	--	FILL
TP-4	S-1	2.0	474.0	20	--	--	--	--	FILL
	S-2	4.0	472.0	22	--	--	--	--	FILL
	S-3	6.0	470.0	25	--	--	--	--	FILL
	S-4	10.0	466.0	18	--	--	--	--	FILL
TP-5	S-1	3.0	483.0	16	--	--	--	--	SILT
	S-2	6.0	480.0	25	--	--	--	--	SILT
	S-3	8.0	478.0	38	--	--	--	--	SILT
	S-4	9.3	476.8	32	--	--	--	--	SILT
TP-6	S-1	2.0	489.5	19	--	--	--	--	SILT
	S-2	4.0	487.5	21	--	--	--	--	SILT
	S-3	6.0	485.5	25	--	--	--	--	SILT
	S-4	8.0	483.5	45	--	--	--	--	Silty GRAVEL
	S-5	10.0	481.5	47	--	--	--	--	Silty GRAVEL
TP-7	S-1	2.0	475.0	21	--	--	--	--	FILL
	S-2	4.0	473.0	28	--	--	--	--	FILL
	S-3	6.0	471.0	25	--	--	--	--	FILL
	S-4	7.5	469.5	30	--	--	--	--	FILL
TP-7A	S-1	8.0	469.0	26	--	--	--	--	Clayey SILT
	S-2	9.5	467.5	31	--	--	--	--	BASALT
TP-8	S-2	2.0	487.0	27	--	--	--	--	FILL
	S-3	4.0	485.0	26	--	--	--	--	SILT
	S-4	6.0	483.0	27	--	--	--	--	SILT

GRI

Table 3A

SUMMARY OF LABORATORY RESULTS

Sample Information						Atterberg Limits			
Location	Sample	Depth, ft	Elevation, ft	Moisture Content, %	Dry Unit Weight, pcf	Liquid Limit, %	Plasticity Index, %	Fines Content, %	Soil Type
TP-8	S-5	8.0	481.0	26	--	--	--	--	Clayey SILT
	S-6	10.0	479.0	24	--	--	--	--	Clayey SILT
TP-9	S-1	2.0	451.0	32	--	--	--	87	SILT
	S-2	4.0	449.0	25	--	--	--	--	SILT
	S-3	6.0	447.0	39	--	--	--	--	SILT
	S-4	8.0	445.0	50	--	--	--	83	SILT
	S-5	10.0	443.0	55	--	--	--	--	SILT
	S-6	12.0	441.0	60	--	--	--	76	SILT
	S-7	14.5	438.5	61	--	--	--	--	SILT
TP-10	S-1	2.0	479.0	27	--	--	--	74	FILL
	S-3	6.0	475.0	26	--	--	--	--	FILL
	S-4	8.0	473.0	22	--	--	--	81	SILT
	S-5	10.0	471.0	26	--	--	--	--	SILT
	S-6	12.0	469.0	26	--	--	--	--	Clayey SILT
	S-7	14.5	466.5	42	--	--	--	--	Clayey SILT
TP-11	S-1	2.0	478.0	20	--	--	--	85	FILL
	S-2	4.0	476.0	21	--	--	--	--	SILT
	S-4	8.0	472.0	23	--	--	--	83	SILT
	S-5	10.0	470.0	26	--	--	--	--	SILT
	S-6	12.0	468.0	39	--	--	--	--	Clayey SILT
	S-7	13.5	466.5	50	--	--	--	--	Clayey SILT
TP-12	S-1	2.0	481.0	20	--	--	--	87	FILL
	S-2	4.0	479.0	22	--	--	--	88	FILL
	S-3	6.0	477.0	24	--	--	--	--	SILT
	S-4	8.0	475.0	28	--	--	--	--	SILT
	S-5	10.0	473.0	42	--	--	--	--	Clayey SILT
	S-6	11.5	471.5	43	--	--	--	--	Clayey SILT

BORING AND TEST PIT LOG LEGEND

SOIL SYMBOLS

Symbol	Typical Description
	LANDSCAPE MATERIALS
	FILL
	GRAVEL; clean to some silt, clay, and sand
	Sandy GRAVEL; clean to some silt and clay
	Silty GRAVEL; up to some clay and sand
	Clayey GRAVEL; up to some silt and sand
	SAND; clean to some silt, clay, and gravel
	Gravelly SAND; clean to some silt and clay
	Silty SAND; up to some clay and gravel
	Clayey SAND; up to some silt and gravel
	SILT; up to some clay, sand, and gravel
	Gravelly SILT; up to some clay and sand
	Sandy SILT; up to some clay and gravel
	Clayey SILT; up to some sand and gravel
	CLAY; up to some silt, sand, and gravel
	Gravelly CLAY; up to some silt and sand
	Sandy CLAY; up to some silt and gravel
	Silty CLAY; up to some sand and gravel
	PEAT

BEDROCK SYMBOLS

Symbol	Typical Description
	BASALT
	MUDSTONE
	SILTSTONE
	SANDSTONE

SURFACE MATERIAL SYMBOLS

Symbol	Typical Description
	Asphalt concrete PAVEMENT
	Portland cement concrete PAVEMENT
	Crushed rock BASE COURSE

SAMPLER SYMBOLS

Symbol	Sampler Description
	2.0-in. O.D. split-spoon sampler and Standard Penetration Test with recovery (ASTM D1586)
	Shelby tube sampler with recovery (ASTM D1587)
	3.0-in. O.D. split-spoon sampler with recovery (ASTM D3550)
	Grab Sample
	Rock core sample interval
	Sonic core sample interval
	Geoprobe sample interval

INSTALLATION SYMBOLS

Symbol	Symbol Description
	Flush-mount monument set in concrete
	Concrete, well casing shown where applicable
	Bentonite seal, well casing shown where applicable
	Filter pack, machine-slotted well casing shown where applicable
	Grout, vibrating-wire transducer cable shown where applicable
P	Vibrating-wire pressure transducer
	1-in.-diameter solid PVC
	1-in.-diameter hand-slotted PVC
	Grout, inclinometer casing shown where applicable

FIELD MEASUREMENTS

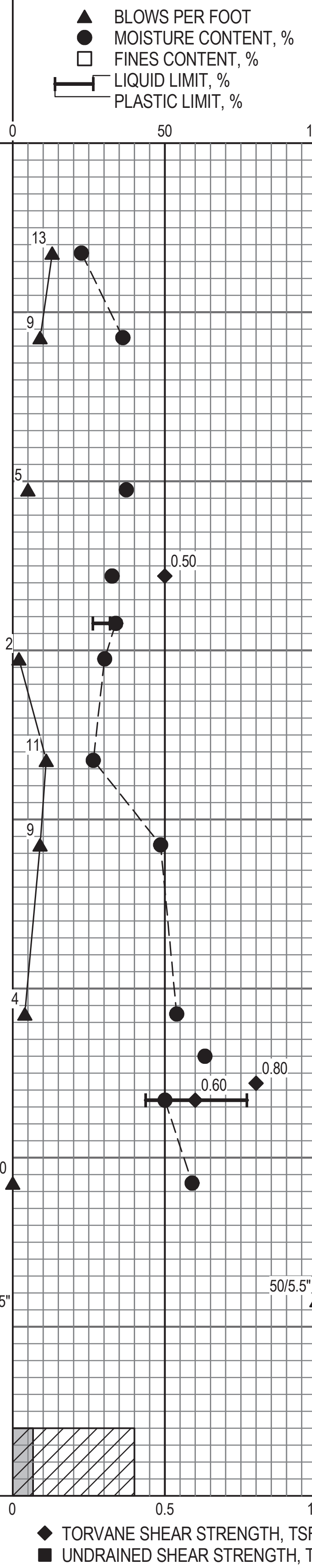
Symbol	Typical Description
▽	Groundwater level during drilling and date measured
▼	Groundwater level after drilling and date measured
	Rock core recovery
	Rock quality designation (RQD)

CLASSIFICATION OF MATERIAL

Surface Elevation: 489.0 ft [±] (NGVD 29)

DEPTH, FT	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT
0	SILT, some clay, trace fine-grained sand, brown, stiff, 6-in.-thick heavily-rooted zone at ground surface (Fill)	
5	---dark gray, contains fine roots and wood debris below 5 ft	
10	---medium stiff below 10 ft	
14.5	---soft, organics absent below 14.5 ft	
17.5	SILT, some clay, trace fine-grained sand, brown mottled gray and rust, stiff (Residual Soil)	471.5 / 17.5
20	Clayey SILT, trace fine- to medium-grained sand, red mottled black, medium stiff to stiff (Residual Soil)	469.0 / 20.0
30	---very soft below 30 ft	
34	Silty GRAVEL, some fine- to coarse-grained sand, red, very dense, angular basalt gravel (Residual Soil)	455.0 / 34.0
38	BASALT, some vesicles, pink-gray, slightly weathered, medium hard to hard (R3 to R4), red clay present on rock fractures	451.0 / 38.0

SAMPLE NO.	BLOW COUNT	BLOWS PER FOOT	COMMENTS AND ADDITIONAL TESTS
S-1	7 6 7	13	
S-2	3 4 5	9	
S-3			
S-4	1 2 3	5	
S-5		0.50	Dry Density = 87 pcf
S-6	1 1 1	2	
S-7	3 4 7	11	
S-8	3 4 5	9	
S-9	1 2 2	4	
S-10		0.80, 0.60	Dry Density = 73 pcf
S-11	0 0 0	0	
			32.0 ft (8/29/2016)
S-12			
S-13	50/5.5"	50/5.5"	Interbedded layers of hard and easy drilling 34 to 38 ft



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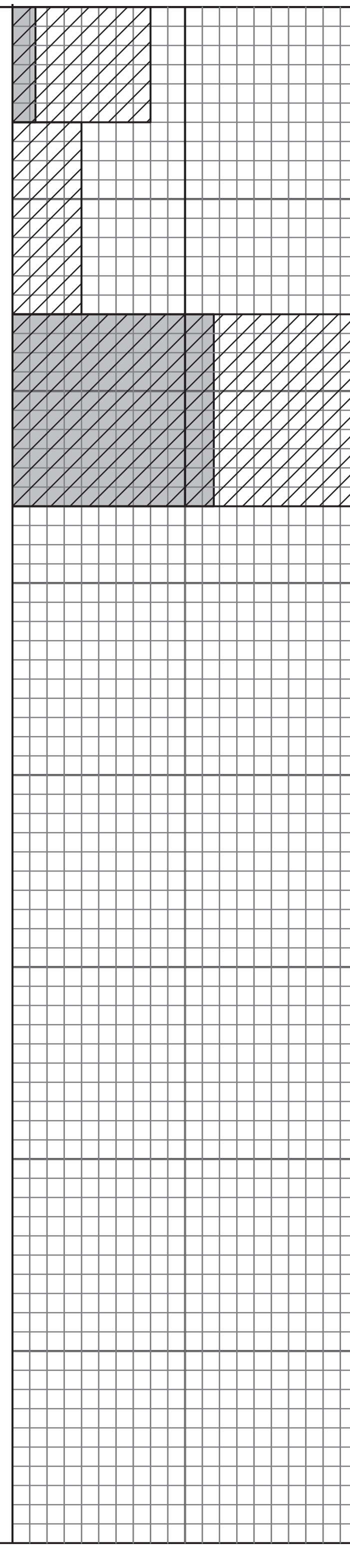
Logged By: T. Gayne	**Drilled by:** Hard Core Drilling, Inc.
Date Started: 8/29/16	**Coordinates:** Not Available
Drilling Method: Mud Rotary **Equipment:** CME 75 Truck-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 72%
Note: See Legend for Explanation of Symbols	

GRI

BORING B-1

JAN. 2017 JOB NO. W1199 FIG. 1A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: 489.0 ft [±] (NGVD 29)	ELEVATION, FT / DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	▲ BLOWS PER FOOT ● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 50 100)	COMMENTS AND ADDITIONAL TESTS
		BASALT, some vesicles, pink-gray, slightly weathered, medium hard to hard (R3 to R4), red clay present on rock fractures	447.0 / 42.0		Run 1				
45		Silty GRAVEL, some fine- to coarse-grained sand, red, very dense, angular basalt gravel (Residual Soil)	441.0 / 48.0		Run 2				
50		BASALT, some vesicles, gray, fresh, hard to very hard (R4 to R5)	436.0 / 53.0		Run 3				
55		(8/30/2016)							
60									
65									
70									
75									
80									



0 0.5 1.0

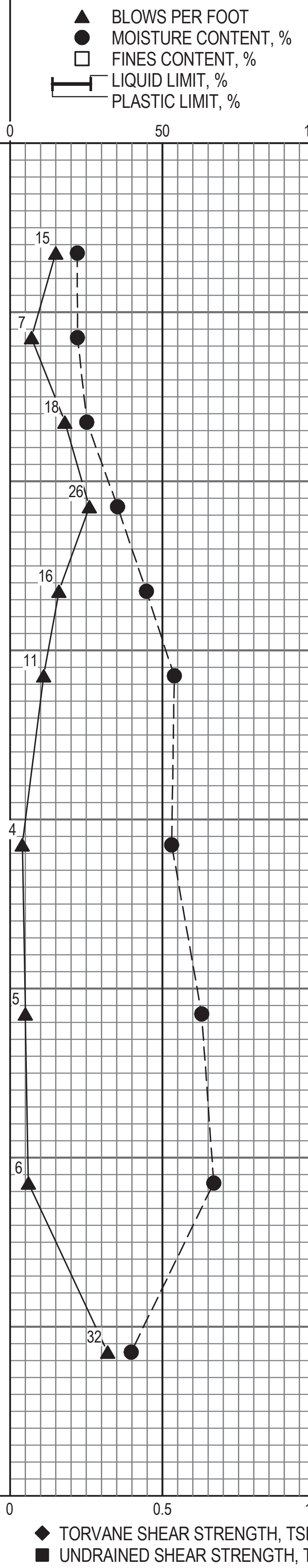
◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

GRI

BORING B-1

JAN. 2017 JOB NO. W1199 FIG. 1A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: 490.0 ft [±] (NGVD 29)	ELEVATION, FT / DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
0–7.5		SILT, some clay, trace fine-grained sand and subangular gravel, brown, stiff to very stiff, contains wood debris and fine roots, 6-in.-thick heavily-rooted zone at ground surface (Fill)			S-1		7 8 7	
5		---brown and gray, medium stiff, wood debris absent below 5 ft			S-2		2 3 4	
7.5		SILT, some clay to clayey, trace fine-grained sand, brown mottled gray and black, very stiff (Residual Soil)	482.5 / 7.5		S-3		5 8 10	
10		Clayey SILT, trace fine-grained sand, red mottled black, very stiff (Residual Soil)	480.0 / 10.0		S-4		8 10 16	
		---trace subangular to subrounded gravel below 12.5 ft			S-5		3 7 9	
15		---medium stiff to stiff, gravel absent below 15 ft			S-6		4 5 6	
								6-in.-thick layer of hard drilling and drill chatter at 17.5 ft
20		---some fine- to medium-grained sand to sandy, trace subangular basalt gravel below 20 ft			S-7		1 2 2	
25					S-8		3 2 3	
30					S-9		2 3 3	
32		Silty GRAVEL, some fine- to coarse-grained sand, red, dense, angular basalt gravel (Residual Soil)	458.0 / 32.0					Interbedded layers of easy and hard drilling below 32 ft, easy drilling is dominant, drill chatter
35					S-10		7 14 18	
39–40		BASALT (full description on next page)	451.0 / 39.0					



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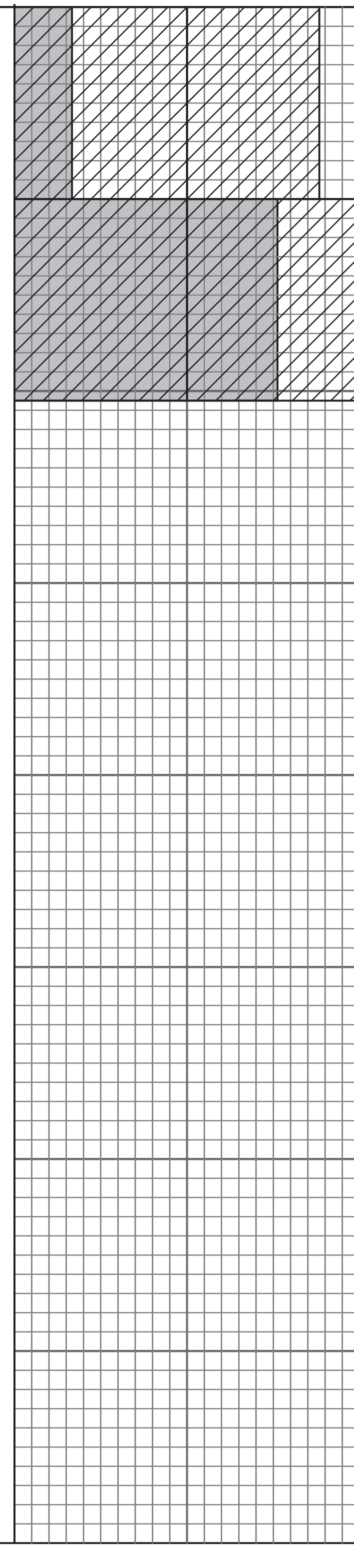
Logged By: T. Gayne	**Drilled by:** Hard Core Drilling, Inc.
Date Started: 8/30/16	**Coordinates:** Not Available
Drilling Method: Mud Rotary **Equipment:** CME 75 Truck-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 72%
Note: See Legend for Explanation of Symbols	

GRI

BORING B-2

JAN. 2017 JOB NO. W1199 FIG. 2A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: 490.0 ft [±] (NGVD 29)	ELEVATION, FT / DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	▲ BLOWS PER FOOT ● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % 0 50 100	COMMENTS AND ADDITIONAL TESTS
		BASALT, some vesicles, pink-gray, slightly weathered, medium hard to hard (R3 to R4), red clay present on rock fractures			Run 1				
45		---gray, fresh, hard to very hard (R4 to R5) below 45 ft			Run 2				
50		(8/31/2016)	439.8 / 50.2						
55									
60									
65									
70									
75									
80									



0 0.5 1.0

◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

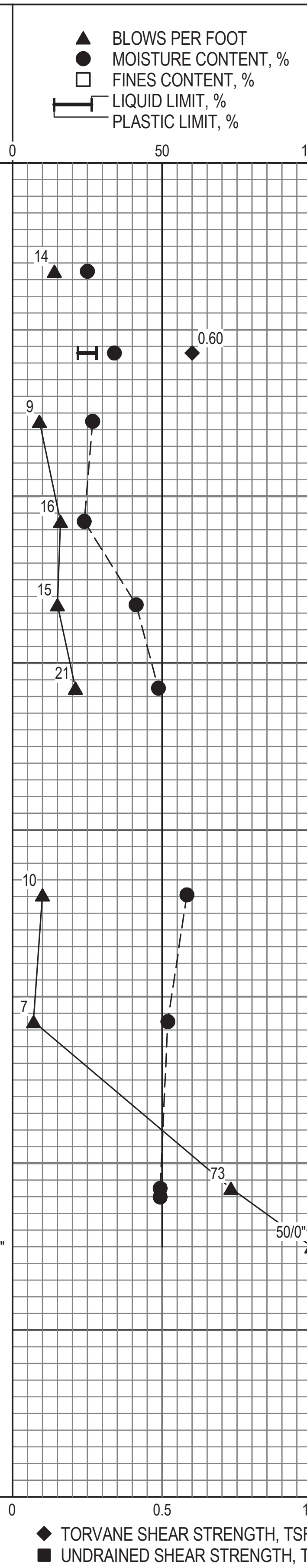
GRI BORING LOG (LAT/LONG) GRI DATA TEMPLATE.GDT 1/11/17

GRI

BORING B-2

JAN. 2017 JOB NO. W1199 FIG. 2A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: 488.5 ft [±] (NGVD 29)	ELEVATION, FT / DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
0		SILT, some clay, trace fine-grained sand, brown to dark brown, stiff, contains fine roots, 6-in.-thick heavily-rooted zone at ground surface (Fill)						
					S-1		8 8 6	
5					S-2			Dry Density = 84 pcf
		---trace subangular to subrounded gravel, brown and gray below 7 ft			S-3		3 4 5	
10		SILT, some clay to clayey, trace fine-grained sand, brown mottled gray and black, very stiff (Residual Soil)	478.5 / 10.0		S-4		5 7 9	
		Clayey SILT, trace fine-grained sand, red, stiff to very stiff (Residual Soil)	476.0 / 12.5		S-5		5 7 8	
15					S-6		5 8 13	
20		---some fine- to coarse-grained sand to sandy, trace subangular basalt gravel below 21 ft			S-7			
					S-8		6 5 5	
25		---gravel absent below 25 ft			S-9		2 3 4	
30		---brown mottled red below 30 ft			S-10		2 24 49	
		Silty SAND, trace to some angular basalt gravel, red, very dense, fine to coarse grained (Residual Soil)	457.5 / 31.0					
		(8/30/2016) Practical refusal on basalt at 32.5 ft	456.0 / 32.5		S-11		50/0"	
35								
40								



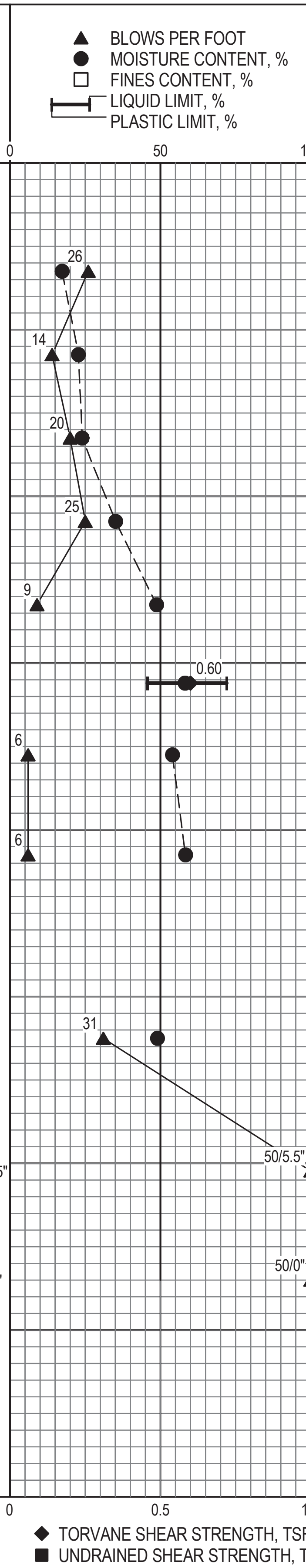
Logged By: T. Gayne	**Drilled by:** Hard Core Drilling, Inc.	
Date Started: 8/30/16	**Coordinates:** Not Available	
Drilling Method: Mud Rotary **Equipment:** CME 75 Truck-Mounted Drill Rig **Hole Diameter:** 5 in.		**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 72%
Note: See Legend for Explanation of Symbols		

GRI

BORING B-3

JAN. 2017 JOB NO. W1199 FIG. 3A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
		Surface Elevation: 489.5 ft [±] (NGVD 29)						
0–3.0		Silty GRAVEL, some fine- to coarse-grained sand, medium dense, angular to subrounded, 6-in.-thick heavily-rooted zone at ground surface (Fill)	486.5 / 3.0					
3.0–25.0		Clayey SILT, some fine- to coarse-grained sand and gravel, brown and gray, stiff to very stiff (Residual Soil)			S-1		12 11 15	
					S-2		5 7 7	
		---trace fine-grained sand, red mottled black below 8.5 ft			S-3		4 6 14	
					S-4		5 12 13	
					S-5		3 4 5	
					S-6			Dry Density = 66 pcf
		---medium stiff below 17 ft			S-7		1 2 4	
					S-8		3 3 3	
25.0–33.5		Silty GRAVEL, some fine- to coarse-grained sand, red, dense, angular basalt gravel (Residual Soil)	464.5 / 25.0		S-9			
					S-10		6 17 14	Interbedded layers of easy and hard drilling below 27 ft
					S-11		50/5.5"	Hard drilling, drill chatter below 30 ft
33.5		(8/30/2016) Practical refusal on basalt at 33.5 ft	456.0 / 33.5		S-12		50/0"	



GRI BORING LOG (LAT/LONG) GRI DATA TEMPLATE.GDT 1/11/17

Logged By: T. Gayne	**Drilled by:** Hard Core Drilling, Inc.	
Date Started: 8/30/16	**Coordinates:** Not Available	
Drilling Method: Mud Rotary **Equipment:** CME 75 Truck-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 72%	
Note: See Legend for Explanation of Symbols		

GRI

BORING B-4

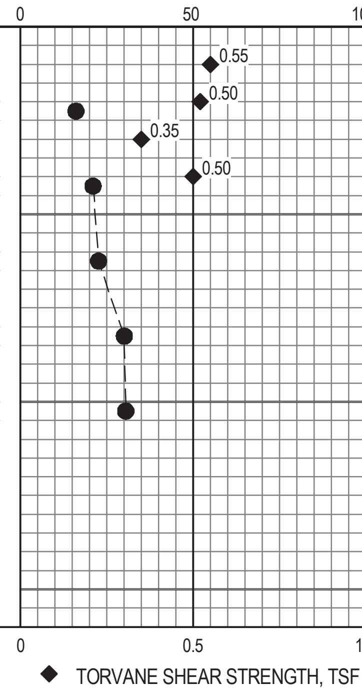
JAN. 2017 JOB NO. W1199 FIG. 4A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % □ FINES CONTENT, % ├─┤ LIQUID LIMIT, % / PLASTIC LIMIT, % (0 50 100)	COMMENTS AND ADDITIONAL TESTS

TP-1

Surface Elevation: 488.0 ft [±] (NGVD 29)

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.
0	SILT, some clay, trace fine-grained sand, brown, medium stiff to stiff, 6-in.-thick heavily-rooted zone at ground surface (Fill)		S-1
	---trace clay, some sand, gray below 4 ft		S-2
5	---organic odor below 6 ft		S-3
	---medium stiff, contains fine roots below 8 ft		S-4
10	---contains fine roots and wood debris below 10 ft	477.5 / 10.5	S-5
	(8/29/2016) Groundwater not encountered		
15			

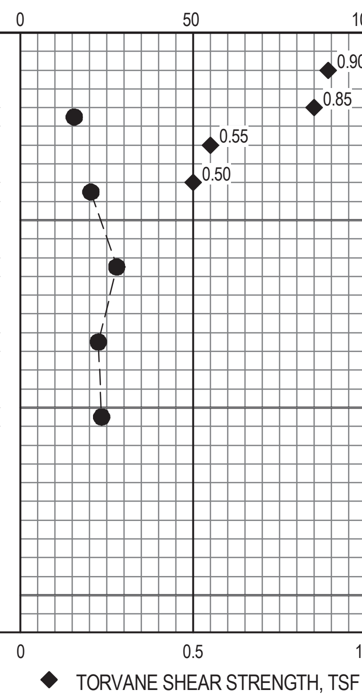


Logged By: B. Cook | **Excavated by:** Dan J. Fischer Excavating, Inc. | **Equipment:** Track-Mounted Excavator
Date Started: 8/29/16 | **Coordinates:** Not Available | **Note:** See Legend for Explanation of Symbols

TP-2

Surface Elevation: 488.5 ft [±] (NGVD 29)

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.
0	SILT, some subangular gravel and fine- to coarse-grained sand, trace clay, brown, stiff, 6-in.-thick heavily-rooted zone at ground surface (Fill)		S-1
	---gray, contains fine roots, wood, and grass below 4.5 ft		S-2
5	---trace to some subangular gravel below 6 ft		S-3
	---trace to some fine-grained sand, gravel and organics absent below 8 ft		S-4
10	---medium stiff below 10 ft	478.0 / 10.5	S-5
	(8/29/2016) Groundwater not encountered		
15			



Logged By: B. Cook | **Excavated by:** Dan J. Fischer Excavating, Inc. | **Equipment:** Track-Mounted Excavator
Date Started: 8/29/16 | **Coordinates:** Not Available | **Note:** See Legend for Explanation of Symbols

GRI

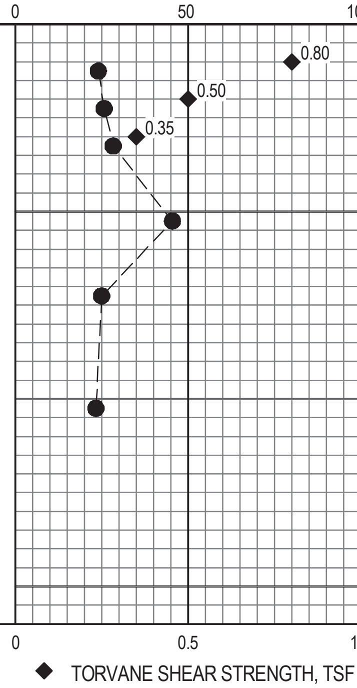
TEST PITS

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 50 100)	COMMENTS AND ADDITIONAL TESTS

TP-3

Surface Elevation: 488.0 ft [±] (NGVD 29)

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.
	SILT, some clay, trace subangular gravel and fine- to coarse-grained sand, brown, stiff, contains cobbles up to 10-in. diameter, 6-in.-thick heavily-rooted zone at ground surface (Fill)		S-1
	---medium stiff to stiff below 2 ft		S-2
	---gravel and cobbles absent below 4 ft		S-3
5	---trace subangular gravel, dark gray below 5 ft		S-4
	---rust mottled gray below 7 ft		S-5
10		477.5 / 10.5	S-6
	(8/29/2016) Groundwater not encountered		
15			

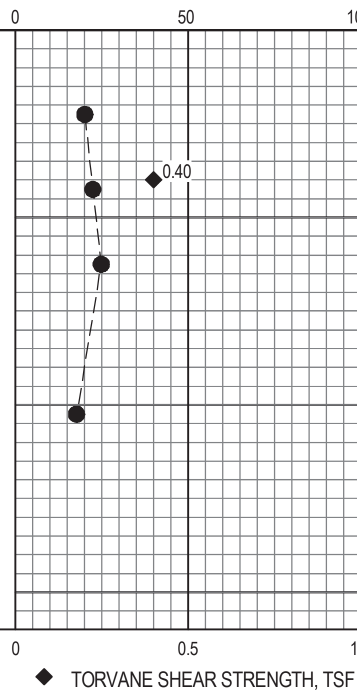


Logged By: B. Cook **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** Track-Mounted Excavator
Date Started: 8/29/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

TP-4

Surface Elevation: 476.0 ft [±] (NGVD 29)

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.
	SILT, some clay, trace fine-grained sand and subrounded gravel, brown, 6-in.-thick heavily-rooted zone at ground surface (Fill)	474.5 / 1.5	
	GRAVEL, COBBLES, and BOULDERS, some dark brown silt and clay, trace to some fine- to coarse-grained sand, dense, angular to subrounded gravel (Fill)	472.5 / 3.5	S-1 S-2
5	SILT, some clay and fine- to coarse-grained sand, dark brown, medium stiff, contains fine roots and grass, organic odor (Fill)		S-3
10		465.5 / 10.5	S-4
	(9/2/2016) Groundwater not encountered		
15			



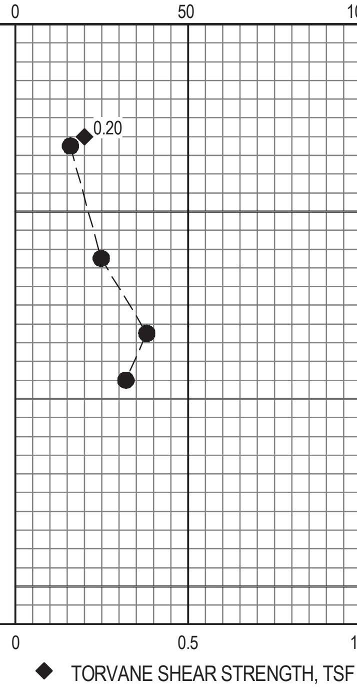
Logged By: T. Gayne **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** Track-Mounted Excavator
Date Started: 9/2/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % ☐ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

TP-5

Surface Elevation: 486.0 ft [±] (NGVD 29)

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.	Comments and Additional Tests
0	SILT, trace fine-grained sand, brown mottled gray and rust, stiff 5-in.-thick heavily-rooted zone at ground surface (Residual Soil) ---soft to medium stiff below 3 ft		S-1	
6.0	SILT, some clay and subrounded to subangular gravel, trace fine-grained sand, brown mottled rust, medium stiff to stiff, contains cobbles up to 10-in. diameter (Residual Soil)	480.0 / 6.0	S-2, S-3, S-4	
9.8	(9/2/2016) Groundwater not encountered	476.2 / 9.8		

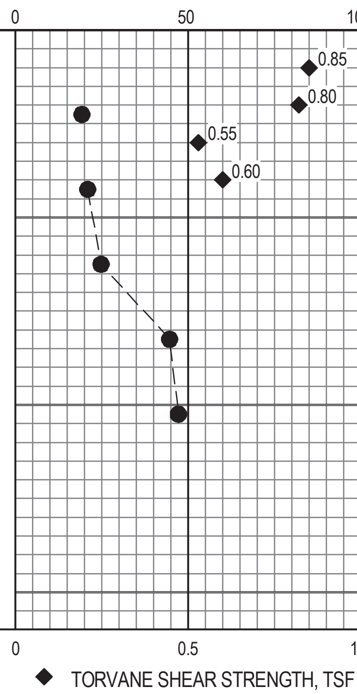


Logged By: T. Gayne **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** Track-Mounted Excavator
Date Started: 9/2/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

TP-6

Surface Elevation: 491.5 ft [±] (NGVD 29)

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.	Comments and Additional Tests
0	SILT, trace to some clay and fine-grained sand, brown mottled rust and gray, stiff, 6-in.-thick heavily-rooted zone at ground surface (Residual Soil)		S-1, S-2	
6.0	SILT, some gravel to gravelly, trace to some fine- to coarse-grained sand, brown, stiff (Residual Soil)	485.5 / 6.0	S-3	Hard excavating below 7 ft
8.0	Silty GRAVEL, some fine- to coarse-grained sand, very dense, subangular (Residual Soil)	483.5 / 8.0	S-4, S-5	
10.5	(8/29/2016) Groundwater not encountered	481.0 / 10.5		



Logged By: B. Cook **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** Track-Mounted Excavator
Date Started: 8/29/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

GRI TP LOG (LAT/LONG) - 2 PP GRI DATA TEMPLATE.GDT 1/16/17

GRI

TEST PITS

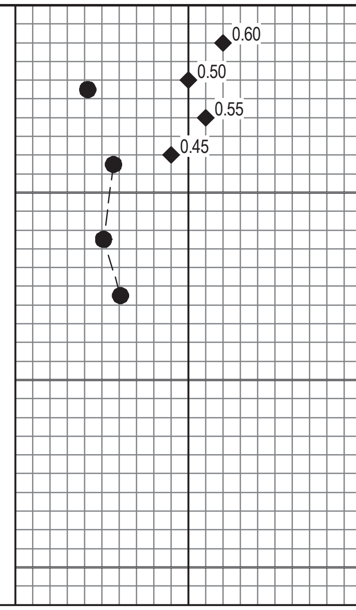
JAN. 2017 JOB NO. W1199 FIG. 7A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % ☐ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

TP-7

Surface Elevation: 477.0 ft [±] (NGVD 29)

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.
0–8	SILT, some fine-grained sand, brown, stiff, contains fine roots and grass, contains cobbles and boulders up to 3 ft diameter, 6-in.-thick heavily-rooted zone at ground surface (Fill)		S-1
	---gray, medium stiff to stiff below 4 ft		S-2
	---trace clay and subangular gravel, contains dimensional lumber, steel pipe, plastic, and other debris below 6 ft	469.0 / 8.0	S-3, S-4
8	(9/2/2016) Refusal on BASALT at 8 ft Groundwater not encountered		



Logged By: T. Gayne **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** Track-Mounted Excavator

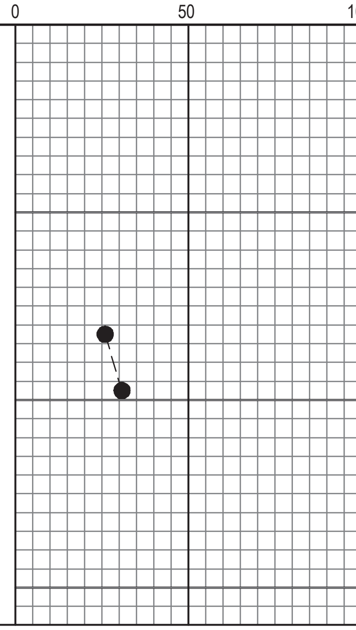
Date Started: 9/2/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

TP-7A

Surface Elevation: 477.0 ft [±] (NGVD 29)

Test pit located 20 ft west of TP-7

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.
0–8	SILT, some fine-grained sand, brown, stiff, contains fine roots and grass, contains cobbles and boulders up to 3 ft diameter, 6-in.-thick heavily-rooted zone at ground surface (Fill)		
	---gray, medium stiff to stiff below 4 ft		
	---trace clay and subangular gravel, contains dimensional lumber, steel pipe, plastic, and other debris below 6 ft	469.0 / 8.0	
8–10	Clayey SILT, some angular to subrounded gravel, trace fine-grained sand, gray, medium stiff to stiff, contains cobbles (Residual Soil)	468.0 / 9.0; 467.0 / 10.0	S-1, S-2
10	BASALT, gray, slightly to moderately weathered, soft to medium hard (R2 to R3), in a matrix of gray clayey silt		
	(9/2/2016) Groundwater not encountered		



Logged By: T. Gayne **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** Track-Mounted Excavator

Date Started: 9/2/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

GRI TP LOG (LAT/LONG) - 2 PP GRI DATA TEMPLATE.GDT 1/16/17

GRI

TEST PITS

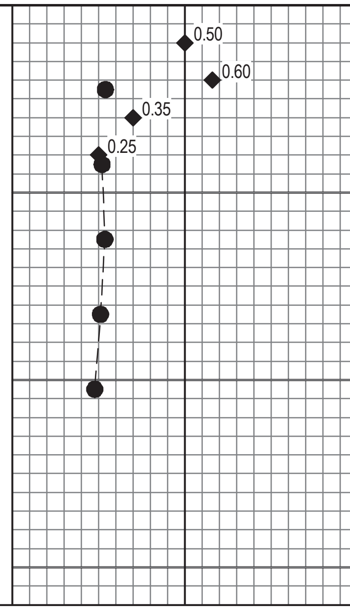
JAN. 2017 JOB NO. W1199 FIG. 8A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % ☐ FINES CONTENT, % LIQUID LIMIT, % / PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

TP-8

Surface Elevation: 489.0 ft [±] (NGVD 29)

DEPTH, FT	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO.	COMMENTS AND ADDITIONAL TESTS
	Silty GRAVEL, some fine- to coarse-grained sand, medium dense, subrounded gravel, 6-in.-thick heavily-rooted zone at ground surface (Fill)	487.7 / 1.3	S-1	
	SILT, some fine-grained sand, trace clay, dark brown, stiff, contains wood debris (Fill)	486.0 / 3.0	S-2	
5	SILT, some fine-grained sand, trace clay, gray mottled rust, soft to medium stiff (Residual Soil)	481.0 / 8.0	S-3, S-4	
10	Clayey SILT, trace fine-grained sand, red-brown, soft to medium stiff (Residual Soil)	478.5 / 10.5	S-5, S-6	▽ 9.0 ft (8/29/2016) Moderate seepage at 9 ft
15	(8/29/2016)			



◆ TORVANE SHEAR STRENGTH, TSF

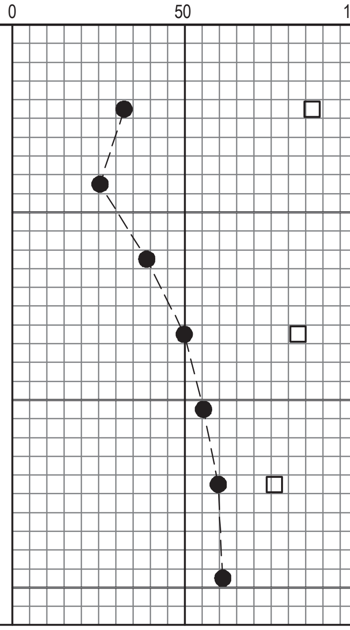
Logged By: B. Cook	**Excavated by:** Dan J. Fischer Excavating, Inc.	**Equipment:** Track-Mounted Excavator
Date Started: 8/29/16	**Coordinates:** Not Available	**Note:** See Legend for Explanation of Symbols

TP-9

Surface Elevation: 453.0 ft [±] (NGVD 29)

DEPTH, FT	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO.	COMMENTS AND ADDITIONAL TESTS
	SILT, some clay, trace fine- to coarse-grained sand, brown mottled gray and rust, stiff, 6-in.-thick heavily rooted zone at ground surface (Residual Soil)	449.0 / 4.0	S-1	
5	SILT, some clay and subangular to subrounded gravel and cobbles up to 10 in. diameter, trace fine- to coarse-grained sand, red and brown mottled black (Residual Soil)		S-2, S-3, S-4	
10	---gray and brown with yellow and black staining below 10 ft	438.0 / 15.0	S-5, S-6, S-7	
15	(12/19/2016)			

Groundwater not encountered



◆ TORVANE SHEAR STRENGTH, TSF

Logged By: T. Meskele	**Excavated by:** Scott Lee Excavating, Inc.	**Equipment:** CAT 308E Track-Mounted Excavator
Date Started: 12/19/16	**Coordinates:** Not Available	**Note:** See Legend for Explanation of Symbols

GRI TP LOG (LAT/LONG) - 2 PP GRI DATA TEMPLATE.GDT 1/16/17

GRI

TEST PITS

JAN. 2017 JOB NO. W1199 FIG. 9A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

TP-10

Surface Elevation: 481.0 ft [±] (NGVD 29)

SILT, some fine- to medium-grained sand, trace clay, brown, medium stiff to stiff, contains scattered subangular to subrounded gravel and cobbles, 6-in.-thick heavily rooted zone at ground surface (Fill)

---some clay, gray, organic smell below 4 ft

473.0 / 8.0

SILT, some clay and fine- to coarse-grained sand, brown mottled gray, stiff (Residual Soil)

---brown mottled rust below 10 ft

---clayey, red-brown below 12 ft

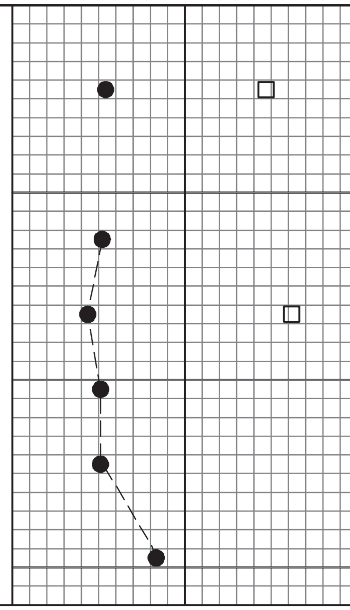
---red mottled black below 14 ft

466.0 / 15.0

(12/19/2016)

Groundwater not encountered

S-1, S-2, S-3, S-4, S-5, S-6, S-7



0 – 0.5 – 1.0

◆ TORVANE SHEAR STRENGTH, TSF

Logged By: T. Meskele **Excavated by:** Scott Lee Excavating, Inc. **Equipment:** CAT 308E Track-Mounted Excavator

Date Started: 12/19/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

TP-11

Surface Elevation: 480.0 ft [±] (NGVD 29)

SILT, some fine-grained sand, trace clay, brown, medium stiff to stiff, contains scattered subangular to subrounded gravel and cobbles, 6-in.-thick heavily rooted zone at ground surface (Fill)

476.0 / 4.0

SILT, some clay and fine- to coarse-grained sand, brown mottled gray, stiff (Residual Soil)

---brown mottled black below 8 ft

---red-brown mottled black, contains about 10-in. diameter cobble at 10 ft

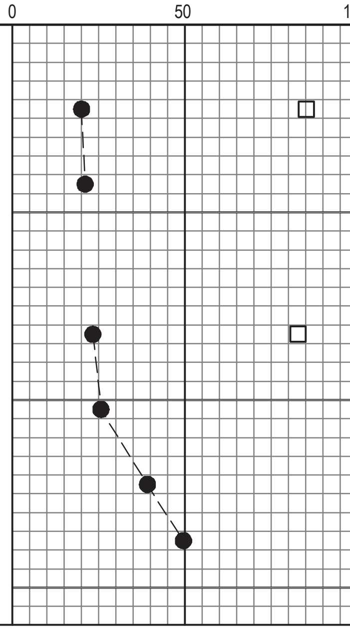
---clayey, red mottled black below 12 ft

466.0 / 14.0

(12/19/2016)

Groundwater not encountered

S-1, S-2, S-3, S-4, S-5, S-6, S-7



0 – 0.5 – 1.0

◆ TORVANE SHEAR STRENGTH, TSF

Logged By: T. Meskele **Excavated by:** Scott Lee Excavating, Inc. **Equipment:** CAT 308E Track-Mounted Excavator

Date Started: 12/19/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

GRI

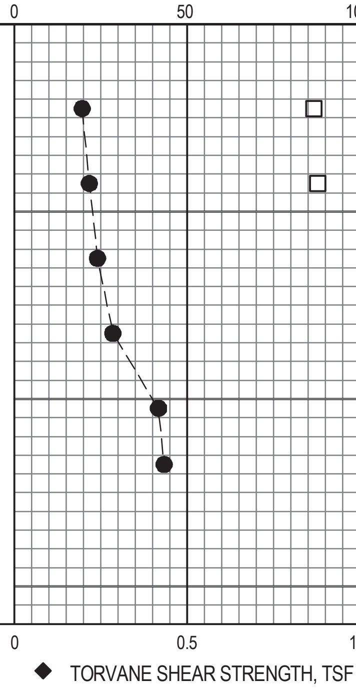
TEST PITS

JAN. 2017 JOB NO. W1199 FIG. 10A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	ELEVATION, FT / DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 50 100)	COMMENTS AND ADDITIONAL TESTS

TP-12 **Surface Elevation:** 483.0 ft [±] (NGVD 29)

Depth, ft	Classification of Material	Elevation, ft / Depth, ft	Sample No.
0–6	SILT, trace clay and fine-grained sand, brown mottled black and rust, medium stiff to stiff, 6-in.-thick heavily rooted zone at ground surface (Fill) ---contains fine roots at 4 ft	477.0 / 6.0	S-1, S-2
6–12	SILT, some clay, trace fine- to coarse-grained sand, brown mottled gray and rust, stiff, contains scattered subangular to subrounded gravel and cobbles (Residual Soil) ---red mottled black below 8 ft ---clayey, some cobbles and boulders up to 16 in. diameter, red below 10 ft	471.0 / 12.0	S-3, S-4, S-5, S-6
	(12/19/2016) Groundwater not encountered		



Logged By: T. Meskele **Excavated by:** Scott Lee Excavating, Inc. **Equipment:** CAT 308E Track-Mounted Excavator

Date Started: 12/19/16 **Coordinates:** Not Available **Note:** See Legend for Explanation of Symbols

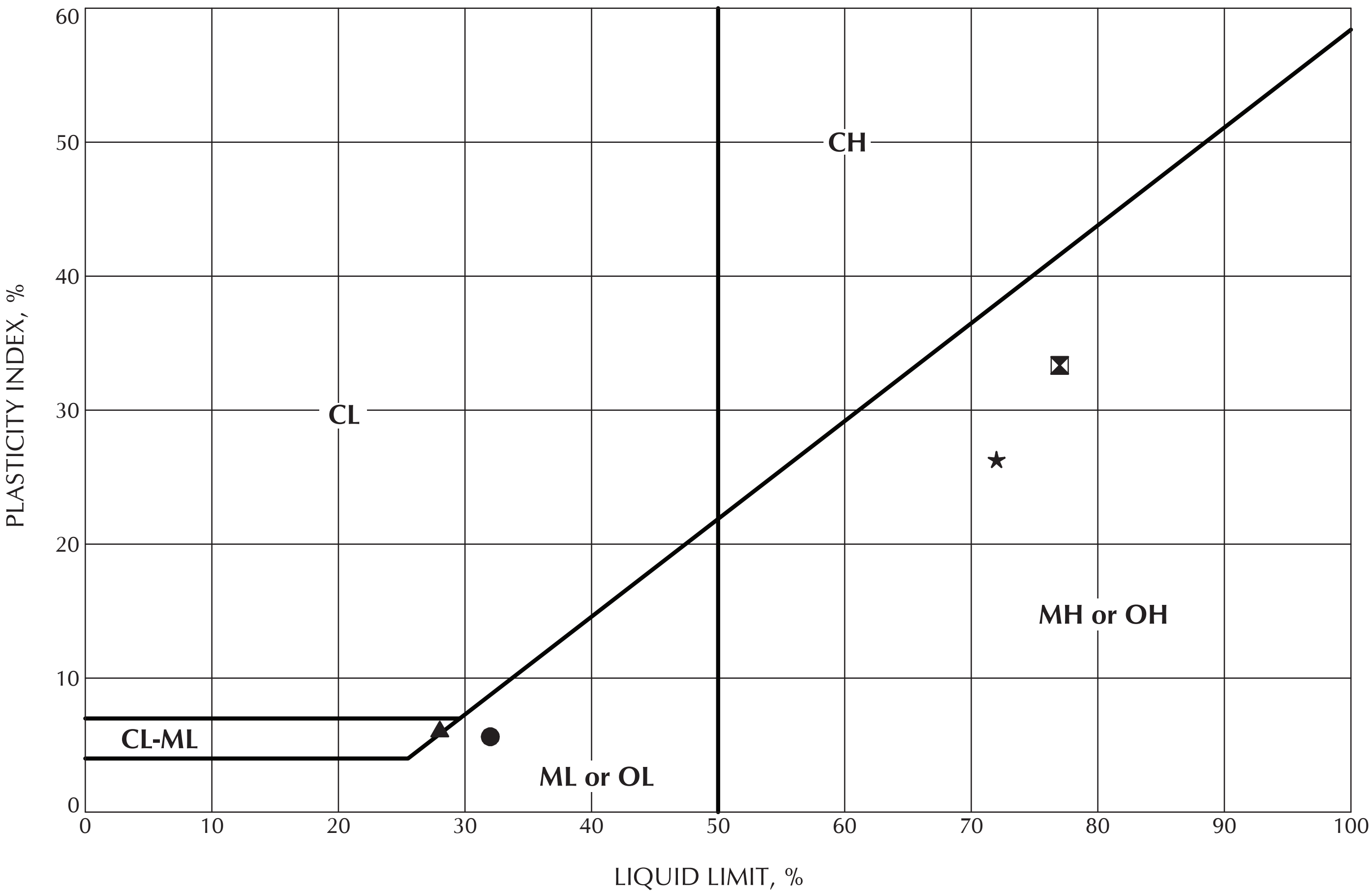
GRI TP LOG (LAT/LONG) - 2 PP GRI DATA TEMPLATE.GDT 1/16/17

GRI

TEST PITS

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY

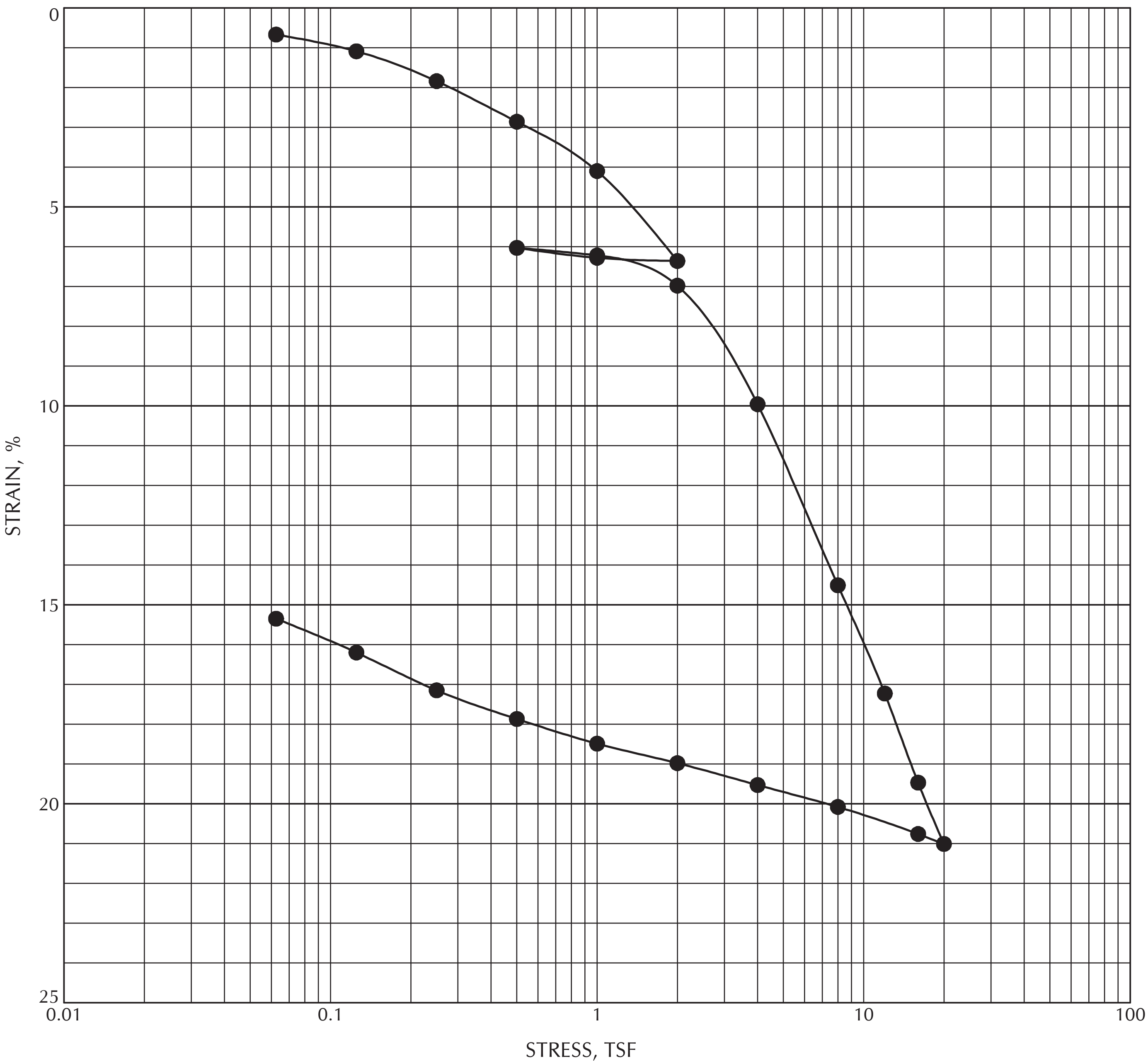


	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-1	S-5	14.2	SILT, some clay, trace fine- grained sand, dark gray, contains fine organics (Fill)	32	26	6	34
⧗	B-1	S-10	28.3	Clayey SILT, trace fine- to medium-grained sand, red mottled black (Residual Soil)	77	44	33	50
▲	B-3	S-2	5.7	SILT, some clay, trace fine-grained sand, brown to dark brown, contains fine roots (Fill)	28	22	6	34
★	B-4	S-6	15.6	Clayey SILT, trace fine-grained sand, red mottled black (Residual Soil)	72	46	26	58

ATTERBERG-PLASTICITY 4 PER PAGE GRI DATA TEMPLATE.GDT 1/16/17

GRI

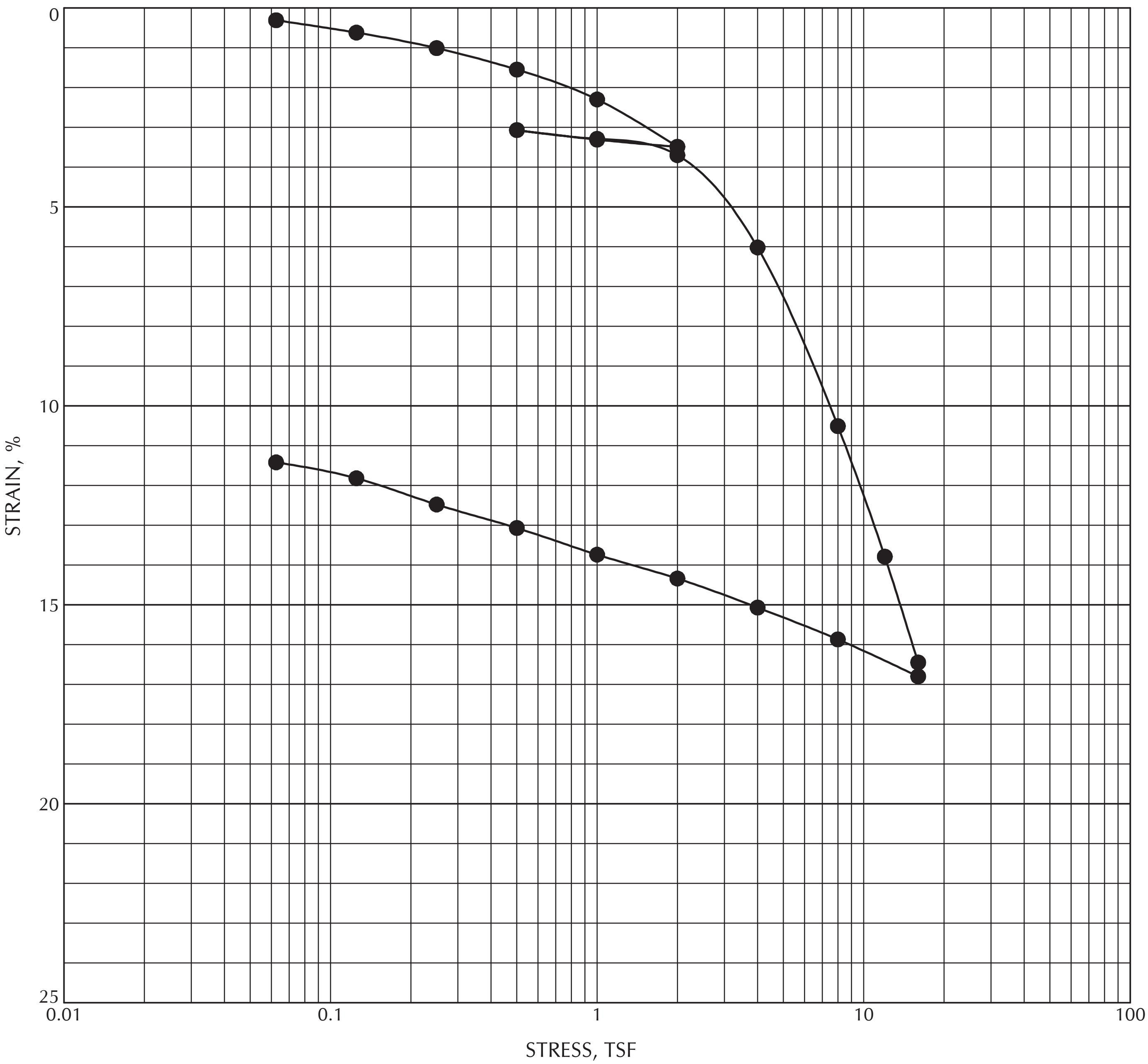
PLASTICITY CHART



	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-1	S-5	14.0	SILT, some clay, trace fine- grained sand, dark gray, contains fine organics (Fill)	83	36

GRI

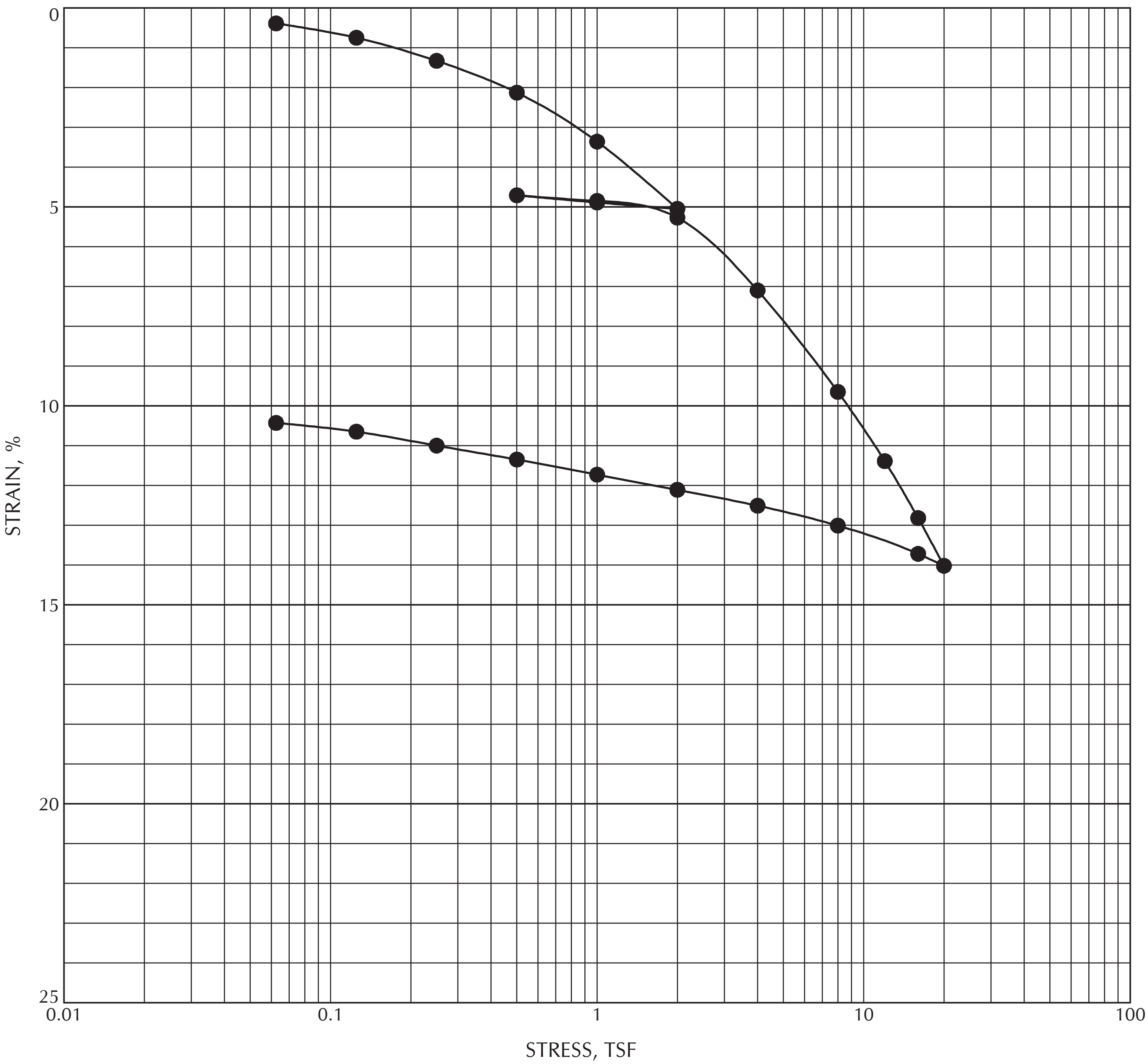
CONSOLIDATION TEST



					Initial	
	Location	Sample	Depth, ft	Classification	γ_d, pcf	MC, %
●	B-1	S-10	27.0	Clayey SILT, trace fine- to medium-grained sand, red mottled black (Residual Soil)	65	60

GRI

CONSOLIDATION TEST

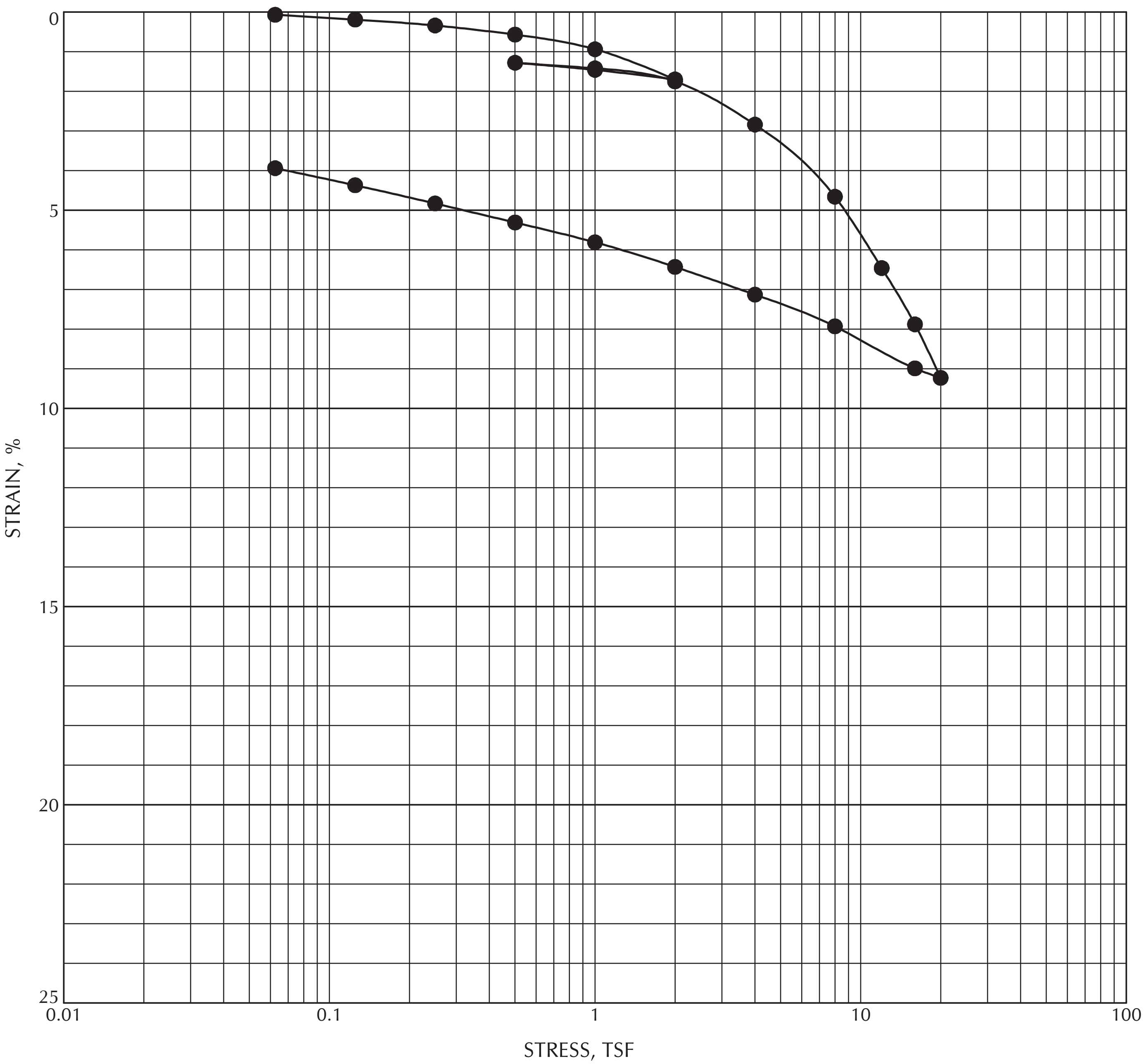


	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-3	S-2	6.5	SILT, some clay, trace fine-grained sand, brown to dark brown, contains fine roots (Fill)	96	29

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE GRI DATA TEMPLATE.GDT 1/16/17

GRI

CONSOLIDATION TEST



	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-4	S-6	16.0	Clayey SILT, trace fine-grained sand, red mottled black (Residual Soil)	69	56

GRI

CONSOLIDATION TEST

APPENDIX B

Rock Core Photographs

Boring B-1 – 38 to 53 ft

Boring B-2 – 40 to 50 ft

GRI

ROCK CORE PHOTOGRAPHS