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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

September 1, 2020

Mr. Majid Jamali
Washington State Department of Enterprise Services
Facility Professional Services – Planning and Project Delivery Team
1500 Jefferson Street, PO Box 41476
Olympia, WA 98504

RE: PREDESIGN GEOTECHNICAL ENGINEERING RECOMMENDATIONS
STATE LEGISLATIVE CAMPUS MODERNIZATION
STATE CAPITOL CAMPUS, OLYMPIA, WASHINGTON

Dear Mr. Jamali:

We have prepared this letter report to present the results of our predesign geotechnical engineering recommendations for the State Legislative Campus Modernization for the buildings at the State Capitol Campus in Olympia, Washington . We understand the State Legislative Campus Modernization project will include the design and construction of the Legislative Agencies and House (LAH) building and the Senate building which are in development. We have prepared these predesign geotechnical engineering recommendations based on existing subsurface information and supplemental geotechnical investigation to assist the design team in estimating the geotechnical-related project costs and to evaluate building layout alternatives. The subsequent sections present the following:

- A site and project description,
- An overview of the existing subsurface information,
- A description of the subsurface conditions at the site,
- The results of our supplemental subsurface exploration and laboratory testing for one boring near the proposed Senate building,
- The results of our predesign geotechnical studies and recommendations, and
- Our recommendations for additional subsurface explorations and geotechnical engineering evaluations.

SITE AND PROJECT DESCRIPTION

The general project location is provided in Figure 1. The proposed site of the new LAH and Senate buildings are currently occupied by the Pritchard Library and Newhouse buildings, respectively, as well as surface parking lots. Just west of the LAH building there is an existing southwest-trending vegetative slope. We understand the positions of the new structures are in development and may be revised as the project progresses. However, we understand the new buildings would range between two and three stories tall and will either be constructed near the existing grade or will include a one-story, approximately 10-foot-deep basement. Figure 2 shows a proposed footprint of the LAH and Senate buildings.

The area within the proposed LAH and Senate building footprints are relatively flat. However, the slope west of the LAH building is approximately 110 feet high and includes slope inclinations approaching approximately 1.5 horizontal to 1 vertical (1.5H:1V). This slope is within a historical landslide feature and has been subject to shallow slope instability in the past as identified in previous landslide stability evaluations performed by others. The impact of slope stability for the LAH building are considered in the recommendations provided in this letter report.

EXISTING SUBSURFACE INFORMATION

We developed our understanding of the subsurface conditions at the site based on existing data generated by previous studies at and near the project location. These reports include previous geotechnical investigations near the proposed LAH building location as part of a Capitol Campus hillside stability study. The subsurface exploration used to inform the analysis of the Senate building is based on the nearby geotechnical explorations that were performed for the Washington State Legislative Building. The references used to develop our recommendations included:

- Hillside Evaluation and Preliminary Design for Olympia Capitol Campus, Olympia, Washington (Golder Associates, 2010)
- Seismic Ground Motion Study for the Washington State Legislative Building, Pre-Schematic Services for Updated Seismic Analyses, Olympia, Washington (Shannon & Wilson, 2001)

SUPPLEMENTAL SUBSURFACE EXPLORATION

Shannon & Wilson performed on boring SW-1 to augment the existing information for geotechnical information near the proposed Senate building. This boring was drilled using mud-rotary techniques by Holt Services, Inc. of Edgewood, Washington on August 18, 2020, under subcontract to Shannon & Wilson. A representative from Shannon & Wilson was present during the boring to observe the drilling and sampling operations, retrieve representative soil samples for subsequent laboratory testing, and prepare descriptive field logs. The samples were placed in jars and returned to our laboratory for additional visual classification.

The boring log for SW-1 is presented in Appendix A. A boring log is a written record of the subsurface conditions encountered in the boring. It graphically shows the geologic units (i.e. soil layers) encountered in the boring and the Unified Soil Classification System (USCS) symbol of each geologic layer. The boring log also includes the natural water content, penetration resistance, percent fines, and the Atterberg Limits of soil samples at various depths within the boring where those tests were performed. Other information shown in the boring logs includes types and depths of sampling, descriptions of obstructions and debris encountered in the borings, and observed drilling problems and soil behavior related to caving, raveling, and heave. A soil description and log key for the boring logs is also included in Appendix A.

Soil Sampling

Soil samples from the project boring were obtained in conjunction with the Standard Penetration Test (SPT) at the depths shown in the boring logs. SPTs were performed in accordance with ASTM Designation D1586, Standard Method for Penetration Testing and Split-Barrel Sampling of Soils (ASTM, 2011). The SPT consists of driving a 2-inch-outside-diameter, split-spoon sampler a distance of 18 inches into the bottom of the borehole with a 140-pound hammer falling 30 inches. The number of blows required for the last 12 inches of penetration is termed the Standard Penetration Resistance (SPT N value). The SPT N value is an empirical parameter that provides a means for evaluating the relative density, or compactness, of granular soils and the consistency, or stiffness, of cohesive soils. SPT N values are plotted at the midpoint of the sample depths on the boring logs. Whenever 50 or more blows were required to cause 6 inches or less of penetration, the test was terminated and the number of blows and the corresponding penetration were recorded. SPTs were performed at 2.5-foot intervals to 20 feet below ground surface (bgs) and at 5-foot intervals thereafter. Soil samples from the SPT were labelled, sealed, and taken to the Shannon & Wilson laboratory for laboratory testing.

Geotechnical Laboratory Testing

Geotechnical laboratory tests were performed by Shannon & Wilson on selected samples retrieved from project borings to classify the soil and determine index and engineering properties of the materials. Laboratory tests included visual classification, grain size, moisture content, and Atterberg Limits on selected samples. Laboratory tests were performed in accordance with applicable ASTM standards. Laboratory test results are presented in Appendix A and incorporated into the boring log, as appropriate.

INTERPRETED SUBSURFACE CONDITIONS

Based on the available subsurface information, the existing soils at the site include fill and native sands, silts, and clays as described below:

- **Fill:** When encountered the fill material included loose silty fine sand and medium stiff to stiff sandy silt and clayey silt. In the existing explorations performed near the proposed LAH and Senate buildings, the surficial fill is generally 4.5 feet thick.
- **Native Soils:** Native sandy silt, clayey silt, silty sand, and fine sand underly the fill. Based on the existing information, the native soils can be predominantly classified as silt with fine sandy and clayey soil interbeds. In general, the native soils are soft to medium stiff within approximately 30 feet of the ground surface and increase in stiffness at depth.

The existing vibrating wire piezometer in boring GB-2 did not record any groundwater readings which indicates groundwater is below the lowest sensor at approximately elevation 50 feet (NAVD88). Given the height of the proposed buildings above Capitol Lake, it is likely the groundwater table is located at least 100 feet below the foundation level, although perched groundwater could be encountered higher.

PREDESIGN GEOTECHNICAL RECOMMENDATIONS

Our predesign geotechnical analyses and recommendations included:

- Seismic ground motion estimates,
- Screening-level evaluation of earthquake-induced geologic hazards,
- Screening-level evaluation of slope stability,
- Conceptual foundation recommendations for the proposed LAH and Senate buildings, and
- Recommendations for additional geotechnical engineering evaluations and subsurface explorations for future project phases.

Each of these topics are discussed individually in the following sections. We understand that the buildings will be designed per the 2020 State Building Code, which has adopted the 2018 International Building Code (IBC; International Code Council, 2017) as the design basis.

The recommendations provided in this memorandum should be considered conceptual and used for preliminary planning purposes only. Our geotechnical recommendations are based on existing subsurface information and supplemental subsurface investigation. These recommendations should be revised as additional explorations, laboratory testing, and engineering analyses are performed for future design phases.

Seismic Design Ground Motions

We developed the seismic design response spectra parameters in general accordance with the 2018 IBC and American Society of Civil Engineers (ASCE) 7-2016 (ASCE 7-16; ASCE, 2017) requirements. Exhibit 1 provides the predesign design response spectra parameters and the risk targeted Maximum Considered Earthquake (MCE_R) and Maximum Considered Earthquake Geometric Mean (MCE_G) ground motion parameters from which the design response spectra parameters were derived. The MCE_R ground motion parameters correspond to a target risk of 1% in 50 years of structural collapse and are derived from probabilistic ground motions with a return period of 2,475 years. The MCE_G ground motion parameters are the 2,475-year ground motion parameters without any adjustment for a target collapse risk. Note that the parameters provided in Exhibit 1 are for predesign and discussion purposes only. Based on the subsurface conditions at the site a site-specific ground motion analysis procedure consisting of either a site response analysis or a ground motion hazard analysis is required per the 2018 IBC and ASCE 7-16. We understand this analysis will be completed as part of a future design phase and the ground motions provided in Exhibit 1 will be updated.

Computation of the ground motion parameters is based on seismological input and site soil response factors. The seismological inputs are the MCE_R horizontal response spectral acceleration values at periods of 0.2-second (S_S) and 1.0-second (S_1) and the MCE_G horizontal peak acceleration (PGA).

We evaluated the site soil response using soil site response factors. The site soil response factors are expressed as a function of the seismological inputs and a site classification based on the subsurface conditions. The seismological inputs S_S, S_1, and peak ground acceleration (PGA) are scaled by the site soil coefficients F_a, F_v, and F_{PGA}, respectively, that are determined based on the site classification and the magnitude of S_S, S_1, and PGA values.

We evaluated the site classification based on the available subsurface information, our understanding of the geologic conditions, and our experience. Based on the ASCE 7-16 Site Class criteria, the LAH building site corresponds to Site Class E based on the existing boring

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GB-2 near the Pritchard Library. Similarly, for the Senate Building corresponds to a Site Class D based on supplemental boring SW-1 and boring S-1 near the Legislative Building. We note per ASCE 7-16, a site response analysis is required for structures without seismic isolation or damping systems on Site Class D and E sites with specific exceptions outlined in Section 11.4.8. The exceptions include:

- Structures on Site Class E sites with S_s greater than or equal to 1.0, provided the site coefficient F_a is taken as equal to that of Site Class C.
- Structures on Site Class D sites with S_1 greater than or equal to 0.2, provided the value of the seismic response coefficient C_s is determined by Eq. (12.8-2) for values of $T \leq 1.5T_S$ and taken as equal to 1.5 times the value computed in accordance with either Eq. (12.8-3) for $T_L \geq T > 1.5\ T_S$ or Eq. (12.8-4) for $T > T_L$.
- Structures on Site Class E sites with S_1 greater than or equal to 0.2, provided that T is less than or equal to T_s and the equivalent static force procedure is used for design.

Exhibit 1: <u>LAH building:</u> Estimated Predesign Response Spectrum Parameters for Site Class E. *<u>Values for pre-design only</u>*. A site-specific analysis will be required prior to final design as specified by ASCE 7-16

Parameter	Description	Value
S_s	Mapped MCE_R, 5% damped, short period acceleration	1.41 g
S_1	Mapped MCE_R, 5% damped, spectral acceleration at a period of 1 second	0.52 g
S_{MS}	Mapped MCE_R, 5% damped, short period acceleration adjusted for site effects (see Note 1)	1.69 g
S_{M1}	Mapped MCE_R, 5% damped, spectral acceleration at a period of 1 second adjusted for site effects (see Note 2)	1.13 g
S_{DS}	Design, 5% damped, short period acceleration (see Note 1)	1.13 g
S_{D1}	Design, 5% damped, spectral acceleration at a period of 1 second (see Note 2)	0.75 g
T_0	Reference Period ($T_0 = 0.2\ S_{D1} / S_{DS}$)	0.13 sec
T_S	Corner Period ($T_s = S_{D1} / S_{DS}$)	0.67 sec
T_L	Long-period transition period	16 sec
PGA	Mapped MCE_G peak ground acceleration	0.61 g
PGA_M	Mapped MCE_G peak ground acceleration adjusted for site effects	0.67 g

NOTES:

1 Values for the short-period site coefficient, F_a, were extrapolated based on values provided in the 2018 IBC and ASCE 7-16. Values are based on the exception for a site-specific ground motion procedure by using F_a values equal to that of Site Class C. A site-

specific ground motion procedure is required otherwise to evaluate the seismic ground motion design parameters and response spectrum. The resulting S_{MS} and S_{DS} values are provided for discussion purposes only.

2 Values for the long-period site coefficient, F_v, were evaluated based on values provided in the 2018 IBC and ASCE 7-16 for the purposes of evaluating T_S. The resulting S_{M1} and S_{D1} values are provided for discussion purposes only. A site-specific ground motion procedure is required to evaluate the seismic ground motion design parameters and response spectrum.

g = acceleration of gravity, sec = seconds

Exhibit 2: <u>Senate Building:</u> Estimated Predesign Response Spectrum Parameters for Site Class D. *<u>Values for pre-design only</u>*. A site-specific analysis will be required prior to final design as specified by ASCE 7-16

Parameter	Description	Value
S_s	Mapped MCE_R, 5% damped, short period acceleration	1.41 g
S_1	Mapped MCE_R, 5% damped, spectral acceleration at a period of 1 second	0.52 g
S_{MS}	Mapped MCE_R, 5% damped, short period acceleration adjusted for site effects (see Note 1)	1.41 g
S_{M1}	Mapped MCE_R, 5% damped, spectral acceleration at a period of 1 second adjusted for site effects (see Note 2)	0.93 g
S_{DS}	Design, 5% damped, short period acceleration (see Note 1)	0.94 g
S_{D1}	Design, 5% damped, spectral acceleration at a period of 1 second (see Note 2)	0.62 g
T_0	Reference Period ($T_0 = 0.2\ S_{D1} / S_{DS}$)	0.13 sec
T_S	Corner Period ($T_s = S_{D1} / S_{DS}$)	0.66 sec
T_L	Long-period transition period	16 sec
PGA	Mapped MCE_G peak ground acceleration	0.61 g
PGA_M	Mapped MCE_G peak ground acceleration adjusted for site effects	0.67 g

NOTES:

1 Values for the short-period site coefficient, F_a, were extrapolated based on values provided in the 2018 IBC and ASCE 7-16. The resulting S_{MS} and S_{DS} values are provided for discussion purposes only. A site-specific ground motion procedure is required to evaluate the seismic ground motion design parameters and response spectrum.

2 Values for the long-period site coefficient, F_v, were evaluated based on values provided in the 2018 IBC and ASCE 7-16. The resulting S_{M1} and S_{D1} values are provided for discussion purposes only. A site-specific ground motion procedure is required to evaluate the seismic ground motion design parameters and response spectrum unless the spectrum is altered per the exception in ASCE 7-16 Section 11.4.8.

g = acceleration of gravity, sec = seconds

The actual response spectrum used for design will need to be evaluated using a site-specific ground motion analysis procedure and would likely vary from the estimate provided above.

Seismically Induced Geologic Hazards

In our opinion, the seismically induced geologic hazards that could affect the site include fault-related ground rupture, landsliding, and liquefaction and its associated effects (such as

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loss of shear strength, bearing capacity failure, settlement, and lateral spreading). Each of these hazards are discussed in the following sections.

Fault-related ground rupture

Based on fault mapping provided by the USGS, the closest known potentially active fault to the site is the Olympia Fault. The sites are potentially located 0.8 miles southwest of the moderately constrained northwest-southeast-trending fault structure. Based on field observations performed at river inlets, Sherrod (2001) inferred that an earthquake may have occurred on the Olympia Fault approximately 1,100 years ago. However, due to the lack of historical seismicity associated with the structure, in our opinion, the risk of ground surface rupture at the site is moderately low.

Liquefaction

Liquefaction is a phenomenon in which excess pore pressure in loose, saturated, cohesionless soil increases during ground shaking to a level near the initial effective stress, thus resulting in a reduction of shear strength of the soil (i.e. a quicksand-like condition). Effects of liquefaction include seismic-induced ground settlement, lateral spreading and slope instability, and loss of vertical and lateral foundation restraint.

We performed preliminary evaluations of the liquefaction potential of the subsurface soils using the Standard Penetration Test (SPT) based procedure of Boulanger and Idriss (2014) and the available explorations and laboratory test data. The liquefaction susceptibility of the native fine-grained soils were evaluated based on the methods proposed by Boulanger and Idriss (2006) and Bray and Sancio (2006). The earthquake loading was evaluated based on the procedures outlined in the 2018 IBC, ASCE 7-16, and deaggregation data provided by the USGS. Based on our preliminary analyses, we anticipate that below the proposed building locations the potential for liquefaction is low during the design ground motion considering the deep groundwater depth.

Soils that liquefy will experience strength loss due to the generation of high excess pore pressures. As the excess pore pressures dissipate, the liquefied soil will consolidate and settle. Based on the results of our preliminary SPT-based liquefaction potential evaluations and the method of Ishihara and Yoshimine (1992), we estimate that seismic settlement of up 4 inches near the Senate building and up to 6 inches near the LAH building could occur within the proposed building footprint.

Landsliding

The existing topography at the proposed LAH and Senate building locations is relatively flat; however, the topography to the west of the LAH building includes slopes about 110 feet high and are inclined from about 1.7H:1V in the upper portion to flatter than 6H:1V at the lower part of the slope. Based on our understanding of the subsurface conditions and the site history, the site is likely susceptible to seismically induced slope instability. The slope west of the site has experienced instability in the past with observations noted by Golder Associates (2010) of a shallow slope failure estimated less than 20 years old in 1997. Also based on LiDAR data, Golder Associates (2010) noted the potential presence of ancient deep-seated landslides in the natural slopes west of the existing Pritchard building. Golder Associates (2010) notes that while these ancient landslide features are currently stable, seismic loading has the potential to initiate additional slope movement. Our predesign recommendations with respect to slope stability are presented in the following section.

Slope Stability

We performed preliminary screening-level limit equilibrium slope stability analysis using SLOPE/W (Geo-Slope International, 2019). We evaluated one northeast-southwest-trending cross section based on the existing site topography through the natural slope near the southwestern portion of the site. Our preliminary stability evaluations considered static and seismic loading conditions described as follows:

- Static Stability: Only static driving forces due to the slope geometry and subsurface conditions contribute to the stability of the slope.
- Seismic Stability: In addition to the static forces, the seismic analyses considered inertial loads due to the earthquake loading using the pseudo-static method. In the pseudo-static method, the seismic response of the slope is represented by a constant acceleration value that acts outboard of the slope.

Limit-equilibrium stability evaluations provide a factor of safety (FS) computed as the sum of the driving forces divided by the sum of the soil resistances. Based on the limit equilibrium FS values we evaluated clear distances, or setbacks, behind the top of the wall / slope for preliminary siting purposes. The 2018 IBC provides very little guidance with respect to slope stability; therefore, our recommendations incorporated guidelines provided in the Washington State Department of Transportation (WSDOT) Geotechnical Design Manual (GDM; WSDOT, 2019) which in our opinion generally summarizes the geotechnical state of practice in Washington State.

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We note that the FS from limit equilibrium methods only provide an indirect estimate of the anticipated slope performance (i.e. deformation). If the slope performance is a critical to the building design more sophisticated analyses, such as numerical modeling continuum methods, can provide a more realistic estimate of the slope deformation due to a seismic event. A further discussion of this method is provided in the Recommendations for Future Analysis section at the end of this report. The following sections provide our predesign slope stability recommendations for the natural slope cross section.

Natural Slope Stability

Under static conditions, the WSDOT GDM recommends a minimum FS of 1.3 for slopes that do not support structures and a minimum FS of 1.5 for slopes that support structures. Our recommendations assume a minimum FS for static conditions of 1.5 given the location of the Pritchard Library/LAH building. For seismic and post-seismic conditions, the WSDOT recommends a minimum FS of 1.1.

To satisfy the static stability requirements, we recommend a minimum building setback of at least 70 feet from the top of the western slope. However, we anticipate that slope movement could occur as far back as 100 feet from the top of the slope during the design ground motion. Our analyses did not consider ground improvement or pile supported foundations. A further discussion on the potential effects of seismic deformation for different foundation options are provided in the Foundation Design section.

Foundation Design

For predesign purposes we considered two general foundation alternatives for the Senate building: shallow foundations and deep foundations. For predesign purposes we considered only deep foundations for the LAH building. Shallow foundations were not considered for the LAH building due to the nearby slope and seismic slope stability concerns. Each foundation alternative is discussed individually in the following sections.

Shallow Foundations

The near surface soils at the Senate building generally consist of loose fill composed of silts to silty sands. Provided that:

- The upper two feet are excavated and replaced with compacted well-graded structural fill,
- The exposed subgrade is evaluated by qualified field representative and soft or unsuitable soils are excavated and replaced with compacted structural fill, and

- The exposed subgrade is compacted to a dense and unyielding condition

An allowable bearing pressure of 2 kips per square foot (ksf) may be used for predesign of shallow spread footings that could support the Senate building. We anticipate that footings designed with this bearing pressure will experience post-construction settlement of less than 1 inch. However, as noted previously, under seismic conditions we anticipate that settlement could occur due to post-liquefaction settlement of the underlying soils. Connecting individual foundations with grade beams could help mitigate the potential for differential settlements, however the building and it's connecting utilities would need to be designed to account for the potential for seismic settlements.

Deep Foundations

Deep foundations can be used to transfer the structural loads through the softer upper soils into deeper, more competent soils. We anticipate that construction activities on the Capitol Campus will have noise and vibration limitations; therefore, we assume that drilled shafts will be the preferred deep foundation option for the LAH and Senate buildings. Drilled shafts involve drilling a hole to a specified depth, placing a rebar cage, and filling the hole with structural concrete. These construction methods greatly reduce the construction induced noise and vibration as compared to pile driving activities. Based on the subsurface conditions, we anticipate a temporary casing may be required to maintain the hole prior to concrete placement.

For predesign purposes, we assume the drilled shafts will extend to 100 feet below the ground surface. We anticipate that 2- or 4-foot-diameter drilled shafts could be sufficient to support the LAH and Senate buildings. For predesign purposes, we recommend the following ultimate axial resistances:

- LAH building
    - 2-foot-diameter drilled shaft: 350 to 600 kips
    - 4-foot-diameter drilled shaft: 1,000 to 1,400 kips
- Senate building
    - 2-foot-diameter drilled shaft: 500 to 700 kips
    - 4-foot-diameter drilled shaft: 1,100 to 1,400 kips

Note that the ultimate resistances provided above need to be reduced by a FS for use in design. Per the 2018 IBC Section 18.10.3.3.1, we recommend FS values of 2 and 3 for compression and uplift, respectively. For shafts designed using the provided resistances

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and FS values we anticipate that the drilled shafts will settle less than 1-inch due to structural loads. If additional shaft resistance is required, the shafts can be extended to depths greater than 100 feet.

The drilled shafts will reduce the building deformations both due to post-seismic settlement and seismic slope instability. The post-seismic settlement at depth could impart downdrag loads on the piles, we anticipate that the shaft settlement due to the additional downdrag loads would be less than 1 inch. However, this estimate will depend on the shaft size and the load applied to the top of the shaft and will need to be revaluated when additional information is available.

Drilled shaft supported building elements may be located using a minimum setback of 60 feet from the slope; provided the drilled shafts and foundation connections would be designed to accommodate the potential lateral slope forces and movements. Slope deformation would induce lateral loads on the shaft due to the soil as it moves around the shaft. The magnitude and location of the lateral loads would need to be estimated using more refined analysis methods performed as part of future studies. Alternatively, to reduce the required deep foundation lateral resistance, the building could be setback as discussed above in the Slope Stability section.

Slope Stability Mitigation

Given the location for the proposed LAH building, seismic slope stability is a concern and deep foundations would likely need to be designed for lateral seismic loads. Alternatives to increase the slope stability and reduce loads on the building foundations include:

- A large diameter secant pile wall along the building perimeter near the top of the slope. The secant pile wall may require tiebacks to resist static and seismic lateral slope forces.
- Building terraced walls on the slope consisting of tieback anchored walls

Vertical members for a secant pile wall consist of a series of successive drilled shafts that intersect the shafts previously placed on either side, forming a continuous wall. For secant pile walls, the drilling sequence typically involves drilling intermediate (non-structural) drilled shafts first and then the primary (structural) drilled shafts are drilled. Vertical reinforcement consisting of a reinforcing bar cage or steel sections are placed into predrilled structural drilled shaft holes and backfilled with concrete.

Depending on design criteria, tiebacks may be required to resist the lateral slope forces and properly retain the secant pile wall. The drilled shaft elements included in the secant pile wall may be 6-foot diameter or larger depending on the assumed height of the slope set down in front of the wall and required lateral resisting force. The tiebacks could assist in reducing the forces and moments on the wall; however, installation of the tiebacks would be challenging due to space limitations. In addition, the LAH building would likely be supported on deep foundations even if the secant pile wall was constructed. Supporting the LAH building on deep foundations could reduce the lateral loads applied on the secant pile wall and long-term slope settlement related impacts on the building. The length of the secant pile wall would be based on the required long-term static and seismic performance of the Pritchard building and LAH building and would be determined during future design phases when the wall design criteria are determined.

The selection of the potential mitigation measures should consider construction installation measures, limited work space between the existing Pritchard building to remain and the top of slope, required long-term Pritchard and LAH building performance, and environmental permitting and impacts.

RECOMMENDATIONS FOR FUTURE ANALYSES AND SUBSURFACE EXPLORATIONS

The recommendations provided in this report are for predesign purposes only. Our engineering analyses were based on existing subsurface information and preliminary site layouts and will need to be updated using additional subsurface explorations, laboratory testing, and engineering analyses. In addition, based on our understanding of the subsurface conditions and the seismic hazard at the site, a site-specific ground motion analysis is required per the 2018 IBC for final design. To facilitate the additional analyses, we recommend additional subsurface explorations and a laboratory testing program including soil borings with downhole geophysical testing and cone penetration test (CPT) explorations. The downhole geophysical testing is required to perform the site-specific ground motion analysis. The boring and CPT exploration program will provide additional subsurface information to refine the predesign geotechnical recommendations.

Based on our predesign engineering analyses, in our opinion the stability of the existing natural slope to the west of the site is a critical component of the building design. Conventional analysis methods are limited in their ability to evaluate the anticipated slope deformation and building performance during a seismic event. In our opinion more advanced numerical continuum modelling methods, such as a finite difference model implemented in FLAC (Itasca, 2020), could provide a direct estimate of the anticipated deformations and impacts to the proposed structures. A numerical continuum model can

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directly incorporate the effects of site response, alterations in slope geometry, and changes in soil strength characteristics due to earthquake loading, all of which are beyond the limits of conventional limit-equilibrium analyses.

CLOSURE

This report was prepared for the exclusive use of the Washington State Department of Enterprise Services and the design team for predesign evaluation of the LAH and Senate buildings to assist in siting and preliminary cost estimating. The recommendations provided in this report were provided for conceptual design only and were based on existing subsurface information. These recommendations will be superseded after layout has been selected and additional explorations, laboratory testing, and engineering analyses have been performed. We have prepared the document "Important Information About Your Geotechnical Report" to assist you and others in understanding the use and limitations of this report.

Thank you for retaining Shannon & Wilson to provide geotechnical services for the predesign phase of the State Legislative Campus Modernization project. We look forward to our continued relationship with you as the project progresses.

Sincerely,

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Robert Mitchell, PE
Vice President

AJB:RAM/ajb

Enc. References
Figure 1 – Vicinity Map
Figure 2 – Site and Existing Exploration Plan
Historic Boring Logs
Appendix A – Boring Log SW-1 and Laboratory Testing
Appendix B – Important Information About your Geotechnical / Geoenvironmental Report

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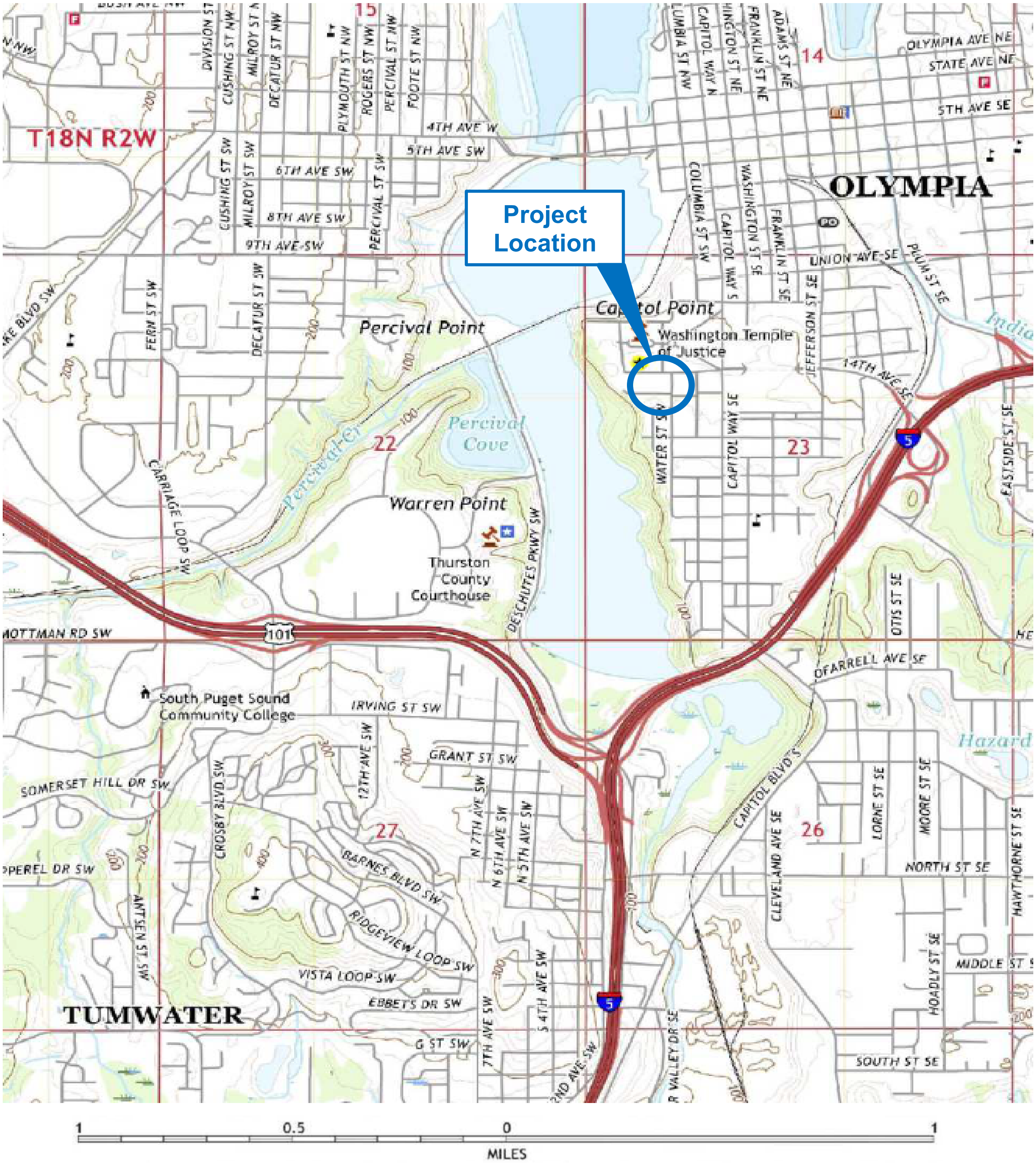


Predesign Geotechnical Engineering Report
State Legislative Campus Modernization
Olympia, Washington

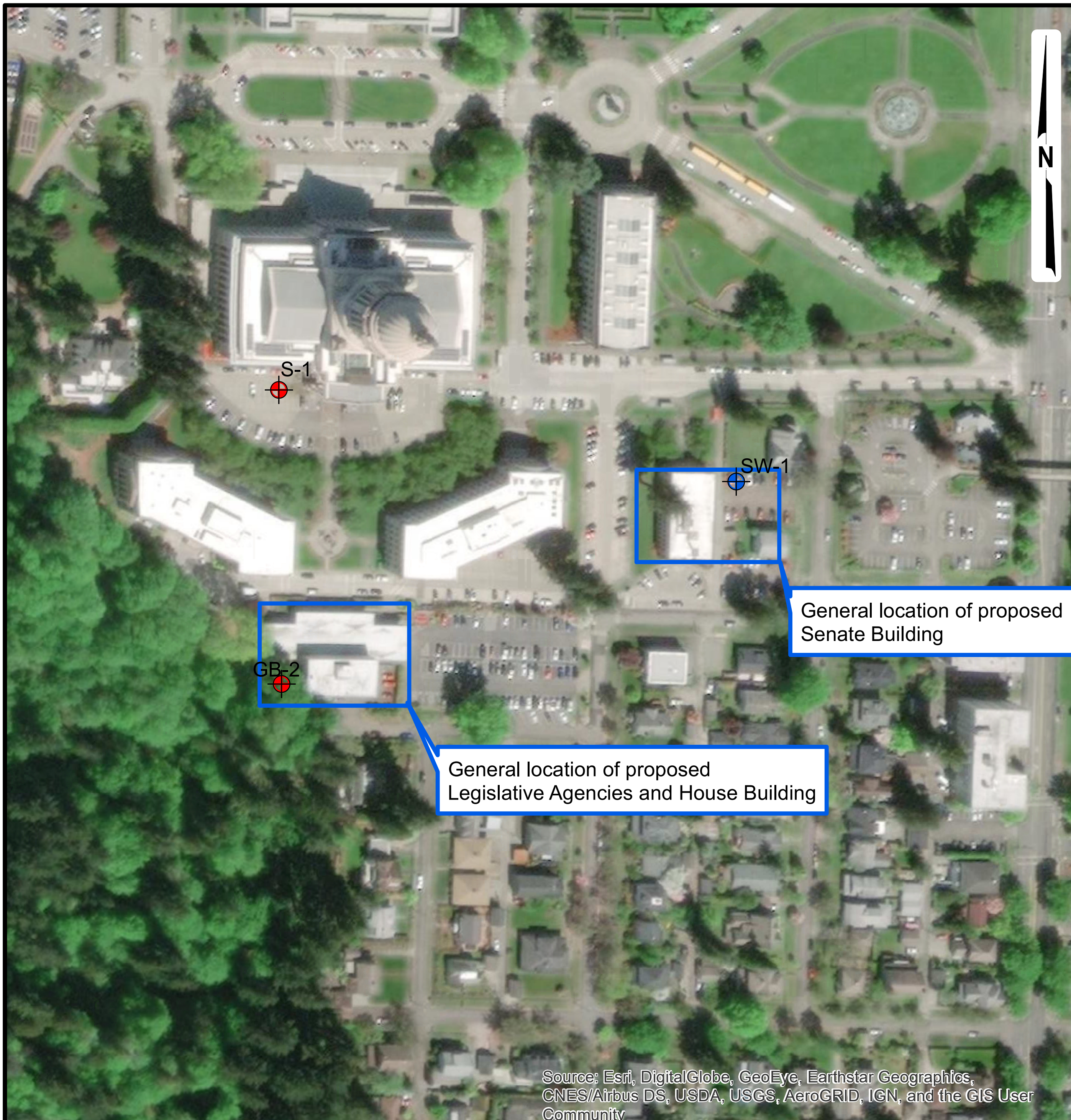
VICINITY MAP

August 2020 105564-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 1

Note:
1. Map adopted from 1:24,000 USGS Topographic map of Tumwater, WA quadrangle, dated 2011, photorevised 2020.



Legend

- Current Boring Designation, Approximate Location
- Previous Boring Designation, Approximate Location

0 125 250 500

Feet

Predesign Geotechnical Engineering Report
State Legislative Campus Modernization
Olympia, Washington

SITE AND EXISTING SUBSURFACE EXPLORATION PLAN

August 2020

105564-001

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Figure 2

Unified Soil Classification System (USCS)

Criteria for Assigning Group Symbols and Names			Soil Classification Generalized Group Descriptions	
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 Sieve	CLEAN GRAVELS Less than 5% fines	GW	Well-graded Gravels
			GP	Poorly-graded gravels
		GRAVELS WITH FINES More than 12% fines	GM	Gravel and Silt Mixtures
			GC	Gravel and Clay Mixtures
	SANDS 50% or more of coarse fraction passes No. 4 Sieve	CLEAN SANDS Less than 5% fines	SW	Well-graded Sand
			SP	Poorly-graded Sand
		SANDS WITH FINES More than 12% fines	SM	Silty Sand
			SC	Clayey Sand
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50	INORGANIC	CL	Low-plasticity Clays
			ML	Non-plastic and Low-Plasticity Silts
		ORGANIC	OL	Organic Silts and Clays, liquid limit less than 50
	SILTS AND CLAYS Liquid limit greater than 50	INORGANIC	CH	High-plasticity Clays
			MH	Elastic Silts
		ORGANIC	OH	Organic Silts and Clays, liquid limit greater than 50
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat

Based on: ASTM D2487-06

Component Definitions by Gradation

Component	Size Range
Boulders	Above 12 in.
Cobbles	3 in. to 12 in.
Gravel	3 in. to No. 4 (4.76mm)
Coarse gravel	3 in. to 3/4 in.
Fine gravel	3/4 in. to No. 4 (4.76mm)
Sand	No. 4 (4.76mm) to No. 200 (0.074mm)
Coarse sand	No. 4 (4.76mm) to No. 10 (2.0mm)
Medium sand	No. 10 (2.0mm) to No. 40 (0.42mm)
Fine sand	No. 40 (0.42mm) to No. 200 (0.074mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

Sample Types

Symbol	Description
SS	SPT Sampler (2.0" OD)
HD	Heavy Duty Split Spoon
SH	Shelby Tube
CA	California Sampler
B	Bulk
C	Cored
G	Grab
P	Pitcher Sampler

Laboratory Tests

Test	Designation
Moisture	(1)
Density	D
Grain Size	G
Hydrometer	H
Atterberg Limits	(1)
Consolidation	C
Unconfined	U
UU Triax	UU
CU Triax	CU
CD Triax	CD
Permeability	P

(1) Moisture and Atterberg Limits plotted on log.

Cohesionless Soils (a)		
Density	N, blows/ft. (c)	Relative Density (%)
Very loose	0 to 4	0 - 15
Loose	4 to 10	15 - 35
Compact	10 to 30	35 - 65
Dense	30 to 50	65 - 85
Very Dense	over 50	>85

Cohesive Soils (b)		
Consistency	N, blows/ft. (c)	Undrained Shear Strength (psf) (d)
Very soft	0 to 2	<250
Soft	2 to 4	250-500
Firm	4 to 8	500-1000
Stiff	8 to 15	1000-2000
Very Stiff	15 to 30	2000-4000
Hard	over 30	>4000

(a) Soils consisting of gravel, sand, and silt, either separately or in combination, possessing no characteristics of plasticity, and exhibiting drained behavior.
(b) Soils possessing the characteristics of plasticity, and exhibiting undrained behavior.
(c) Refer to text of ASTM D 1586-84 for a definition of N; in normally consolidated cohesionless soils. Relative Density terms are based on N values corrected for overburden pressures.
(d) Undrained shear strength = 1/2 unconfined compression strength.

Silt and Clay Descriptions

Description	Typical Unified Designation
Silt	ML (non-plastic)
Clayey Silt	CL-ML (low plasticity)
Silty Clay	CL
Clay	CH
Elastic Silt	MH
Organic Soils	OL, OH, Pt

Qualitative Descriptive Terminology for Moisture Content

Dry	No discernible moisture present
Damp	Enough moisture present to darken the appearance but no moisture on materials adheres to the hand
Moist	Will moisten the hand
Wet	Visible water present on materials

Descriptive Terminology Denoting Component Proportions

Descriptive Terms	Range of Proportion
Trace	0-5%
Little	5-12%
Some or Adjective (a)	12-30%
And	30-50%

(a) Use Gravelly, Sandy or Silty as appropriate.

SOIL CLASSIFICATION LEGEND

Golder Associates

RECORD OF BOREHOLE GB-2

PROJECT: WAGA/Hillside Evaluation
PROJECT NUMBER: 083-93287.300
LOCATION: Pritchard Building

DRILLING METHOD: Mud Rotary
DRILLING DATE: 5/26&27/09
DRILL RIG: B-61 Truck-Mounted

DATUM: Local
AZIMUTH: N/A
COORDINATES: N: 47.04 E: 122.91

ELEVATION: 133
INCLINATION: -90

BORING METHOD: 4-inch inner diameter mud rotary with 140 lbs auto hammer

Depth (ft)	Description	USCS	Elev. / Depth (ft)	Number	Type	Blows per 6 in (140 lb hammer, 30 inch drop)	N	Rec / Att
0 – 1.5	0.0 - 1.5 Loose to compact, dark brown, non-stratified, silty fine to medium SAND, some organics, damp (SM) (TOPSOIL/FILL).	SM	131.5 / 1.5					
1.5 – 4.5	1.5 - 4.5 Stiff, brown gray, heterogenous, sandy SILT, sand is fine to coarse, some fine to coarse gravel, iron-oxide stained pockets, trace organic fragments, moist (ML) (FILL) SIEVE	ML	128.5 / 4.5	1	SS	6-7-7	14	1.5/1.5
4.5 – 7.0	4.5 - 7.0 Firm, gray, stratified, SILT, iron-oxide stained and fine to coarse sand layers, trace fine gravel, moist (ML) (VASHON RECESSIONAL DEPOSITS) ATTERBERG	ML	126.0 / 7.0	2	SS	2-4-3	7	1.5/1.5
7.0 – 9.5	7.0 - 9.5 Firm/loose, brown gray, stratified, SILT and silty fine SAND, trace fine to coarse sand pockets, iron-oxide stained layers, trace fine gravel, damp to moist (ML/SM) (VASHON RECESSIONAL DEPOSITS) MOISTURE CONTENT	ML/SM	123.5 / 9.5	3	SS	2-4-4	8	1.5/1.5
9.5 – 12.0	9.5 - 12.0 Loose, gray brown, stratified, silty fine to medium SAND, silt lenses, iron-oxide staining, moist (SM) (VASHON RECESSIONAL DEPOSITS)	SM	121.0 / 12.0	4	SS	2-3-6	9	1.0/1.5
12.0 – 14.5	12.0 - 14.5 Stiff, red brown, stratified, SILT, some fine sand, iron-oxide stained layers, moist (ML) (VASHON RECESSIONAL DEPOSITS) SIEVE	ML	118.5 / 14.5	5	SS	2-5-5	10	1.3/1.5
14.5 – 17.0	14.5 - 17.0 Very soft to soft, stratified, SILT, trace iron-oxide stained lenses, trace coarse sand, moist (ML) (VASHON RECESSIONAL DEPOSITS) ATTERBERG	ML	116.0 / 17.0	6	SS	2-1-1	2	1.5/1.5
17.0 – 19.5	17.0 - 19.5 Loose to compact, gray brown, stratified, silty fine to medium SAND, trace silt layers less than 1/4-inch thick, iron-oxide stained layers near 17.5 ft, moist (SM) (VASHON RECESSIONAL DEPOSITS)	SM	113.5 / 19.5	7	SS	2-4-6	10	1.5/1.5
19.5 – 20		ML						

PENETRATION RESISTANCE BLOWS / ft ■ (10, 20, 30, 40); WATER CONTENT (PERCENT) W_p — W — W_l (20, 40, 60, 80)

NOTES / WATER LEVELS / GRAPHIC: Inclinometer set in flush-mount monument. Concrete used to set monutment.

Log continued on next page

1 in to 3 ft
DRILLING CONTRACTOR: Holocene Drilling
DRILLER: Matt Graham

LOGGED: A. Dennison
CHECKED: D. Ladd
DATE: 8/3/2009

Golder Associates

RECORD OF BOREHOLE GB-2

PROJECT: WAGA/Hillside Evaluation
PROJECT NUMBER: 083-93287.300
LOCATION: Pritchard Building
DRILLING METHOD: Mud Rotary
DRILLING DATE: 5/26&27/09
DRILL RIG: B-61 Truck-Mounted
DATUM: Local
AZIMUTH: N/A
COORDINATES: N: 47.04 E: 122.91
ELEVATION: 133
INCLINATION: -90

BORING METHOD: 4-inch inner diameter mud rotary with 140 lbs auto hammer

DEPTH (ft)	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ / WATER CONTENT (PERCENT)	NOTES WATER LEVELS GRAPHIC
20	19.5 - 22.0 Firm, gray brown, stratified, SILT, trace silt layers less than 1/4-inch thick, iron-oxide stained layers near 20 ft, moist (ML) (VASHON RECESSIONAL DEPOSITS) 20-ATTERBERG *(Continued)*	ML		8	SS	1-3-5	8	1.5/1.5		
	22.0 - 27.0 Loose to compact, brown gray, slightly stratified, sandy SILT, sand is fine to medium, trace iron-oxide stained partings, moist (ML) (VASHON RECESSIONAL DEPOSITS) #200 WASH	ML	111.0 / 22.0	9	SS	4-4-6	10	1.5/1.5		
25				10	SS	4-5-4	9	1.5/1.5		
	27.0 - 32.0 Compact, brown gray, slightly stratified, fine to medium SAND, little silt, iron-oxide stained layers, dark brown organic layers, damp to moist (SP-SM) (VASHON RECESSIONAL DEPOSITS) MOISTURE CONTENT	SP-SM	106.0 / 27.0	11	SS	4-9-9	18	1.5/1.5		
30				12	SS	11-13-12	25	1.2/1.5		
	32.0 - 38.5 Firm to stiff, gray brown, stratified, SILT, little fine sand, moist (ML) (VASHON RECESSIONAL DEPOSITS) 32.5-#200 WASH 35- ATTERBERG	ML	101.0 / 32.0	13	SS	6-6-6	12	1.5/1.5		
35				14	SS	2-3-5	8	1.5/1.5		
				15	SS	2-4-9	13	1.5/1.5		
	38.5 - 39.5 Stiff, light gray, stratified, SILT, trace fine sand, trace iron-oxide stained hard silt layers up to 1/4-inch thick, moist (ML) (VASHON RECESSIONAL DEPOSITS)	ML	94.5 / 38.5							
40		SM	93.5 / 39.5							

Log continued on next page

1 in to 3 ft
DRILLING CONTRACTOR: Holocene Drilling
DRILLER: Matt Graham
LOGGED: A. Dennison
CHECKED: D. Ladd
DATE: 8/3/2009

Golder Associates

RECORD OF BOREHOLE GB-2

PROJECT: WAGA/Hillside Evaluation
PROJECT NUMBER: 083-93287.300
LOCATION: Pritchard Building
DRILLING METHOD: Mud Rotary
DRILLING DATE: 5/26&27/09
DRILL RIG: B-61 Truck-Mounted
DATUM: Local
AZIMUTH: N/A
COORDINATES: N: 47.04 E: 122.91
ELEVATION: 133
INCLINATION: -90

BORING METHOD: 4-inch inner diameter mud rotary with 140 lbs auto hammer

DEPTH (ft)	SOIL PROFILE: DESCRIPTION	USCS	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40	39.5 - 56.0 Compact, brown gray, slightly stratified, silty fine SAND, trace iron-oxide stained layers, moist (SM) (VASHON RECESSIONAL DEPOSITS) 42.5- MOISTURE CONTENT 47.5- SIEVE *(Continued)*	SM		16	SS	5-9-12	21	1.5/1.5
				17	SS	10-11-14	25	1.5/1.5
45								
				18	SS	10-12-13	25	1.5/1.5
50								
	-1-inch thick clayey silt layer with trace fine to coarse gravel, socketed.			19	SS	12-13-15	28	1.5/1.5
55			77.0 / 56.0					
	56.0 - 61.0 Hard, brown gray, stratified, SILT, silty fine to medium sand layers 1 to 3 inches thick, iron-oxide stained layers, moist (ML) (VASHON RECESSIONAL DEPOSITS)	ML		20	SS	5-12-28	40	1.5/1.5
60								

PENETRATION RESISTANCE BLOWS / ft ■ (10, 20, 30, 40); WATER CONTENT (PERCENT) W_p —○W— W_l (20, 40, 60, 80)

NOTES WATER LEVELS GRAPHIC:
Vibrating Wire Piezometer set 50 ft bgs in grout.
2.75-inch diameter solid PVC inclinometer pipe embedded in grout.

Log continued on next page

1 in to 3 ft
DRILLING CONTRACTOR: Holocene Drilling
DRILLER: Matt Graham
LOGGED: A. Dennison
CHECKED: D. Ladd
DATE: 8/3/2009

Golder Associates

RECORD OF BOREHOLE GB-2

PROJECT: WAGA/Hillside Evaluation
PROJECT NUMBER: 083-93287.300
LOCATION: Pritchard Building

DRILLING METHOD: Mud Rotary
DRILLING DATE: 5/26&27/09
DRILL RIG: B-61 Truck-Mounted

DATUM: Local
AZIMUTH: N/A
COORDINATES: N: 47.04 E: 122.91

ELEVATION: 133
INCLINATION: -90

Boring method: 4-inch inner diameter mud rotary with 140 lbs auto hammer

DEPTH (ft)	SOIL PROFILE – DESCRIPTION	USCS	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft (10, 20, 30, 40) / WATER CONTENT (PERCENT) W_p — W — W_l (20, 40, 60, 80)	NOTES WATER LEVELS GRAPHIC
60		ML	72.0 / 61.0							
	61.0 - 71.0 Very stiff to hard, brown gray, slightly stratified, SILT, little fine sand, clayey silt layers, moist (ML) (VASHON RECESSIONAL DEPOSITS) 67.5- MOISTURE CONTENT	ML		21	SS	15-19-22	41	1.5/1.5	■	
65				22	SS	9-13-13	26	1.5/1.5	○ ■	
70			62.0 / 71.0							
	71.0 - 77.5 Very stiff, brown gray, stratified, SILT, little fine sand, iron-oxide staining layers up to 1/4-inch thick, moist (ML) (VASHON RECESSIONAL DEPOSITS)	ML		23	SS	8-12-16	28	1.5/1.5	■	
75			55.5 / 77.5							
	77.5 - 79.0 No recovery.		54.0 / 79.0	24	SS	6-8-11	19	0.0/1.5	■	
80		ML								

Log continued on next page

1 in to 3 ft
DRILLING CONTRACTOR: Holocene Drilling
DRILLER: Matt Graham

LOGGED: A. Dennison
CHECKED: D. Ladd
DATE: 8/3/2009

Golder Associates

RECORD OF BOREHOLE GB-2

PROJECT: WAGA/Hillside Evaluation
PROJECT NUMBER: 083-93287.300
LOCATION: Pritchard Building

DRILLING METHOD: Mud Rotary
DRILLING DATE: 5/26&27/09
DRILL RIG: B-61 Truck-Mounted

DATUM: Local
AZIMUTH: N/A
COORDINATES: N: 47.04 E: 122.91

ELEVATION: 133
INCLINATION: -90

BORING METHOD: 4-inch inner diameter mud rotary with 140 lbs auto hammer

SOIL PROFILE

DEPTH (ft)	DESCRIPTION	USCS	ELEV. / DEPTH (ft)
80	79.0 - 91.0 Firm to very stiff, medium gray, stratified, SILT, little fine sand, iron-oxide staining layers up to 1/4-inch thick, moist (ML) (VASHON RECESSIONAL DEPOSITS) 82.5- MOISTURE CONTENT 87.5- ATTERBERG *(Continued)*	ML	
88	-Became olive gray in color.		
91	91.0 - 96.0 Dense, green gray, stratified, fine to medium SAND, little silt, moist (SP-SM) (PRE-VASHON DEPOSITS)	SP-SM	42.0 / 91.0
96	96.0 - 101.0 Very dense, green gray, stratified, fine to coarse SAND, little silt, trace fine gravel, moist (SP-SM) (PRE-VASHON DEPOSITS)	SP-SM	37.0 / 96.0
100	Log continued on next page		

SAMPLES

NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT
24c	SS	3-4-4	8	1.5/1.5
25	SS	2-4-8	12	1.5/1.5
26	SS	0-7-15	22	1.5/1.5
27	SS	15-17-22	39	0.8/1.5
28	SS	27-30-30	>50	1.5/1.5

PENETRATION RESISTANCE BLOWS / ft ■ (10, 20, 30, 40)
WATER CONTENT (PERCENT) W_p —o W— W_l (20, 40, 60, 80)

NOTES WATER LEVELS GRAPHIC

1 in to 3 ft
DRILLING CONTRACTOR: Holocene Drilling
DRILLER: Matt Graham

LOGGED: A. Dennison
CHECKED: D. Ladd
DATE: 8/3/2009

Golder Associates

RECORD OF BOREHOLE GB-2

PROJECT: WAGA/Hillside Evaluation
PROJECT NUMBER: 083-93287.300
LOCATION: Pritchard Building

DRILLING METHOD: Mud Rotary
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DRILL RIG: B-61 Truck-Mounted

DATUM: Local
AZIMUTH: N/A
COORDINATES: N: 47.04 E: 122.91

ELEVATION: 133
INCLINATION: -90

DEPTH (ft)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft / WATER CONTENT (PERCENT)	NOTES WATER LEVELS GRAPHIC
100		96.0 - 101.0 Very dense, green gray, stratified, fine to coarse SAND, little silt, trace fine gravel, moist (SP-SM) (PRE-VASHON DEPOSITS) *(Continued)*	SP-SM	32.0 / 101.0							
		101.0 - 104.0 Very dense, orange brown gray to gray, slightly stratified, fine to medium SAND, some fine gravel, socketing, moist (SM) (PRE-VASHON DEPOSITS)	SM	29.0 / 104.0	29	SS	30-32-50	>50	1.5/1.5	>>	Grout backfill.
		Boring completed at 104.0 ft.									
105											
110											
115											
120											

1 in to 3 ft
DRILLING CONTRACTOR: Holocene Drilling
DRILLER: Matt Graham

LOGGED: A. Dennison
CHECKED: D. Ladd
DATE: 8/3/2009

Golder Associates

Shannon & Wilson, Inc. (S&W), uses a soil classification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following page. Soil descriptions are based on visual-manual procedures (ASTM D 2488-93) unless otherwise noted.

S&W CLASSIFICATION OF SOIL CONSTITUENTS

- MAJOR constituents compose more than 50 percent, by weight, of the soil. Major constituents are capitalized (SAND).
- Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (slightly silty SAND).
- Trace constituents compose 0 to 5 percent of the soil (slightly silty SAND, trace of gravel).

MOISTURE CONTENT DEFINITIONS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

ABBREVIATIONS

ATD	At Time of Drilling
Elev.	Elevation
ft	feet
HSA	Hollow Stem Auger
ID	Inside Diameter
in	inches
lbs	pounds
Mon.	Monument cover
N	Blows for last two 6-inch increments
NA	Not Applicable or Not Available
OD	Outside Diameter
OVA	Organic Vapor Analyzer
PID	Photoionization Detector
ppm	parts per million
PVC	Polyvinyl Chloride
SS	Split Spoon sampler
SPT	Standard Penetration Test
USC	Unified Soil Classification
WLI	Water Level Indicator

GRAIN SIZE DEFINITIONS

DESCRIPTION	SIEVE SIZE
FINES	< #200 (0.8 mm)
SAND*	
• Fine	#200 - #40 (0.4 mm)
• Medium	#40 - #10 (2 mm)
• Coarse	#10 - #4 (5 mm)
GRAVEL*	
• Fine	#4 - $\frac{3}{4}$ inch
• Coarse	$\frac{3}{4}$ - 3 inches
COBBLES	3 - 12 inches
BOULDERS	> 12 inches

* Unless otherwise noted, sand and gravel, when present, range from fine to coarse in grain size.

RELATIVE DENSITY / CONSISTENCY

COARSE-GRAINED SOILS		FINE-GRAINED/COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
0 - 4	Very loose	<2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
Over 50	Very dense	15 - 30	Very stiff
		Over 30	Hard

WELL AND OTHER SYMBOLS

Cement/Concrete	Asphalt or PVC Cap
Bentonite Grout	Cobbles
Bentonite Seal	Fill
Slough	Ash
Silica Sand	Bedrock
2" I.D. PVC Screen (0.020-inch Slot)	Gravel

Seismic Ground Motion Study
Washington State Legislative Building
Olympia, Washington

SOIL CLASSIFICATION AND LOG KEY

September 2001 21-1-09343-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 1 of 2

File: I:\Drafting\211\09343-002\21-1-09343-002 Fig a-1.dwg Date: 09-11-2001 Author: cnk

UNIFIED SOIL CLASSIFICATION SYSTEM
(From ASTM D 2488-93 & 2487-93)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL ②	TYPICAL DESCRIPTION
Coarse-Grained Soils *(more than 50% retained on No. 200 sieve)* *[use Dual Symbols for 5 - 12% Fines (i.e. GP-GM)]* ①	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Clean Gravels ① *(less than 5% fines)*	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		Gravels with ① Fines *(more than 12% fines)*	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Clean sands ① *(less than 5% fines)*	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly Graded Sand, Gravelly Sands, Little or No Fines
		Sands with ① Fines *(more than 12% fines)*	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Silt Mixtures
Fine-Grained Soils *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML	Inorganic Silts of Low to Medium Plasticity, Rock Flour, or Clayey Silts With Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		Organic	OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	CH	Inorganic Clays of Medium to High Plasticity, Sandy Fat Clay, Gravelly Fat Clay
			MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sands or Silty Soils, Elastic Silt
		Organic	OH	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		PT	Peat, Humus, Swamp Soils with High Organic Content (See D 4427-92)

KEY TO GEOLOGIC UNITS

Hf	Holocene Fill
Qvrl	Quaternary Vashon Recessional Lacustrine
Qvro	Quaternary Vashon Recessional Outwash
Qpnl	Quaternary Pre-Vashon Non-Glacial Lacustrine
Qpnf	Quaternary Pre-Vashon Non-Glacial Fluvial
Qpgo	Quaternary Pre-Vashon Glacial Outwash
Qpgt	Quaternary Pre-Vashon Glacial Till

NOTES

1. Dual Symbols (symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND) are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.
2. Borderline symbols (symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND) indicate that the soil may fall into one of two possible basic groups.

Seismic Ground Motion Study
Washington State Legislative Building
Olympia, Washington

SOIL CLASSIFICATION AND LOG KEY

September 2001 21-1-09343-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 2 of 2

File: I:\Drafting\211\09343-002\21-1-09343-002 Fig a-1.dwg Date: 09-11-2001 Author: cnk

SOIL DESCRIPTION Surface elevation: Approx. 113.5 Ft.	Depth (ft)	Symbol	Samples	Ground Water
CONCRETE	0.6			
Medium dense, light gray and brown, mottled, slightly clayey, fine sandy SILT; moist; scattered iron oxide-stained lenses; (Hf) ML.	3.5		1	
Medium dense, brown, slightly fine sandy SILT; moist; abundant iron oxide-stained lenses and partings, abundant slightly clayey silt seams; (Qvrl) ML.	12.0		2, 3, 4	
Stiff, light brown to reddish-brown, clayey SILT; wet; bedded, abundant iron oxide-stained seams, scattered organic fragments; (Qvrl) ML.	19.5		5, 6, 7	
Interbedded, very stiff, brown, clayey SILT and medium dense, fine sandy SILT; moist; (Qvrl) ML.	22.5		8	
Medium dense, brown, fine sandy SILT; moist to wet; locally trace of clay, massive to laminated, scattered fine organic fragments; (Qvrl) ML. - lens of brown to gray, blocky, high plasticity, silty clay from 30.8 to 31.1 feet	39.0		9, 10, 11	
Dense, brown, fine to medium SAND; moist; (Qvro) SP.	41.0		12	
Dense, brown, slightly fine sandy SILT; moist; massive; (Qvrl) ML.	44.5			
Very stiff to stiff, brown to gray, clayey SILT, trace of fine sand; wet; massive, scattered silt lenses; (Qvrl) ML.	52.0		13, 14	
Very dense, brown, fine sandy SILT; moist; massive, trace of clay; (Qpnl) ML.	58.0		15	

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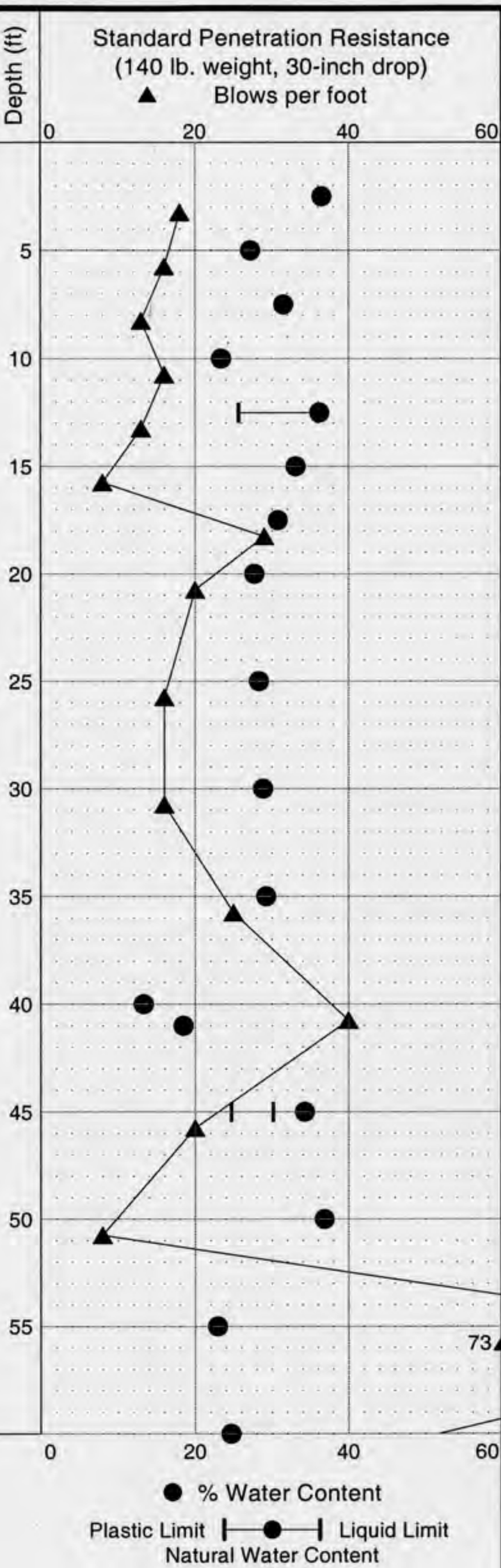


LEGEND

* Sample Not Recovered

2-inch O.D. Split Spoon Sample

3-inch O.D. Shelby Tube Sample

Ground Water Level ATD

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

Seismic Ground Motion Study
Washington State Legislative Building
Olympia, Washington

LOG OF BORING S-1

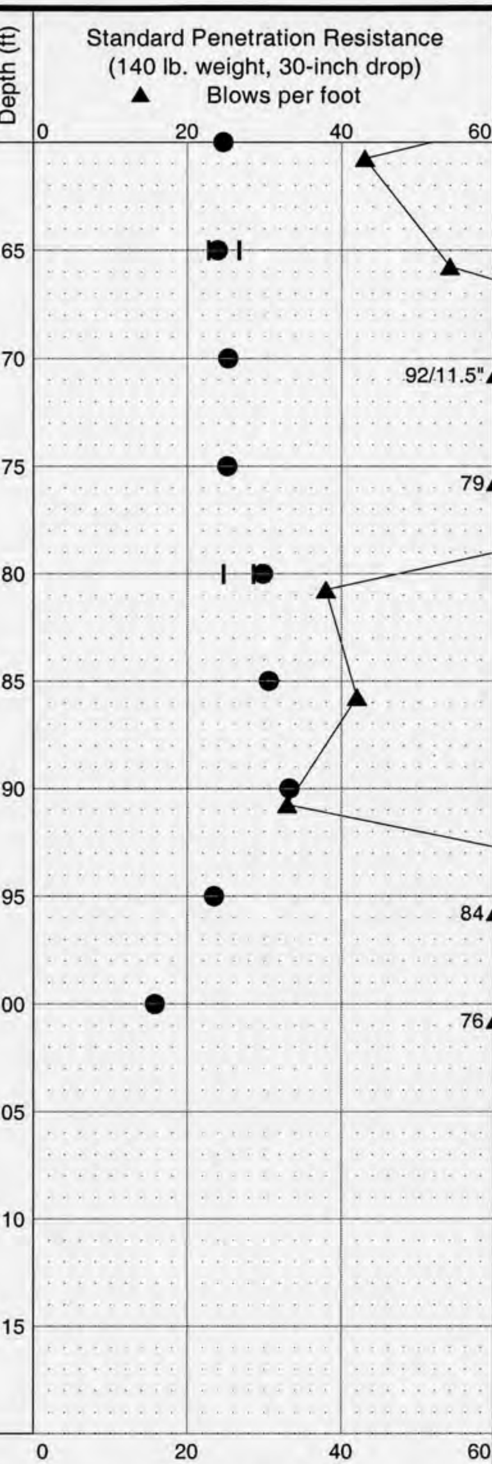
September 2001 21-1-09343-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 1 of 2

MASTER_LOG 21-09343.GPJ SHAN_WIL.GDT 9/11/01 Log: JER Rev: WDN Typ: MGI

SOIL DESCRIPTION Surface elevation: Approx. 113.5 Ft.	Depth (ft)	Symbol	Samples	Ground Water
Dense to very dense, brown SILT, trace of fine sand; moist; massive, abundant iron oxide staining, abundant fine organic fragments, locally trace of clay at bottom; (Qpnl) ML.			16, 17, 18	
Hard, gray, clayey SILT, trace of fine sand; moist to wet; massive, abundant fine organic fragments; (Qpnl) ML.	73.0		19, 20, 21, 22	
Very dense, gray, silty fine SAND; moist; scattered clayey silt pockets, abundant wood debris, massive; (Qpnf) SM.	94.0		23	
Very dense, gray, silty, gravelly SAND, trace of clay; moist; massive; (Qpgt) SM.	98.0		24	
BOTTOM OF BORING COMPLETED ON 04/29/2001	101.5			



LEGEND

* Sample Not Recovered

2-inch O.D. Split Spoon Sample

3-inch O.D. Shelby Tube Sample

Ground Water Level ATD

● % Water Content

Plastic Limit ├──●──┤ Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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Olympia, Washington

LOG OF BORING S-1

September 2001 21-1-09343-002

SHANNON & WILSON, INC.
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FIG. A-3
Sheet 2 of 2

Log: JER Rev: WDN Typ: MGI

MASTER_LOG 21-09343.GPJ SHAN_WIL.GDT 9/11/01

Appendix A

Boring Log SW-1 and Laboratory Testing

APPENDIX A

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1]All percentages are by weight of total specimen passing a 3-inch sieve.
[2]The order of terms is: *Modifying Major with Minor*.
[3]Determined based on behavior.
[4]Determined based on which constituent comprises a larger percentage.
[5]Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm NOTE: If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND	
Fine	#200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.)
Medium	#40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.)
Coarse	#10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL	
Fine	#4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.)
Coarse	3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS

Bentonite Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Inclinometer or Non-perforated Casing
Perforated or Screened Casing	Vibrating Wire Piezometer

PERCENTAGES TERMS [1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

[1]Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

[2]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

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SOIL DESCRIPTION AND LOG KEY

September 2020 105564-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 1 of 3

SOIL_CLASS_KEY_PG1 P2E.GPJ SHAN_WIL.GDT 8/14/19

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL	TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW	Well-Graded Gravel; Well-Graded Gravel with Sand
			GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM	Silty Gravel; Silty Gravel with Sand
			GC	Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW	Well-Graded Sand; Well-Graded Sand with Gravel
			SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM	Silty Sand; Silty Sand with Gravel
			SC	Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat or other highly organic soils (see ASTM D4427)

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

IGNEOUS ROCK

SEDIMENTARY ROCK

METAMORPHIC ROCK

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

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SOIL DESCRIPTION AND LOG KEY

September 2020

105564-001

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FIG. A-1
Sheet 2 of 3

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASTICITY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20
High	It takes considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

[1]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

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SOIL DESCRIPTION AND LOG KEY

September 2020 105564-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1

SOIL_CLASS_KEY_PG3 P2E.GPJ SHAN_WIL.GDT 8/14/19

Total Depth:	101.5 ft.	Latitude:		Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	~	Longitude:		Drilling Company:	Holt Services	Rod Diam.:	NWJ
Vert. Datum:		Station:		Drill Rig Equipment:	Mobile Drill Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION

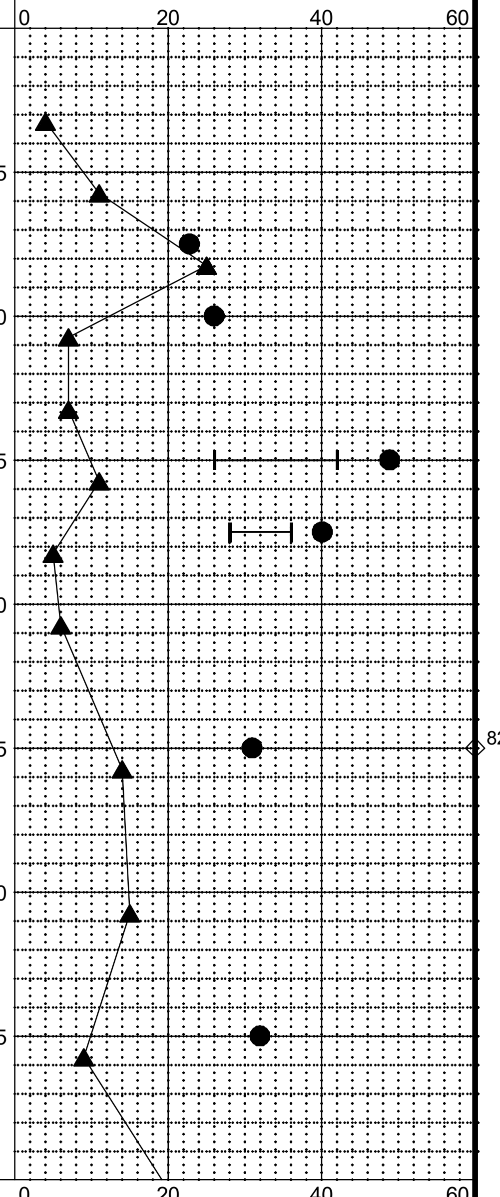
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soil Description	Depth, ft.
Crushed *Gravel (GP)*.	0.6
Loose to medium dense, brown *Silt (ML)*; moist; few fine sand; low plasticity; trace dark brown organics and organic seams; strong iron oxide locally.	7.0
Medium dense, brown, *Silty Sand (SM)*; moist; fine sand; low plasticity to nonplastic; silt seam with organics at about 9 feet.	10.5
Medium stiff, brown *Silt (ML)* grading to *Lean Clay (CL)*; moist; few fine sand; low to medium plasticity; trace organics.	12.7
Loose to medium dense, brown, interbedded, *Sandy Silt (ML), Silt (ML)*, and *Silty Sand (SM)*; moist; fine sand; nonplastic to medium plasticity; 4-inch lean clay at about 15 feet.	20.0
Loose, brown *Silt (ML)* to *Silt with Sand (ML)*; moist; fine sand; low plasticity to nonplastic; laminated; 1-inch fine silty sand at 20 feet; 3-inch lean clay at 25 feet.	25.2
Medium dense, brown, *Silty Sand (SM)*; moist; fine sand; nonplastic; few low to medium plasticity seams; strong iron oxide at 25 feet.	28.0
Loose to medium dense, brown *Silt (ML)*; moist; fine sand; low plasticity to nonplastic; interbedded, faint iron oxide staining at 36.2 feet; few fine sand seams.	38.0
Medium dense *Silt (ML)*; moist; trace to few fine sand; low plasticity	

CONTINUED NEXT SHEET

Symbol | Samples (1–11) | Ground Water: None Observed During Drilling | Depth, ft.

PENETRATION RESISTANCE (blows/foot)
▲ Hammer Wt. & Drop: 140 lbs / 30 inches



LEGEND
* Sample Not Recovered
⌶ 2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES
1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

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LOG OF BORING SW-1

September 2020 105564-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 1 of 3

REV 3

Total Depth:	*101.5 ft.*	Latitude:		Drilling Method:	*Mud Rotary*	Hole Diam.:	*5 in.*
Top Elevation:	*~*	Longitude:		Drilling Company:	*Holt Services*	Rod Diam.:	*NWJ*
Vert. Datum:		Station:		Drill Rig Equipment:	*Mobile Drill Track*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION

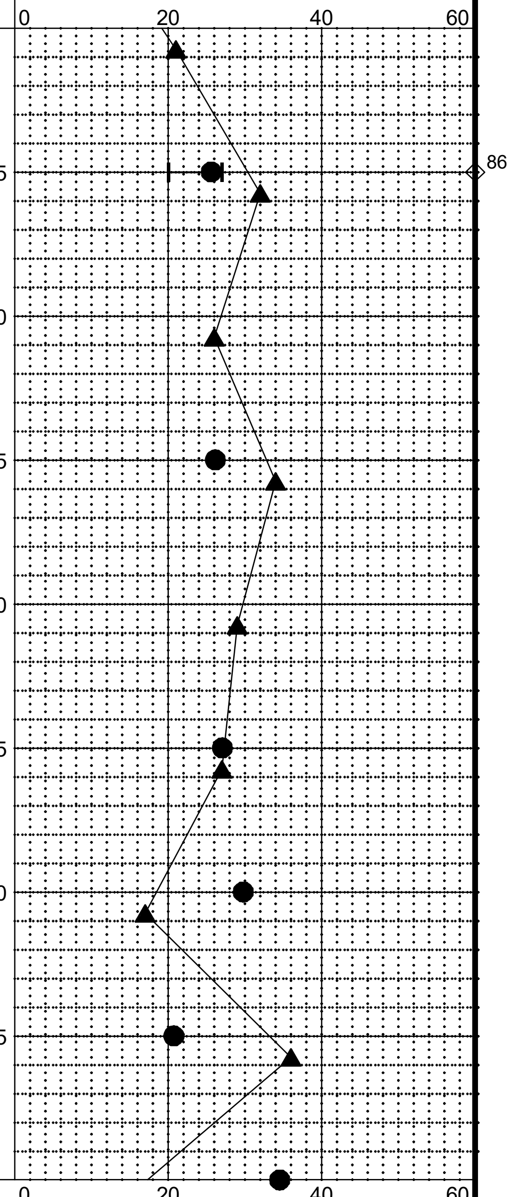
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
		12
Dense *Silty Clay (CL-ML)*; moist; trace fine, subrounded gravel; few fine sand; low plasticity; laminated silt and few sand from 45 to 45.5 feet; strong iron oxide staining at 45.5 feet.	43.0	13
Medium dense to dense, brown, interbedded, *Sandy Silt (ML), Silt (ML)*, and *Silty Sand (SM)*; fine sand; nonplastic to low plasticity; laminated locally; iron oxide staining locally; transitions to gray at 70.5 feet.	48.0	14, 15, 16, 17, 18
Dense, gray, *Silty Sand (SM)*; moist; fine sand; nonplastic.	71.5	19

CONTINUED NEXT SHEET

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├──●──┤ Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered

⌶ 2.0" O.D. Split Spoon Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

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LOG OF BORING SW-1

September 2020 105564-001

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FIG. A-2
Sheet 2 of 3

REV 3

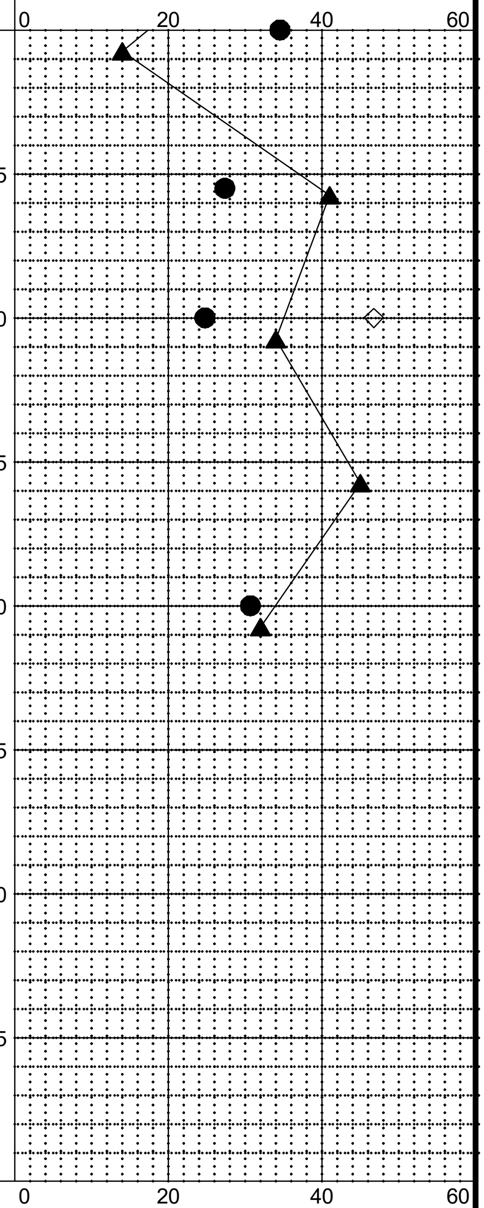
Total Depth:	101.5 ft.	Latitude:		Drilling Method:	Mud Rotary
Top Elevation:	~	Longitude:		Drilling Company:	Holt Services
Vert. Datum:		Station:		Drill Rig Equipment:	Mobile Drill Track
Horiz. Datum:		Offset:		Other Comments:	

Hole Diam.:	5 in.
Rod Diam.:	NWJ
Hammer Type:	Automatic

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water
Medium dense to dense, gray *Silt (ML)*; moist; few fine sand; nonplastic and low plasticity interbedded.	80.0		20	
Dense, gray, *Silty Sand (SM)*; moist; fine sand; nonplastic. - Sandy silt layers interbedded from 95 to 96 feet. - Trace organics below 100 feet.	85.5		21, 22, 23, 24	
BOTTOM OF BORING COMPLETED 8/18/2020	101.5			

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ●── Liquid Limit
Natural Water Content

LEGEND

* Sample Not Recovered
2.0" O.D. Split Spoon Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

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LOG OF BORING SW-1

September 2020 105564-001

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FIG. A-2
Sheet 3 of 3

REV 3

LABORATORY TERMS

Abbreviations, Symbols, and Terms	Descriptions
%	Percent
*	Sample specimen weight did not meet required minimum mass for the test method
"	Inch
#	Test not performed by Shannon & Wilson, Inc. laboratory
ASTM Std.	ASTM International Standard
C_c	Coefficient of curvature
Clay-size	Soil particles finer than 0.002 mm
cm	Centimeter
cm^2	Square centimeter
Coarse-grained	Soil particles coarser than 0.075 mm (cobble-, gravel- and sand-sized particles)
Cobbles	Soil particles finer than 305 mm and coarser than 76.2 mm
C_u	Coefficient of uniformity
CU	Consolidated-Undrained
ε	Axial strain
Fine-grained	Soil particles finer than 0.075 mm (silt- and clay-sized particles)
ft	Feet
γm	Wet unit weight
Gravel	Soil particles finer than 76.2 mm and coarser than 4.75 mm
G_s	Specific gravity of soil solids
H_o	Initial height
ΔH	Change in height
ΔH_{load}	End of load increment deformation
in	Inch
in^3	Cubic inch
LL	Liquid Limit
min	Minute
mm	Millimeter
μ_m	Micrometer
MC	Moisture content
MPa	Mega-Pascal
NP	Non-plastic
OC	Organic content
p	Total stress
p'	Effective stress
Pa	Pascal
pcf	Pounds per cubic foot
PI	Plasticity Index
PL	Plastic Limit
psf	Pounds per square foot
psi	Pounds per square inch
q	Deviatoric stress
Sand	Soil particles finer than 4.75 mm and coarser than 0.075 mm
sec	Second
Silt	Soil particles finer than 0.075 mm and coarser than 0.002 mm
t_n	Time to n% primary consolidation
t_{load}	Duration of load increment
tsf	Short tons per square foot
USCS	Unified Soil Classification System
UU	Unconsolidated-Undrained
WC	Water content

SAMPLE TYPES

Abbreviations, Symbols, and Terms	Descriptions
2SS	2.5-inch Outside Diameter Split-Spoon Sample
2ST	2-inch Outside Diameter Thin-Walled Tube
3HSA	3-inch CME Hollow-stem Auger Sampler
3SS	3-inch Outside Diameter Split-Spoon Sample
4SS	4-inch Inside Diameter Split-Spoon Sample
6SS	6-inch Inside Diameter Split-Spoon Sample
CA_MC	Modified California Sampler
CA_SPT	Standard Penetration Test (SPT)
CORE	Rock Core
DM	+3.25 inch Outside Diameter Split-Spoon Sample
DMR	3.25-inch Sampler with Internal Rings
GRAB	Grab Sample
GUS	3-inch Outside Diameter Gregory Undisturbed Sampler (GUS) Sample
OSTER	3-inch Outside Diameter Osterberg Sample
PITCHER	3-inch Outside Diameter Pitcher Sample
PMT	Pressuremeter Test (f=failed)
PO	Porter Penetration Test Sample
PT	2.5-inch Outside Diameter Thin-Walled Tube
ROCK	Rock Core Sample
SCORE	Soil Core (as in Sonic Core Borings)
SH1	1-inch Plastic Sheath
SH2	2-inch Plastic Sheath with Soil Recovery
SH3	2-inch Plastic Sheath with no Soil Recovery
SPT	2-inch Outside Diameter Split-Spoon Sample
SS	Split-Spoon
ST	3-inch Outside Diameter Thin-Walled Tube
STW	3-inch Outside Diameter Thin-Walled Tube
TEST	Sample Test Interval
TW	Thin Wall Sample
UNDIST	Undisturbed Sample
VANE	Vane Shear
WATER	Water Sample for Probe Logs
XCORE	Core Sample

LABORATORY TEST SUMMARY

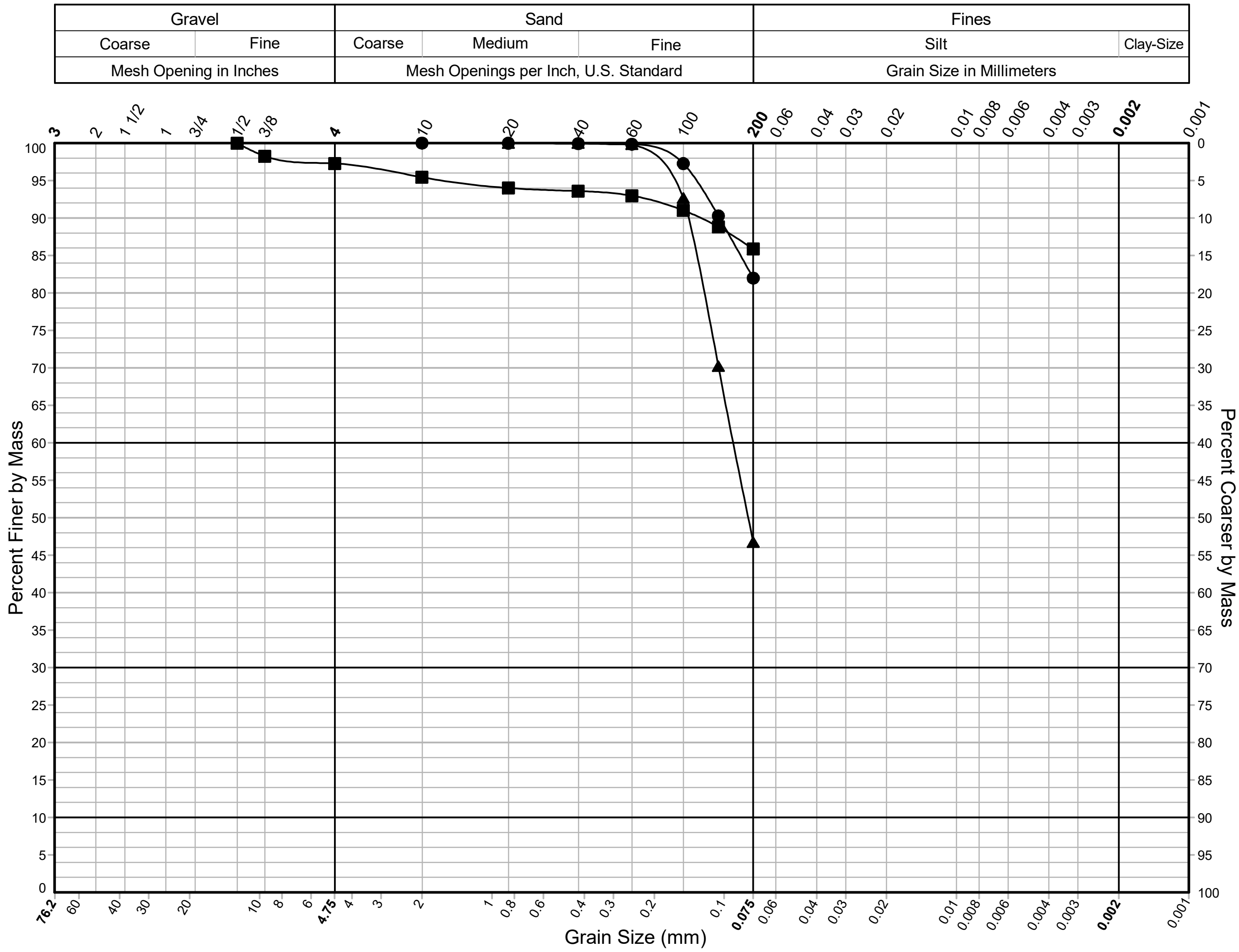
Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Gravel	% Sand	% Fines	LL	PL	Soil Description
SW-1	7.5	S-3	SPT	25		22.8						
SW-1	10	S-4	SPT	7		26.0						
SW-1	15	S-6A	SPT	11	ML	48.9				42	26	Silt
SW-1	17.5	S-7	SPT	5	ML	40.1				36	28	Silt
SW-1	25	S-9	SPT	14	ML	30.9		18	82			Silt with Sand
SW-1	35	S-11	SPT	9		32.0						
SW-1	45	S-13	SPT	32	CL-ML	25.6	3*	11*	86*	27	20	Silty Clay
SW-1	55	S-15	SPT	34		26.1						
SW-1	65	S-17	SPT	27		27.1						
SW-1	70	S-18	SPT	17		29.8						
SW-1	75	S-19	SPT	36		20.7						
SW-1	80	S-20	SPT	14		34.5						
SW-1	85.5	S-21	SPT	41		27.4						
SW-1	90	S-22	SPT	34	SM	24.8		53	47			Silty Sand
SW-1	100	S-24	SPT	32		30.7						

SHANNON & WILSON, INC.

GRAIN SIZE DISTRIBUTION PLOT

State Legislative Campus
Olympia, Washington

BORING SW-1

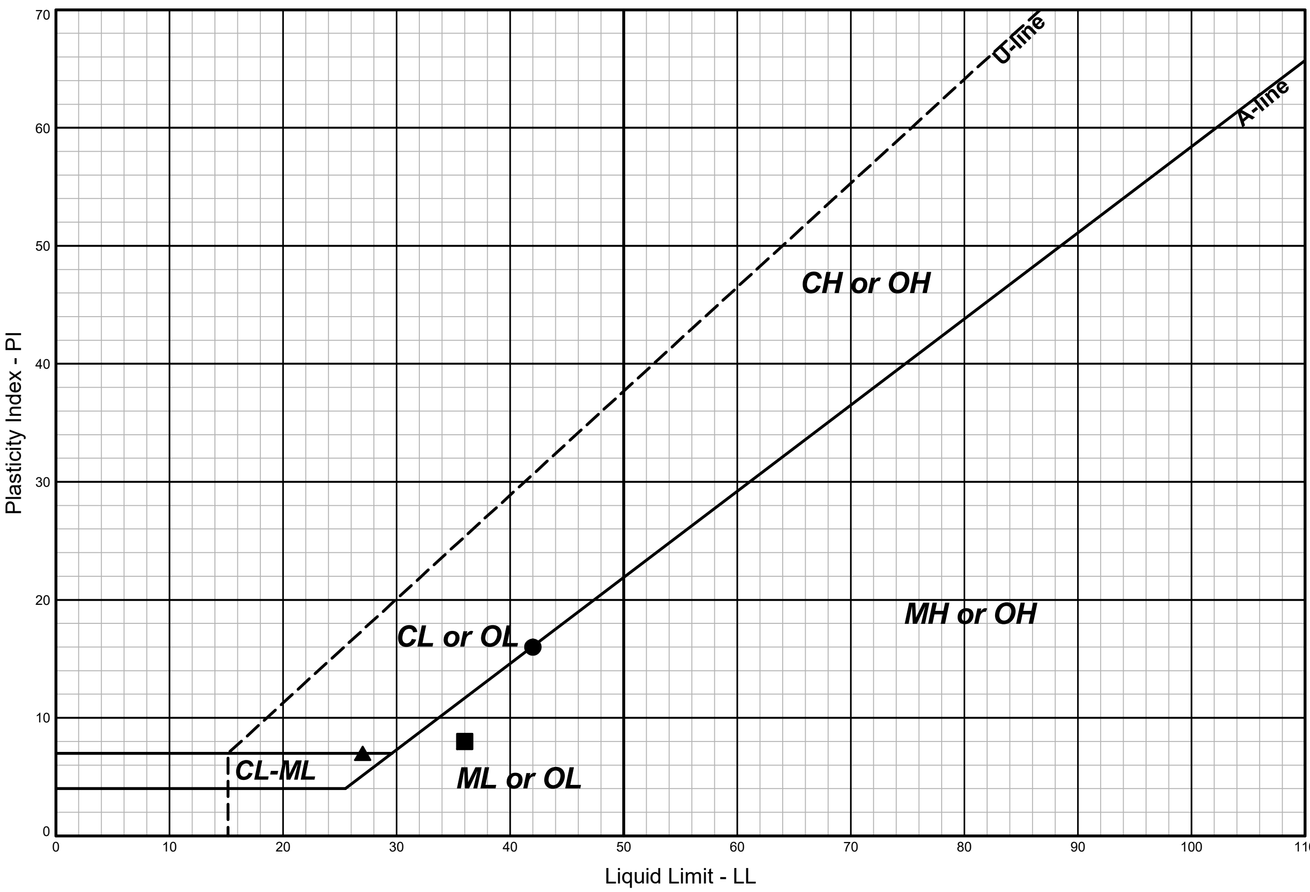


Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SW-1, S-9	25.0	ML	Silt with Sand		18	82			30.9	MXC		D6913
■ SW-1, S-13*	45.0	CL-ML	Silty Clay	3	11	86			25.6	MXC		D6913
▲ SW-1, S-22	90.0	SM	Silty Sand		53	47			24.8	MXC		D6913

* *Test specimen did not meet minimum mass recommendations.*

State Legislative Campus
Olympia, Washington

BORING SW-1



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	LL	PL	PI	WC %	Gravel %	Sand %	Fines %	< 2µm %	Tested By	Review By	ASTM Std.
● SW-1, S-6A	15.0	ML	Silt	42	26	16	48.9					MRH		D4318
■ SW-1, S-7	17.5	ML	Silt	36	28	8	40.1					MRH		D4318
▲ SW-1, S-13	45.0	CL-ML	Silty Clay	27	20	7	25.6	3	11	86		AKV		D4318

Important Information

About Your Geotechnical/Environmental Report

IMPORTANT INFORMATION

IMPORTANT INFORMATION

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland