Appendix E

Geotechnical Exploration Report

Leighton

Leighton Consulting, Inc.
A Leighton Group Company

PROJECT MEMORANDUM

To: Lewis Management Corp.
1156 N. Mountain Ave.
Upland, CA 91786

Date: 12/09/2022

Project No. 11227.010

Attention: Waen Messner, Project Manager

From: Robert Riha, CEG and Simon Saiid, GE

Subject: Geotechncial Conditions along Planned Meridain Lateral B Master Storm Drain (Perris Valley Lateral B), east of I-215 and south of Van Buren Blbd, Riverside County, California.

Reference: Geotechnical Exploration, Proposed Mridian Trunk Sewer, March Bsiness Center – Tract No. 30857-7, Riverside County, California, by Leighton Consulting, dated October 5, 2018.

In accordance with your request, Leighton Consulting is providing this memorandum regarding the applicability and use of the above referenced Geotechnical Exploration report (Leighton 2018) to the planned Meridian Lateral B Master Storm Drain.

Due to the general proximity of our referenced study to the planned storm drain Line B alignment, it is our opinion the general geologic/Geotechnical findings and relevant geotechnical recommendations may be considered for use in design and construction of the proposed storm drain. Please note that the referenced report was prepared specifically for the purpose of the sewer trunk main and as such, some portions of the report may not be applicable to planned storm drain. In addition, the nature of many sites is such that differing soils characteristics can be experienced within small distances and under various climatic conditions.

Should you have any questions regarding this memorandum please contact this office.

Respectfully submitted,
LEIGHTON CONSULTING, INC.

Simon I. Saiid, GE
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Distribution: (1) Addressee (via email pdf)

GEOTECHNICAL EXPLORATION
PROPOSED MERIDIAN TRUNK SEWER
MARCH BUSINESS CENTER – TRACT NO. 30857-7
RIVERSIDE COUNTY, CALIFORNIA

Prepared for

MERIDIAN PARK
1156 N. Mountain Avenue
Upland, California 91785-0670

Project No. 11227.010

October 5, 2018

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

October 5, 2018

Project No. 11227.010

Meridian Park
1156 N. Mountain Avenue
Upland, California 91785-0670

Attention: Mr. Timothy Reeves

**Subject: Geotechnical Exploration
Proposed Meridian Trunk Sewer
March Business Center – Tract No. 30857-7
Riverside County, California**

In accordance with your authorization and our proposal dated September 7, 2018, we are pleased to present herewith our geotechnical exploration for the subject project. This report presents our findings and provides geotechnical recommendations for design and construction.

Based on the results of our exploration, the proposed alignment is underlain by artificial fill and alluvial deposits consisting primarily of dense silty sand to clayey sand with interbedded sandy to sandy silt layers. Weathered granitic bedrock and groundwater was encountered locally along portions of the alignment. We did not detect flammable gas or petroleum vapors in our three borings drilled adjacent to the proposed jacking and receiving pits. The soils should be considered CalOSHA Type C soils and as such, sloped excavations will be required to protect workers within excavations, if shoring and/or shields are not used. The proposed pipeline alignment is not located within currently designated County or State AP Earthquake Fault Zones.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to call our office.

Respectfully submitted,
LEIGHTON CONSULTING, INC.

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1.0 INTRODUCTION

1.1 Site and Project Description

The proposed alignment of the Meridian Trunk Sewer Line is located within the unincorporated area of Riverside County on the west side of the Interstate 215 and Van Buren Boulevard interchange. The northernmost point of the alignment begins at an existing sewer lift station located within the Meridian Business Park, approximately 850 feet north of Van Buren Boulevard between Interstate 215 and Opportunity Way. The alignment extends south for approximately 8,600 feet (1.62 miles) to the Western Municipal Water District (WMWD) treatment plant. Approximately 6,400 linear feet of the alignment traverses the eastern edge of the Riverside National Cemetery located at 22495 Van Buren Blvd, Riverside, California, 92518. The approximate alignment is depicted on Figure 1, *Site Location Map*, and Figure 2, *Boring Location Plan.* The proposed trunk sewer is a 24-inch VCP pipeline installed at approximately 5 to 17 feet below ground surface (BGS). Up to 36 feet of cover is expected at Van Buren Boulevard, and as such, Bore-and-Jack excavation method is anticipated at this location.

1.2 Purpose and Scope

The purpose of our exploration is to: (1) evaluate geotechnical engineering characteristics of the earth materials along the pipeline alignment, and (2) provide geotechnical recommendations for design and construction of the proposed pipeline. More specifically and as described in our proposal, the scope of our work included the following tasks:

- Background Review: We reviewed readily available, relevant, geotechnical/ geologic reports and maps pertinent to the project.
- Field Exploration: Our field exploration consisted of twelve (12) hollow stem auger borings drilled, sampled and logged along accessible areas of the proposed pipeline alignment.
- Geotechnical Laboratory Tests: Geotechnical laboratory tests were performed on selected soil samples collected during our field exploration. This laboratory testing program was designed to evaluate general physical and engineering characteristics of the encountered soils.
- Engineering Analysis: Data obtained from our background review, field exploration, and geotechnical laboratory testing program was evaluated to develop geotechnical conclusions and recommendations.

- Report Preparation: Results of this evaluation have been summarized in this report, presenting our findings, conclusions and recommendations.

This report does not address the potential for encountering hazardous materials along the pipeline alignment. Important information about limitations of geotechnical reports, in general, is presented in Appendix C, *GBA Important Information About This Geotechnical Report.*

1.3 Field Exploration

Our field exploration consisted of the excavation of twelve (12) hollow stem auger borings in accessible areas along the proposed alignment. Prior to drilling, we located and marked boring locations for coordination with Underground Service Alert (USA). Our field exploration was performed on September 26th and 27th, 2018. Approximate locations of the borings are depicted on the Boring Location Plan (Figure 2). The exploratory borings were generally excavated as close as practical to proposed pipeline alignment; however, some borings were offset to avoid conflicts with existing underground or above ground utilities and asphalt pavement. The borings were advanced utilizing a truck-mounted, CME 75 drill rig using an 8-inch hollow-stem augers. During the drilling operation, bulk and relatively undisturbed samples were obtained from the borings for laboratory testing and evaluation. Sampling of the borings was conducted by a staff engineer from our office. Where encountered, groundwater depth was measured after completion of drilling and the borings were backfilled with spoils generated during excavation. Where drilled in existing asphaltic concrete (LB-6), the boring was patched with cold patch asphalt. The collected samples were transported to our laboratory for testing. Borings were backfilled with native soils. The logs of borings are presented in Appendix A.

1.4 Laboratory Testing

Laboratory tests were performed on representative samples to provide a basis for development of geotechnical conclusions and recommendations. Selected samples were tested to determine the following parameters: insitu moisture and density, maximum dry density and optimum moisture content, sieve analysis (gradation), collapse potential, sand equivalent, soluble sulfate and chloride content, pH and resistivity. The results of our laboratory testing and summaries of the testing procedures are presented in Appendix B.

2.0 GEOTECHNICAL AND GEOLOGIC FINDINGS

A summary of our findings from research of pertinent literature, site-specific field exploration, geotechnical laboratory testing and engineering analysis, is discussed in this section.

2.1 Regional Geology

The site is located within a prominent natural geomorphic province in southwestern California known as the Peninsular Ranges. This province is characterized by steep, elongated ranges and valleys that trend northwestward. More specifically, the proposed site is located within the relatively stable Perris Block.

The Perris Block, approximately 20 miles by 50 miles in extent, is bounded by the San Jacinto Fault Zone to the northeast, the Elsinore Fault Zone to the southwest. The Perris Block has had a complex tectonic history, apparently undergoing relative vertical land-movements of several thousand feet in response to movement on the Elsinore and San Jacinto Fault Zones. Thin sedimentary and volcanic materials locally mantle crystalline bedrock, consisting of the Val Verde Tonalite (Kvt) and lesser amounts of Cretaceous granitic dikes (Kg).

2.2 Subsurface Conditions

Our field exploration and review of pertinent literature indicates that alluvial valley deposits along the proposed alignment are generally covered with varying thicknesses of artificial fill associated with existing streets. Detailed descriptions of the earth materials encountered in each excavation are provided in Appendix A.

2.2.1 Artificial Fill

Artificial fill was locally encountered in several borings as typical embankment fill associated with existing roadways or from previous grading of the Riverside National Cemetery. The fill thickness varied from several inches to less than 5 feet. The fill appears to be generated from near or onsite sources (i.e. alluvium) and generally consisted of silty sand (SM) with varying amounts of gravel.

2.2.2 Alluvium Deposits

Quaternary alluvial deposits (Qalo as referred to on the boring logs) was encountered in all of our borings. The alluvium generally consisted of silty sand to clayey sand with interbedded poorly to well-graded sand and silty sand layers. The encountered alluvium is generally dense to very dense with N-value ranging from 17 to over 50 blows per foot. The Expansion Index (EI) of the silty clayey sand materials in the alluvial deposits feet BGS are expected to be low (EI<51). The Sand Equivalent (SE) is expected to vary depending on silt content. The collapse potential is typically less than 2 percent which is considered low. Cohesionless alluvium is expected to possess “fast raveling” behavior in tunnel excavation in saturated condition and/or below groundwater.

2.2.3 Granitic Bedrock

Granitic bedrock was locally encountered along the southern reach of the alignment in Borings LB-1 and LB-2 and is expected to underlie the alluvium at depth elsewhere. The granitic bedrock was encountered at a depth of approximately 19 feet (LB-1), which is about the same depth as pipeline invert near this location. Within the depth explored, granitic bedrock is highly weathered/completely disintegrated rock that has become a dense soil-like deposit. The bedrock is expected to range from readily rippable/excavatable to non-rippable depending on the degree of weathering. This weathered bedrock is likely to produce fine to coarse sand with gravel size rock fragments and is expected to be generally suitable for re-use as compacted fill. However, it should be anticipated that deeper excavations in the southern portions of the alignment may encounter undulating/less weathered bedrock surfaces that may be very difficult to excavate and generate boulders or core stones (greater than 12 inches).

2.3 Surface and Groundwater

No surface water was observed along the alignment except for the existing WMWD pond along the east side of the alignment between Borings LB-1 and LB-2. Although groundwater was encountered in five borings at depths of 18 to 20 feet BGS (LB-1, LB-6, LB-9, LB-10, and LB-11), similar conditions or shallower groundwater may exist along other portions of the alignment. Groundwater is not anticipated to be encountered along the majority of trench excavation, except along the southern reaches of alignment where ground water was encountered in LB-1 at 19 feet, which is approximately the planned pipeline trench excavation depth. In addition, groundwater may also be encountered at the Bore-and-Jack crossing depending on depth of excavation got jacking and receiving pits. Groundwater conditions can fluctuate seasonally and may also be directly-impacted by other factors not observed at the time of our field explorations or groundwater seepage may appear in trench excavations exposing earth materials of contrasting permeabilities.

2.4 Faulting and Seismicity

The subject site, like the rest of Southern California, is located within a seismically active region as a result of being located near the active margin between the North

American and Pacific tectonic plates. The principal source of seismic activity on this site is movement along the northwest-trending regional fault systems such as the San Andreas and San Jacinto. Based on our review of published geologic map (Hart, 2007), the site is not located within any Fault Zone per the Alquist-Priolo Earthquake Fault Zoning Act.

For the purpose of structural design, seismic coefficients based on the 2016 California Building Code (CBC) are provided below. These seismic coefficients were calculated based on a software program, available on the United States Geological Survey website), which follows the procedures, included in American Society of Civil Engineers (ASCE) Publication ASCE 7-10 and Chapter 16 of 2016 CBC.

Table 1. CBC Site Categorization and Seismic Coefficients

Categorization /Coefficient	Value
Site Longitude (decimal degrees)	-117.2689
Site Latitude (decimal degrees)	33.8820
Site Class Definition	D
Mapped Spectral Response Acceleration at 0.2s Period, S_s	1.50g
Mapped Spectral Response Acceleration at 1s Period, S_1	0.60g
Short Period Site Coefficient at 0.2s Period, F_a	1.0
Long Period Site Coefficient at1s Period, F_v	1.5
Adjusted Spectral Response Acceleration at 0.2s Period, S_{MS}	1.50g
Adjusted Spectral Response Acceleration at 1s Period, S_{M1}	0.90g
Design Spectral Response Acceleration at 0.2s Period, S_{DS}	1.00g
Design Spectral Response Acceleration at 1s Period, S_{D1}	0.60g

2.5 Secondary Seismic Hazards

The potential for secondary hazards such as ground rupture, seiches and tsunamis, landsliding, rockfall, ground fissuring, and liquefaction and seismic densification are considered very low for the proposed alignment. Differential settlement along pipeline is not expected to exceed 0.5-inch over a distance of 30 feet.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 General

The proposed pipeline appears feasible from a geotechnical viewpoint provided that the following recommendations are incorporated into the design and construction phases of development. Based on results of this exploration, **we did not detect flammable gas or petroleum vapors** (i.e. concentration >5 percent of the lower explosive limit, LEL) in our three borings drilled adjacent to the proposed jacking and receiving pits. In addition, we are unaware of any oil and/or natural gas production in this area. However, there is a local-service pressurized gas pipeline aligned within the Van Buren Boulevard roadway embankment, over the proposed bore and jack alignment (DRC, 2018). In accordance with Cal/OSHA requirements, this proposed tunnel/bore-and-jack alignment may be classified as **potentially gassy** due to the presence of this gas pipeline. Natural gas concentrations should be carefully monitored within excavated pits and bored tunnel during construction. Additionally, based on the results of this geotechnical exploration, the soil encountered is considered CalOSHA Type C soils, and sloped excavations will be required to protect workers, if shoring and/or shields are not used.

3.2 Earthwork Considerations

Earthwork associated with the proposed pipelines should be performed in accordance with applicable WMWD Specifications, “Standard Specifications for Public Works Construction” (GreenBook, latest edition) and the recommendations included in the text of this report.

3.2.1 Trench Excavation

Based on the results of our exploratory borings, the onsite alluvium should generally be easy to excavate with conventional earthmoving excavation equipment. Some possibly difficult excavation may be encountered in the southern portion of the alignment near the March Wastewater facility if granitic bedrock is encountered. Excavation should be performed in accordance with the project plans, specifications, and all applicable OSHA requirements. The contractor should be responsible for providing the "competent person" required by OSHA standards. Contractors should be advised that sandy soils (such as existing, onsite soils) could make excavations particularly unsafe, and hence necessary safety precautions should be taken at all times.

3.2.2 Pipe Subgrade Preparation

Pipe subgrade soils are expected to generally consist of relatively medium dense to very dense sand with varying amounts of silt. Where very loose and/or saturated soils are encountered or the subgrade become disturbed due to localized seepage or surface water, the contractor should over-excavate the disturbed or saturated soils to a maximum depth of 2 feet and replace with suitable materials properly compacted to provide a stable trench bottom. Crushed rock (1-inch maximum size) may be used if found necessary to stabilize bottom of trench prior to placing bedding materials. Placement of filter fabric separation layer may be required due to the granular nature of onsite soils and to provide further stability of the subgrade soils. Any oversize particles larger than 3-inches in largest dimension, if any, within the subgrade, should be removed from the trench bottom and replaced with compacted uniform bedding materials.

3.2.3 Trench Backfill

Prior to backfilling trenches, pipes should be bedded in and covered with a uniform, granular material that has a Sand Equivalent (SE) of 30 or greater, and a gradation meeting requirements of the pipe manufacturer and WMWD Standards. A minimum cover of 12 inches of bedding material should be provided above the top of the pipe. Pipe bedding should be water-densified in-place. Onsite soils (SM/ML materials) are generally too silty to be considered for bedding material. However, some SP/SW materials with SE greater than 30 may be suitable for this purpose.

Native soils are generally considered suitable as backfill materials over the pipe bedding zone. However, excavations in granitic rock may produce oversize fragments and screening may be required prior to use as trench backfill. Trench backfill materials should be placed in thin lifts moisture conditioned, as necessary, and mechanically compacted to a minimum of 90 percent relative compaction per ASTM D1557 or as required per District standard specifications. The actual lift thickness should depend on the compaction equipment used. If rolling equipment is used for compaction (sheepsfoot, smooth-wheel, segmented wheels, etc.), the fill lift should be a maximum of 8 inches in thickness prior to compaction. For hand-directed mechanical equipment as vibratory plates or tamper, the maximum lift thickness should not exceed 4 inches.

3.2.4 Shrinkage

Change in volume of excavated and recompacted soil varies according to initial density, which is a function of soil type and location. This volume change is represented as a percentage increase (bulking) or decrease (shrinkage) in volume of fill after removal and recompaction. Field and laboratory data used in our calculations included laboratory-measured maximum dry densities for soil types encountered at this site relative to measured, in-place densities of soils sampled. We estimate that shrinkage due to recompaction of soils will vary with depth (shrinkage typically decreases with depth). We suggest an estimated shrinkage ranging from 5 to 10 percent for the upper 5 feet BGS and 0 to 5 percent shrinkage for deeper excavations in the alignment.

3.3 Bearing Capacity and Earth Pressures

3.3.1 Bearing Capacity

A net allowable bearing capacity of 2,000 psf, or a modulus of subgrade reaction of 150 pci may be used for design of pipeline installed a depth of 5 feet or greater. However, the bottom of trench/bedding materials should be compacted to minimum of 90 percent relative compaction or as described in Section 3.2 above.

Same bearing pressure may be used for footings of miscellaneous appurtenant structures founded at this depth. A minimum base width of 18 inches for continuous footings and a minimum bearing area of 3 square feet (1.75 ft by 1.75 ft) for pad foundations should be used. Additionally, an increase of one-third may be applied when considering short-term live loads (e.g. seismic and wind).

If applicable, lateral loads on thrust blocks and other appurtenant structures may be resisted by passive soil pressure and friction, in combination. An allowable passive pressure based on an equivalent fluid pressure of 300 pounds-per-cubic-foot (pcf), not to exceed 3,500 pounds per square foot (psf) can be used if the pipe is embedded in the alluvium or compacted fill (minimum 2 feet embedment). This equivalent fluid pressure may be doubled for isolated thrust blocks. We have not applied a factor-of-safety to these values. A soil-pipeline surface friction of 0.20 for PVC pipes.

A modulus of soil reaction (E’) of 1,000 psi can be used to estimate the stiffness of the soil bedding backfill at the sides and below buried flexible pipelines for the purpose of evaluating deflection caused by weight of the backfill over the pipe. This value assumes that the proposed pipelines in embedded at 5 to 6 feet below exiting grades and a granular bedding material with an average relative compaction of 90 percent or more (per ASTM D1557) is placed. An E’ of 1,200 psi can be used where pipeline is underlain by at least 2 feet of compacted soils or crushed rock.

3.3.2 Soils Parameters for Pipeline Design

Structural design of pipes requires proper evaluation of possible loads acting on the pipe, including dead and live or transient loads. Stresses and strains induced in a buried pipe depend on many factors, including the type of pipe, depth and width of trench, bedding and embedment conditions, soil density, angle of internal friction, coefficient of passive earth pressure, and coefficient of friction at the interface between the backfill and in-situ soils. We recommend the following soil parameters for the proposed pipe design:

Table 2. Soil Parameters for Pipe Design

Soil Parameters	Recommended Values
Average compacted fill moist unit weight, (pcf)	130
Angle of internal friction of soils (degrees)	33
Soil cohesion, c (psf)	100
Sliding friction between pipe and native soils	0.20
Coefficient of friction between backfill and native soils	0.40

3.3.3 External Loads on Pipe by Soil

Structural design of pipes requires proper evaluation of possible loads acting on the pipe, including dead and live or transient loads. Stresses and strains induced. The magnitude of the load supported depends on the amount of backfill, type of soil, and pipe stiffness. For flexible pipes, the approximate dead load per unit length can be calculated from the following formula:

$$W = C\gamma \ BD$$

Where,

W	External soil load on pipe: (pounds per foot of pipe)
C	Unit less load coefficient (C = 1.4 for 5 feet deep trench, and 1.8 for 10 feet deep trench, assuming a trench width of 3 feet just above the pipe)
γ	Total unit weight of soil above pipe (pounds-per-cubic-foot)
B	Width of the trench (width just above top of the pipe, in feet)
D	Pipe diameter (feet)

In addition to the load from backfill (above equation), loads due to embankments (if applicable) and other loads (live loads) should be considered.

3.4 Asphalt Paving

If applicable, the upper 8 inches of trench backfill and pavement areas should be scarified, moisture conditioned to near optimum moisture content and recompacted to a minimum of 95 percent relative compaction. Aggregate base should also be compacted to 95-percent of the ASTM D1557 laboratory maximum dry density.

Where applicable, pavement patching should at least match existing pavement section or be design based on actual R-value testing and appropriate Traffic Index (TI) selected by the project Civil Engineer.

Asphalt concrete and aggregate base should conform to *Caltrans Standard Specifications,* Sections 39 and/or the *Standard Specifications for Public Works Construction* (Green Book, latest Edition), and applicable City Standards.

3.5 Temporary Cut Slopes

The contractor is responsible for all temporary slopes and trenches excavated at the site and the design of any required temporary shoring. Shoring, bracing and benching should be performed by the contractor in accordance with the current edition of the *California Construction Safety Orders*, see:

http://www.dir.ca.gov/title8/sb4a6.html

During construction, exposed earth material conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor is responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Close coordination between the competent person and geotechnical consultant should be maintained to facilitate construction while providing safe excavations. Existing alluvial soils encountered are classified as OSHA soil Type C. Therefore, unshored temporary cut slopes should be no steeper than 1½:1 (horizontal:vertical), for a height no greater than (≤) 20 feet (*California Construction Safety Orders*, Appendix B to Section 1541.1, Table B-1). These recommended temporary cut slopes assume a level ground surface for a distance equal to one-and-a-half (x1.5) the depth of excavation. For steeper temporary slopes, deeper excavations, and/or where slopes terrain exists within close proximity to excavation (<1.5xdepth), appropriate shoring methods or flatter slopes may be required to protect the workers in the excavation and adjacent improvements. Such methods should be implemented by the contractor and approved by the geotechnical consultant.

3.6 Temporary Shoring

If the sloped open cut excavation is not feasible based on requirements above and due to existing pavement or structures, excavations for the proposed pipeline should be supported by a temporary shoring system such as cross-braced hydraulic shoring, conventional shields, sheet piles, soldier piles and wood lagging. The choice should be left to the contractor's judgment since economic considerations and/or the individual contractor's construction experience may determine which method is more economical and/or appropriate. The contractor and shoring designer should also perform additional geotechnical studies as necessary to refine the means-and-methods of shoring construction.

The support of all adjacent existing structures during excavation and construction (including pavements) without distress is the contractor's responsibility. In addition, it should be the contractor's responsibility to undertake a pre-construction survey with benchmarks and photographs of the adjacent properties. Shoring systems should be designed by a California licensed civil or structural engineer. As preliminary design guidelines, we present the following geotechnical parameters for shoring design. The following lateral earth pressures are recommended for temporary shoring supporting encountered alignment soils with level ground behind the shoring. Passive pressure also may be used to compute lateral soil resistance, if necessary, for sheet piles. Earth pressures provided are ultimate values and a safety factor should be applied as appropriate.

Table 3. Static Lateral Earth Pressures

Conditions[1]	Static Equivalent Fluid Weight (pcf)
Active (cantilever)	36
At-Rest (braced)	55
Passive[2]	300

1. For temporary excavations only, with level backfill, not including surcharges
2. Passive equivalent fluid pressure may be doubled for isolated soldier piles spaced at least 2½ diameters on-center. Passive resistance should not exceed 3,000 pounds-per-square-foot (psf)

Determination of appropriate design conditions (active or at-rest) depends on shoring flexibility. If a rotation of more than 0.001 radian (0.06 degrees) is allowed, active pressure conditions apply; otherwise, at-rest condition governs.

Surcharge loads (dead or live) should be added to the indicated lateral earth pressures and should be applied uniformly, if such loads are within a horizontal distance that is less-than the exposed shoring height. The corresponding lateral earth pressure will approximately be 33-percent of the vertical surcharge for active conditions, and 50-percent for at-rest conditions. Surcharge pressures from concentrated loads should be evaluated after geometric constraints and loading conditions are determined on individual basis.

3.7 Dewatering during Trenching and Pipeline Construction

Based on the results of our exploration, groundwater was locally encountered within the anticipated depth of trench excavation. Localized trench dewatering may be required. Groundwater control, such as dewatering, will be required to limit instability of the trench excavation bottom, side and face, and soil backfill. Groundwater due to perched saturated conditions can be dewatered utilizing sump-pumps. Dewatering or any other suitable method for stabilizing excavation bottom may be selected by the contractor based on actual groundwater conditions encountered and based on the contractor's chosen means-and-methods of construction. The selected method by the contractor should be able to effectively mitigate for bottom heave or stabilize subgrade soils during construction/ backfilling. However, deep groundwater drawdown should be avoided to reduce the potential for damaging adjacent structures, if applicable. Dewatering flow/volume will vary significantly based on the specific geologic conditions described in our report and actual depth and geometry of excavated trench or pit. Contractors should be responsible for estimating dewatering quantities and verify subsurface conditions prior to construction.

3.8 Pipe Jacking

Jacking of new pipe casing is feasible from a geotechnical perspective, within encountered alluvial soils. However, the contractor should (1) review our findings to confirm that jacking is feasible, and (2) perform additional studies as deemed necessary to evaluate jacking. Passive earth pressure developed at the jacking reaction block may provide support during pipe jacking operations. Passive resistance for design of jacking reaction block(s) may be assumed to be 300 pcf (pounds-per-square-foot per foot below lowest adjacent grade), when jacking against level undisturbed lacustrine deposits or alluvium. For small jacking reaction surfaces (properly cribbed), passive resistance can be doubled for isolated thrust vectors. However, some deformation will occur, and thrusting could result in heave and damage to overlying surfaces in the direction of the thrust vector. This should be carefully considered by the contractor when choosing jacking and/or receiving pit locations, particularly with respect to adjacent buried utilities.

3.9 Corrosivity Testing

Sulfate ions in the soil can lower soil resistivity and can be highly aggressive to portland cement concrete by combining chemically with certain constituents of the concrete, principally tricalcium aluminate. This reaction is accompanied by expansion and eventual disruption of the concrete matrix. Potentially high sulfate content could also cause corrosion of the reinforcing steel in concrete. Table below summarizes current standards for concrete exposed to sulfate-containing solutions.

Table 4. Sulfate Concentration and Sulfate Exposure

Sulfate In Water (parts-per-million)	Water-Soluble Sulfate (SO4) in soil (percentage by weight)	Sulfate Exposure
0-150	0.00 - 0.10	Negligible
150-1,500	0.10 - 0.20	Moderate (Seawater)
1,500-10,000	0.20 - 2.00	Severe
>10,000	Over 2.00	Very Severe

The sulfate content was determined in the laboratory for representative onsite soil samples. The results indicate that the water-soluble sulfate is considered negligible to moderate along this alignment.

Many factors can affect corrosion potential of soil including soil moisture content, resistivity, permeability and pH, as well as chloride and sulfate concentration. In general, soil resistivity, which is a measure of how easily electrical current flows through soils, is the most influential factor. Based on the findings of studies presented in ASTM STP 1013 titled “Effects of Soil Characteristics on Corrosion” (February 1989), the approximate relationship between soil resistivity and soil corrosiveness was developed as shown in Table below.

Table 5. Relationship between Soil Resistivity and Soil Corrosivity

Soil Resistivity (ohm-cm)	Classification of Soil Corrosiveness
0 to 900	Very Severely Corrosive
900 to 2,300	Severely Corrosive
2,300 to 5,000	Moderately Corrosive
5,000 to 10,000	Mildly Corrosive
10,000 to >100,000	Very Mildly Corrosive

Acidity is an important factor of soil corrosivity. The lower the pH (the more acidic the environment), the higher the soil corrosivity will be with respect to buried metallic structures and utilities. As soil pH increases above 7 (the neutral value), the soil is increasingly more alkaline and less corrosive to buried steel structures, due to protective surface films, which form on steel in high pH environments. Chloride and sulfate ion concentrations, and pH appear to play secondary roles in affecting corrosion potential. High chloride levels tend to reduce soil resistivity and break down otherwise protective surface deposits, which can result in corrosion of buried steel or reinforced concrete structures. The results of the individual tests are included in Appendix B.

Table 6. Summary of Corrosivity Testing

Location / Boring	Sulfate Content (PPM)	Chloride Content (PPM)	pH	Minimum Resistivity (ohm-cm)
LB-3	259	40	7.4	1250
LB-5	91	0	6.1	2180
LB-9	-	-	-	1625
LB-11	152	140	6.2	520

Based on the above, the corrosivity characteristics of the onsite soils vary from one location to another and from “severely corrosive” to “very severely corrosive” soils. The test results are included in Appendix B.

Ferrous pipe can be protected by polyethylene bags, tape or coatings, di-electric fittings, concrete encasement or other means to separate the pipe from wet onsite soils. Further testing of import and possibly site soil corrosivity could be performed and specific recommendations for corrosion protection may need to be provided by a qualified corrosion engineer.

3.10 Additional Geotechnical Services

Recommendations are based on information available at the time our report was prepared and may change as plans are developed, or if supplemental subsurface exploration is authorized. Leighton Consulting, Inc. should review improvements plans, when available, and comment further on geotechnical aspects of the project. Geotechnical observation and testing should be conducted during excavation and all phases of construction. Geotechnical conclusions and preliminary recommendations should be reviewed and verified by us (Leighton Consulting, Inc.) during construction, and revised accordingly if geotechnical conditions encountered vary from our findings and interpretations.

4.0 LIMITATIONS

This report was necessarily based in part upon data obtained from a limited number of observances, site visits, soil samples, tests, analyses, histories of occurrences, spaced subsurface explorations and limited information on historical events and observations. Such information is necessarily incomplete. The nature of many sites is such that differing characteristics can be experienced within small distances and under various climatic conditions. Changes in subsurface conditions can and do occur over time. This exploration was performed with the understanding that the project as described in Section 1.1 of this report.

This report was prepared for Meridian Park based on Meridian Park needs, directions, and requirements at the time of our investigation. This report is not authorized for use by, and is not to be relied upon by any party except Meridian Park, and its successors and assigns as owner of the property, with whom Leighton Consulting, Inc. has contracted for the work. Use of or reliance on this report by any other party is at that party's risk. Unauthorized use of or reliance on this report constitutes an agreement to defend and indemnify Leighton Consulting, Inc. from and against any liability which may arise as a result of such use or reliance, regardless of any fault, negligence, or strict liability of Leighton Consulting, Inc.

The client is referred to Appendix C regarding important information provided by the Geoprofessional Business Association (GBA) on geotechnical engineering studies and report and their applicability.

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Project: 11227.010

Eng/Geol: SIS/RFR

Scale:1 " = 2,000 '

Date: October 2018

Base Map: ESRI ArcGIS Online 2018
Thematic Information: Leighton
Author: Leighton Geomatics (btran)

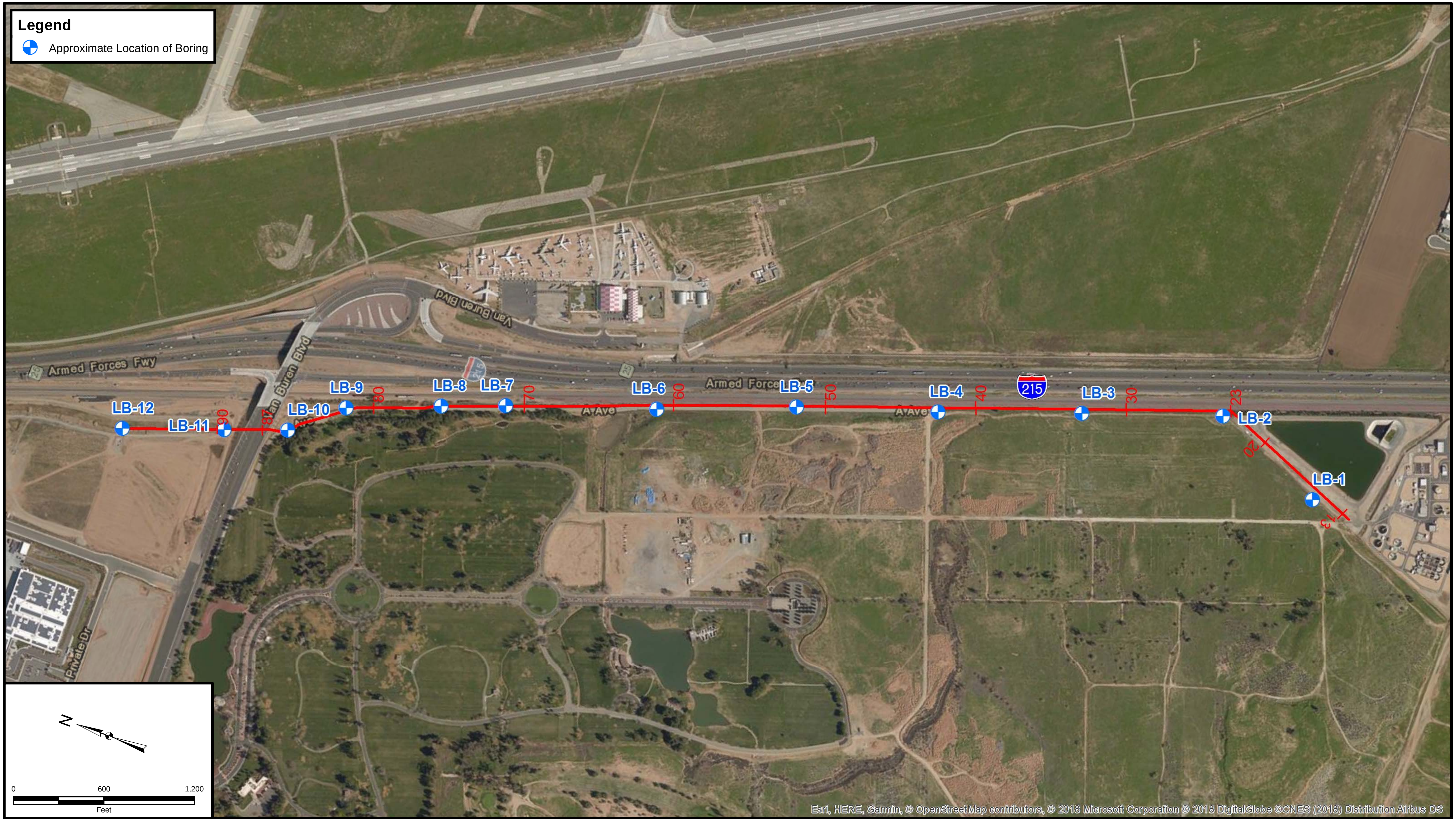
SITE LOCATION MAP

WMWD Meridian Trunk Sewer
March Business Center
Riverside County, California

Figure 1

Leighton

Map Saved as V:\Drafting\11227\010\Maps\11227-010_F01_SLM_2018-10-03.mxd on 9/24/2018 4:52:37 PM



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Project: 11227.010	Eng/Geol: SIS/RFR
Scale:1 " = 600 '	Date: October 2018

Base Map: ESRI ArcGIS Online 2018
Thematic Information: Leighton
Author: Leighton Geomatics (btran)

BORING LOCATION MAP

WMWD Meridian Trunk Sewer
March Business Center
Riverside County, California

Figure 2

Leighton

Map Saved as V:\Drafting\11227\010\Maps\11227-010_F02_BLM_2018-10-03.mxd on 10/3/2018 12:31:32 PM

APPENDIX A

Field Exploration / Logs of Exploratory Borings

Our field exploration consisted of drilling 10 hollow stem borings. Prior to drilling, we marked proposed boring locations for coordination with Underground Service Alert (USA). Our field exploration was performed on September 26 and 27, 2018 Boring locations are depicted on Figure 2.

Relatively undisturbed soil samples were obtained at selected intervals within the borings using a California ring sampler, with 2.42-inch inside diameter brass rings, driven into the soil with a 140-pound hammer free falling 30-inches in general accordance with ASTM Test Method D3550. The numbers of blows required for each 6 inches of drive penetration were noted in the field and are recorded on the boring logs. Unless otherwise indicated, the blows per foot recorded on the boring logs represent the number of blows required to drive 18 inches in 6-inch increments. Recovered soil samples were “sniffed” with a photo-ionization detector (PID) on site, and an “explosimeter” (GEM 2000) was also used to detect hazardous gasses that may emanate from these boreholes or recovered samples on site. These readings are also presented on the boring logs. In addition, disturbed bag (or bulk) samples were also obtained from soil cuttings. Where drilling occurred in existing pavement, penetrated asphalt and aggregate base thicknesses was measured and documented on the boring log. Types of samples obtained from each location are shown on the boring logs at corresponding depths. Our borings were backfilled with soil cuttings obtained during the drilling. Representative earth-material samples obtained from these subsurface explorations were transported to our Temecula geotechnical laboratory for evaluation and appropriate testing.

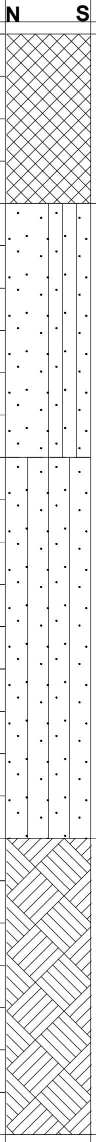
The attached subsurface exploration logs and related information depict subsurface conditions only at the locations indicated and at the particular date designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at these locations. The passage of time may result in altered subsurface conditions due to environmental changes. In addition, any stratification lines on the logs represent the approximate boundary between soil types and the transition may be gradual.

GEOTECHNICAL BORING LOG LB-1

Project No.	11227.010	**Date Drilled**	9-26-18
Project	Meridian Trunk Sewer	**Logged By**	BSS
Drilling Co.	CalPac Drilling	**Hole Diameter**	6"
Drilling Method	Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop	**Ground Elevation**	1533'
Location	~ Station 13+00 - See Boring Location Map - Figure 2	**Sampled By**	BSS

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.



Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0						SM	**Artificial Fill (Afu):** SILTY SAND, medium dense, light brown, dry to moist, fine sand, few gravel	
1530									
								Quaternary Older Alluvium (Qaol):	
	5		R-1	5 7 10	117	3	SP-SM	Poorly graded SAND with SILT, loose, light brown, dry to moist, fine to medium sand, some rootlets	
1525									
	10		R-2	13 50-5"			SM	SILTY SAND with gravel, very dense, light reddish brown, moist, fine to coarse sand, some weathered gravel, trace clay, micaceous	
1520									
	15		R-3 B-1	50-6"				very dense, light brownish gray, dry to moist, fine to coarse sand with fine gravel, micaceous (13% fines, 3% gravel)	SA
1515									
								Granitic Bedrock (Kgr): Highly weathered bedrock, recovered as:	
	20		R-4	33 50-2"				Well-graded SAND, very dense, light brownish gray, moist, fine to coarse sand with fine gravel, micaceous, some silt	
1510									
	25		R-5	50-5"				very dense, light brownish gray, wet, fine to coarse sand, some silt and gravel, micaceous	
								Drilled to 25' Sampled to 25.5' Groundwater at 19.1' Backfilled with soil cuttings (9/26/18)	
1505									
	30								

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

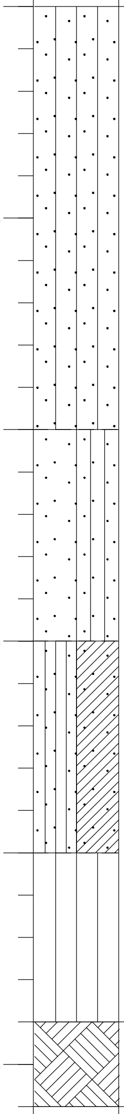
*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-2

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 22+50 - See Boring Location Map - Figure 2

Date Drilled 9-26-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1527'
Sampled By BSS

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.



Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							**Quaternary Older Alluvium (Qaol):**	
			B-1				SM	SILTY SAND, medium dense, light brown, dry to moist, fine sand, few gravel	
1525									
	5		R-1	22 40 50-4"	118	10		very dense, light brown, dry, fine sand, some clay layers	
1520									
	10		R-2	9 27 32	124	6	SP-SM	Poorly graded SAND with SILT, dense, light reddish brown, dry to moist, fine to medium sand, few gravel	
1515									
	15		R-3	16 27 38	115	16	SC-SM	SILTY, CLAYEY SAND, dense, light brown, dry to moist, fine sand	
1510									
	20		R-4	8 15 25	103	22	ML	SANDY SILT, very stiff, light brown, moist, very fine sand, few fine gravel, some mica	
1505									
								Granitic Bedrock (Kgr): Highly weathered bedrock, recovered as:	
	25		R-5	50-6"				Well-graded SAND, very dense, dark gray, moist, fine to coarse sand with fine gravel, micaceous	
								Drilled to 25' Sampled to 25.5' Groundwater not encountered Backfilled with soil cuttings (9/26/18)	
1500									
	30								

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

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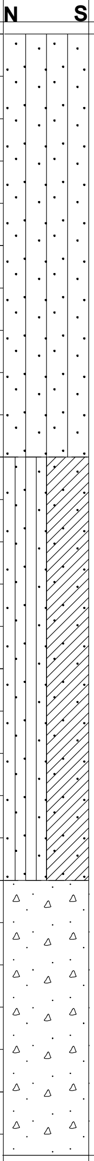
GEOTECHNICAL BORING LOG LB-3

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 32+00 - See Boring Location Map - Figure 2

Date Drilled 9-26-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1529'
Sampled By BSS



Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0							SM	**Quaternary Older Alluvium (Qaol):** SILTY SAND, medium dense, light brown, dry, fine sand	
1525										
	5			R-1	11 22 40	126	8		dense, light reddish brown, dry to moist, fine sand, some clay with calcium carbonate, few gravel	
1520										
	10			R-2 B-1	14 21 30	119	13	SC-SM	SILTY, CLAYEY SAND, dense, brown, moist, fine to medium sand, trace gravel (47% fines, 1% gravel, SE = 10, EI = 16, MD: 130.5 @ 10.3%)	SA, SE, MD, CR
1515										
	15			R-3	13 32 50-5"	130	10		very dense, brown, moist, fine to medium sand, some caliche, become weathered gravel at the bottom	
1510										
	20			R-4	14 19 32			SW	Well-graded SAND, dense, light brown, dry to moist, fine to coarse sand with fine gravel	
1505										
	25			R-5	9 11 14				medium dense, light yellowish brown, moist, fine to coarse sand with fine gravel, micaceous, trace silt	
									Drilled to 25' Sampled to 26.5' Groundwater not encountered Backfilled with soil cuttings (9/26/18)	
1500										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-4

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 42+00 - See Boring Location Map - Figure 2

Date Drilled 9-26-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1527'
Sampled By BSS

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0							SM	**Quaternary Older Alluvium (Qaol):** SILTY SAND, medium dense, brown, dry to moist, fine sand, some clay	
1525										
	5			R-1	23 50-5"	127	7		very dense, brown, dry to moist, fine to coarse sand, some clay	
1520										
	10			R-2	9 12 19	122	12	SC-SM	SILTY, CLAYEY SAND, medium dense, brown, moist, fine sand, (CO = -0.09%)	CO
1515										
	15			R-3	14 39 50-5"	125	13		very dense, reddish brown, moist, fine sand, some weathered gravel	
1510										
	20			R-4	8 36 50-6"			SW	Well-graded SAND with GRAVEL, very dense, grayish brown, dry to moist, fine to coarse sand, some silt, micaceous	
									Drilled to 20' Sampled to 21.5' Groundwater not encountered Backfilled with soil cuttings (9/26/18)	
1505										
	25									
1500										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-5

Project No.	11227.010	**Date Drilled**	9-26-18
Project	Meridian Trunk Sewer	**Logged By**	BSS
Drilling Co.	CalPac Drilling	**Hole Diameter**	6"
Drilling Method	Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop	**Ground Elevation**	1524'
Location	~ Station 52+00 - See Boring Location Map - Figure 2	**Sampled By**	BSS

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							SM	**Quaternary Older Alluvium (Qaol):** SILTY SAND, medium dense, light brown, dry, fine sand, some gravel on surface (MD 128.3 @ 9.5%)	
1520										
	5			R-1 B-1	14 21 36	123	9		dense, light reddish brown, moist, fine sand, few coarse sand	MD, CR
1515										
	10			R-2	16 27 33	119	16		dense, brown, dry to moist, fine sand, some weathered gravel	
1510										
	15			R-3	9 20 41	126	6	SC-SM	SILTY, CLAYEY SAND, dense, brown, moist, fine sand, some caliche	
									Drilled to 15' Sampled to 16.5' Groundwater not encountered Backfilled with soil cuttings (9/26/18)	
1505										
	20									
1500										
	25									
1495										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-6

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 61+25 - See Boring Location Map - Figure 2

Date Drilled 9-26-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1529'
Sampled By BSS

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								3 inches Asphalt over 4 inches Base	
								SM	SILTY SAND, medium dense, brown, dry to moist, fine sand, surface covered with gravel	
									Quaternary Older Alluvium (Qaol):	
1525										
	5			R-1	19 50-5"	124	9		very dense, light brown, dry to moist, fine sand, few coarse sand, some caliche	
1520										
	10			R-2	6 18 28	128	8		medium dense, brown, moist, fine to coarse sand, some weathered gravel	
1515										
	15			R-3	8 13 28	118	13	SC	CLAYEY SAND, dense, grayish brown, moist, fine to medium sand, some caliche	
1510										
	20			R-4	8 17 17	120	14	SW	Well-graded SAND with GRAVEL, medium dense, light gray, moist to wet, fine to coarse sand, trace clay	
									Drilled to 20' Sampled to 21.5' Groundwater at 19.8' Backfilled with soil cuttings (9/26/18)	
1505										
	25									
1500										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-7

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 71+50 - See Boring Location Map - Figure 2
Date Drilled 9-26-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1533'
Sampled By BSS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0								**Quaternary Older Alluvium (Qaol):**	
								SM	SILTY SAND, medium dense, reddish brown, moist, fine sand, some clay	
1530										
	5			R-1 B-1	17 48 50-5"	117	13		very dense, light brown, dry to moist, fine sand, trace fine gravel (SE = 7)	SE
1525										
	10			R-2	17 44 50-4"	112	14		very dense, brown, moist, fine to medium sand, few weathered gravel, few caliche	
1520										
	15			R-3	9 17 30	107	20	SC-SM	SILTY, CLAYEY SAND, dense, grayish brown, moist, fine sand	
1515										
	20			R-4	9 16 25	113	18	SM	SILTY SAND, dense, grayish brown, moist, very fine sand, some mica	
									Drilled to 20' Sampled to 21.5' Groundwater not encountered Backfilled with soil cuttings (9/26/18)	
1510										
	25									
1505										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-8

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 75+50 - See Boring Location Map - Figure 2

Date Drilled 9-26-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1534'
Sampled By BSS

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0							SM	**<u>Quaternary Older Alluvium (Qaol):</u>** SILTY SAND, medium dense, brown, moist, fine sand, some clay	
1530										
	5			R-1	7 14 33	127	8	SC-SM	SILTY, CLAYEY SAND, dense, reddish brown, moist, fine sand, some weathered gravel	
1525										
	10			R-2	9 20 22	117	5	SM	SILTY SAND, dense, grayish brown, moist, fine sand, some caliche (CO = -1.89%)	CO
1520										
	15			R-3	18 21 30	121	7	SP-SM	Poorly graded SAND with SILT, dense, reddish brown, moist, fine to medium sand, some weathered gravel	
1515										
	20			R-4	18 19 34			SM	SILTY SAND, dense, olive brown, moist, fine sand, some coarse sand	
									Drilled to 20' Sampled to 21.5' Groundwater not encountered Backfilled with soil cuttings (9/27/18)	
1510										
	25									
1505										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-9

Project No.	11227.010	**Date Drilled**	9-27-18
Project	Meridian Trunk Sewer	**Logged By**	BSS
Drilling Co.	CalPac Drilling	**Hole Diameter**	6"
Drilling Method	Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop	**Ground Elevation**	1535'
Location	~ Station 81+50 - See Boring Location Map - Figure 2	**Sampled By**	BSS

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
1535	0							SM	**Quaternary Older Alluvium (Qaol):** SILTY SAND, medium dense, brown, dry to moist, fine sand, trace clay	
1530	5			R-1	20 36 50-5"	127	8		very dense, light reddish brown, dry to moist, fine to medium sand, some weathered gravel	
1525	10			R-2 B-1	8 20 40	119	9		dense, grayish brown, moist, fine to medium sand, trace gravel, some caliche (30% fines, 1% gravel) (PID Reading: VOC = 4.6 ppm, LEL = 4.0 %)	SA, CR
1520	15			R-3	11 37 50-3"	124	9		very dense, grayish brown, moist, fine to medium sand, some weathered gravel	
	▼									
1515	20			R-4	17 32 33	121	13	SW-SM	Well-graded SAND with SILT and GRAVEL, dense, grayish brown, moist to wet, fine to coarse sand, few caliche (12% fines, 12% gravel)	SA
1510	25			R-5	9 23 31			SW	Well-graded SAND with GRAVEL, dense, grayish brown, wet, fine to coarse sand, micaceous	
									Drilled to 25' Sampled to 26.5' Groundwater at 19' Backfilled with soil cuttings (9/27/18)	
1505	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-10

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 85+50 - See Boring Location Map - Figure 2

Date Drilled 9-27-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1537'
Sampled By BSS

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0							SM	**Quaternary Older Alluvium (Qaol):** SILTY SAND, medium dense, brown, dry to moist, fine sand, some gravel	
1535										
	5			R-1	50-6"				very dense, light reddish brown, dry to moist, fine sand, few fine gravel, some clay	
1530										
	10			R-2	24 50-6"	116	10		very dense, reddish brown, dry to moist, fine sand, some fine gravel	
1525										
	15			R-3 B-1	11 17 34	113	16		dense, grayish brown, moist, fine sand, trace weathered gravel, micaceous (36% fines, 1% gravel) (PID Reading: VOC = 3.9 ppm, LEL = 2.0%)	SA
1520										
▼	20			R-4	15 24 34	113	13	SW	Well-graded SAND with GRAVEL, dense, grayish brown, moist to wet, fine to coarse sand, some silt, micaceous	
1515										
	25			R-5	11 26 50-6"				very dense, grayish brown, wet, fine to coarse sand with fine gravel, some silt	
1510										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG LB-10

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 85+50 - See Boring Location Map - Figure 2

Date Drilled 9-27-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1537'
Sampled By BSS

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	30			R-6	8 21 26				dense, light reddish brown, wet, fine to coarse sand with fine gravel	
1505									Drilled to 30' Sampled to 31.5' Groundwater at 20.2' Backfilled with soil cuttings (9/27/18)	
	35									
1500										
	40									
1495										
	45									
1490										
	50									
1485										
	55									
1480										
	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-11

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 89+50 - See Boring Location Map - Figure 2

Date Drilled 9-27-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1543'
Sampled By BSS

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							SM	**Quaternary Older Alluvium (Qaol):** SILTY SAND, medium dense, brown, dry to moist, fine sand, some gravel	
1540										
	5			R-1	14 22 23	123	6		dense, dark brown, dry to moist, fine sand, some fine gravel	
1535										
	10			R-2	11 35 50-6"	121	8	SC-SM	SILTY, CLAYEY SAND, very dense, reddish brown, moist, fine sand	
1530										
	15			R-3	20 27 44	91	28		very dense, light reddish brown, moist, fine sand, some caliche (34% fines, 1% gravel, EI = 32) (PID Reading: VOC = 3.8 ppm, LEL = 4.5%)	SA, CR
1525										
	20			R-4	17 22 50-5"	111	15	SM	SILTY SAND, very dense, grayish brown, moist to wet, fine sand, caliche, some coarse sand	
1520										
	25			R-5	18 23 34	124	9	SW	Well-graded SAND with GRAVEL, dense, dark gray, wet, fine to coarse sand, micaceous	
1515										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-11

Project No. 11227.010
Project Meridian Trunk Sewer
Drilling Co. CalPac Drilling
Drilling Method Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop
Location ~ Station 89+50 - See Boring Location Map - Figure 2

Date Drilled 9-27-18
Logged By BSS
Hole Diameter 6"
Ground Elevation 1543'
Sampled By BSS

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	30			R-6	12 18 44			SM	SILTY SAND, dense, olive brown, moist to wet, fine sand, some gravel	
									Drilled to 30' Sampled to 31.5' Groundwater at 26.2' Backfilled with soil cuttings (9/27/18)	
1510										
	35									
1505										
	40									
1500										
	45									
1495										
	50									
1490										
	55									
1485										
	60									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING
AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CO	COLLAPSE
CR	CORROSION
CU	UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
H	HYDROMETER
MD	MAXIMUM DENSITY
PP	POCKET PENETROMETER
RV	R VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT
SG	SPECIFIC GRAVITY
UC	UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-12

Project No.	11227.010	**Date Drilled**	9-27-18
Project	Meridian Trunk Sewer	**Logged By**	BSS
Drilling Co.	CalPac Drilling	**Hole Diameter**	6"
Drilling Method	Hollow Stem Auger - 140lb - Hollow Stem Auger - 30" Drop	**Ground Elevation**	1548'
Location	~ Station 96+25 - See Boring Location Map - Figure 2	**Sampled By**	BSS

Elevation Feet	Depth Feet	Graphic Log N S	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0							SM	**Quaternary Older Alluvium (Qaol):** SILTY SAND, medium dense, dark brown, moist, fine sand	
1545										
	5			R-1	8 9 10	117	6		medium dense, brown, dry to moist, fine sand, some fine gravel	
1540										
	10			R-2	7 15 19	117	6		medium dense, reddish brown, moist, fine sand, some fine gravel	
1535										
	15			R-3	17 35 50-6"	129	8	SP-SM	Poorly graded SAND with SILT, very dense, light reddish brown, moist, fine to medium sand, some caliche	
1530										
	20			R-4	22 33 42	113	13	SM	SILTY SAND, dense, light brown, moist, fine to medium sand, some caliche	
1525										
	25			R-5	7 20 30	117	13		dense, olive brown, moist, fine sand, micaceous, some caliche	
									Drilled to 25' Sampled to 26.5' Groundwater not encountered Backfilled with soil cuttings (9/27/18)	
1520										
	30									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

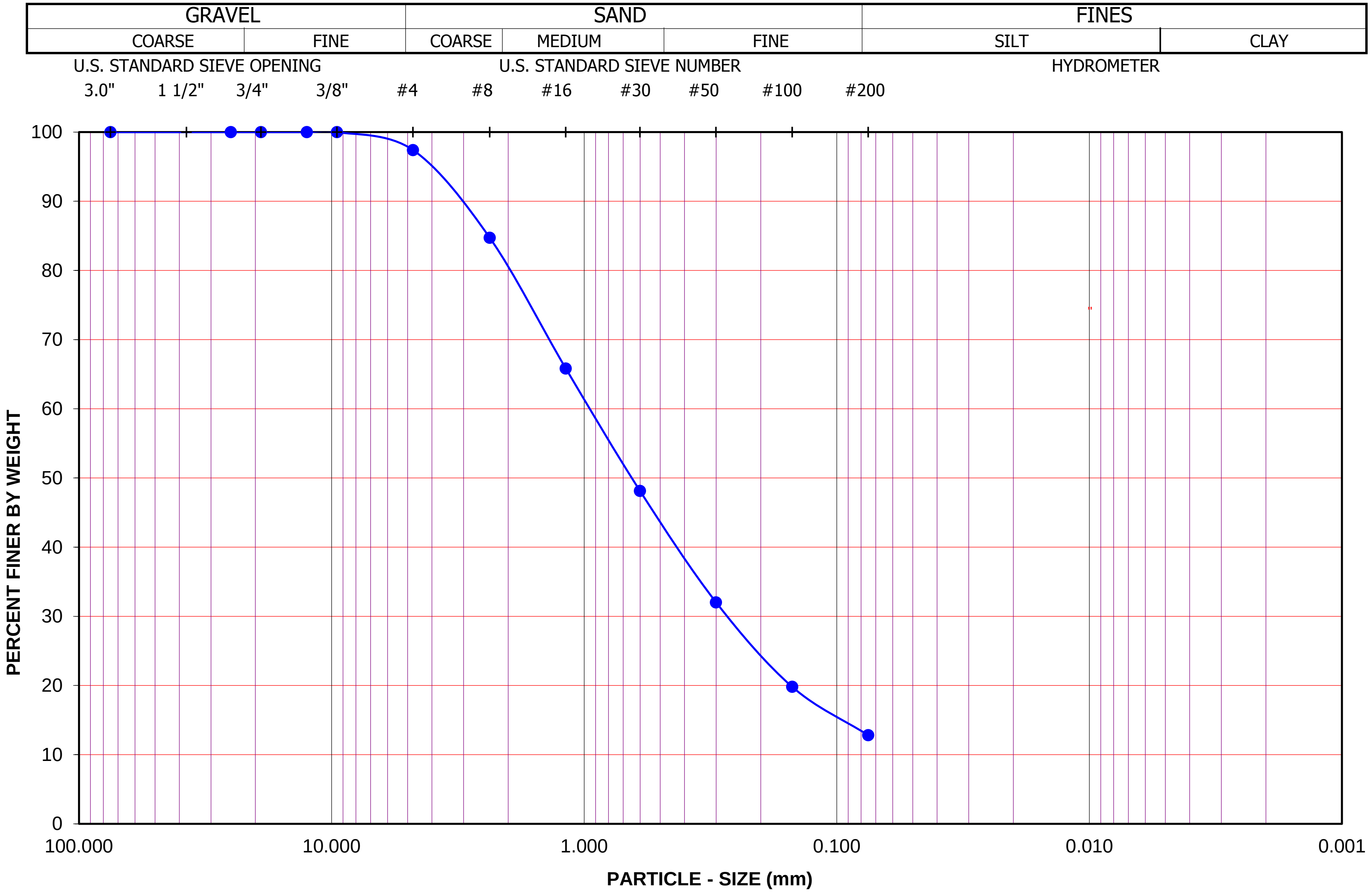
TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

APPENDIX B

Results of Laboratory Testing



Project Name: Meridian Park S VA Trunk Sewer

Project No.: 11227.010

Boring No.: LB-1

Sample No.: B-1

Depth (feet): 16.0 - 18.0

Soil Type : SM

Soil Identification: Silty Sand (SM), Brown.

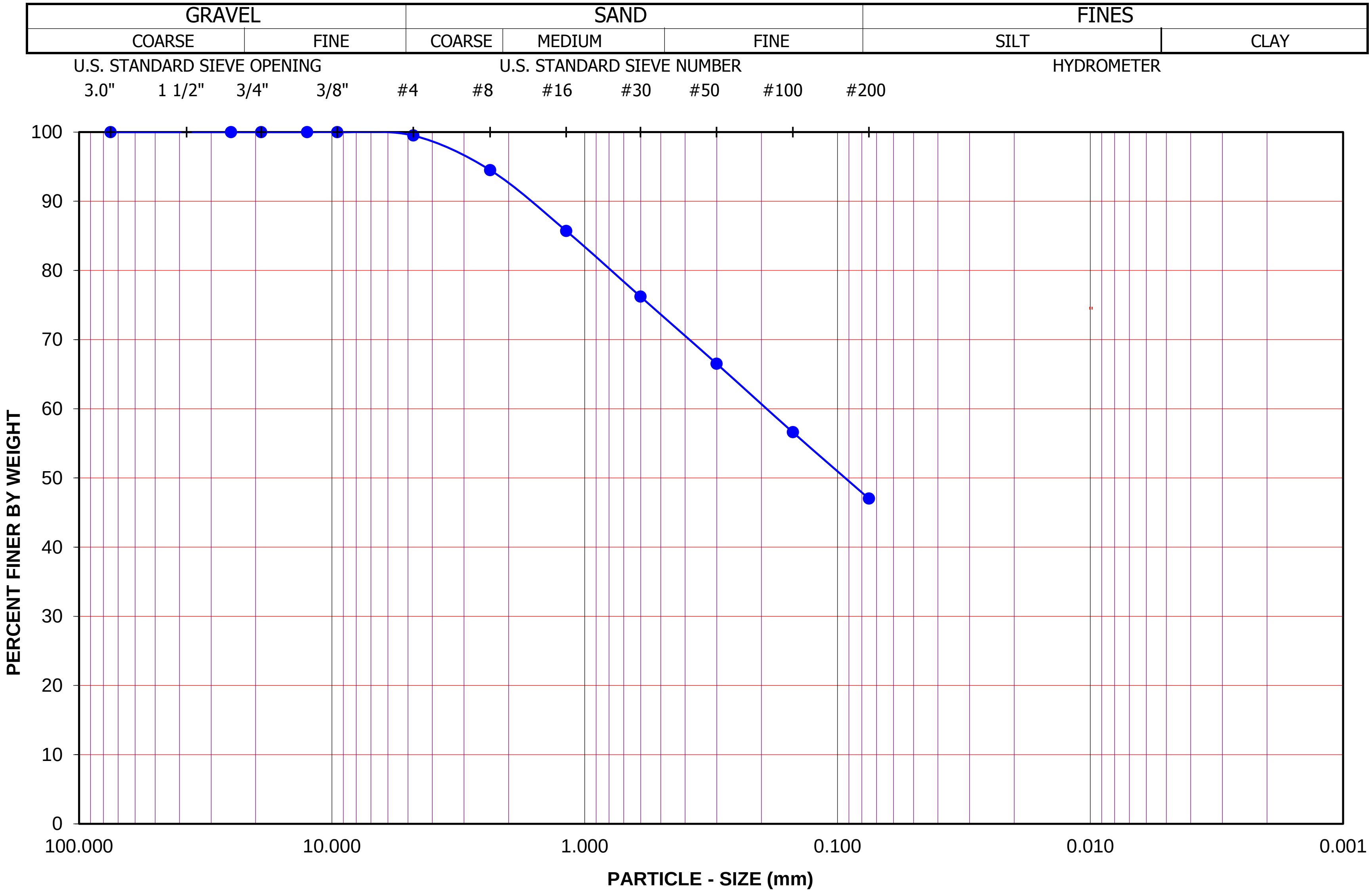
Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 3 : 84 : 13

Oct-18

Sieve; LB-1, B-1 (9-26-18)



Project Name: Meridian Park S VA Trunk Sewer

Project No.: 11227.010

Boring No.:	LB-3	Sample No.:	B-1
Depth (feet):	11.0 - 14.0	Soil Type :	SC-SM

Soil Identification: Silty, Clayey Sand (SC-SM), Brown.

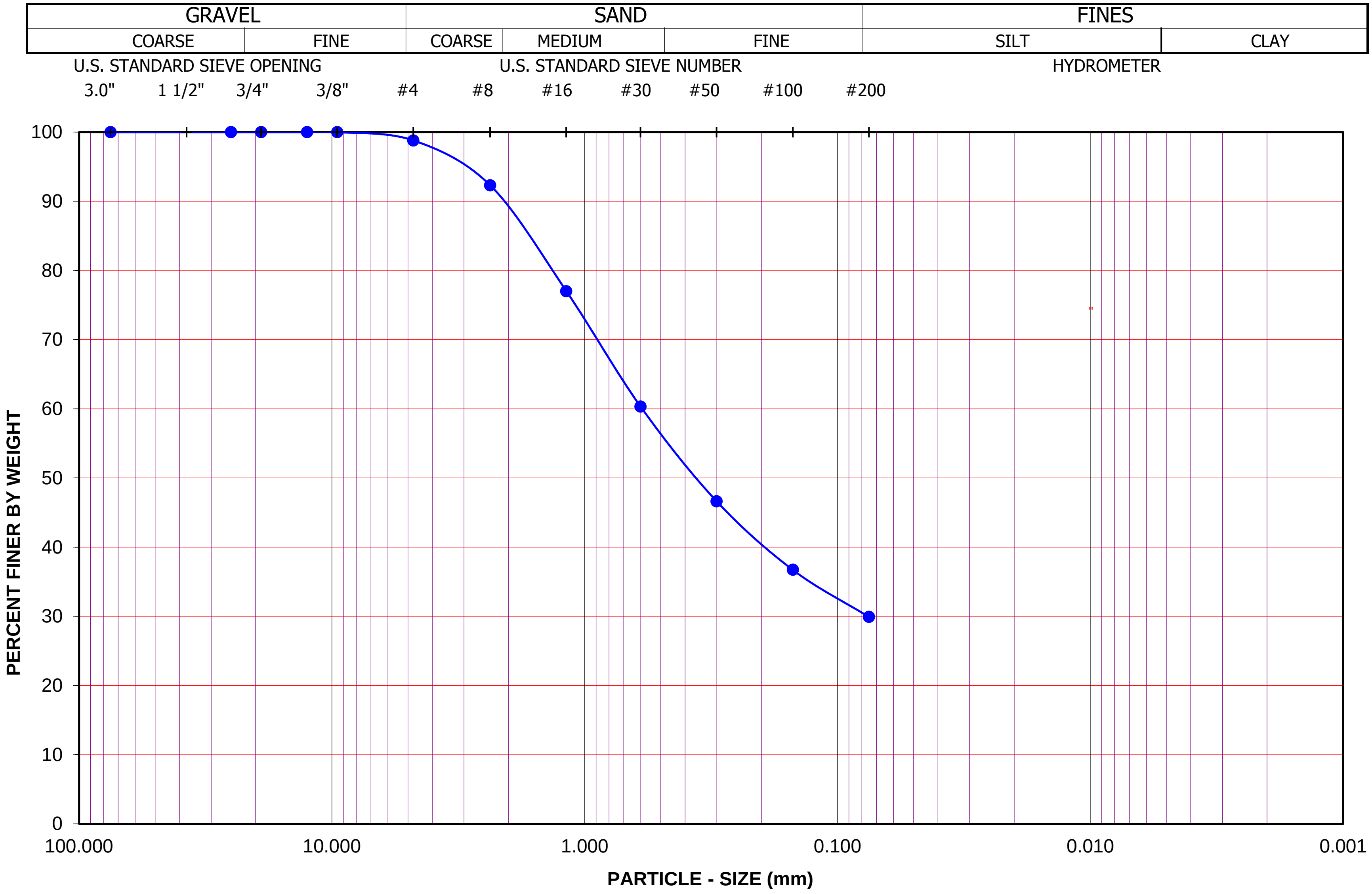
GR:SA:FI : (%) 1 : 52 : 47

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

Oct-18

Sieve; LB-3, B-1 (9-26-18)



Project Name: Meridian Park S VA Trunk Sewer

Project No.: 11227.010

Boring No.: LB-9

Sample No.: B-1

Depth (feet): 11.0 - 14.0

Soil Type : SM

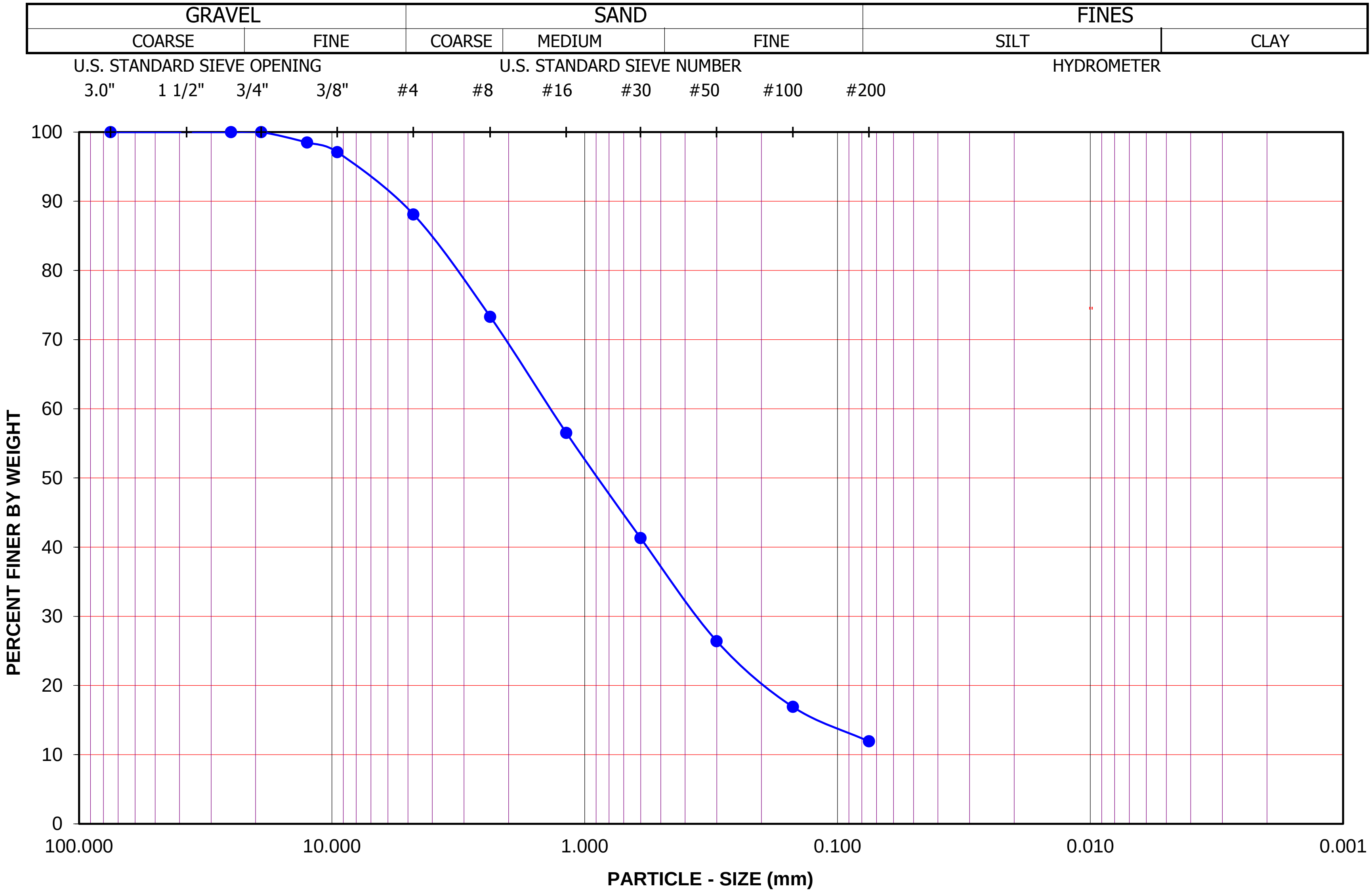
Soil Identification: Silty Sand (SM), Brown.

GR:SA:FI : (%) 1 : 69 : 30

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

Oct-18



Project Name: Meridian Park S VA Trunk Sewer

Project No.: 11227.010

Boring No.: LB-9

Sample No.: R-4

Depth (feet): 20.0

Soil Type : SW-SM

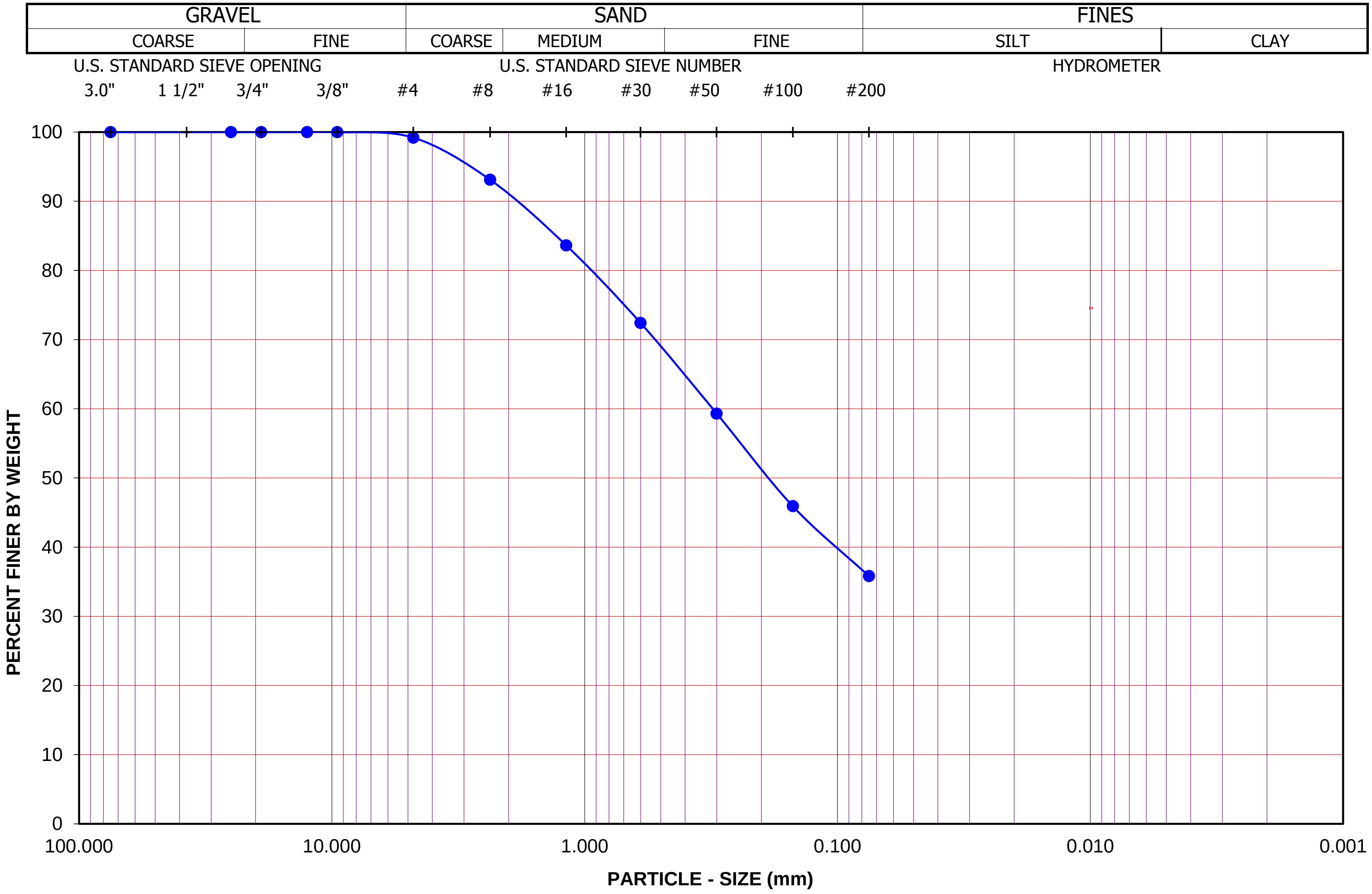
Soil Identification: Well-Graded Sand with Silt (SW-SM), Brown.

Leighton

PARTICLE - SIZE
DISTRIBUTION
ASTM D 6913

GR:SA:FI : (%) **12 : 76 : 12**

Oct-18



Project Name: Meridian Park S VA Trunk Sewer

Project No.: 11227.010

Boring No.: LB-10 Sample No.: B-1

Depth (feet): 16.0 - 19.0 Soil Type : SM

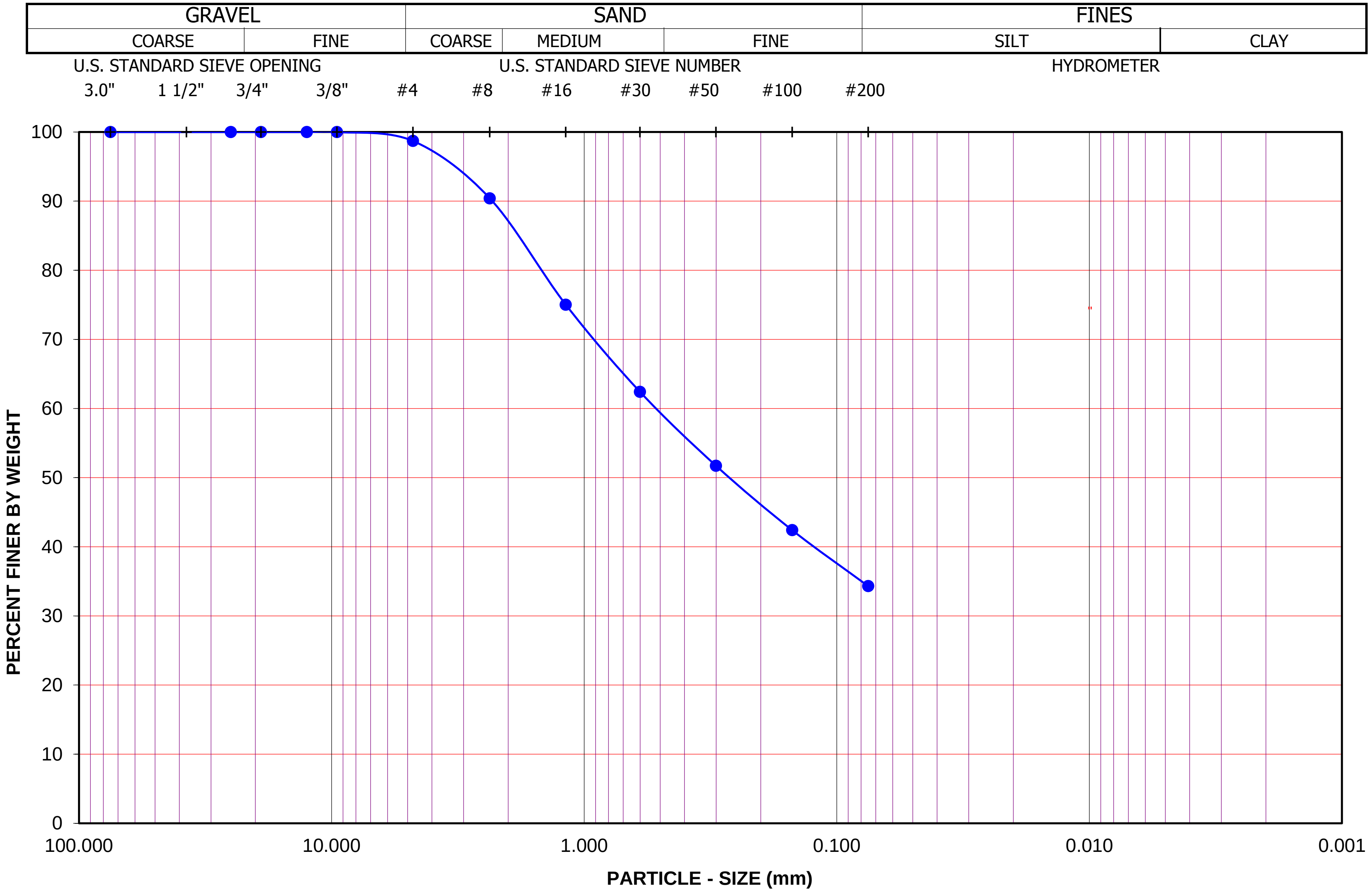
Soil Identification: Silty Sand (SM), Brown.

GR:SA:FI : (%) 1 : 63 : 36

Leighton

PARTICLE - SIZE
DISTRIBUTION
ASTM D 6913

Oct-18



Project Name: Meridian Park S VA Trunk Sewer

Project No.: 11227.010

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

Boring No.: LB-11

Sample No.: B-1

Depth (feet): 16.0 - 18.0

Soil Type : SC-SM

Soil Identification: Silty, Clayey Sand (SC-SM), Reddish Brown.

GR:SA:FI : (%) 1 : 65 : 34

Oct-18

Leighton

SAND EQUIVALENT TEST

ASTM D 2419 / DOT CA Test 217

Project Name: Meridian Park S VA Trunk Sewer

Tested By: M. Vinet

Date: 10/1/18

Project No. : 11227.010

Computed By: M. Vinet

Date: 10/1/18

Client: Meridian West Campus

Checked By: M. Vinet

Date: 10/1/18

Boring No.	Sample No.	Depth (ft.)	Soil Description	T1	T2	T3	T4	R1	R2	SE	Average SE
LB-3	B-1	11.0 - 14.0	Silty, Clayey Sand (SC-SM)	08:00	08:10	08:12	08:32	12.9	1.2	10	**10**
				08:02	08:12	08:14	08:34	13.4	1.3	10	

T1 = Starting Time

T2 = (T1 + 10 min) Begin Agitation

T3 = Settlement Starting Time

T4 = (T3 + 20 min) Take Clay Reading (R1)

Sand Equivalent = R2 / R1 * 100

Record SE as Next Higher Integer

Leighton

SAND EQUIVALENT TEST

ASTM D 2419 / DOT CA Test 217

Project Name: Meridian Park S VA Trunk Sewer

Project No. : 11227.010

Client: Meridian West Campus

Tested By: M. Vinet Date: 10/1/18

Computed By: M. Vinet Date: 10/1/18

Checked By: M. Vinet Date: 10/1/18

Boring No.	Sample No.	Depth (ft.)	Soil Description	T1	T2	T3	T4	R1	R2	SE	Average SE
LB-7	B-1	6.0 - 9.0	Silty, Clayey Sand (SC-SM)	08:04	08:14	08:16	08:36	12.9	0.9	7	**7**
				08:06	08:16	08:18	08:38	13.1	0.9	7	

T1 = Starting Time

T2 = (T1 + 10 min) Begin Agitation

T3 = Settlement Starting Time

T4 = (T3 + 20 min) Take Clay Reading (R1)

Sand Equivalent = R2 / R1 * 100

Record SE as Next Higher Integer

Leighton

One-Dimensional Swell or Settlement Potential of Cohesive Soils

(ASTM D 4546) -- Method 'B'

Project Name: Meridian Park S VA Trunk Sewer
Tested By: M. Vinet Date: 9/27/18
Project No.: 11227.010
Checked By: M. Vinet Date: 10/1/18
Boring No.: **LB-4**
Sample Type: IN SITU
Sample No.: **R-2**
Depth (ft.) 10.0
Sample Description: Silty Sand (SM), Brown.
Source and Type of Water Used for Inundation: Arrowhead (Distilled)

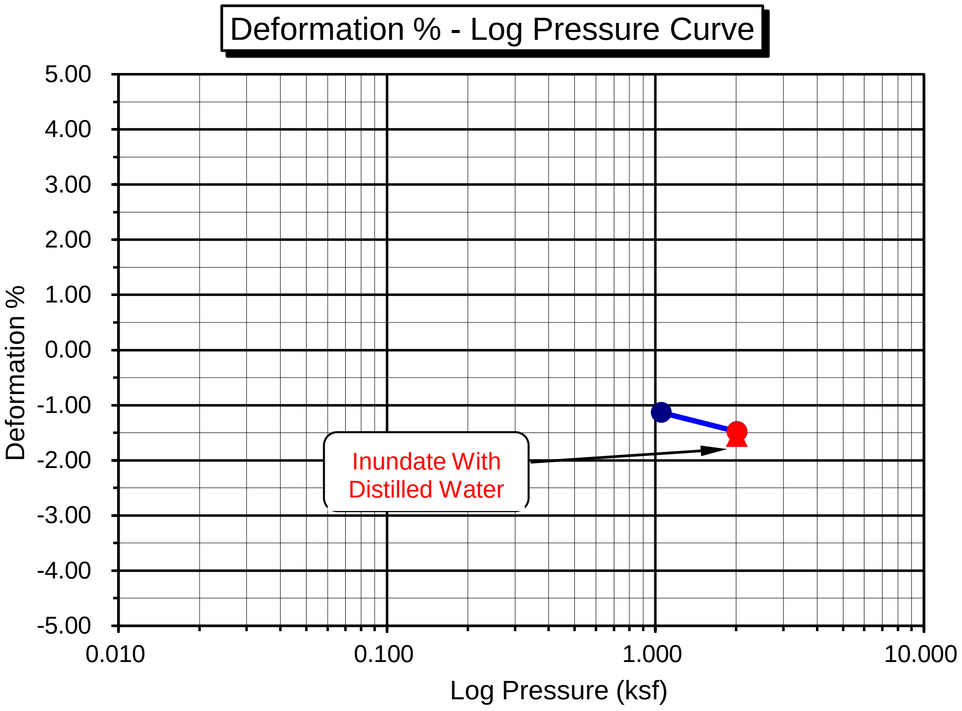
** Note: Loading After Wetting (Inundation) not Performed Using this Test Method.

Initial Dry Density (pcf):	117.8
Initial Moisture (%):	13.2
Initial Height (in.):	1.0000
Initial Dial Reading (in):	0.0000
Inside Diameter of Ring (in):	2.416

Final Dry Density (pcf):	119.6
Final Moisture (%) :	15.4
Initial Void ratio:	0.4315
Specific Gravity (assumed):	2.70
Initial Degree of Saturation (%):	82.6

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
1.050	0.0113	0.9887	0.00	-1.13	0.4153	-1.13
2.013	0.0148	0.9852	0.00	-1.48	0.4103	-1.48
H2O	0.0157	0.9843	0.00	-1.57	0.4090	-1.57

Percent Swell / Settlement After Inundation = -0.09



Rev. 01-10

Leighton

One-Dimensional Swell or Settlement Potential of Cohesive Soils

(ASTM D 4546) -- Method 'B'

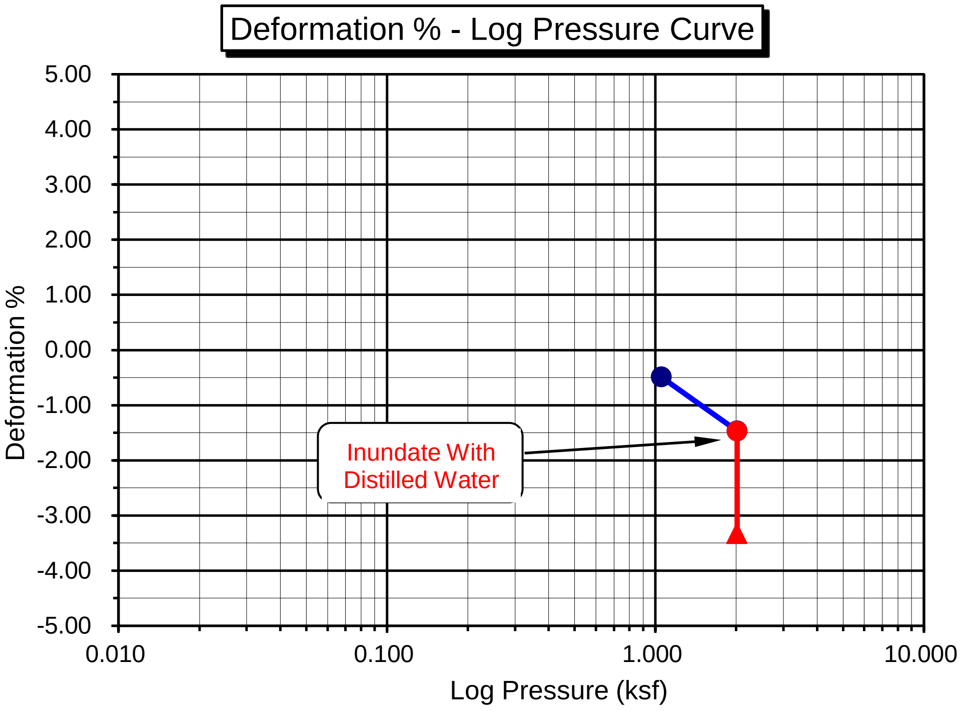
Project Name: Meridian Park S VA Trunk Sewer
Project No.: 11227.010
Boring No.: **LB-8**
Sample No.: **R-2**
Sample Description: Silty Sand (SM), Brown.
Tested By: M. Vinet Date: 10/1/18
Checked By: M. Vinet Date: 10/1/18
Sample Type: IN SITU
Depth (ft.) 10.0
Source and Type of Water Used for Inundation: Arrowhead (Distilled)
** Note: Loading After Wetting (Inundation) not Performed Using this Test Method.

Initial Dry Density (pcf):	119.9
Initial Moisture (%):	5.1
Initial Height (in.):	1.0000
Initial Dial Reading (in):	0.0000
Inside Diameter of Ring (in):	2.416

Final Dry Density (pcf):	124.0
Final Moisture (%) :	13.4
Initial Void ratio:	0.4057
Specific Gravity (assumed):	2.70
Initial Degree of Saturation (%):	33.7

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
1.050	0.0049	0.9951	0.00	-0.49	0.3988	-0.49
2.013	0.0147	0.9853	0.00	-1.47	0.3850	-1.47
H2O	0.0333	0.9667	0.00	-3.33	0.3589	-3.33

Percent Swell / Settlement After Inundation = -1.89



Rev. 01-10

Leighton

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name: Meridian Park S VA Trunk Sewer
Tested By: M. Vinet
Date: 9/27/18
Project No. : 11227.010
Checked By: M. Vinet
Date: 9/28/18
Boring No.: LB-3
Depth: 11.0 - 14.0
Sample No. : B-1
Location: N/A
Sample Description: Silty, Clayey Sand (SC-SM), Brown.

Dry Wt. of Soil + Cont. (gm.)	
Wt. of Container No. (gm.)	0.0
Dry Wt. of Soil (gm.)	0.0
Weight Soil Retained on #4 Sieve	
Percent Passing # 4	#DIV/0!

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0162
Wt. Comp. Soil + Mold (gm.)	605.0	631.4
Wt. of Mold (gm.)	182.9	182.9
Specific Gravity (Assumed)	2.70	2.70
Container No.	11	11
Wet Wt. of Soil + Cont. (gm.)	1271.6	631.4
Dry Wt. of Soil + Cont. (gm.)	1248.9	390.1
Wt. of Container (gm.)	971.6	182.9
Moisture Content (%)	8.2	15.0
Wet Density (pcf)	127.3	133.1
Dry Density (pcf)	117.7	115.8
Void Ratio	0.433	0.456
Total Porosity	0.302	0.313
Pore Volume (cc)	62.5	65.9
Degree of Saturation (%) [S meas]	**51.2**	**88.7**

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h.

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
9/27/18	12:00	1.0	0	0.5000
9/27/18	12:10	1.0	10	0.5000
	Add Distilled Water to the Specimen			
9/28/18	8:00	1.0	1190	0.5162
9/28/18	9:00	1.0	1250	0.5162

Expansion Index (EI meas) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	16.2
Expansion Index (Report) = Nearest Whole Number or Zero (0) if Initial Height is > than Final Heigh	**16**

Rev. 03-08

Leighton

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name: Meridian Park S VA Trunk Sewer
Tested By: F. Mina
Date: 10/1/18
Project No. : 11227.010
Checked By: M. Vinet
Date: 10/2/18
Boring No.: LB-11
Depth: 16.0 - 18.0
Sample No. : B-1
Location: N/A
Sample Description: Silty Clayey Sand (SC-SM), Reddish Brown.

Dry Wt. of Soil + Cont. (gm.)	301.9
Wt. of Container No. (gm.)	0.0
Dry Wt. of Soil (gm.)	301.9
Weight Soil Retained on #4 Sieve	3.9
Percent Passing # 4	98.7

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0318
Wt. Comp. Soil + Mold (gm.)	575.1	605.5
Wt. of Mold (gm.)	181.1	181.1
Specific Gravity (Assumed)	2.70	2.70
Container No.	7	7
Wet Wt. of Soil + Cont. (gm.)	350.8	605.5
Dry Wt. of Soil + Cont. (gm.)	321.1	355.0
Wt. of Container (gm.)	50.8	181.1
Moisture Content (%)	11.0	19.6
Wet Density (pcf)	118.8	124.1
Dry Density (pcf)	107.1	103.8
Void Ratio	0.575	0.625
Total Porosity	0.365	0.384
Pore Volume (cc)	75.5	82.1
Degree of Saturation (%) [S meas]	**51.7**	**84.6**

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h.

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
10/1/18	11:30	1.0	0	0.5000
10/1/18	11:40	1.0	10	0.5000
	Add Distilled Water to the Specimen			
10/2/18	12:00	1.0	1460	0.5318
10/2/18	13:00	1.0	1520	0.5318

Expansion Index (EI meas) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	31.8
Expansion Index (Report) = Nearest Whole Number or Zero (0) if Initial Height is > than Final Heigh	**32**

Leighton

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Project Name: Meridian Park S VA Trunk Sewer
Tested By: M. Vinet
Date: 09/28/18
Project No.: 11227.010
Input By: M. Vinet
Date: 10/01/18
Boring No.: LB-3
Depth (ft.): 11.0 - 14.0
Sample No.: B-1
Soil Identification: Silty, Clayey Sand (SC-SM), Brown.

Preparation Method: ☒ Moist ☐ Dry

☒ Mechanical Ram ☐ Manual Ram

Mold Volume (ft³) 0.03340

Ram Weight = 10 lb.; Drop = 18 in.

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	5632	5718	5649			
Weight of Mold (g)	3531	3531	3531			
Net Weight of Soil (g)	2101	2187	2118			
Wet Weight of Soil + Cont. (g)	2512.3	2567.6	2536.0			
Dry Weight of Soil + Cont. (g)	2347.8	2355.3	2289.0			
Weight of Container (g)	418.9	420.8	420.9			
Moisture Content (%)	8.5	11.0	13.2			
Wet Density (pcf)	138.7	144.4	139.8			
Dry Density (pcf)	127.8	130.1	123.5			

Maximum Dry Density (pcf) 130.5 **Optimum Moisture Content (%)** 10.3

PROCEDURE USED

☒ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

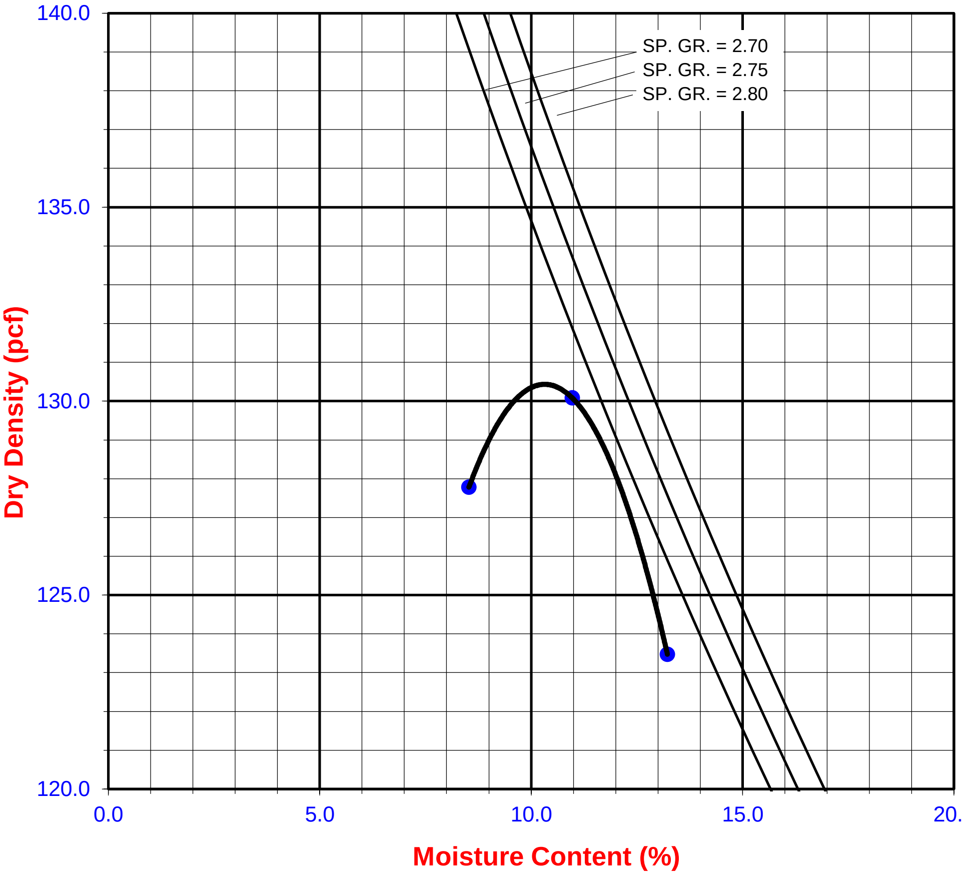
☐ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

☐ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:
1:52:47
GR:SA:FI

Atterberg Limits:

LL,PL,PI



Compaction; LB-3, B-1 (9-26-18)

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name: Meridian Park S VA Trunk Sewer
Tested By: M. Vinet
Date: 09/28/18
Project No.: 11227.010
Input By: M. Vinet
Date: 10/01/18
Boring No.: LB-5
Depth (ft.): 5.0 - 9.0
Sample No.: B-1
Soil Identification: Silty Sand (SM), Brown.

Preparation Method: ☒ Moist ☐ Dry

☒ Mechanical Ram ☐ Manual Ram

Mold Volume (ft³) 0.03340

Ram Weight = 10 lb.; Drop = 18 in.

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	5620	5673	5643			
Weight of Mold (g)	3531	3531	3531			
Net Weight of Soil (g)	2089	2142	2112			
Wet Weight of Soil + Cont. (g)	2404.8	2285.8	2265.0			
Dry Weight of Soil + Cont. (g)	2245.9	2084.0	2029.3			
Weight of Container (g)	311.8	154.6	155.3			
Moisture Content (%)	8.2	10.5	12.6			
Wet Density (pcf)	137.9	141.4	139.4			
Dry Density (pcf)	127.4	128.0	123.8			

Maximum Dry Density (pcf) 128.3 **Optimum Moisture Content (%)** 9.5

PROCEDURE USED

☒ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☐ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

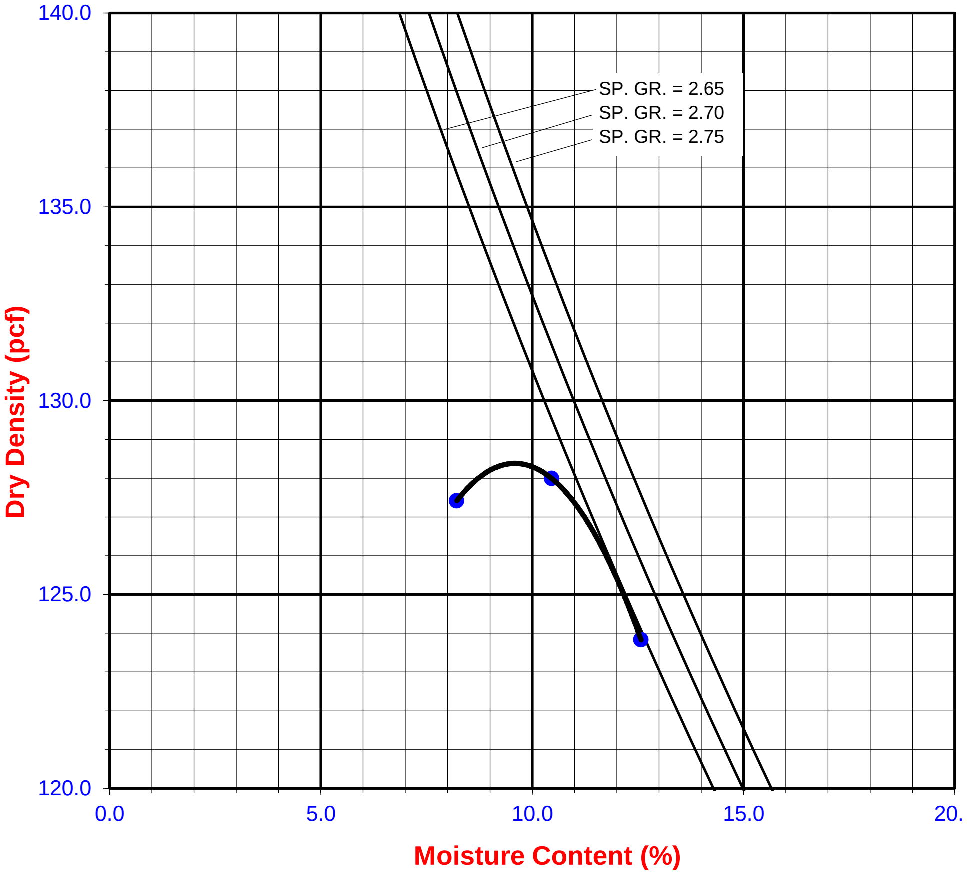
☐ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



Compaction; LB-5, B-1 (9-26-18)

SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name:	Meridian Park S VA Trunk Sewer	Tested By :	M. Vinet	Date:	10/01/18
Project No. :	11227.010	Data Input By:	M. Vinet	Date:	10/01/18
Boring No.:	LB-3	Depth (ft.) :	11.0 - 14.0		
Sample No. :	B-1				
Soil Identification:*	SC-SM				

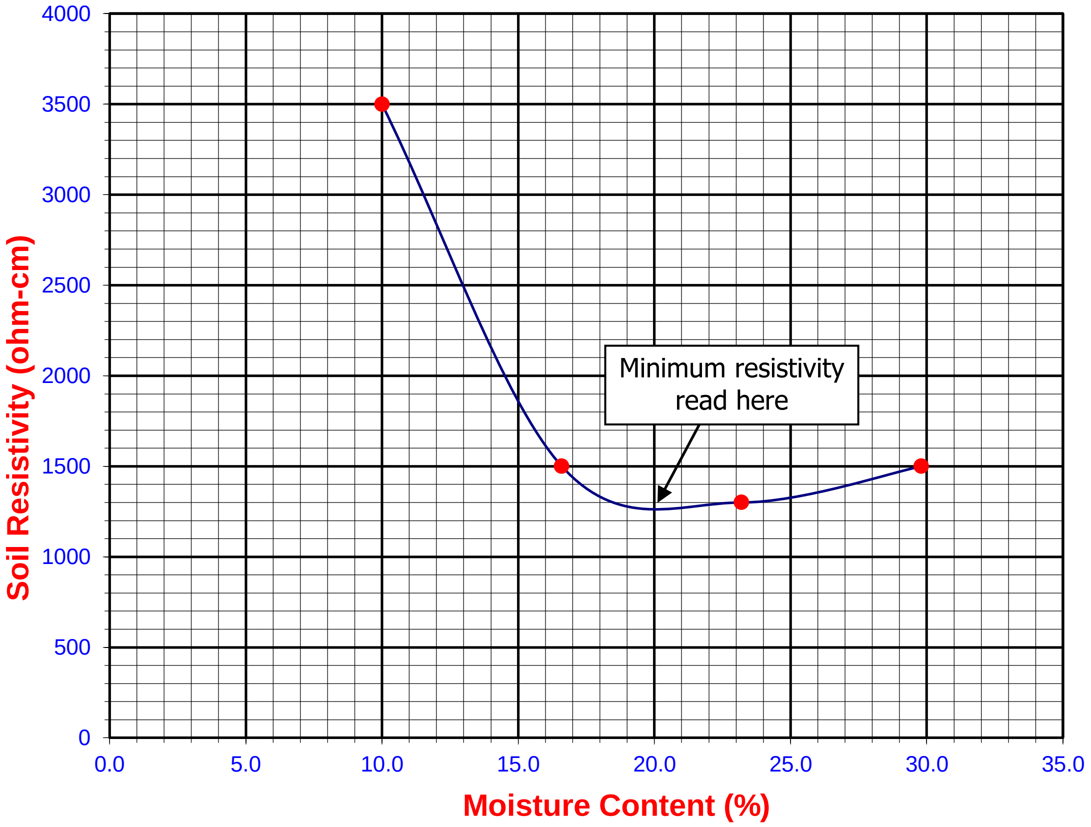
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	50	10.00	3500	3500
2	83	16.60	1500	1500
3	116	23.20	1300	1300
4	149	29.80	1500	1500
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	100.00
Dry Wt. of Soil + Cont. (g)	100.00
Wt. of Container (g)	0.00
Container No.	A
Initial Soil Wt. (g) (Wt)	500.00
Box Constant	1.000

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
1250	**20.0**	**259**	**40**	**7.40**	**21.0**



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SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name: Meridian Park S VA Trunk Sewer

Tested By : M. Vinet Date: 10/01/18

Project No. : 11227.010

Data Input By: M. Vinet Date: 10/01/18

Boring No.: LB-5

Depth (ft.) : 5.0 - 9.0

Sample No. : B-1

Soil Identification:* SM

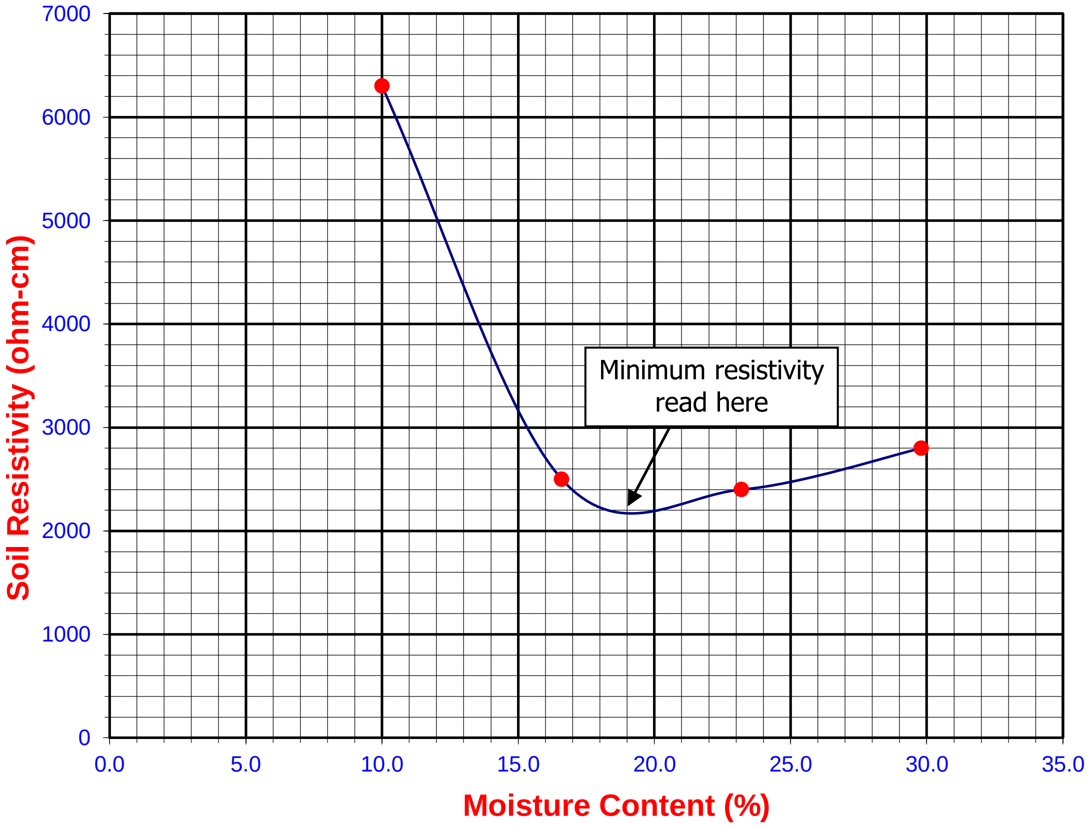
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	50	10.00	6300	6300
2	83	16.60	2500	2500
3	116	23.20	2400	2400
4	149	29.80	2800	2800
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	100.00
Dry Wt. of Soil + Cont. (g)	100.00
Wt. of Container (g)	0.00
Container No.	A
Initial Soil Wt. (g) (Wt)	500.00
Box Constant	1.000

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
2180	**19.0**	**91**	**0**	**6.14**	**21.0**



SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name: Meridian Park S VA Trunk Sewer
Project No. : 11227.010
Boring No.: LB-9
Sample No. : B-1
Soil Identification:* Silty Sand (SM)

Tested By : M. Vinet Date: 10/03/18
Data Input By: M. Vinet Date: 10/03/18
Depth (ft.) : 11.0 - 14.0

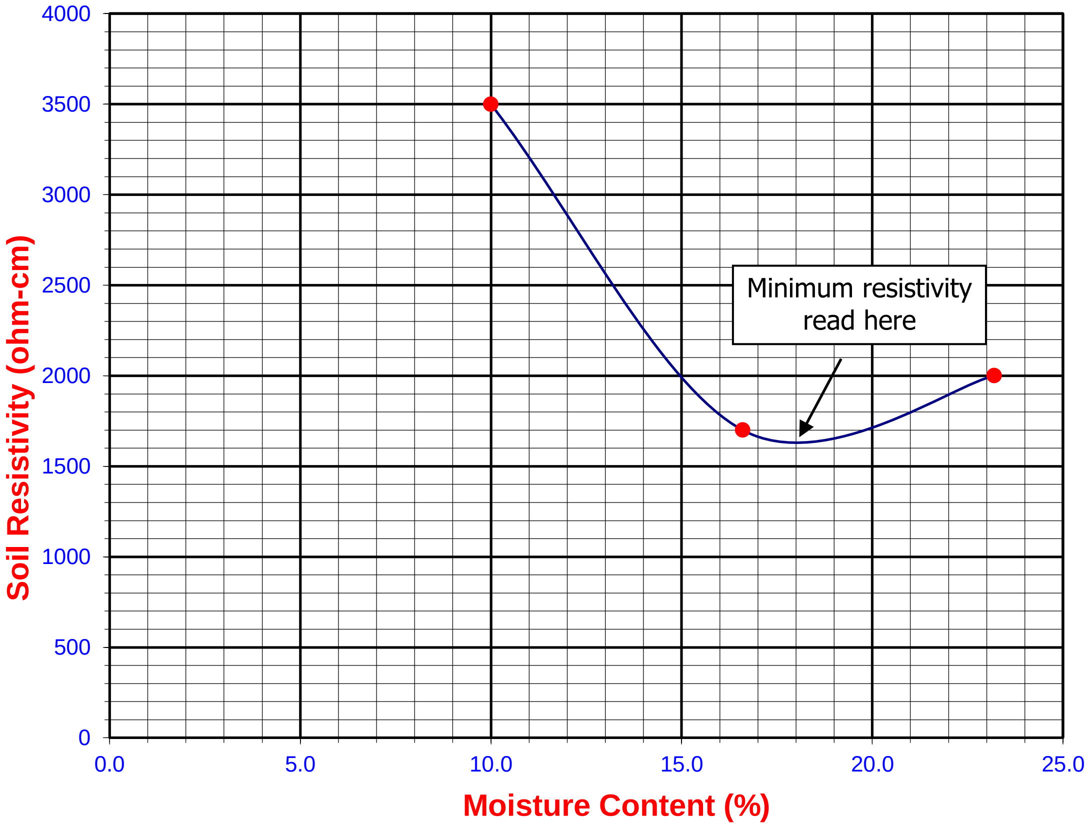
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	50	10.00	3500	3500
2	83	16.60	1700	1700
3	116	23.20	2000	2000
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	100.00
Dry Wt. of Soil + Cont. (g)	100.00
Wt. of Container (g)	0.00
Container No.	A
Initial Soil Wt. (g) (Wt)	500.00
Box Constant	1.000

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
1625	**18.0**	-	-	-	-



SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name:	Meridian Park S VA Trunk Sewer	Tested By :	M. Vinet	Date:	10/03/18
Project No. :	11227.010	Data Input By:	M. Vinet	Date:	10/03/18
Boring No.:	LB-11	Depth (ft.) :	16.0 - 18.0		
Sample No. :	B-1				

Soil Identification:* Silty, Clayey Sand (SC-SM)

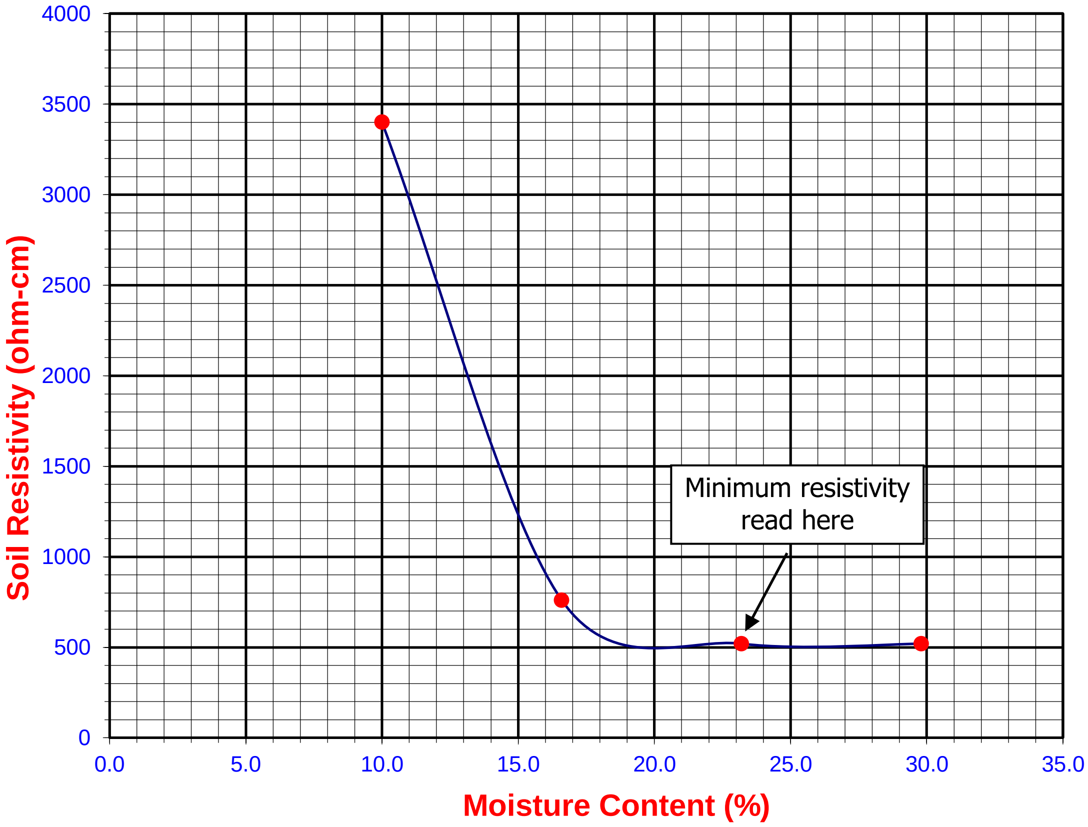
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	50	10.00	3400	3400
2	83	16.60	760	760
3	116	23.20	520	520
4	149	29.80	520	520
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	100.00
Dry Wt. of Soil + Cont. (g)	100.00
Wt. of Container (g)	0.00
Container No.	A
Initial Soil Wt. (g) (Wt)	500.00
Box Constant	1.000

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
520	**23.2**	**152**	**140**	**6.15**	**21.0**



APPENDIX C

GBA Important Information About This Geotechnical Report

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

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