SUBMITTED TO:
WA State Department of Enterprise Services,
Facility Professional Services
1500 Jefferson Street
Olympia, WA 98504

BY:
Shannon & Wilson
400 N. 34th Street, Suite 100
Seattle, WA 98103

(206) 632-8020
www.shannonwilson.com

GEOTECHNICAL ENGINEERING REPORT

# Newhouse Building Replacement

STATE CAPITOL CAMPUS, OLYMPIA, WASHINGTON

SHANNON & WILSON

March 14, 2022

Shannon & Wilson No: 105564-003

Submitted To: WA State Department of Enterprise Services,
Facility Professional Services
1500 Jefferson Street
Olympia, WA 98504
Attn: Ms. Amy Kim

Subject: GEOTECHNICAL ENGINEERING REPORT, NEWHOUSE BUILDING REPLACEMENT, STATE CAPITOL CAMPUS, OLYMPIA, WASHINGTON

Shannon & Wilson prepared this report and participated in this Project as a consultant to the Washington State Department of Enterprise Services. Our scope of services was specified in our Proposal for Geotechnical Engineering Services dated October 19, 2021. This report presents the results of our geotechnical investigation and provides the geotechnical engineering recommendations for the design team for the design and construction of the Newhouse Building Replacement.

We appreciate the opportunity to be of service to you on this Project. If you have questions concerning this report, or we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON



Robert A. Mitchell, PE
Vice President

Hamid R. Nouri, PhD. PE
Senior Geotechnical Engineer

HRN:RAM/hrn

CONTENTS

## Exhibits



## Tables



## Figures



## Appendices



CONTENTS

# ACRONYMS

| | |
|---|---|
| ASCE | American Society of Civil Engineers |
| AASHTO | American Association of State Highway and Transportation Officials |
| bgs | below ground surface |
| bpf | blows per foot |
| CEC | cation exchange capacity |
| CSBC | Crushed Surfacing Base Course |
| DDECM | Drainage Design and Erosion Control Manual |
| Ecology | Washington State Department of Ecology |
| FS | factor of safety |
| H:V | Horizontal to Vertical |
| IBC | International Building Code |
| in/hr | inches per hour |
| $MCE_G$ | maximum considered earthquake geometric mean |
| $MCE_R$ | risk-targeted maximum considered earthquake |
| OSHA | Occupational Safety and Health Administration |
| pcf | pounds per cubic foot |
| PGA | peak ground acceleration |
| SMMWW | Stormwater Management Manual for Western Washington |
| SPT | Standard Penetration Test |
| USCS | Unified Soil Classification System |
| USGS | U.S. Geological Survey |
| VWP | vibrating wire piezometer |
| WSDOT | Washington State Department of Transportation |

# 1 INTRODUCTION

This geotechnical report presents the results of our subsurface explorations and laboratory testing and provides geotechnical recommendations for design and construction of the Newhouse Building Replacement that is part of the State Legislative Campus Modernization plan for buildings at the State Capitol Campus in Olympia, Washington. This report was prepared for use by the design team.

Our scope of geotechnical services was outlined in our Proposal for Geotechnical Engineering Services dated October 19, 2021. Our scope of services included:

- Completing a field investigation, which included subsurface explorations, field testing, and sample collection;
- Conducting laboratory testing;
- Providing the design seismic ground motion parameters;
- Developing foundation recommendations for shallow and deep foundations;
- Evaluating earthquake-induced geologic hazards (faulting, liquefaction, lateral spreading, flow failure, etc.) and mitigation measure recommendations;
- Determining static, seismic/active, and passive lateral earth pressures for foundation walls, as well as yielding and non-yielding retaining/shoring walls;
- Estimating the vertical modulus of subgrade reaction and total and differential settlement of the ground supported slab if it is not tied into the foundation;
- Providing construction recommendations, which included:
  - Determining if on-site materials could be used for backfill under slabs and/or behind retaining walls;
  - Providing a recommended cross section for capillary break material below slabs on grade, requirements for a slab underdrain system, and determining the need for waterproofing or vapor barriers below slabs or on retaining walls;
  - Recommending the need for depth of overexcavation, replacement, and compaction below the slab;
  - Providing recommendations for potential excavation methods and slopes;
  - Recommending excavation and backfill requirements for the removal of the existing basement;
  - Determining utility trench excavation and backfill requirements; and
  - Recommending requirements for building and retaining wall footing drains.

- Pavement recommendations, including subgrade preparation; hot-mix asphalt pavement sections for the parking lot, fire lane, and street; and portland cement concrete pavement sections for the sidewalk, hardscape, loading dock, and fire lane; and
- Preparing a draft and final report summarizing the results of our analyses.

The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist, and further assume that the explorations are representative of the subsurface conditions at the Project site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by our explorations. Within the limitations of the scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied.

Our conclusions and recommendations are based on our understanding of the Project as described in this report and the site conditions as interpreted from the explorations. Shannon & Wilson has prepared a document, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of our reports.

# 2 SITE AND PROJECT DESCRIPTION

The general Project location is provided in Figure 1. The proposed site of the Project is currently occupied by the existing Newhouse building (215 Sid Snyder Avenue SW), the existing Carlyon House (201 Sid Snyder Avenue SW), and the existing Ayer House (1417 Columbia Street SW), as well as surface parking lots. Figure 2 shows the footprint of the proposed Newhouse building. It is our understanding that:

- The proposed multi-story Newhouse building will be constructed near the existing grade, except for the east section of the building where a one-story basement is anticipated.
- The at-grade southwest portion of the proposed Newhouse building will be built over the footprint of the existing building basement with a depth of approximately 10 feet.

The area within the proposed Newhouse building footprint is relatively flat, with elevations ranging from 114 to 121 feet North American Vertical Datum of 1988. There is a slope at about 500 feet southwest of the proposed Newhouse building that is approximately 110 feet high and includes slope inclinations approaching approximately 1.7 Horizontal to 1 Vertical (1.7H: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 the slope for the Newhouse building is discussed in the recommendations provided in this report.

# 3 GEOTECHNICAL SUBSURFACE DATA

## 3.1 Historical Data and Field Explorations

We reviewed the existing subsurface geotechnical data generated by previous studies at and near the Project location. Each of the reviewed studies included geotechnical field investigations. Exhibit 3-1 also summarizes the related study, depth, and other information for each exploration. The reviewed references include:

- *Seismic Ground Motion Study for the Washington State Legislative Building, Pre-Schematic Services for Updated Seismic Analyses, Olympia, Washington* (Shannon & Wilson, 2001).
  Purpose: Seismic ground motion studies and subsurface seismic evaluations for seismic rehabilitation of the Washington State Legislative Building.
- *Conceptual Geotechnical Report for the Executive Office Plaza/Heritage Center, Olympia, Washington* (Shannon & Wilson, 2007).
  Purpose: Conceptual engineering studies and recommendations for the proposed Executive Office Plaza/Heritage Center at the State Capitol Campus.
- *Hillside Evaluation and Preliminary Design for Olympia Capitol Campus, Olympia, Washington* (Golder Associates, 2010).
  Purpose: Capitol Campus hillside stability study to evaluate stability of slopes, risk of failure, and consequences of slope failure.

**Exhibit 3-1: Summary of Historic Field Explorations**

| Related Study | Boring Designation | Surface Elevation (feet) | Boring Depth (feet) | Piezometer Installed | Seismic Velocity Measurement |
|---|---|---|---|---|---|
| Shannon & Wilson (2001) | S-1 | 113.5 | 101.5 | ---- | Seismic Downhole |
| | N-1 | 111 | 151.5 | ---- | |
| Shannon & Wilson (2007) | HC-1 to HC-15 | 80 to 102 | 34 to 11.5 | MW HC-2, HC-3, HC-5, HC-6, HC-7 | ---- |
| | HC-16 to HC-20 | 15 to 35 | 51.5 to 71.5 | ---- | |
| Golder Associates (2010) | GB-1 | 145 | 102.9 | VWP | ---- |
| | GB-2 | 135 | 104 | VWP | |

MW = monitoring well; VWP = vibrating wire piezometer

## 3.2 2020 to 2021 Field Explorations

### 3.2.1 Drilling

Shannon & Wilson performed the following explorations at different stages of the Project between 2020 and 2021. The most recent exploration locations are shown in Figure 2 and the historic explorations are summarized in Exhibit 3-2:

- *2020 Predesign Stage*: Shannon & Wilson subcontracted Holt Services, Inc. of Edgewood, Washington, to drill one boring, designated SW-1, using mud rotary techniques on August 18, 2020. SW-1 data was used as a supplement to historic data for developing the predesign geotechnical engineering recommendations.
- *2021 Final Design Stage*: Holt was subcontracted by Shannon & Wilson to drill four borings, designated B-1 through B-4A, using mud rotary techniques from December 6 through 10, 2021.

A representative from Shannon & Wilson was present during the boring to observe the drilling and sampling operations, to retrieve representative soil samples for subsequent laboratory testing, and to prepare descriptive field logs. The samples were placed in jars and returned to our laboratory for additional visual classification.

**Exhibit 3-2: Summary of 2020 to 2021 Field Explorations**

| Design Stage | Boring Designation | Surface Elevation[1] (feet) | Boring Depth (feet) |
|---|---|---|---|
| 2020 Predesign Stage | SW-1 | 121 | 101.5 |
| 2021 Final Design Stage | B-1 | 121 | 101.5 |
| | B-2 | 119 | 101.5 |
| | B-3 | 114 | 151.5 |
| | B-4A | 120 | 101.5 |

NOTE:
1 All surface elevations are approximate.

The boring logs are presented in Appendix A and these logs graphically show 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.

### 3.2.2 Field Testing and Sampling

***Disturbed Sampling***: Soil samples from the project borings 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 boring 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 due to refusal conditions 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 to the bottom of the hole with an automatic trip hammer. Soil samples from the SPT were labelled, sealed, and taken to the Shannon & Wilson laboratory for laboratory testing. N-values were corrected to account for the efficiency of the hammer used in the test and converted to $N_{60}$ (normalized to 60% hammer efficiency) in our analysis.

***Undisturbed Sampling*****:** We also collected relatively undisturbed samples in the subsurface fine-grained layers using a 3-inch-diameter, thin-walled, Shelby tube sampler. During sampling, the tube was pushed into the undisturbed soil at the bottom of the boring by hydraulically pushing the tube into the soil with a piston sampler. After the tube was collected, it was sealed, stored in an upright position, and transported back to our Seattle Laboratory.

# 4 GEOTECHNICAL LABORATORY TESTING

The collected soil samples from the borings were returned to the Shannon & Wilson soil laboratory for geotechnical laboratory testing. The disturbed soil samples were visually examined and then grouped together based on particle size distribution, consistency, and color. Once groups of samples were established that had similar characteristics, typically at least one sample per group was tested for index properties.

The results of the index tests are used to classify the soils according to the USCS. Index test results can be used with published correlations to estimate soil parameters. The following tests were performed on selected samples:

- Moisture Content (American Association of State Highway and Transportation Officials [AASHTO] T265)
- Atterberg Limits (AASHTO T89 and T90)
- Particle-Size Analysis (AASHTO T11 and T27)

Laboratory test results are presented in Appendix B and incorporated into the boring log, as appropriate.

# 5 GEOLOGY AND SUBSURFACE CONDITIONS

## 5.1 Regional Geologic Setting

Tertiary bedrock and a thick accumulation of Quaternary sediments underlie Olympia and its immediate vicinity (Noble and Wallace, 1966; Hall and Othberg, 1974). Although bedrock underlying Olympia is presumed to be submarine basalt of the Crescent Formation, no deep wells have penetrated to rock in the immediate vicinity. These marine volcanic rocks, which are exposed locally in Tumwater, crop out in isolated areas just southwest of Olympia and are exposed extensively in the nearby Black Hills to the southwest.

The Quaternary sediments, which unconformably overlie the Tertiary bedrock, may be as much as 600 feet thick in the Olympia area (Hall and Othberg, 1974; Buchanan-Banks and Collins, 1994). The older pre-Vashon Pleistocene deposits include both glacial and non-glacial sediments. These sediments are overlain by the younger Pleistocene deposits of the Vashon Stade of the Fraser Glaciation. Geologic maps of the Olympia area (Walsh and others, 2003; Palmer and others, 2004) indicate the surficial materials at the site consist of recessional glaciolacustrine and low-energy glaciofluvial sand and silt (Qgof) with local clay and gravel. These soils were deposited around the margins of glacial and low-energy streams during the recession of the Vashon ice sheet. Subsurface explorations throughout the Capitol Campus, including the borings at the Project site, show natural deposits of lacustrine and fluvial sediments consistent with the description of recessional fine-grained sediments (Qgof). Over time, the naturally formed surface has been altered by the placement of fill to flatten topography and provide usable land.

## 5.2 Site Subsurface Conditions

Based on our review of the site geology and subsurface conditions encountered in the historical borings and our borings at the Project site, we grouped the subsurface materials into two main soil units, as described below:

- **Fill:** When encountered, the fill material included topsoil and gravel, very loose to loose silt with sand/gravel. The surficial fill in our borings is generally 0.6 to 4.5 feet thick.
- **Native Soils:** This unit was encountered below the fill. This unit could be subdivided into two subunits, as described below:
  - ***Silt Deposit*:** This unit is predominantly a fine-grained deposit and consists of very loose to dense silt with sand/gravel, and interbedded layers of medium dense to dense, silty sand. This deposit is wet, with water content varying from 30 to 40% and generally higher than the liquid limit. The silt dominant samples in this unit are very dilatant (i.e., react to shaking, squeezing, and vigorous tapping by releasing the pore water to the surface, densification, and losing strength). The silt deposit is mainly nonplastic to low plasticity, with plasticity index ranging from 1 to 11%. This unit is generally very loose to loose with N-values ranging from 0 to 8 blows per foot (bpf) in the top 25 feet. The unit becomes medium dense to dense with N-values ranging from 10 to 39 bpf at deeper elevations. Silty sand lenses are generally denser with N-values ranging from 20 to 30 bpf. This deposit generally extends about 80 to 100 feet below grade.
  - ***Silty Sand Deposit***: The fine-grained silt deposit is underlain by a dense to very dense, silty sand layer with N-values varying from 30 to 55 bpf. This unit extends to the bottom of borings at 100 to 150 feet below grade.

Refer to the boring logs in Appendix A for a more detailed description of the materials encountered in each boring.

## 5.3 Site Groundwater Conditions

We used the groundwater data from the borings with piezometers or monitoring wells near the Project site. Exhibit 5-1 summarizes the groundwater measurement data in the nearby historic borings.

The closest borings with a vibrating wire piezometer (VWP) for groundwater measurement are GB-1 and GB-2, which are located at about 600 and 900 feet southwest and west of the Project site, respectively (see Figures 2). The existing VWPs in GB-1 and GB-2 did not record any groundwater readings that indicate groundwater is below the lowest piezometer sensor location (i.e., below the approximate elevation of 65 feet). We also reviewed the Shannon & Wilson (2007) monitoring wells (see Exhibit 3-1), which extend deeper below grade. Generally, the static groundwater elevation determined from the observation wells at the top of the western slope ranged between 30 and 34 feet with an average groundwater elevation of approximately 32 feet. As such, we used a groundwater elevation of 32 feet in our analysis.

**Exhibit 5-1: Summary of Groundwater Level Measurements in Historic Field Explorations**

| Related Study | Boring Designation | Ground Surface Elevation[1] (feet) | VWP Location | | Measured Groundwater Level | |
|---|---|---|---|---|---|---|
| | | | Depth bgs (feet) | Elevation (feet) | Depth bgs (feet) | Elevation (feet) |
| Shannon & Wilson (2007) | HC-2 | 99 | ----[2] | ----[2] | 94 | 5 |
| | HC-3 | 95 | ----[2] | ----[2] | 61 | 34 |
| | HC-5 | 89 | ----[2] | ----[2] | 57 | 32 |
| | HC-6 | 84 | ----[2] | ----[2] | 54 | 30 |
| | HC-7 | 84 | ----[2] | ----[2] | 54 | 30 |
| Golder (2010) | GB-1 | 145 | 80 | 65 | Dry [3] | Dry [3] |
| | GB-2 | 135 | 50 | 85 | Dry [3] | Dry [3] |

NOTES:
1 All elevations are approximate and based on North American Vertical Datum (of 1988).
2 No vibrating wire piezometer was installed.
3 No groundwater-induced pressure recorded, indicating the groundwater level is below the piezometer location.

# 6 ANALYSIS AND RECOMMENDATIONS

Our geotechnical analyses and recommendations included:

- Seismic ground motion estimates,
- Evaluation of earthquake-induced geologic hazards,
- Evaluation of slope stability,
- Foundation recommendations for the proposed Newhouse building, 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 building 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.

## 6.1 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) 7-16 (ASCE, 2017) requirements. Computation of the ground motion parameters is based on seismological input and site soil response factors. For this design reference, the seismological inputs include:

- Risk-targeted maximum considered earthquake ($MCE_R$) horizontal response spectral acceleration values at periods of 0.2-second ($S_S$) and 1.0-second ($S_1$). 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.
- Maximum considered earthquake geometric mean ($MCE_G$) horizontal peak ground acceleration (PGA). The $MCE_G$ ground motion parameters are the 2,475-year ground motion parameters without any adjustment for a target collapse risk. The PGA of the $MCE_G$ is used for our geotechnical engineering analyses, including liquefaction assessment and earth pressures estimations.

### 6.1.1 Site Classification

$MCE_R$ and $MCE_G$ horizontal response spectral accelerations need to be adjusted for site class to account for site amplification effects. We evaluated the site classification for the Project based on ASCE 7-16, which specifies the site class based on a depth-weighted average shear wave velocity, SPT blow count, or undrained shear strength in the upper 100 feet of the soil profile. The depth-weighted average SPT blow count for the 2020 predesign and 2021 final design stages resulted in Site Class D and E. We also used the shear wave velocity profile from seismic downhole tests completed in S-1 and N-1 historical borings near the Legislative Building (Shannon & Wilson, 2001) to calculate the depth-weighted average shear wave velocity. The average shear wave velocity for the top 100 feet at S-1 and N-1 locations indicates Site Class D. Since shear wave velocity measurement is a more reliable approach to determine site classification, we used Site Class D for our seismic parameter calculations.

Per ASCE 7-16, we note that a site response analysis is required for structures without seismic isolation or damping systems on a Site Class D site with specific exceptions outlined in Section 11.4.8. The exception for a Site Class D is as below:

> 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 $T > T_L$.

### 6.1.2 Near-Fault Effect

The Project site is located within 0.8 mile of Olympia fault structure and therefore considered a near-fault site. Per ASCE 7.16, Section 11.4.1 however, ASCE exempts faults with an estimated slip rate along the fault less than 1 millimeter per year. The slip rate of the Olympia fault structure is between 0.2 to 1.0 millimeter per year. As such, the Project site is not considered a near-fault site and we did not modify the design spectra for near-fault effects.

### 6.1.3 Seismic Design Parameters

We evaluated the site soil response using site soil 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 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.

Exhibit 6-1 provides the design response spectra parameters, $MCE_R$, and $MCE_G$ ground motion parameters from which the design response spectra parameters were derived.

**Exhibit 6-1: Estimated Predesign Response Spectrum Parameters for Site Class D**

| 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[1] | 1.41 g |
| $S_{M1}$ | Mapped $MCE_R$, 5% damped, spectral acceleration at a period of 1 second adjusted for site effects[2] | 0.93 g |
| $S_{DS}$ | Design, 5% damped, short period acceleration[1] | 0.94 g |
| $S_{D1}$ | Design, 5% damped, spectral acceleration at a period of 1 second[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 $MCE_G$ PGA | 0.61 g |
| $PGA_M$ | Mapped $MCE_G$ PGA adjusted for site effects | 0.67 g |
| $M_w$ | Mean magnitude[3] | 7.0 |

NOTES:

1 Values for the short-period spectral acceleration were adjusted based on $F_a$ site coefficient. $F_a$ values were extrapolated based on $F_a$ values provided in the 2018 IBC and ASCE 7-16.

2 Values for the long-period spectral acceleration were adjusted based on $F_v$ site coefficient. $F_v$ values were extrapolated based on $F_v$ values provided in the 2018 IBC and ASCE 7-16. The spectrum should be altered per the exception in ASCE 7-16 Section 11.4.8 for Site Class D.

3 Based on the USGS Uniform Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) using the U.S. Dynamic Conterminous edition for 2014 (update) (v.4.2.0).

g = acceleration of gravity, sec = seconds; USGS = U.S. Geological Survey

For basement seismic earth pressure calculations, we also used a horizontal acceleration coefficient ($k_h$) equal to 0.34, which considers a minimum of 1 to 2 inches of wall deformation. Vertical acceleration ($k_v$) was not considered in our analysis.

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

### 6.2.1 Fault-Related Ground Rupture

Based on fault mapping provided by the U.S. Geological Survey (USGS), the closest known potentially active fault to the site is the Olympia Fault Structure. The Project site is potentially located 0.8 mile 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, no fault scarps have been found above this structure, and the location of the fault trace is poorly known. There is also a lack of historical seismicity associated with the structure. In our opinion, the risk of ground surface rupture at the site is moderately low.

### 6.2.2 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 evaluations of the liquefaction potential of the subsurface soils using the SPT-based procedure of Boulanger and Idriss (2014), the 2020 to 2021 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. As such, we performed our liquefaction analyses for an earthquake magnitude of 7.0 and an adjusted PGA of 0.67g (see Exhibit 6-1). 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 a seismic settlement of about 4 inches within the proposed Newhouse building footprint.

### 6.2.3 Landsliding

The existing topography at the proposed Newhouse building location is relatively flat; however, the topography 500 feet to the southwest of the proposed building includes slopes about 110 feet high, with slope inclinations changing 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. In our opinion, the risk of landsliding in our site is minimal, given the 500 feet clearance distance of the building from the slope.

## 6.3 Foundation Design

We considered two general foundation alternatives for the proposed Newhouse building: shallow foundations and deep foundations. Each foundation alternative is discussed individually in the following sections.

### 6.3.1 Shallow Foundations

We understand that the new building will be constructed near the existing grade except for the east section which will include an approximately 10-foot-deep basement. As discussed in Section 5.2, the soils at the proposed Newhouse building generally consist of very loose to loose silts to silty sands in the top 25 feet.

An allowable bearing pressure of 2 kips per square foot may be used for shallow spread footings that could support the proposed Newhouse building. Provided that:

- The upper 2 feet are excavated and replaced with compacted, well-graded structural fill,
- The existing basement below the southwest corner of the proposed Newhouse building is backfilled 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,
- The exposed subgrade is compacted to a dense and unyielding condition, and
- The footing is embedded at least 2 feet below grade.

The allowable bearing pressure can be increased by up to one-third for seismic and wind loads. Continuous footings should have a minimum width of 18 inches, and column footings should have a minimum width of 24 inches. The base of all footings should be located at least 24 inches below the adjacent exterior grade and at least 18 inches below the lowest adjacent interior grade.

We anticipate that footings designed with this bearing pressure will experience postconstruction settlement of 0.5 to 1 inch. Differential settlement between adjacent column footings or over a 20-foot span of continuous footing are estimated to be approximately half of the total settlement. It is anticipated that the majority of the estimated settlements would occur simultaneously as the loads are applied. Connecting individual foundations with grade beams could help mitigate the potential for differential settlements; however, the building and its connecting utilities would need to be designed to account for the potential for seismic settlements.

***Lateral Resistance and Friction on Footings***: Lateral forces on shallow foundations may be resisted by passive pressure against the buried portions of the footings and friction against the bottom of footings. The passive earth pressure assumes if the soil against the buried portions of the footings is excavated and replaced with compacted well-graded structural fill, passive earth pressures could be estimated using an equivalent fluid unit weight of 300 pounds per cubic foot (pcf). This value assumes that the footings extend at least 2 feet below the lowest adjacent exterior grade, are properly drained, that the backfill around the structure is compacted in accordance with the recommendations for structural fill outlined in Section 7.2, and the ground surface is horizontal for a minimum distance of 1½ times the embedment depth. The above equivalent fluid unit weight includes a factor of safety (FS) of 1.5.

We recommend that a coefficient of friction of 0.35 be used between foundation cast-in-place concrete and footing subgrade soil. This value assumes compacted structural fill as the footing subgrade soil. The coefficient of friction includes a FS equal to 1.5 to limit lateral deflection.

### 6.3.2 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 cast-in-place piles will be the preferred deep foundation option for the proposed Newhouse building. We recommend augercast piles to provide cost-effective deep foundation support of the structure. Augercast piles, also known as continuous-flight auger piles, are constructed by advancing a hollow-stem continuous-flight auger into the ground to a design depth. Concrete or grout is pumped through the hollow stem to fill the drilled hole, as the auger is slowly removed. This construction method reduces the construction-induced noise and vibration as compared to pile driving activities. We anticipate that 18- and 24-inch-diameter augercast piles could be sufficient to support the proposed Newhouse building.

***Pile Axial Capacity***: The ultimate axial capacity was developed in compression and uplift conditions for static and seismic cases. The augercast pile ultimate capacity was divided by a FS to calculate the allowable value for use in design. Per the 2018 IBC, we used FS values of 2 and 3 for static compression and uplift, respectively. To calculate the allowable capacity for seismic conditions, we reduced the static FS by 33% for transient load conditions; that is, FS values of 1.5 and 2 for seismic compression and uplift, respectively. The allowable axial compression/uplift capacity plots for 18- and 24-inch-diameter augercast piles in static/seismic conditions are shown in Figures 3 and 4.

The pile lengths are considered from the following elevations:

- For building portions constructed at grade including the portion over the existing building basement footprint: lengths are considered from the “at-grade” elevation
- For building portions with a proposed basement: lengths are considered from the proposed basement base elevation

For augercast piles designed using the provided capacities and FS values, we anticipate that the pile will settle less than 1 inch due to structural loads.

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

***Pile Lateral Capacity***: The lateral response of deep foundations is evaluated using the computer program LPILE (Ensoft, 2018). Table 1 presents recommended input parameters for lateral resistance analysis in static and seismic conditions for a single pile using LPile. The designated columns on Table 1 include the reduced shear strength parameters to account for cyclic softening during seismic event.

The recommended parameters in Table 1 are developed for a single, isolated pile and do not consider group action of closely spaced piles. P-multipliers listed in AASHTO LRFD BDS (2020) Table 10.7.2.4-1 should be applied if piles are spaced closer than five diameters, center to center.

## 6.4 Floor Slabs

Floor slabs for the proposed Newhouse building may be slab-on-grade. Floor slabs should not bear on the loose/soft material. Given the presence of very loose to loose silt in the top 25 feet of the Project site, we recommend that the upper 2 feet below the floor slab are excavated and replaced with densely compacted, well-graded structural fill. A subgrade reaction modulus of 250 pounds per cubic inch may be used to design floor slabs, assuming that they are constructed on subgrade prepared as recommended.

We recommend placing a capillary break consisting of a minimum 4-inch-thick layer of washed pea gravel or ⅝-inch-minus crushed rock. Where moisture control is necessary, a plastic vapor retarder should be placed over the capillary break prior to pouring the concrete floor slab. The vapor retarder should consist of 10-mil polyethylene plastic sheeting or comparable material approved by the design team.

## 6.5 Lateral Earth Pressures for Permanent Walls

The lateral pressures against buried walls are dependent upon many factors, including method of backfill placement and degree of compaction, backfill slope, surcharges, the type of backfill soil and/or adjacent native soil, drainage provisions, and whether or not the wall can yield or deflect laterally or rotate at the top after or during placement of backfill during and after excavation. For building and retaining walls that are allowed to move at least 0.001 times the wall height, we recommend that a static, active, lateral earth pressure be used. For walls that are not allowed to move 0.001 times the wall height, static, at-rest, lateral earth pressures should be used.

Soldier pile walls are recommended to shore the site excavation where open cuts are not possible. At these locations, we recommend that permanent basement wall designs be based on active earth pressures. Figure 5 presents the active and at-rest earth pressure diagrams recommended for design of the proposed Newhouse building. At-rest earth pressures should be considered to limit shoring wall movement next to critical structures or utilities. The equivalent fluid weights given are based on the assumptions that the ground surface behind the wall is level, and that proper drainage is installed to prevent water from building up behind the wall. Lateral pressures due to surcharge loads should be added where appropriate and should be based on the diagrams shown in Figure 6.

The total earth pressures should be analyzed for seismic loading conditions using a dynamic load increment equal to a percentage of the static earth forces. The seismic load increment is presented in Figure 5. A percentage load increase for seismic conditions is consistent with a pseudo-static analysis using the Mononobe-Okabe equation for lateral earth pressures and a horizontal seismic coefficient of 0.34. These pressures assume drained conditions and a horizontal ground surface.

## 6.6 Temporary Shoring Walls

It is our understanding that the excavation for the proposed Newhouse building will extend up to about 10 feet below grade to accommodate a one-story basement on the east side of proposed building. Open-cut excavations are anticipated where possible, but temporary shoring will be required where open cuts cannot be adequately constructed. We recommend a conventional soldier pile for temporary shoring purposes. The static, active, and passive earth pressures for native soil (i.e., no native soil excavation and replacement) presented in Figure 5 are recommended for design of a temporary soldier pile cantilever wall. The seismic earth pressure increment does not apply for the temporary shoring. Recommended surcharge loading for temporary and permanent walls is presented in Figure 6. All the pressures in Figure 6 assume a proper drainage is installed to prevent water from building up behind the wall. Figure 7 presents the typical section of the shoring wall and floor slab drainage system.

Soldier pile penetration depth below the final excavation level should also be adequate for kick-out resistance. Lagging should be installed between the soldier piles as the excavation proceeds down. The Contractor should provide means, such as weep holes, to prevent the buildup of hydrostatic pressures behind the temporary shoring walls.

## 6.7 Subsurface Drainage

We recommend installing a subsurface drainage (subdrain) system along the outside of the perimeter footings to prevent water from accumulating against the building foundations. The subdrain system should consist of a perforated or slotted, 4-inch-diameter (minimum) plastic pipe bedded in ⅜-inch to No. 8 size washed pea gravel. Please refer to Figure 8 for typical wall subdrainage and backfilling recommendations.

Where a perforated or slotted drainpipe from a subdrain system connects into a tightline, we recommend that a low-permeability concrete collar or dam be placed along the first 2 feet of the tightline to force all water into the tightline and prevent it from flowing through pipe bedding material. Cleanouts should be provided at convenient locations along all drain lines, such as at the building corners. To promote surface water drainage, provisions should be made to direct it away from structures. Ground surface finished grades should be sloped away from the building perimeter. Surface water should be collected in catch basins and conveyed in a nonperforated pipe (tightline) to an approved discharge point.

## 6.8 Stormwater Infiltration

### 6.8.1 Estimated and Design Infiltration Rates

We evaluated the infiltration rate of the site soil in accordance with Volume III of the City of Olympia Drainage Design and Erosion Control Manual (DDECM) (City of Olympia, 2016) and the Stormwater Management Manual for Western Washington (SMMWW) (Washington State Department of Ecology [Ecology], 2014). We used the grain-size analysis method to estimate the infiltration rate. This method was developed to account for soil variability, long-term siltation, and biomass buildup.

We used the available grain-size distribution for the predominant silt samples in our analysis. The estimated short-term (calculated) infiltration rate for the Project site is about 0.85 to 2.2 inches per hour (in/hr).

The DDECM and SMMWW provide correction factors to apply to the calculated short-term infiltration rates to obtain design rates for infiltration facilities. The correction factors consist of:

- $CF_v$: Site variability and number of locations tested. This value ranges from 0.33 to 1. We assumed 0.6 for this factor in our analysis.
- $CF_t$: Test method (0.4 for infiltration rate estimations using grain-size).
- $CF_m$: Degree of influent control to prevent siltation and bio-buildup (0.9).

The total correction factor ($CF_T$) equals the product of the partial correction factor values described above (i.e., $CF_T = CF_v * CF_t * CF_m = 0.6 * 0.4 * 0.9 = 0.216$). As such, the long-term design infiltration rates range between 0.2 and 0.5 in/hr. The low infiltration rates are due to the predominant silty soil and low permeable nature of the subsurface soil layers.

### 6.8.2 Soil Suitability for Treatment

Based on the DDECM, Volume III, Section 3.3.7 (2016) and the SMMWW, Volume III, Section 3.3.7 (2014), the following are required of subgrade soils beneath infiltration facilities that are used for treatment purposes:

1. Cation exchange capacity (CEC) greater or equal to 5 milliequivalents per 100 grams of dry soil.
2. Organic content of at least 1%.
3. Minimum of 18 inches of soil with the above characteristics.
4. Waste fill materials should not be used as infiltration soil media, nor should such media be placed over uncontrolled or non-engineered fill soils.

We collected two representative soil samples from B-1 and B-3 at 5 and 2.5 feet bgs for analytical laboratory sampling to determine CEC and organic content. The results of our analytical testing program are shown in Exhibit 6.2 and Appendix B.

**Exhibit 6-2: Summary of Cation Exchange Capacity and Organic Content Data**

| Boring | Sample Number | Sample Depth (feet) | CEC (meq/100g) | Organic Content (%) |
|---|---|---|---|---|
| B-1 | S-2 | 5 - 6.5 | 3.11 | 3.89 |
| B-3 | S-1 | 2.5 - 4 | 3.05 | 3.48 |

meq/g = milliequivalents per grams

## 6.9 Pavement Design

In the absence of data required for pavement design, such as traffic data, subgrade data, etc., our preliminary pavement design recommendations are based on Washington State Department of Transportation (WSDOT) typical pavement designs for traffic levels less than 5 million equivalent single-axle loads, according to Table 5.1 of WSDOT Pavement Policy:

- Flexible Pavement for streets and fire lane:
  - Hot-Mix Asphalt: 6 inches
  - Crushed Surfacing Base Course (CSBC): 6 inches
- Flexible Pavement for parking lot assuming only passenger cars, pickup trucks, ambulances, and other four-tire single-unit vehicles:
  - Hot-Mix Asphalt: 4 inches
  - Crushed Surfacing Base Course (CSBC): 6 inches
- Rigid Pavement for loading dock and fire lane:
  - Portland Cement Concrete Pavement: 8 inches
  - CSBC: 4 inches
- Rigid sidewalks and hardscape:
  - Portland Cement Concrete: 4 inches

We should revisit these pavement recommendations if specific traffic loading is available.

# 7 CONSTRUCTION CONSIDERATIONS

## 7.1 Site Preparation

Site preparation will include: (1) clearing and grubbing (2) removal of existing structures and underground utilities, and (3) subgrade preparation and excavation. We understand that the entire existing building will be demolished, except portion on the southwest side of the proposed Newhouse building. These construction activities should generally be accomplished in accordance with the Division 2 of the WSDOT Standard Specifications (WSDOT, 2018).

## 7.2 Clearing, Grubbing, and Subgrade Preparation

We recommend that brush be cleared, and roots, stumps, and construction debris be removed from beneath building areas and all areas to be graded. Any grass and topsoil that covers the site is loose and organic and should be removed from the site except in landscape areas where settlements would not be objectionable. Topsoil is not considered suitable for reuse as structural fill and should be removed from the site or stockpiled for reuse in landscape areas.

In areas to be filled such as beneath footings and floor slabs, or at-grade areas, the exposed soil surface, after clearing and stripping and prior to any fill placement or foundations or pavement construction, should be proof-rolled and compacted using a vibratory roller or hoe-pac.

## 7.3 Backfill Material Selection, Placement, and Compaction

The proposed Newhouse building will have a 10-foot-deep basement on the east side and the remainder with be constructed at grade. This will require backfilling the existing 10-foot deep basement at the southwest corner (see Figure 2). As such, approximately 10 feet of fill should be placed and compacted at the existing basement location. For the remaining portions of the Newhouse building, we recommend that the upper 2 feet below the proposed shallow foundations and proposed floor slabs are excavated and replaced with densely compacted, well-graded structural fill.

Fill placed beneath structures, such as footings, floor slabs, pavements, sidewalks, or backfill against footings or walls, should be structural fill. Structural fill should be placed and compacted upon native soil surfaces observed during construction by a geotechnical engineer or the engineer's representative.

We recommend using imported granular backfill for all structural fill on the Project site. Imported backfill should meet gradation requirements of the WSDOT Standard Specifications Section 9-03.14(1) Gravel Borrow.

Structural fill should be placed in horizontal, uniform lifts and compacted to a dense and unyielding condition, at least 95% of the Modified Proctor maximum dry density (ASTM D1557). Subgrades to receive structural fill should be dense and unyielding and should be evaluated by the geotechnical engineer prior to the placement of fill. Preparation of subgrades should be in accordance with Section 2-09 of the WSDOT Standard Specifications (WSDOT, 2018). In general, the thickness of soil layers before compaction should not exceed 8 inches for heavy equipment compactors or 6 inches for hand-operated mechanical compactors. The most appropriate lift thickness should be determined in the field using the Contractor's selected equipment and fill and verified with in situ soil density testing (nuclear gauge or T-probe methods). All compacted surfaces should be sloped to drain to prevent ponding. Structural fill placement operations should be observed and evaluated by an experienced geotechnical engineer or technician.

## 7.4 Reuse of Excavated Soil and Pavement Demolition Debris

The existing fill material and native soil is described as silt with sand/gravel. Based on gradation analyses (see Appendix B), fill material and native soil generally do not meet the criteria in the WSDOT Standard Specifications 9-03.14(1) for Gravel Borrow. As such, native site soils, including the silt and clay layers with high fines content, are not suitable to be used as structural fill, since it would be difficult to place and compact them to a dense and unyielding condition. Demolition debris should meet the criteria in the WSDOT Standard Specifications 9-03.14(1) for Gravel Borrow to be used as structural fill at the site. On-site soil not suitable for structural backfill could be used as backfill within landscaped areas where settlement is acceptable.

## 7.5 Site Grading and Temporary and Permanent Excavation Slopes

Excavations could be accomplished with conventional excavating equipment, such as dozers, front-end loaders, and excavators. Safe temporary excavations are the responsibility of the Contractor, depend on the actual site conditions at the time of construction, and should comply with applicable Occupational Safety and Health Administration (OSHA) and Washington Industrial Safety and Health Administration Standards. For trench safety purposes, site soils should be considered as OSHA "Class C" material, which requires side slopes be no steeper than 1.5H:1V. For planning purposes, we recommend assuming that temporary, unsupported, and open-cut slopes would be no steeper than 1.5H:1V. Flatter cut slopes could be required if loose soils or perched water seepage zones are encountered. We recommend that all exposed cut slopes be protected with a waterproof covering during periods of wet weather to reduce sloughing and erosion.

All traffic and/or construction equipment loads should be set back from the edge of the cut slopes a minimum of 5 feet. Excavated material, stockpiles of construction materials, and equipment should not be placed closer to the edge of any excavation than the depth of the excavation, unless the excavation is shored, and such materials are accounted for as a surcharge load on the shoring system.

## 7.6 Construction Drainage

Even during dry weather, we recommend that site drainage measures be incorporated into the project construction. Surface runoff can be controlled during construction by careful grading practices. Typically, these include the construction of shallow perimeter ditches or low earthen berms, and the use of temporary sumps to collect runoff and prevent water from damaging slopes and exposed subgrades. All collected water should be directed, under control, to a positive and permanent discharge system. The site will need to be graded at all times to facilitate drainage and minimize the ponding of water.

## 7.7 Excavations

We anticipate that the proposed Newhouse building will be constructed in open cut excavations, except for the east side of the building, where the Columbia Street is located. Excavations will primarily expose fill and the native, very loose to loose, silt deposit. Considerations for temporary excavation slopes are provided in Section 7.2 and temporary shoring recommendations are provided in Section 6.6.

As discussed in Section 5.3, the groundwater level is deep, at an approximate elevation of 32 feet (i.e., about 83 to 90 feet below grade). Given the approximate 10 feet excavation depth on the east portion of the building and deep groundwater level, we anticipate that groundwater will not be encountered. However, perched water seepage zones may be encountered during excavation. Under this condition, we anticipate that sumps and pumps to be sufficient to dewater the excavation.

## 7.8 Utility Trench Excavation and Backfill

For backfill of utility trenches, the pipe zone bedding should extend from the trench bottom to at least 8 to 12 inches above the pipe. Pipe zone bedding should consist of select granular soil free from organic matter meeting the requirements for Gravel Backfill for Pipe Zone Bedding as specified in WSDOT Standard Specification Section 9.03.12(3) (WSDOT, 2018).

## 7.9 Wet Weather Earthwork and Erosion Control

Most of the soils at the site contain sufficient fines to produce an unstable mixture when wet and are highly susceptible to changes in water content. They may become muddy, unstable, and difficult to compact if their moisture content significantly exceeds the optimum. Should wet weather/wet condition earthwork be unavoidable, we recommend implementing the following measures:

- Earthwork should be accomplished in small sections to minimize exposure to wet conditions. That is, each section should be small enough such that the removal of unsuitable soils and the placement and compaction of clean structural fill can be accomplished on the same day. If there is to be traffic over the exposed subgrade, the subgrade should be protected with a compacted layer (generally 8 inches or more) of clean crushed rock.
- The ground surface in the construction area should be sloped and sealed with a smooth-drum roller to promote the rapid runoff of precipitation, to prevent surface water from flowing into excavations, and to prevent ponding of water.
- Excavation and placement of fill material (imported structural fill) should be observed on a full-time basis by a geotechnical engineer, experienced in wet-weather earthwork, to determine that all work is being accomplished in accordance with the Project plans and specifications, and our recommendations.
- Covering of work areas, soil stockpiles, or slopes with plastic; sloping, ditching, and installing sumps; dewatering; and other measures should be employed, as necessary, to permit proper completion of the work.
- Grading and earthwork should not be accomplished during periods of heavy, continuous rainfall.

Erosion control for the site should include Best Management Practices incorporated into the civil design drawings and may include the following recommendations:

- Limit exposed cut slopes.
- Route surface water through temporary drainage channels around and away from exposed slopes.
- Use silt fences, straw, and temporary sedimentation ponds to collect and hold eroded material on the site.
- Seed or plant vegetation on exposed areas where grading work is complete, and no buildings are proposed.
- Retain existing vegetation to the greatest possible extent.

## 7.10 Construction Observation

We recommend that Shannon & Wilson be retained to review those portions of the plans and specifications that pertain to foundations and earthwork to determine if they are consistent with our recommendations. We also recommend we be retained to observe the geotechnical aspects of construction, including foundation excavation, structural backfill and compaction, and subdrainage installation. This observation will allow us to verify the subsurface conditions as they are exposed during construction and to determine that the work is accomplished in accordance with our recommendations.

Temporary construction dewatering design should be the Contractor's responsibility and should be reviewed by the design team prior to its implementation.

# 8 CLOSURE

This report was prepared for the exclusive use of the Washington State Department of Enterprise Services for the design of the Newhouse Building Replacement as it relates to the geotechnical and geological aspects discussed in this report.

The conclusions and recommendations contained in this report are based on site conditions as they existed at the time our site reconnaissance and explorations were performed, and further assume conditions interpreted from the explorations are representative of the subsurface conditions beneath the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations. If conditions different from those described in this report are observed or appear present, we should be advised at once so that we can review these conditions and reconsider our recommendations, where necessary.

If more than two years have passed between the issuance of this report and the Newhouse Building Replacement construction; if Project details, site ownership, or land use have changed; or if conditions have changed because of natural processes or human activity at or near the site, we recommend this report be reviewed to determine the applicability of the conclusions and recommendations.

Within the limitations of the scope, schedule, and budget, the conclusions and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering and geologic principles and practices in this area at the time this report was prepared. We make no other warranty, either express or implied. The conclusions and recommendations are based on our understanding of the

Project as described in this report and the site conditions as interpreted from our site reconnaissance and field explorations.

Unanticipated soil and groundwater conditions are commonly encountered and cannot be fully determined by merely performing a site reconnaissance or taking samples from a limited number of explorations. Our observations are specific to the locations, depths, and dates noted on the logs and tables and may not be applicable to all areas of the site. No amount of exploration or testing can precisely predict the characteristics, quality, or distribution of subsurface and site conditions. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, a contingency fund is recommended to accommodate such potential extra costs.

The scope of our services did not include any environmental assessment or evaluation regarding the presence or absence of wetlands, or hazardous or toxic materials; in the soil, surface water, groundwater, or air; on, below, or around the site. Shannon & Wilson has qualified personnel to assist you with these services should they be necessary.

# 9 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 2020, AASHTO LRFD bridge design specifications (9th ed.): Washington, D. C., AASHTO.

American Society of Civil Engineers (ASCE), 2017, Minimum design loads and associated criteria for buildings and other structures: Reston, Va. American Society of Civil Engineers, ASCE Standard ASCE/SEI 7-16, 2 v.

ASTM International (ASTM), 2011, Standard test method for standard penetration test (SPT) and split-barrel sampling of soils, D1586-11: West Conshohocken, Pa., ASTM International, Annual book of standards, v. 04.08, soil and rock (I): D420 - D5876, 9 p., available: www.astm.org.

Ensoft, Inc., 2018, LPILE: Austin, Texas, Ensoft, Inc.

Boulanger, R. W. and Idriss, I. M., 2006, Liquefaction susceptibility criteria for silts and clays: Journal of Geotechnical and Geoenvironmental Engineering, v. 132, no. 11, p. 1413-1426.

Boulanger, R. W. and Idriss, I. M., 2014, CPT and SPT-based liquefaction triggering procedures: Davis, Calif., University of California Davis, Center for Geotechnical Modeling, report UCD/CGM-14/01, 134 p.

Bray, J.D. and Sancio, R.B., 2006, Assessment of the liquefaction susceptibility of fine-grained soils: Journal of Geotechnical and Geoenvironmental Engineering, v. 132, no. 9, p. 1165-1177.

Buchanan-Bank, J.M., and Collins, D.S., 1994, Map showing depth to bedrock of the Tacoma and part of the Centralia 30' x 60' quadrangles, Washington: U.S. Geological Survey Miscellaneous Field Studies Map MF-2265.

City of Olympia, 2016, Drainage design and flow control manual, volume III: Hydraulic analysis and flow control bmps, December.

Geo-Slope International, 2019, SLOPE/W v. 10.1.1: Calgary, Alberta, Geo-Slope International.

Golder Associates, 2010, Hillside evaluation and preliminary design, Olympia Capitol Campus, Olympia, Washington: Report prepared by Golder Associates, Redmond, Wash., job no. 083-93287.400, for the Washington State Department of General Administration, Olympia, Wash., March, 40 p.

Hall, J.B., and Othberg, K.L., 1974, Thickness of unconsolidated sediments, Puget Lowland, Washington: Geologic Map GM-12, Washington Division of Geology and Earth Sciences.

International Code Council, Inc., 2017, International building code 2018: Country Club Hills, Ill., International Code Council, Inc., 726 p.

Ishihara, Kenji and Yoshimine, Mitsutoshi, 1992, Evaluation of settlements in sand deposits following liquefaction during earthquakes: Soils and Foundations, v. 32, no. 1, p. 173-188.

Noble, J.B., and Wallace, E.F., 1966, Geology and groundwater resources of Thurston County, Washington: Water Supply Bulletin vol. 2, no. 10.

Palmer, S. P.; Magsino, S. L.; Bilderback, E. L.; and others, 2004, Site class map of Thurston County, Washington, in Liquefaction susceptibility and site class maps of Washington State, by county: Washington State Department of Geology and Earth Resources, Open File Report 2004-20, sheets 39A&B, scale 1:150,000.

Shannon & Wilson, 2001, Seismic Ground Motion Study for the Washington State Legislative Building, Pre-Schematic Services for Updated Seismic Analyses, Olympia, Washington: Report prepared by Shannon & Wilson, Inc., Seattle Wash., job no. 21-1-09343-002, for the Washington State Department of General Administration, Olympia, Wash., December, 180 p.

Shannon & Wilson, 2007, Conceptual Geotechnical Report Executive Office Plaza / Heritage Center, Olympia Washington: Report prepared by Shannon & Wilson, Seattle, Wash., job no. 21-1-20767-001 for Washington State Department of General Administration, Olympia, Wash.

Sherrod, B.L., 2001, Evidence for earthquake-induced subsidence about 1,100 yr ago in coastal marshlands of southern Puget Sound, Washington: Geological Society of America Bulletin, v. 113, p. 1299-1311.

Walsh, T. J; Logan, R. L.; Schasse, H. W.; and Polenz, Michael, 2003, Geologic map of the Lacey 7.5-minute quadrangle, Thurston County, Washington: Washington State Division of Geology and Earth Resources Open-File Report 2003-9, scale 1:24,000.

Washington State Department of Ecology (Ecology), 2014, Stormwater management manual for western Washington: Olympia, Wash., Washington State Department of Ecology Publication no. 14-10-055, 5 v., available: https://fortress.wa.gov/ecy/madcap/wq/2014SWMMWWinteractive/ 2014 SWMMWW.htm.

Washington Department of Transportation (WSDOT), 2018, Standard specifications for road, bridge, and municipal construction: Olympia, Wash., WSDOT, Manual M 41-10, 1 v., available: http://www.wsdot.wa.gov/Publications/Manuals/M41-10.htm.

Washington State Department of Transportation (WSDOT), 2019, Geotechnical design manual: Olympia, Wash., WSDOT, Manual M 46-03.12, 1 v., July, available: https://www.wsdot.wa.gov/Publications/Manuals/M46-03.htmAmerican Society of Civil Engineers (ASCE), 2013, Minimum design loads for buildings and other structures, ASCE Standard 7-10.

## Table 1: LPILE Parameters for Deep Foundation Lateral Resistance Analyses

| SOIL LAYER INFORMATION | | | | LPILE PARAMETERS [4] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Soil Layer Description | Layer Top Elevation [1,2] | Layer Depth Below Pile Top | | LPILE Model | Effective Unit Weight ($\gamma$') [3] | | Effective Friction Angle ($\phi$') | | Subgrade Modulus (k) | |
| | | Top | Bottom | | Static | Seismic / Strength Reduced | Static | Seismic / Strength Reduced | Static | Seismic / Strength Reduced |
| | (feet) | (feet) | (feet) | ---- | (pcf) | (pcf) | (degree) | (degree) | (pci) | (pci) |
| Interbedded Very Loose to Dense Silt, Sandy Silt (ML), and Silty Sand (SM) | 120 | 0 | 45 | Sand (Reese) | 105 | 105 | 27 | 19 | 15 | 15 |
| | 75 | 45 | 88 | Sand (Reese) | 115 | 115 | 31 | 31 | 65 | 65 |
| | 32 | 88 | 150 | Sand (Reese) | 62.6 | 62.6 | 35 | 35 | 85 | 85 |

NOTES:

1 All Elevation values are approximate and begins from at-grade elevation.

2 For piles supporting the foundations below the proposed basement, LPILE parameters should be considered from the proposed basement bottom elevation.

3 Value shown represents total unit weight above the groundwater table and effective unit weight below the groundwater table.

pcf = pounds per cubic foot; pci = pounds per cubic inch

4 LPILE parameters do not consider group effect. P-multipliers listed in AASHTO LRFD BDS (2020) Table 10.7.2.4-1 should be applied if piles are spaced closer than five pile diameters, center to center.

Filename: I:\EF\SEA\105000s\105564 WA Capitol Campus LAH and Senate\GIS\Report_Figure1_Vicinity.mxd Date: 1/10/2022 SNS


LEGEND

Building Replacement Footprint

Basemap Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

N W E S

0 500

Feet

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

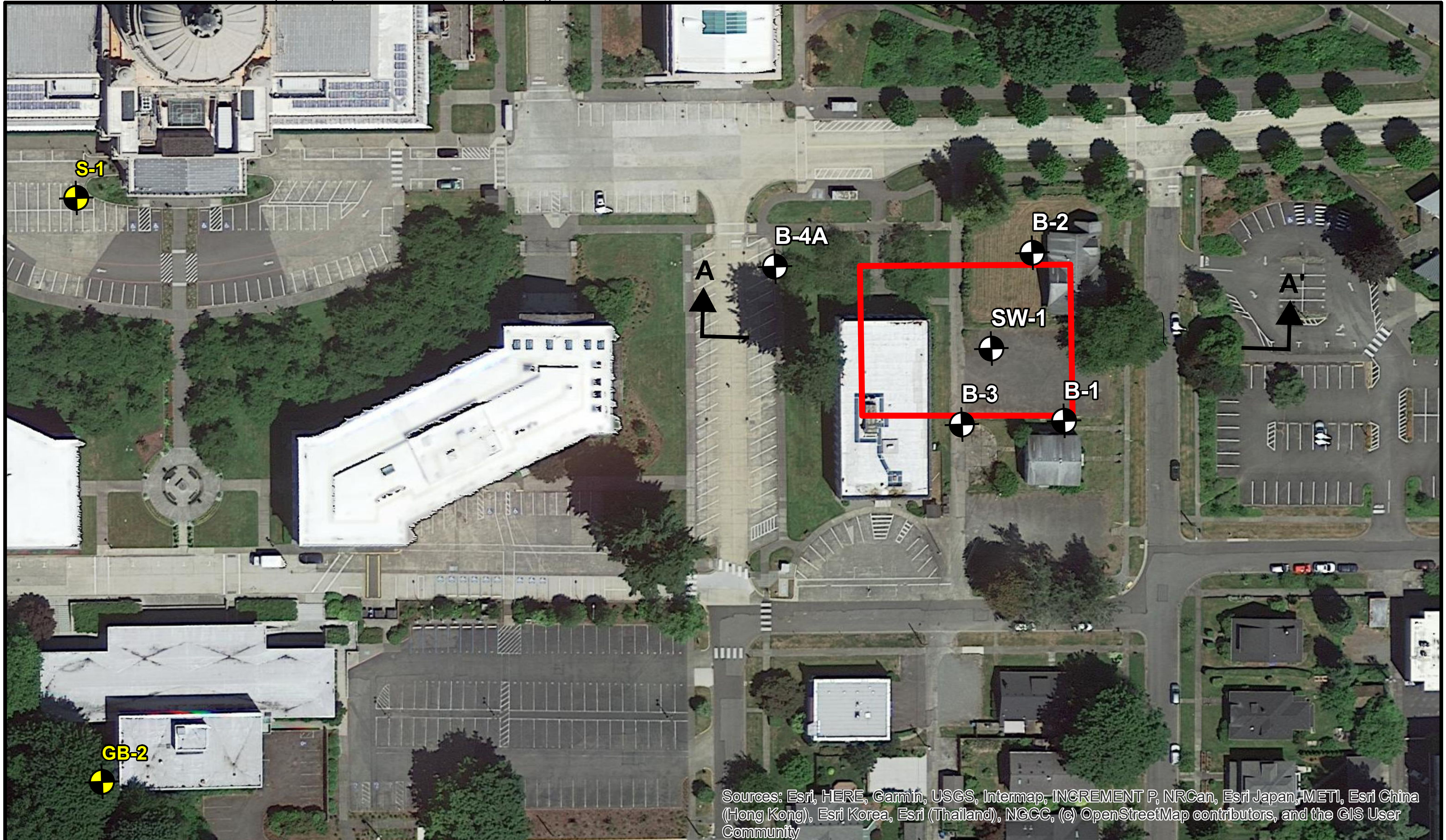
**VICINITY MAP**

March 2022 105564-003

SHANNON & WILSON

**FIG. 1**

Filename: I:\EF\SEA\105000s\105564 WA Capitol Campus LAH and Senate\GIS\Report_Figure2_Site.mxd Date: 1/10/2022 SNS




LEGEND

- Project Borings
- Historic Exporation
- Building Replacement Footprint

N
W E
S

0 100

Feet

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

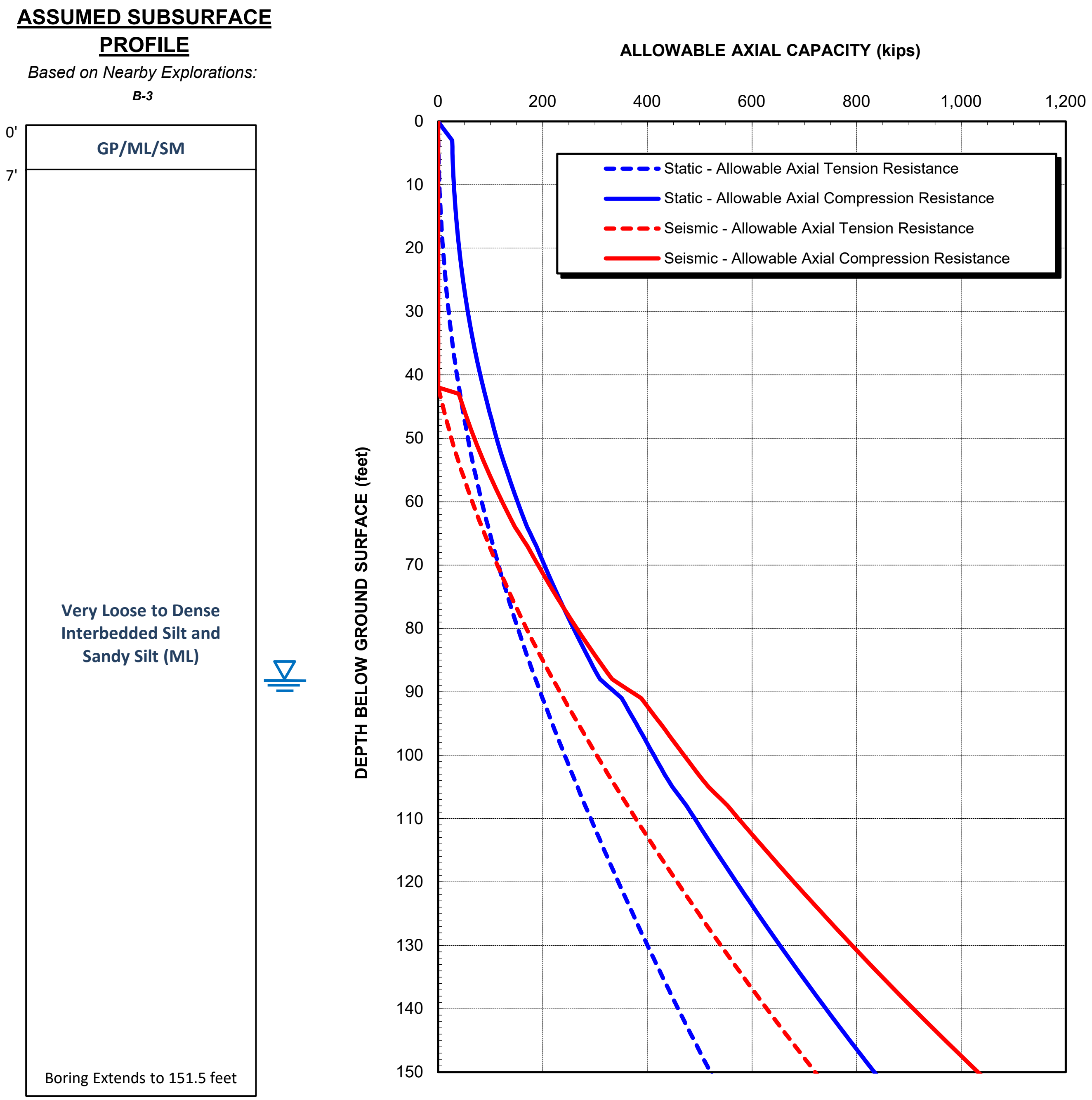
**SITE AND EXISTING SUBSURFACE EXPLORATION PLAN**

March 2022

105564-003

SHANNON & WILSON

**FIG. 2**




## NOTES:

1. The analyses were performed based on the available field and laboratory data, the IBC (2018) recommendations, and our experience.
2. The plot above provides the allowable axial resistance for the auger cast pile under static and seismic loading conditions. The allowable capacity of the pile is determined by dividing the ultimate resistance by a factor of safety (FS). Per IBC Sections 1810.3.3.1.5 and 1810.3.3.1.7: Static (Compression) FS = 2, Static (Uplift or Tension) FS = 3, Seismic (Compression) FS = 1.5, and Seismic (Uplift or Tension) FS = 2. Seismic (Compression or Tension) FS is based on the static FS reduced by 33% for transient load conditions.
3. The earthquake-induced settlement will impart a downdrag load on the pile. We estimate the unfactored downdrag load will be 120 kips. Downdrag force should be added to the design loads for the post-seismic load case to determine minimum pile depth.
4. The resistances provided above are for a single auger cast pile and do not account for group action. The axial resistances provided above assume the center-to-center spacing between piles is at least three pile diameters. If the pile center-to-center spacing is less than three pile diameters, we should be notified to reevaluate our axial pile recommendations.
5. The analyses provided are for the geotechnical resistance of the pile and do not consider the structural capacity of the pile section.

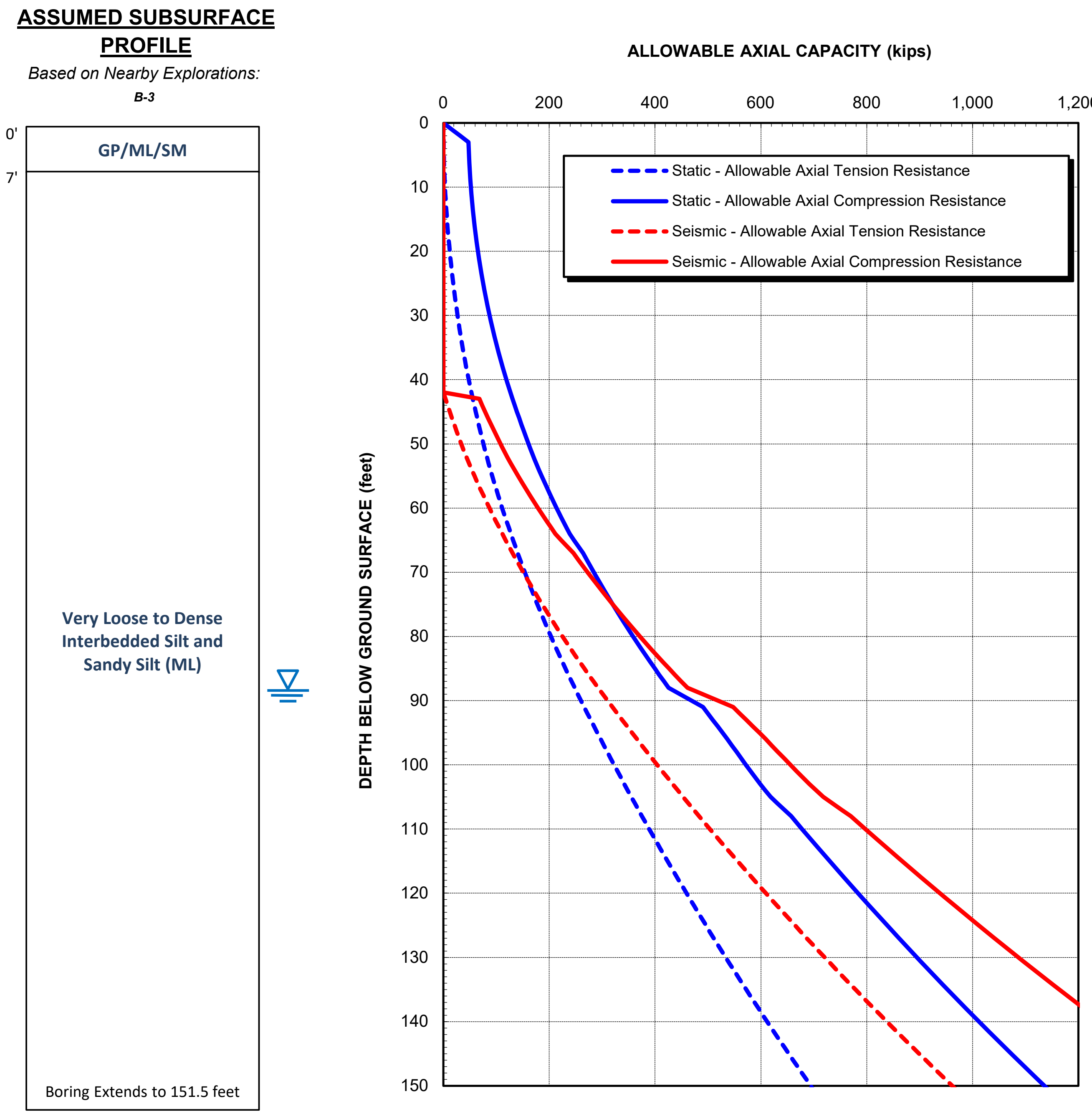
Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

**ALLOWABLE AXIAL PILE CAPACITY**
**PILE DIAMETER = 18-INCH**

March 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. 3**




## NOTES:

1. The analyses were performed based on the available field and laboratory data, the IBC (2018) recommendations, and our experience.
2. The plot above provides the allowable axial resistance for the auger cast pile under static and seismic loading conditions. The allowable capacity of the pile is determined by dividing the ultimate resistance by a factor of safety (FS). Per IBC Sections 1810.3.3.1.5 and 1810.3.3.1.7: Static (Compression) FS = 2, Static (Uplift or Tension) FS = 3, Seismic (Compression) FS = 1.5, and Seismic (Uplift or Tension) FS = 2.
Seismic (Compression or Tension) FS is based on the static FS reduced by 33% for transient load conditions.
3. The earthquake-induced settlement will impart a downdrag load on the pile. We estimate the unfactored downdrag load will be 160 kips. Downdrag force should be added to the design loads for the post-seismic load case to determine minimum pile depth.
4. The resistances provided above are for a single auger cast pile and do not account for group action. The axial resistances provided above assume the center-to-center spacing between piles is at least three pile diameters. If the pile center-to-center spacing is less than three pile diameters, we should be notified to reevaluate our axial pile recommendations.
5. The analyses provided are for the geotechnical resistance of the pile and do not consider the structural capacity of the pile section.

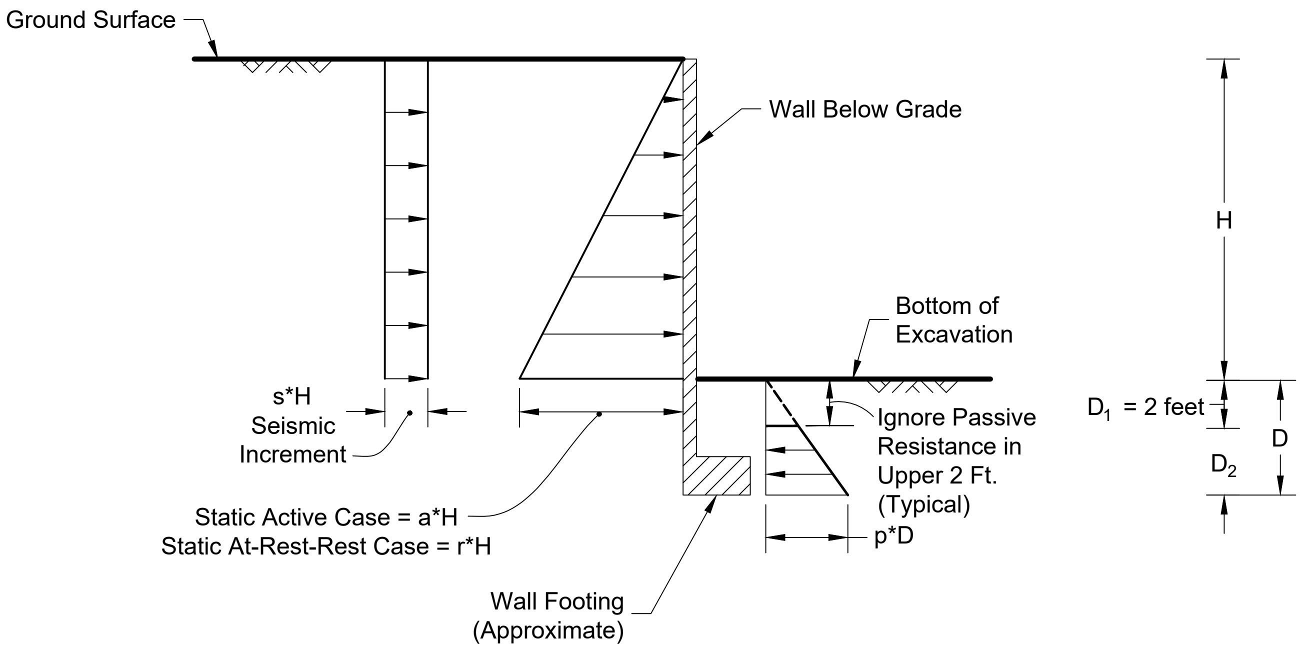
Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

**ALLOWABLE AXIAL PILE CAPACITY**
**PILE DIAMETER = 24-INCH**

March 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. 4**




Not to Scale

| | a (Active EFD) (pcf) | r (At-Rest EFD) (pcf) | p (Passive EFD) (pcf) | s (Seismic Increment) (pcf) |
|---|---|---|---|---|
| Structural Backfill (Open Cut) | 34 | 54 | 300 | 15 |
| Native Soil | 40 | 57 | 150 | 16 |

EFD: Equivalent Fluid Density
pcf: pounds per cubic feet

NOTES

1. All earth pressures are in units of pounds per square foot. The earth pressure diagram applies for conceptual design of temporary shoring and permanent walls at the proposed Newhouse building. Seismic increment does not apply to temporary shoring walls.
2. Passive pressure values include a factor of safety of 1.5.
3. Lateral pressures for surcharge loading should be added to the earth pressures given above. See Figure 6.
4. If a sloping grounds surface exists, the earth pressures should be adjusted. Refer to text.
5. The recommended pressure diagrams are based on a continuous wall system.
6. Free drainage is assumed behind the wall.

LEGEND

H = Wall Height (Ft.)

D, $D_1$, $D_2$ = Embedment Depths (Ft.)

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

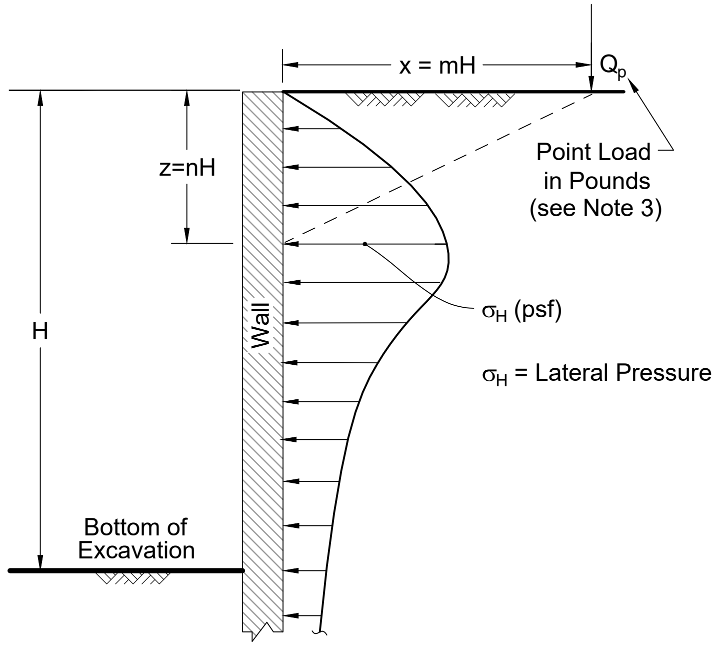
**LATERAL EARTH PRESSURES FOR PERMANENT WALL DESIGN**

March 2022 105564-003

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

**FIG. 5**

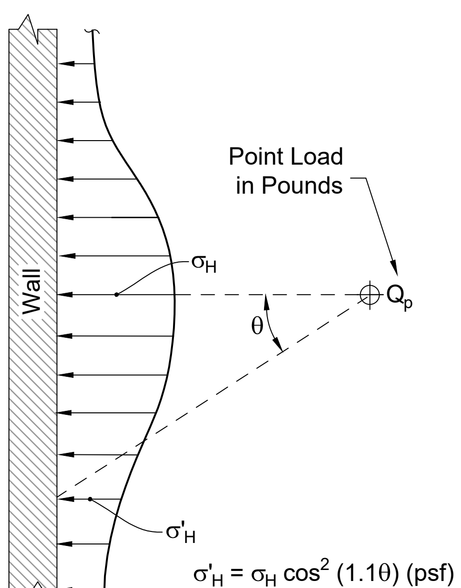
Filename: E:\J_SEA\105564\003\105564-003 Fig 7 - LEP Diagram.dwg Layout: Layout1 Date: 02-18-2022 Login: SAC




ELEVATION VIEW

For m ≤ 0.4: $\sigma_H = 0.28 \dfrac{Q_p}{H^2} \dfrac{n^2}{(0.16 + n^2)^3}$ (psf) (see Note 3)

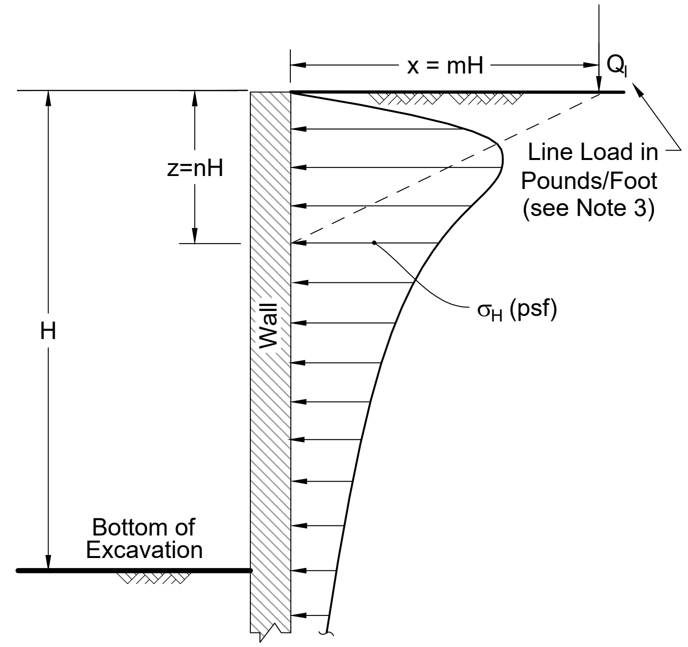
For m > 0.4: $\sigma_H = 1.77 \dfrac{Q_p}{H^2} \dfrac{m^2 n^2}{(m^2 + n^2)^3}$ (psf)




PLAN VIEW

**A) LATERAL PRESSURE DUE TO POINT LOAD i.e. SMALL ISOLATED FOOTING OR WHEEL LOAD**

(NAVFAC DM 7.02, 1986)



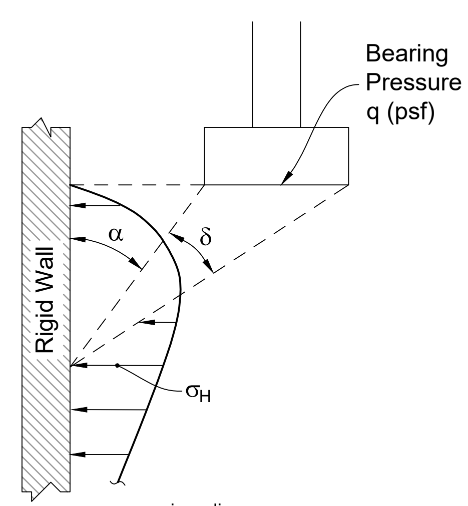

ELEVATION VIEW

For m ≤ 0.4: $\sigma_H = 0.20 \dfrac{Q_l}{H} \dfrac{n}{(0.16 + n^2)^2}$ (psf) (see Note 3)

For m > 0.4: $\sigma_H = 1.28 \dfrac{Q_l}{H} \dfrac{m^2 n}{(m^2 + n^2)^2}$ (psf)

**B) LATERAL PRESSURE DUE TO LINE LOAD i.e. NARROW CONTINUOUS FOOTING PARALLEL TO WALL**

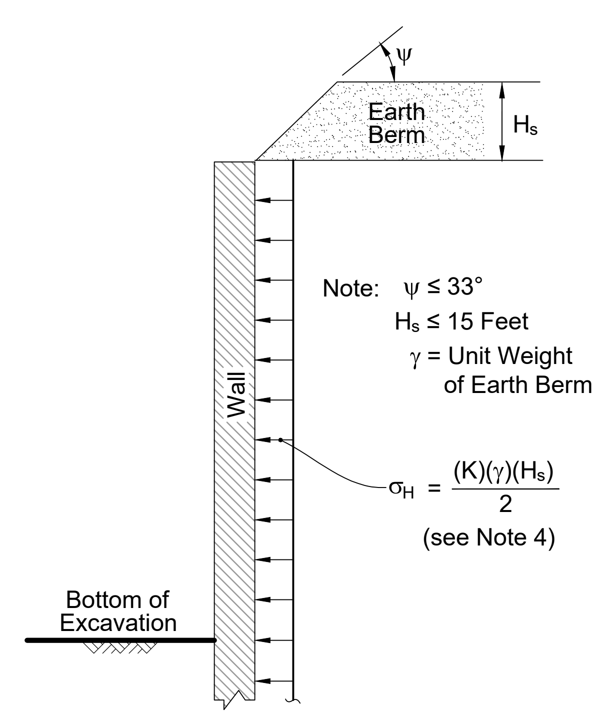
(NAVFAC DM 7.02, 1986)



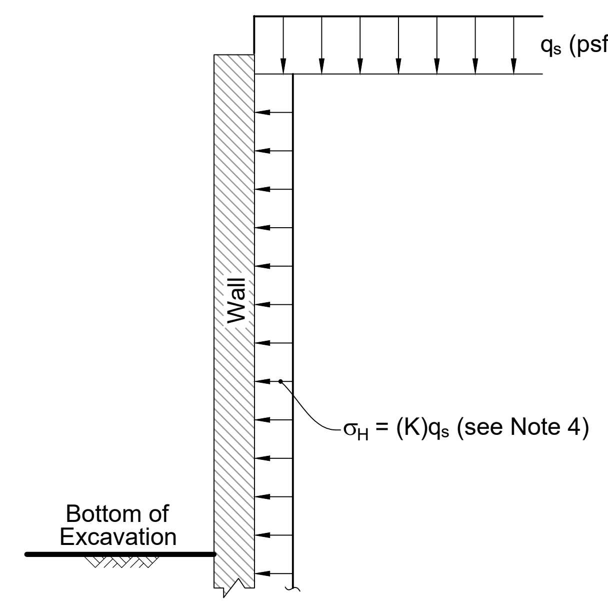

$\sigma_H = \dfrac{2q}{\pi} [\delta - \sin\delta \cos(\delta + 2\alpha)]$ (psf) ($\delta$ in radians)

**C) LATERAL PRESSURE DUE TO STRIP LOAD**

(AASHTO LRFD Bridge Design Specifications, 2020)



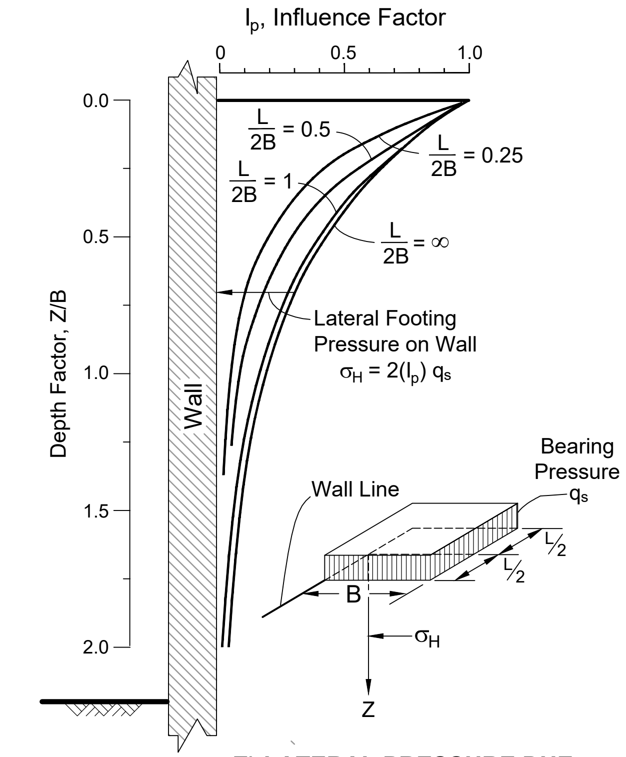

EARTH BERM




UNIFORM SURCHARGE

**D) LATERAL PRESSURE DUE TO EARTH BERM OR UNIFORM SURCHARGE**

(derived from Poulos and Davis, *Elastic Solutions for Soil and Rock Mechanics*, 1974; and Terzaghi and Peck, *Soil Mechanics in Engineering Practice*, 1967)




**E) LATERAL PRESSURE DUE TO ADJACENT FOOTING**

(see Notes 5 and 6)

(derived from NAVFAC DM 7.02, 1986; and Sandhu, *Earth Pressure on Walls Due to Surcharge*, 1974)

NOTES

1. Figures are not drawn to scale.
2. Applicable surcharge pressures should be added to appropriate permanent wall lateral earth and water pressure.
3. If point or line loads are close to the back of the wall such that m ≤ 0.4, it may be more appropriate to model the actual load distribution (i.e., Detail E) or use more rigorous analysis methods.
4. K (structural fill) = 0.26 and 0.41 for Static active and at-rest
   K (Native soil) = 0.38 and 0.55 for Static active and at-rest
5. The stress is estimated on the back of the wall at the center of the length, L, of loading.
6. The estimated stress is based on a Poisson's ratio of 0.5.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

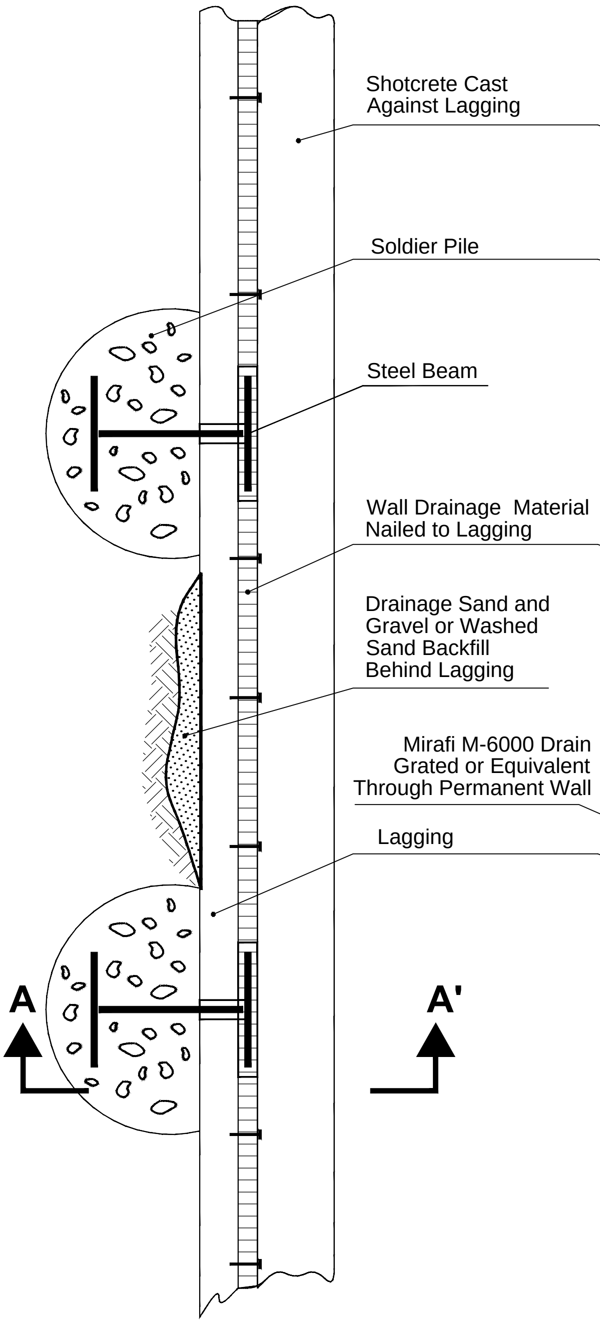
**RECOMMENDED SURCHARGE LOADING FOR TEMPORARY AND PERMANENT WALLS**

March 2022 105564-003

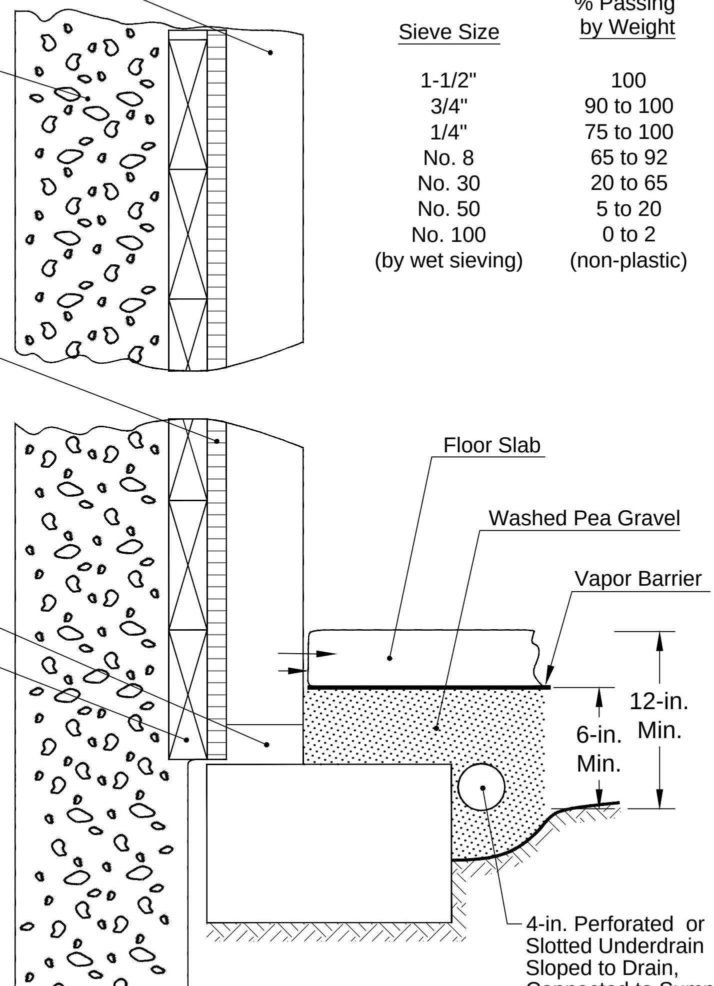
SHANNON & WILSON, INC. GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

**FIG. 6**

File: E:\J_SEA\105564\003\105564-003 Fig 8 - Surcharge Loading.dwg Date: 02-18-2022 Author: SAC




**PLAN VIEW**




**Section A-A'**

BACKFILL MATERIAL

Drainage Sand & Gravel with the Following Specifications:

| Sieve Size | % Passing by Weight |
|---|---|
| 1-1/2" | 100 |
| 3/4" | 90 to 100 |
| 1/4" | 75 to 100 |
| No. 8 | 65 to 92 |
| No. 30 | 20 to 65 |
| No. 50 | 5 to 20 |
| No. 100 (by wet sieving) | 0 to 2 (non-plastic) |

Not to Scale

NOTES

1. Wall drainage material: Geodrain, Miradrain 6000 or equivalent.
2. Clean-outs should be provided in the underdrain system.
3. Slotted pipe to have 1/8-inch maximum width slots. Perforated pipe holes (3/16" to 3/8" diameter) to be in lower half of pipe with lower quarter segment unperforated for waterflow.
4. Weep holes should be provided through lagging if concrete or steel panels are used.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

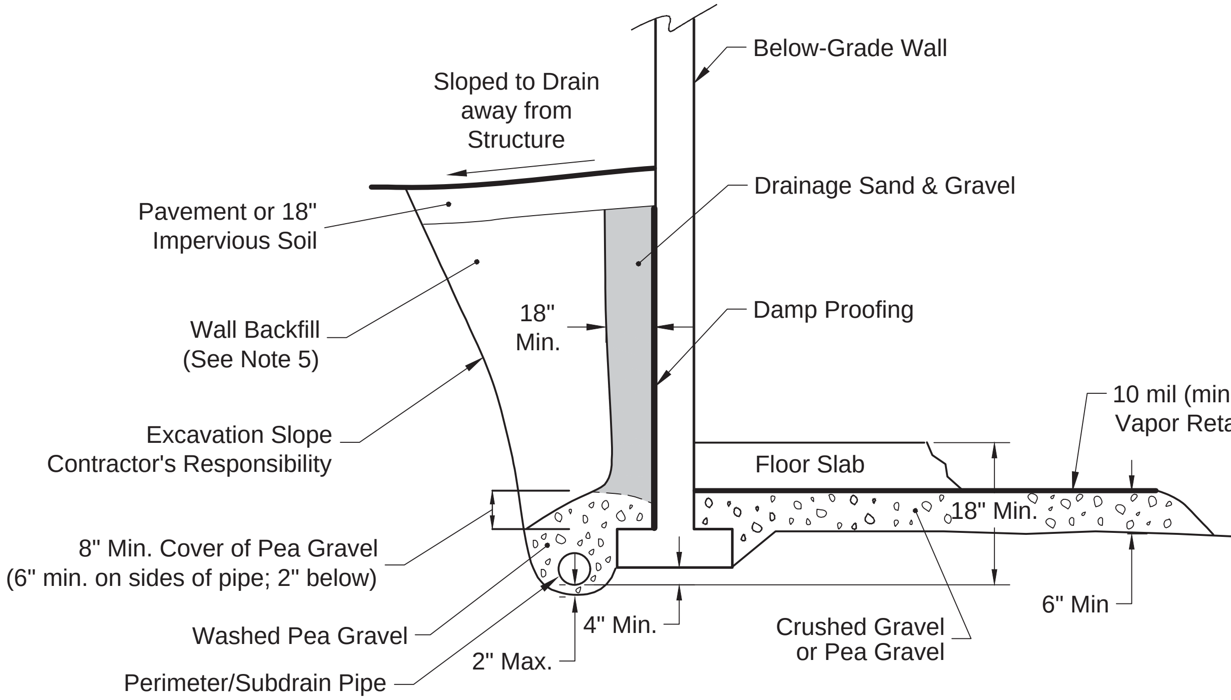
**SHORING WALL AND FLOOR SLAB DRAINAGE RECOMMENDATIONS**

March 2022 | 105564-003

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

**FIG. 7**

Filename: J:\Support\library\Standard Figures\Wall Drainage.dwg Layout: Layout2 Date: 03-12-2014 Login: SAC




Not to Scale

NOTES

1. Drainage sand and gravel backfill within 18" of wall should be compacted with hand-operated equipment. Heavy equipment should not be used to compact backfill, as such equipment operated near the wall could increase lateral earth pressures and possibly damage the wall.

2. Drainage sand and gravel may be replaced with a geocomposite core sheet drain placed against the wall and connected to the subdrain pipe. The geocomposite core sheet should have a minimum transmissivity of 3.0 gallons/minute/foot when tested under a gradient of 1.0 according to ASTM D4716.

3. The subdrain should consist of 4" diameter (minimum), slotted or perforated plastic pipe meeting the requirements of AASHTO M 304; 1/8-inch maximum slot width; 3/16- to 3/8-inch perforated pipe holes in the lower half of pipe, with lower third segment unperforated for water flow; tight joints; sloped at a minimum of 6"/100' to drain; cleanouts to be provided at regular intervals.

4. Surround subdrain pipe with 8 inches (minimum) of washed pea gravel (2" below pipe) or clean 1"-minus crushed gravel.

5. See report text for floor slab subgrade preparation and backfill materials specifications.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

**TYPICAL BELOW-GRADE WALL AND FLOOR SLAB SUBDRAINAGE AND BACKFILL**

March 2022 | 105564-003

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

**FIG. 8**

File: C:\Users\jrs\CAD Group Dropbox\JDrive_SEA\105062\002\002\105062-002.002 Subdrain and Backfill.dwg Date: 10-07-2020 Author: JRS

APPENDIX A: BORING LOGS

Appendix A
# Boring Logs

## CONTENTS

### Figures

*Shannon & Wilson 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 page. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.*

## Structure[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. |

## Angularity and Shape[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. |

## Standard Penetration Test (SPT)[3]

| | |
|---|---|
| Hammer | 140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diameter cathead 2-1/4 rope turns, > 100 rpm. 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<br>Shoe I.D. = 1.375 inches<br>Barrel I.D. = 1.5 inches<br>Barrel O.D. = 2 inches |
| N-Value | Sum blow counts for second and third 6-inch increments.<br>Refusal: 50 blows for 6 inches or less or 10 blows for 0 inch. |

## Moisture Content

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

## Gradation

| | |
|---|---|
| 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[1]

| | |
|---|---|
| Weak | Crumbles/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]

| | | |
|---|---|---|
| Nonplastic | Cannot roll a 1/8-in. thread at any water content. | PI < 4 |
| Low | A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit. | 4 < PI < 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 < PI < 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. | PI > 21 |

## 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. |

**Notes:**

[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.

[2]Adapted, 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.

[3]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.

## Unified Soil Classification System (USCS)
Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488

| Major Divisions | | | 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) |

## Acronyms and Abbreviations

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

## Well and Backfill Symbols

- Bentonite Cement Grout
- Bentonite Grout
- Bentonite Chips
- Silica Sand
- Perforated or Screened Casing
- Surface Cement Seal
- Asphalt or Cap
- Slough
- Inclinometer or Non-perforated Casing
- Instrumentation Riser or Electrical Lead
- Vibrating Wire Piezometer with Designation

## Relative Density
Cohesionless Soils

| N, SPT, Blows/ft | Relative Density |
|---|---|
| < 4 | Very loose |
| 4 - 10 | Loose |
| 10 - 30 | Medium dense |
| 30 - 50 | Dense |
| > 50 | Very dense |

## Relative Consistency
Cohesive Soils

| N, SPT, Blows/ft | Relative Consistency |
|---|---|
| < 2 | Very soft |
| 2 - 4 | Soft |
| 4 - 8 | Medium stiff |
| 8 - 15 | Stiff |
| 15 - 30 | Very stiff |
| > 30 | Hard |

## Percentages[1, 2]

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

**Notes:**

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).

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.

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

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | ~ 629,648 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 121 ft. | Easting: | ~ 1,041,475 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

**SOIL DESCRIPTION**

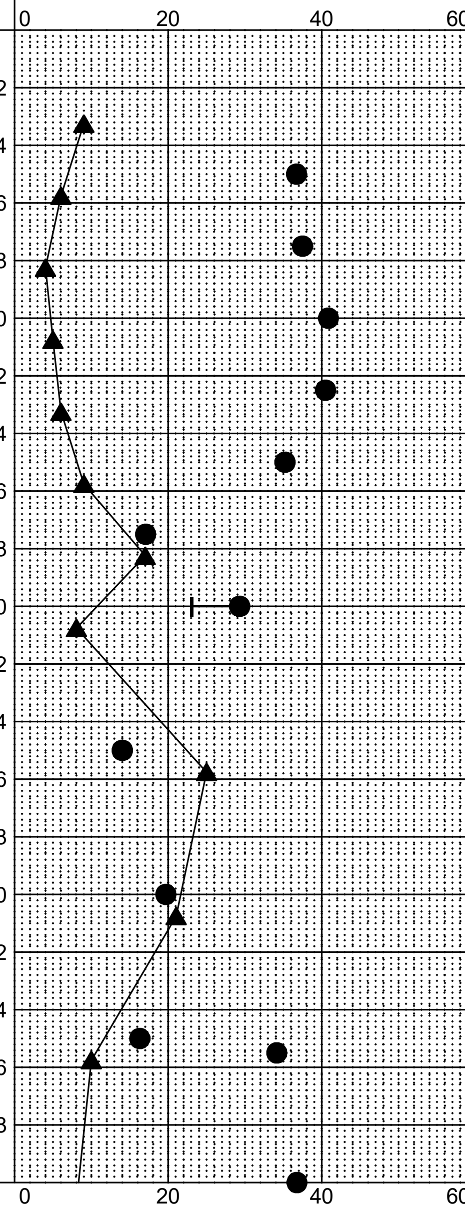
*Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*

| Soil Description | Depth, ft. | Samples |
|---|---|---|
| Compacted gravel lot. | 2.0 | |
| Loose, brown, *Silt with Gravel (ML)*; moist; fine to coarse gravel; few fine sand; low plasticity. | 4.5 | 1 |
| Loose, gray-brown to brown, *Silt (ML)*; moist; few fine sand; low plasticity, grading to nonplastic; iron-oxide stained seams.<br>- Trace organics at about 10 feet. | 17.0 | 2, 3, 4, 5, 6 |
| Medium dense, brown, *Sandy Silt (ML)*; moist; fine sand; nonplastic; trace laminations. | 19.5 | 7 |
| Medium stiff, gray-brown, *Silt (ML)*; moist; trace fine sand; low plasticity, few laminated layers. | 23.0 | 8 |
| Medium dense, brown, *Silty Sand (SM)*; moist; fine sand; nonplastic; trace iron-oxide staining.<br>- Few low plasticity laminated silt layers and seams with iron-oxide staining at about 30 feet. | 33.0 | 9, 10 |
| Medium dense, gray-brown, *Silt (ML)*; moist; grading nonplastic to low plasticity; iron-oxide staining.<br>- 6-inch thick layer of silty sand at 35 feet. | 35.5 | 11 |
| Loose, brown to gray-brown, *Silt (ML)*; moist; few fine sand; nonplastic to low plasticity; trace | | |

Ground Water: Water Level Not Determined

**PENETRATION RESISTANCE** (blows/foot)

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




CONTINUED NEXT SHEET

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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

## LOG OF BORING B-1

February 2022 105564-003

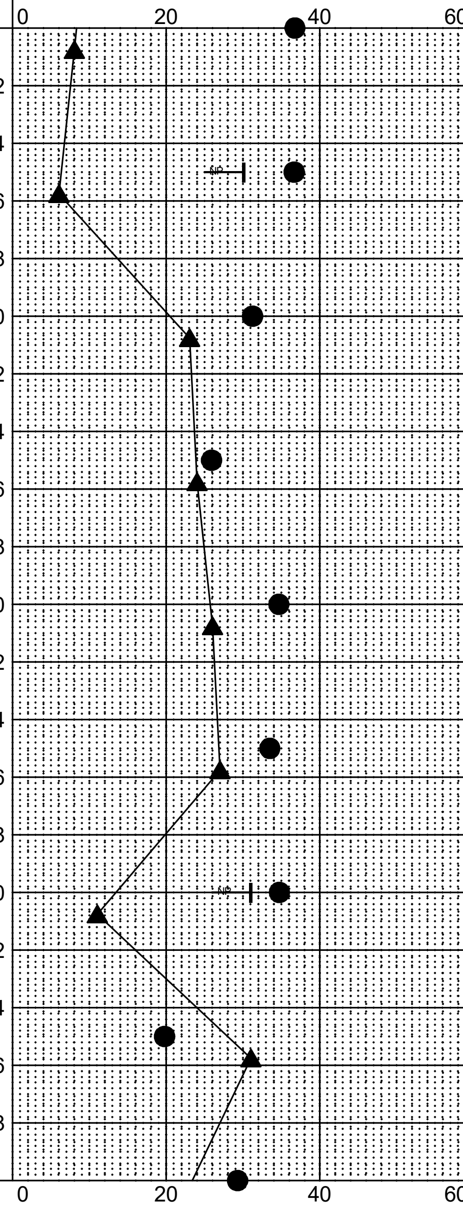
**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-2**
Sheet 1 of 3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | ~ 629,648 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 121 ft. | Easting: | ~ 1,041,475 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

| SOIL DESCRIPTION<br>*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 |
|---|---|---|---|---|
| iron-oxide staining. | | | 12, 13 | |
| Medium dense, gray, *Silt (ML)*; moist; trace to few fine sand; nonplastic to low plasticity; trace iron-oxide staining; trace organics to 56.5 feet.<br><br>- Laminated silt and clay layers and sand seams below 60 feet. | 48.0 | | 14, 15, 16, 17 | |
| Loose, gray-brown, *Silt (ML)*; moist; few fine sand; nonplastic; strong iron-oxide staining locally. | 68.0 | | 18 | |
| Medium dense, gray, *Sandy Silt (ML)*; moist; fine sand; nonplastic; grades to silty sand; trace iron-oxide staining. | 74.0 | | 19 | |

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




CONTINUED NEXT SHEET

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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

## LOG OF BORING B-1

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-2**
Sheet 2 of 3

VERSION 3
REVISED

Log: SYD Rev: SAW Typ: LKN

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | ~ 629,648 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 121 ft. | Easting: | ~ 1,041,475 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

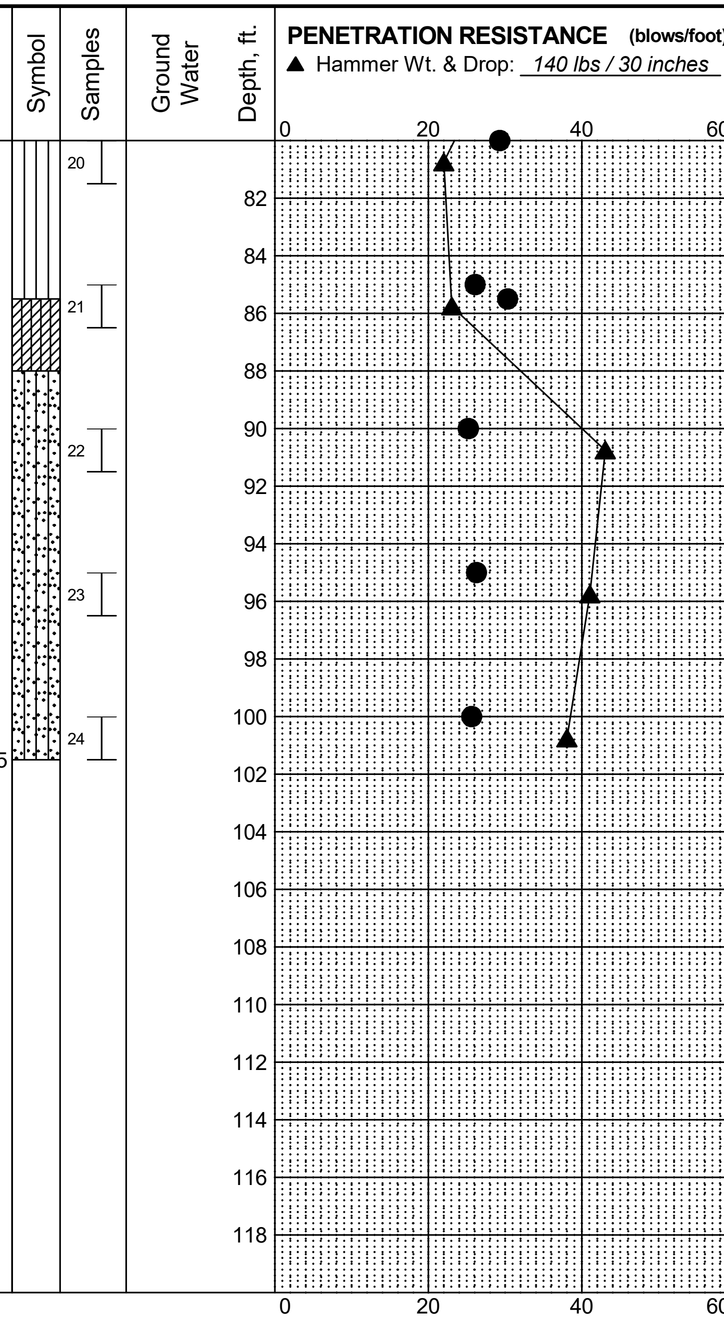
**SOIL DESCRIPTION**

*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 |
|---|---|---|
| | | 20 |
| Very stiff, gray to blue-gray, *Silty Clay (CL-ML)*; moist; trace fine sand; low plasticity. | 85.5 | 21 |
| Dense, gray, *Silty Sand (SM)*; moist; fine sand; nonplastic; grading finer below 95 feet. | 88.0 | 22, 23, 24 |
| BOTTOM OF BORING COMPLETED 12/6/2021 | 101.5 | |

**PENETRATION RESISTANCE** (blows/foot)

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




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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

**LOG OF BORING B-1**

February 2022 — 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-2**
Sheet 3 of 3

VERSION 3 REVISED

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22 Log: SYD Rev: SAW Typ: LKN

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | ~ 629,768 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 121 ft. | Easting: | ~ 1,041,457 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

**SOIL DESCRIPTION**

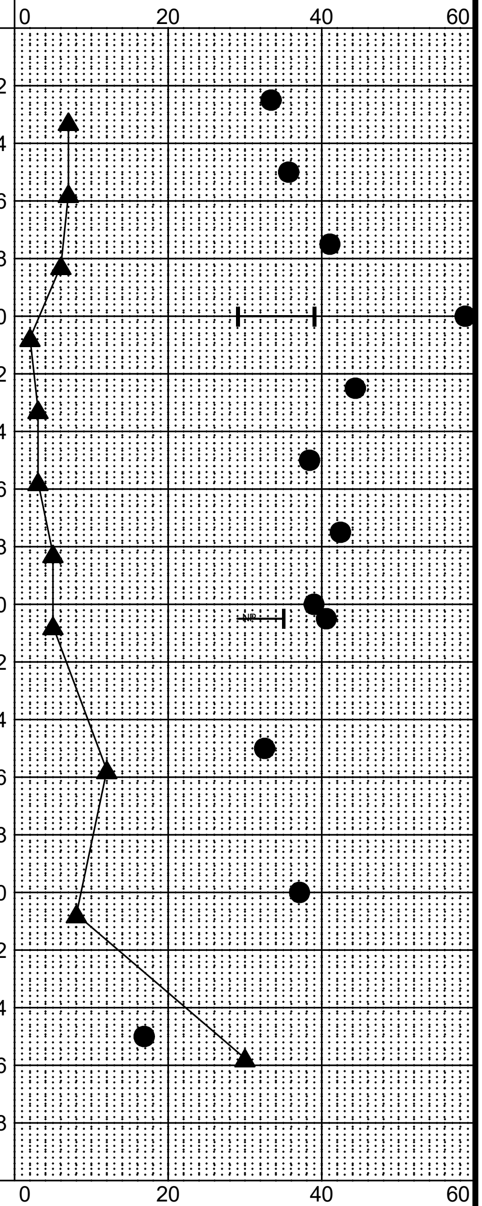
*Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*

| Soil Description | Depth, ft. | Samples |
|---|---|---|
| Topsoil, trace gravel. | 2.5 | |
| Loose, brown, *Silt (ML)*; moist; few fine sand; low plasticity with few nonplastic layers interbedded.<br>- Trace iron-oxide staining below 7.5 feet. | 9.5 | 1, 2, 3 |
| Soft, gray-brown, *Silt (ML)*; moist; trace gravel and sand; low to medium plasticity trace roots. | 12.0 | 4 |
| Very loose to loose, brown to gray-brown, *Silt (ML)*; moist; trace gravel; trace sand; low plasticity to nonplastic; trace laminations; iron-oxide stained seams.<br>- Strong iron-oxide staining at 12.5 feet.<br>- Strong iron-oxide staining in laminated silt and clay layer between 18 and 19 feet. | 23.0 | 5, 6, 7, 8 |
| Loose to medium dense, brown, *Silt with Sand (ML)*; moist; fine sand; nonplastic; few low plasticity silt and fine sand layers.<br>- Sand seam with strong iron-oxide staining at about 30 feet. | 33.0 | 9, 10 |
| Dense, brown, *Silty Sand (SM)*; moist; fine sand; nonplastic; few low plasticity laminated silt layers. | 38.0 | 11 |
| Soft, gray-brown, *Silt (ML)*; moist; trace fine sand; low to medium plasticity. | | |

Ground Water: Water Level Not Determined

**PENETRATION RESISTANCE** (blows/foot)

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




CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Thin Wall 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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

**LOG OF BORING B-2**

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-3**
Sheet 1 of 3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | ~ 629,768 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 121 ft. | Easting: | ~ 1,041,457 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

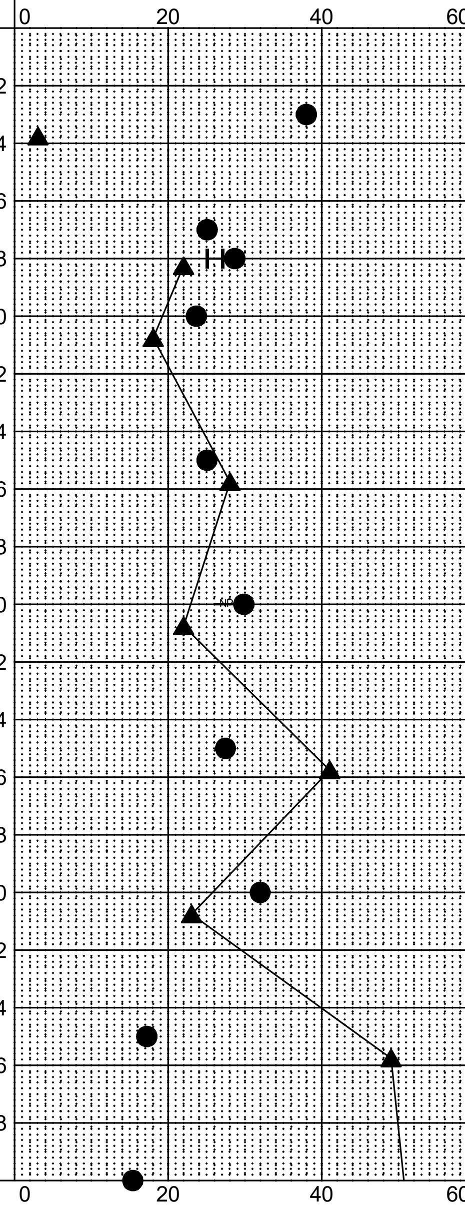
**SOIL DESCRIPTION**

*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 |
|---|---|---|
| - Few nonplastic silt and fine sand lenses at about 44 feet. | | 12, 13, 14 |
| Medium dense, brown, *Sandy Silt (ML)*; moist; nonplastic with few low plasticity silt layers; laminated; trace organics; trace iron-oxide staining. | 47.5 | 15, 16 |
| - Grades finer below about 55 feet. | | 17 |
| Medium dense to dense, brown, *Silt (ML)*; moist; trace to few fine sand; nonplastic to low plasticity. | 58.0 | 18 |
| - 1/2-inch thick gray silt layers at about 65 and 70.5 feet. | | 19, 20 |
| Dense to very dense, gray, *Silty Sand (SM)*; moist; fine sand; nonplastic. | 73.0 | 21 |

**PENETRATION RESISTANCE** (blows/foot)

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




CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

Thin Wall 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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

## LOG OF BORING B-2

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-3**
Sheet 2 of 3

VERSION 3
REVISED

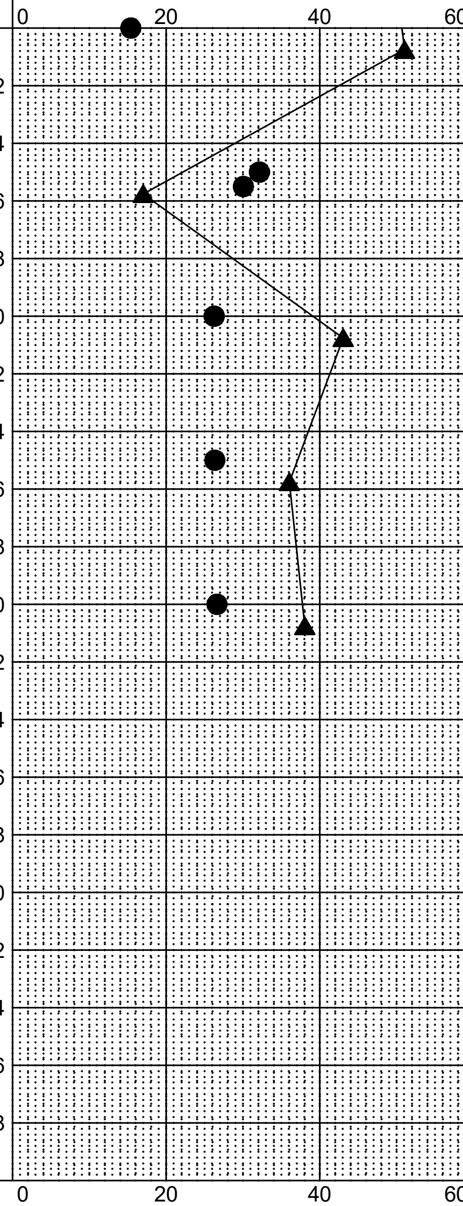
MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22 Log: SYD Rev: SAW Typ: LKN

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | ~ 629,768 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 121 ft. | Easting: | ~ 1,041,457 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

| SOIL DESCRIPTION<br>*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 |
|---|---|---|---|---|
| | | | 22 | |
| Very stiff, gray, *Silt (ML)*; moist; few fine sand; low plasticity; fine sand lenses at 85.3, 85.8, and 86.2 feet. | 83.0 | | 23 | |
| Dense, gray, *Silty Sand (SM)*; moist; fine sand; nonplastic; grades finer with depth. | 88.0 | | 24, 25, 26 | |
| BOTTOM OF BORING<br>COMPLETED 12/7/2021 | 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

Thin Wall 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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

## LOG OF BORING B-2

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-3**
Sheet 3 of 3

VERSION 3
REVISED

Log: SYD Rev: SAW Typ: LKN

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | *151.5 ft.* | Northing: | *~ 629,649 ft.* | Drilling Method: | *Mud Rotary* | Hole Diam.: | *6 in.* |
| Top Elevation: | *~ 119 ft.* | Easting: | *~ 1,041,403 ft.* | Drilling Company: | *Holt Services* | Rod Diam.: | *NWJ* |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | *CME 85 Truck* | Hammer Type: | *Automatic* |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

**SOIL DESCRIPTION**

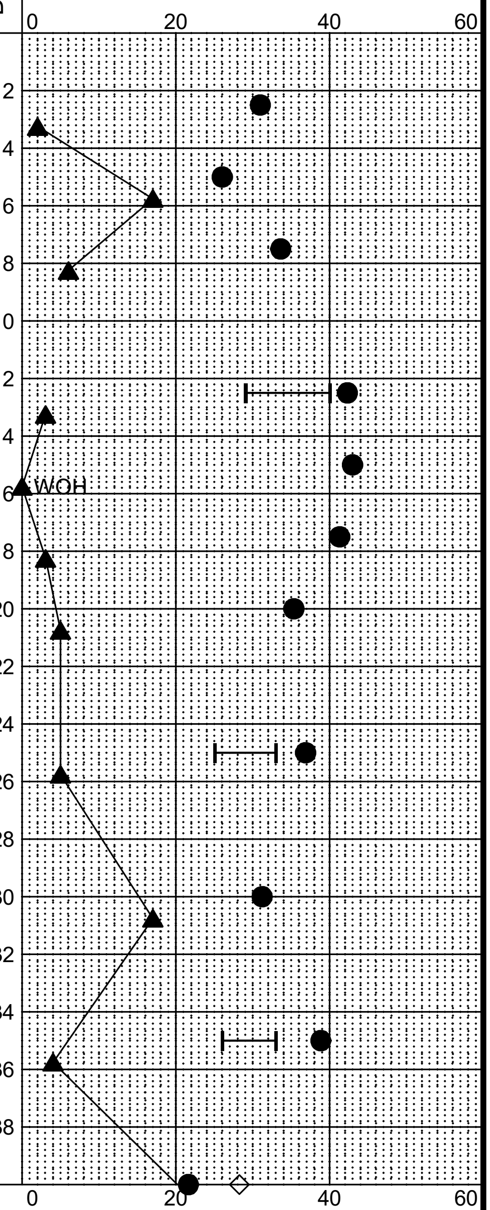
*Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*

| Soil Description | Depth, ft. | Samples |
|---|---|---|
| Asphalt and gravel. | | |
| Very loose, brown, *Silt with Sand (ML)*; moist; fine sand; nonplastic to low plasticity; trace organics; trace iron-oxide staining. | 2.5 | 1 |
| Medium dense, brown, *Silty Sand (SM)*; moist; fine sand; nonplastic; trace organics; trace iron-oxide staining; 1/2-inch thick silt layer. | 4.0 | 2 |
| Loose, brown, *Silt (ML)*; moist; few fine sand; low plasticity; iron-oxide staining; trace laminations. | 7.0 | 3, 4 |
| Very soft to medium stiff, gray-brown, *Silt (ML)*; moist; trace fine gravel and fine sand; low to medium plasticity; trace organics; trace iron-oxide staining.<br>- Trace organics at 17.5 feet.<br>- Few sand and silt seams below 20 feet. | 12.5 | 5, 6, 7, 8 |
| Loose, gray-brown, *Silt (ML)*; moist; trace fine sand; low plasticity; iron-oxide staining. | 23.0 | 9 |
| Medium dense, brown, *Silt with Sand (ML)*; moist; fine sand; nonplastic; 3-inch thick laminated silt and clay layer with iron-oxide staining at 31 feet. | 28.0 | 10 |
| Soft, gray-brown, *Silt (ML)*; moist; trace fine sand; low plasticity. | 33.0 | 11 |
| Medium dense, brown, *Silty Sand (SM)*; moist; fine sand; nonplastic; trace iron-oxide staining. | 38.0 | |

Ground Water: Water Level Not Determined

**PENETRATION RESISTANCE** (blows/foot)

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




CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

Thin Wall 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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

**LOG OF BORING B-3**

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-4**
Sheet 1 of 4

VERSION 3
REVISED

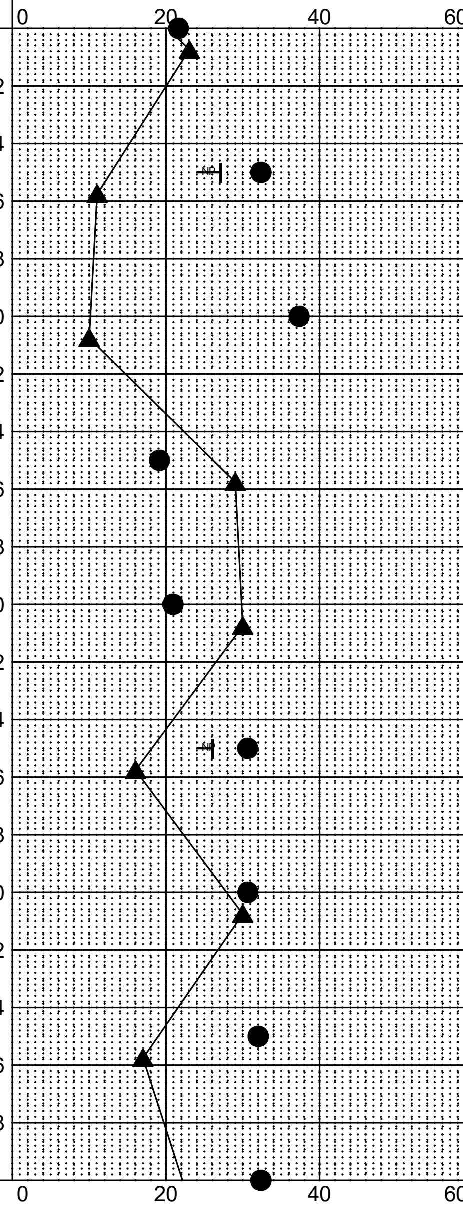
MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22 Log: SYD Rev: SAW Typ: LKN

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 151.5 ft. | Northing: | ~ 629,649 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 119 ft. | Easting: | ~ 1,041,403 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | 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.* | Depth, ft. | Samples |
|---|---|---|
| | | 12 |
| Medium dense, brown to gray-brown, *Silt (ML)*; moist; few fine sand; nonplastic to low plasticity; trace iron-oxide staining.<br>- Few fine sand seams at about 50 feet. | 43.0 | 13, 14 |
| Medium dense, brown, *Silty Sand (SM)*; moist; fine sand; nonplastic; laminated to stratified. | 53.0 | 15, 16 |
| Medium dense to dense, gray-brown, *Silt (ML)* grading to *Sandy Silt (ML)*; moist; fine sand; nonplastic to low plasticity; trace laminations; iron-oxide staining.<br>- 1-inch thick gray silt layer at 70 feet. | 64.0 | 17, 18, 19 |

**PENETRATION RESISTANCE** (blows/foot)

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




CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Thin Wall 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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

## LOG OF BORING B-3

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-4**
Sheet 2 of 4

Log: SYD Rev: SAW Typ: LKN

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22

VERSION 3
REVISED

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 151.5 ft. | Northing: | ~ 629,649 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 119 ft. | Easting: | ~ 1,041,403 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

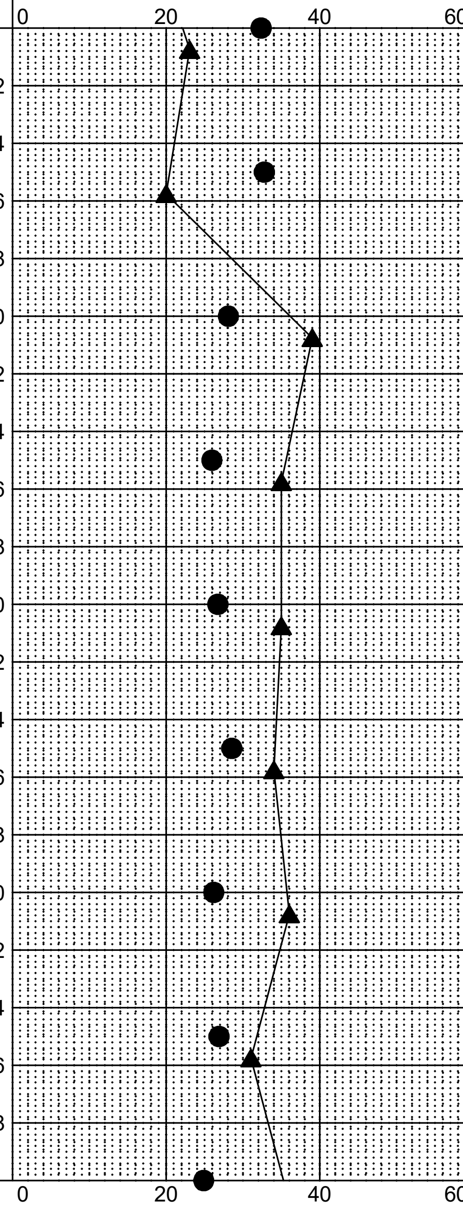
**SOIL DESCRIPTION**

*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 |
|---|---|---|
| - Strong iron-oxide stained seams at 90.5 feet. | | 20, 21, 22, 23, 24, 25 |
| Dense to very dense, gray, *Silty Sand (SM)*; moist; fine sand; nonplastic. | 108.0 | 26, 27 |

Symbol | Ground Water | Depth, ft.

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




CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Thin Wall 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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

**LOG OF BORING B-3**

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-4**
Sheet 3 of 4

VERSION 3
REVISED

Log: SYD Rev: SAW Typ: LKN

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | *151.5 ft.* | Northing: | *~ 629,649 ft.* | Drilling Method: | *Mud Rotary* | Hole Diam.: | *6 in.* |
| Top Elevation: | *~ 119 ft.* | Easting: | *~ 1,041,403 ft.* | Drilling Company: | *Holt Services* | Rod Diam.: | *NWJ* |
| Vert. Datum: | | Station: | *~* | Drill Rig Equipment: | *CME 85 Truck* | 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.*

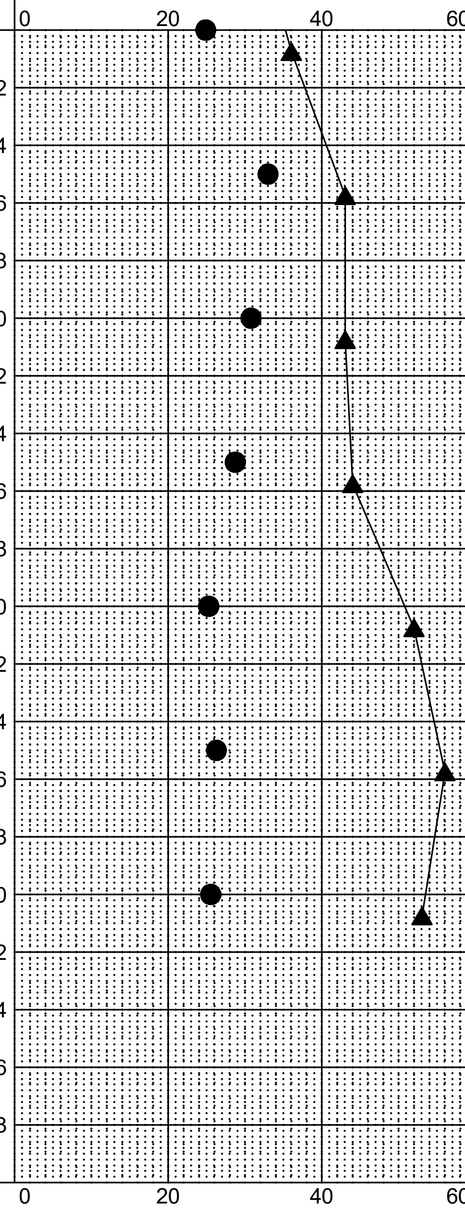
Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

**PENETRATION RESISTANCE** (blows/foot)

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

Samples: 28, 29, 30, 31, 32, 33, 33

Depth, ft.: 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158




151.5

BOTTOM OF BORING
COMPLETED 12/9/2021

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Thin Wall 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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

# LOG OF BORING B-3

February 2022 | 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-4**
Sheet 4 of 4

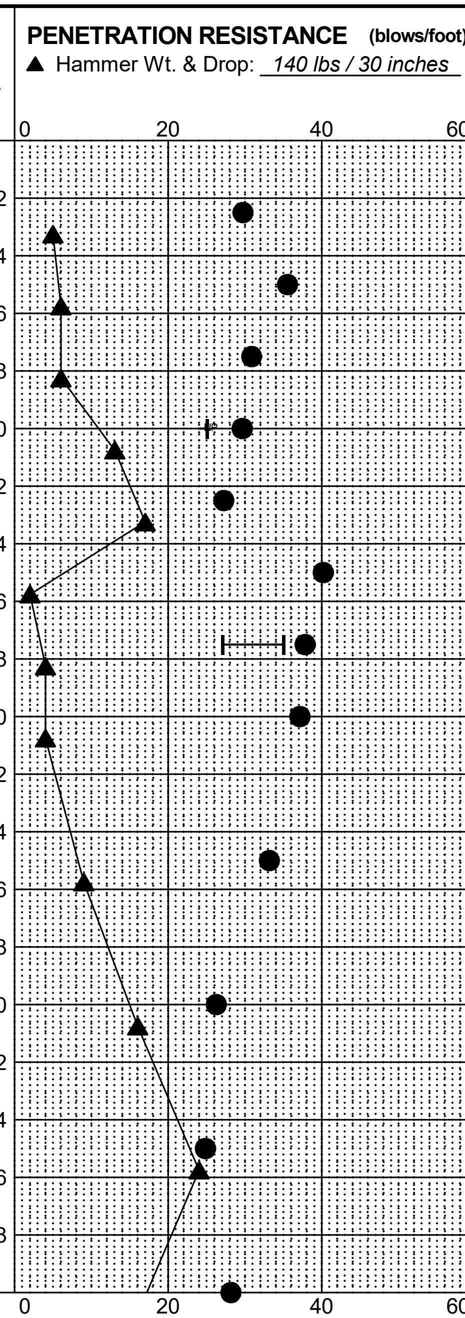
VERSION 3
REVISED

Log: SYD Rev: SAW Typ: LKN

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | ~ 629,765 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 114 ft. | Easting: | ~ 1,041,275 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | ~ | Other Comments: | | | |

| SOIL DESCRIPTION<br>*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 |
|---|---|---|---|---|
| Concrete and subbase. | | | | |
| Loose, brown, *Silt (ML)*; moist; trace gravel; trace fine sand; low plasticity; fine sand lenses at 2.5 and 3.5 feet; trace organics below 7.5 feet. | 2.5 | | 1, 2, 3 | Water Level Not Determined |
| Medium dense, brown, *Silt (ML)*; moist; trace fine gravel; few fine sand; nonplastic; trace iron-oxide staining and laminations; trace organics. | 9.5 | | 4, 5 | |
| Soft, brown, *Silt (ML)*; moist; trace gravel; trace fine sand; low plasticity; few gray silt seams; iron-oxide staining locally.<br>- 1/2-inch thick lean clay layer with strong oxidation at 20.8 feet. | 14.5 | | 6, 7, 8 | |
| Loose to medium dense, brown to gray-brown, *Sandy Silt (ML)*; moist; fine to medium sand; nonplastic with few low plasticity layers; few fine sand seams; few laminations; iron-oxide staining locally. | 23.0 | | 9, 10, 11 | |




CONTINUED NEXT SHEET

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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

# LOG OF BORING B-4A

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-5**
Sheet 1 of 3

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22 Log: SYD Rev: SAW Typ: LKN

VERSION 3
REVISED

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | *101.5 ft.* | Northing: | *~ 629,765 ft.* | Drilling Method: | *Mud Rotary* | Hole Diam.: | *6 in.* |
| Top Elevation: | *~ 114 ft.* | Easting: | *~ 1,041,275 ft.* | Drilling Company: | *Holt Services* | Rod Diam.: | *NWJ* |
| Vert. Datum: | | Station: | *~* | Drill Rig Equipment: | *CME 85 Truck* | Hammer Type: | *Automatic* |
| Horiz. Datum: | | Offset: | *~* | Other Comments: | | | |

**SOIL DESCRIPTION**

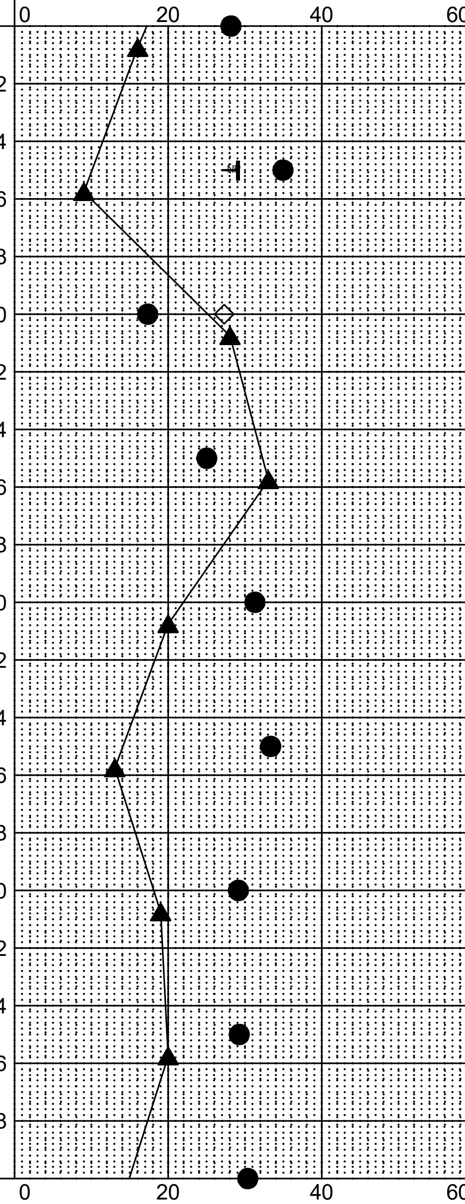
*Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*

| Soil Description | Depth, ft. | Samples |
|---|---|---|
| - Strong iron-oxide staining at 40.3 feet. | | 12 |
| Loose, gray-brown, *Silt (ML)*; moist, trace fine sand; nonplastic; few laminated layers. | 43.0 | 13 |
| Medium dense, brown to gray-brown, *Silty Sand (SM)*; moist; fine sand; nonplastic.<br>- Few low plasticity silt layers with iron-oxide staining at 55 feet. | 47.0 | 14, 15 |
| Medium dense, gray-brown, *Silt (ML)*; moist; few fine sand; low plasticity; few iron-oxide stained laminations. | 58.0 | 16 |
| Medium dense, gray to gray-brown, *Silt (ML)*; moist; few fine sand; nonplastic; trace iron-oxide staining.<br>- Brown sandy silt layer from 70 to 70.5 feet, grading to gray silt. | 63.0 | 17, 18, 19 |

Depth, ft.: 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78

**PENETRATION RESISTANCE** (blows/foot)

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




CONTINUED NEXT SHEET

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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

# LOG OF BORING B-4A

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-5**
Sheet 2 of 3

VERSION 3
REVISED

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22

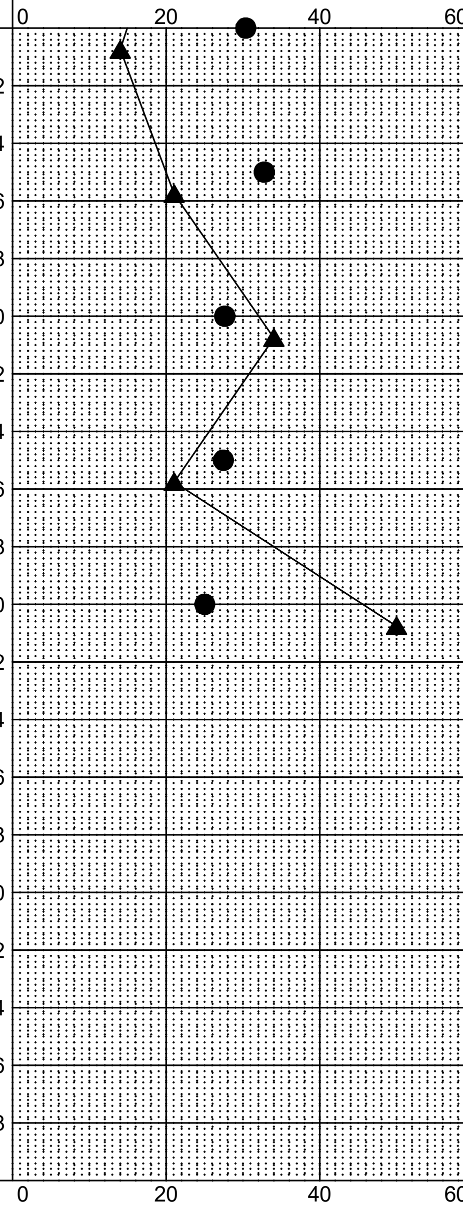
Log: SYD Rev: SAW Typ: LKN

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | ~ 629,765 ft. | Drilling Method: | Mud Rotary | Hole Diam.: | 6 in. |
| Top Elevation: | ~ 114 ft. | Easting: | ~ 1,041,275 ft. | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | ~ | Drill Rig Equipment: | CME 85 Truck | 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 |
|---|---|---|
| Medium dense to dense, gray, *Silty Sand (SM)*; moist; fine to medium sand; nonplastic. | 87.0 | 20, 21, 22, 23, 24 |
| BOTTOM OF BORING COMPLETED 12/10/2021 | 101.5 | |




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.
4. The hole location was measured from existing site features and should be considered approximate.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

# LOG OF BORING B-4A

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-5**
Sheet 3 of 3

VERSION 3
REVISED

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22 Log: SYD Rev: SAW Typ: LKN

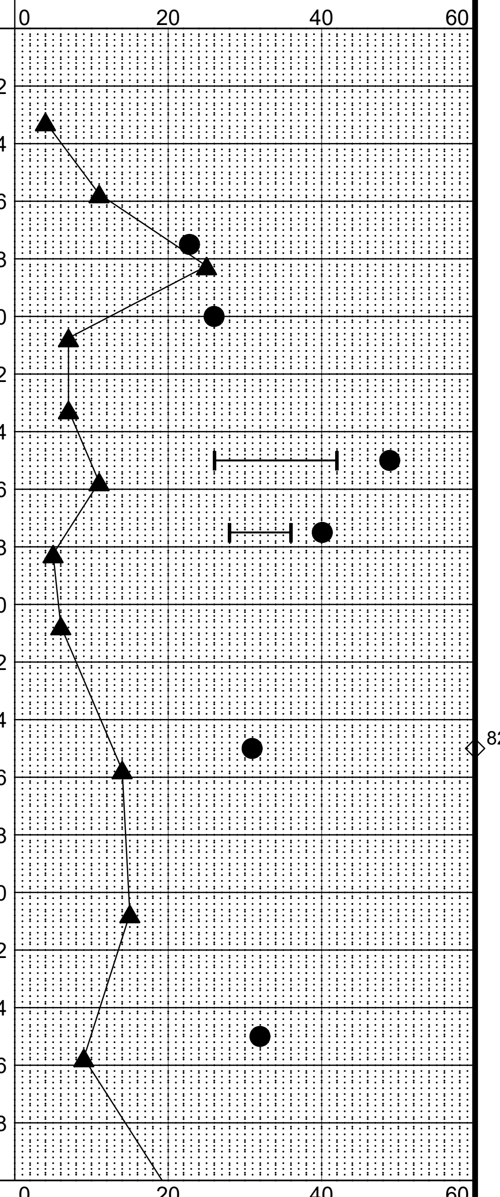
| | | | | | |
|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | | Drilling Method: | Mud Rotary |
| Top Elevation: | ~ | Easting: | | Drilling Company: | Holt Services |
| Vert. Datum: | | Station: | | Drill Rig Equipment: | CME 85 Truck |
| Horiz. Datum: | | Offset: | | Other Comments: | |

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

| SOIL DESCRIPTION<br>*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. |
|---|---|
| Crushed *Gravel (GP)*.<br>(Hf) | 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.<br>(Qvrl) | 7.0 |
| Medium dense, brown, *Silty Sand (SM)*; moist; fine sand; low plasticity to nonplastic; silt seam with organics at about 9 feet.<br>(Qvro) | 10.5 |
| Medium stiff, brown, *Silt (ML)* grading to *Lean Clay (CL)*; moist; few fine sand; low to medium plasticity; trace organics.<br>(Qvrl) | 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.<br>(Qvrl) | 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.<br>(Qvrl) | 25.2 |
| Medium dense, brown, *Silty Sand (SM)*; moist; fine sand; nonplastic; few low to medium plasticity seams; strong iron oxide at 25 feet.<br>(Qvro) | 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.<br>(Qvrl) | 38.0 |
| Medium dense, brown, *Silt (ML)*; moist; trace to few fine sand; low plasticity. | |

Symbol | Samples: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 | Ground Water: Water Level Not Determined

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




CONTINUED NEXT SHEET

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.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

# LOG OF BORING SW-1

February 2022 | 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-6**
Sheet 1 of 3

VERSION 3
REVISED

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | | Drilling Method: | Mud Rotary | Hole Diam.: | 5 in. |
| Top Elevation: | ~ | Easting: | | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | | Other Comments: | | | |

**SOIL DESCRIPTION**

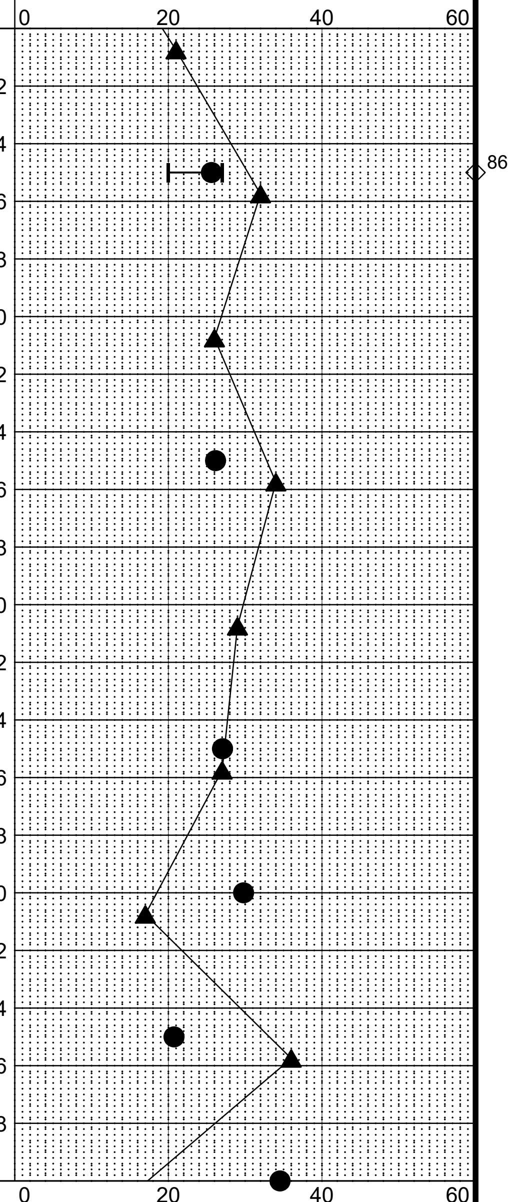
*Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*

| Soil Description | Depth, ft. | Samples |
|---|---|---|
| (Qvrl) | | 12 |
| Dense, brown, *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. (Qvrl) | 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. (Qvro) | 48.0 | 14, 15, 16, 17, 18 |
| Dense, gray, *Silty Sand (SM)*; moist; fine sand; nonplastic. (Qpnf) | 71.5 | 19 |

Symbol | Samples | Ground Water | Depth, ft.

**PENETRATION RESISTANCE** (blows/foot)

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




CONTINUED NEXT SHEET

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.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

**LOG OF BORING SW-1**

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-6**
Sheet 2 of 3

VERSION 3
REVISED

Log: SAW Rev: AJB Typ: LKN

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Depth: | 101.5 ft. | Northing: | | Drilling Method: | Mud Rotary | Hole Diam.: | 5 in. |
| Top Elevation: | ~ | Easting: | | Drilling Company: | Holt Services | Rod Diam.: | NWJ |
| Vert. Datum: | | Station: | | Drill Rig Equipment: | CME 85 Truck | Hammer Type: | Automatic |
| Horiz. Datum: | | Offset: | | Other Comments: | | | |

**SOIL DESCRIPTION**

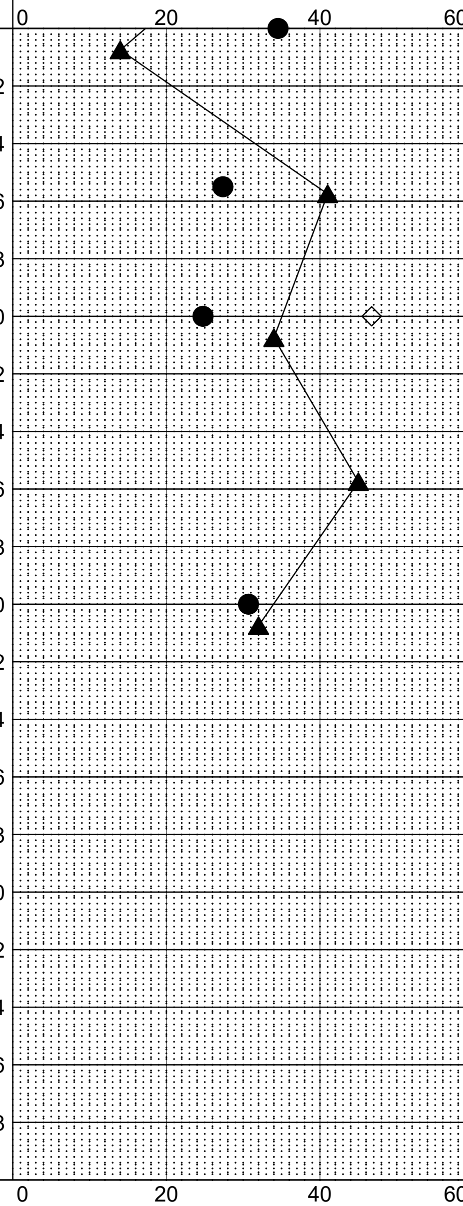
*Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*

| Soil Description | Depth, ft. | Samples |
|---|---|---|
| Medium dense to dense, gray, *Silt (ML)*; moist; few fine sand; nonplastic and low plasticity interbedded. (Qpnf) | 80.0 | 20 |
| Dense, gray, *Silty Sand (SM)*; moist; fine sand; nonplastic. (Qpnf) | 85.5 | 21, 22 |
| - Sandy silt layers interbedded from 95 to 96 feet. | | 23 |
| - Trace organics below 100 feet. | | 24 |
| BOTTOM OF BORING COMPLETED 8/18/2020 | 101.5 | |

Symbol | Samples | Ground Water | 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.

Newhouse Building Replacement
State Capitol Campus
Olympia, Washington

## LOG OF BORING SW-1

February 2022 105564-003

**SHANNON & WILSON, INC.**
Geotechnical and Environmental Consultants

**FIG. A-6**
Sheet 3 of 3

MASTER_LOG_E 105564.GPJ SHAN_WIL.GDT 2/16/22 Log: SAW Rev: AJB Typ: LKN

VERSION 3
REVISED

APPENDIX B: GEOTECHNICAL LABORATORY TESTING

Appendix B

# Geotechnical Laboratory Testing

CONTENTS

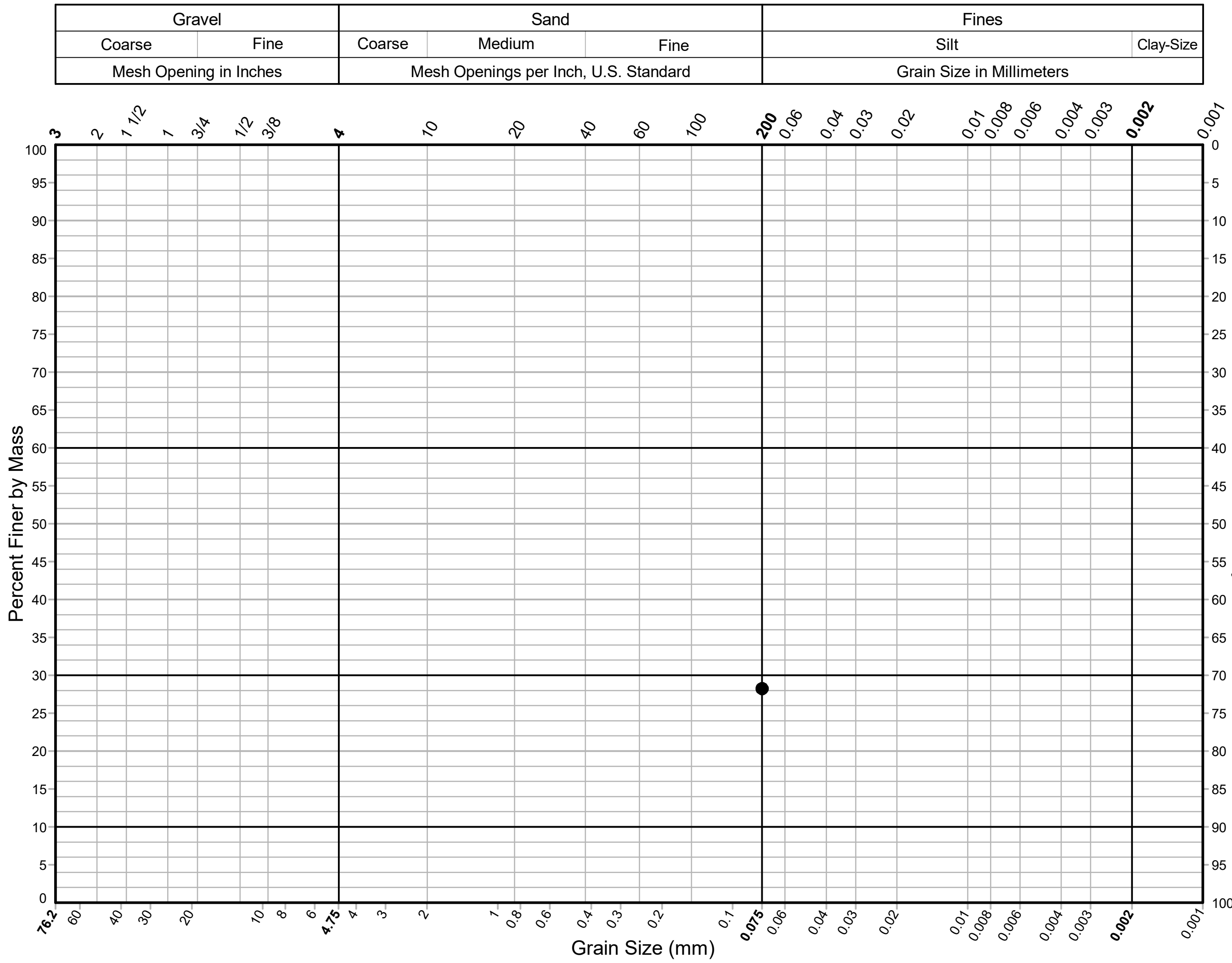
## Figures

SHANNON & WILSON

# GRAIN SIZE DISTRIBUTION PLOT

**Legislative Campus Modernization**
**Newhouse Building**
**Olympia, Washington**

## BORING B-3




| Sample Identification | Depth (ft) | USCS Group Symbol | USCS Group Name | Gravel % | Sand % | Fines % | < 20µm % | < 2µm % | WC % | Tested By | Review By | ASTM Std. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● B-3, S-12 | 40.0 | SM | Silty Sand | | | 28 | | | 21.6 | BXK | MXM | D1140 |

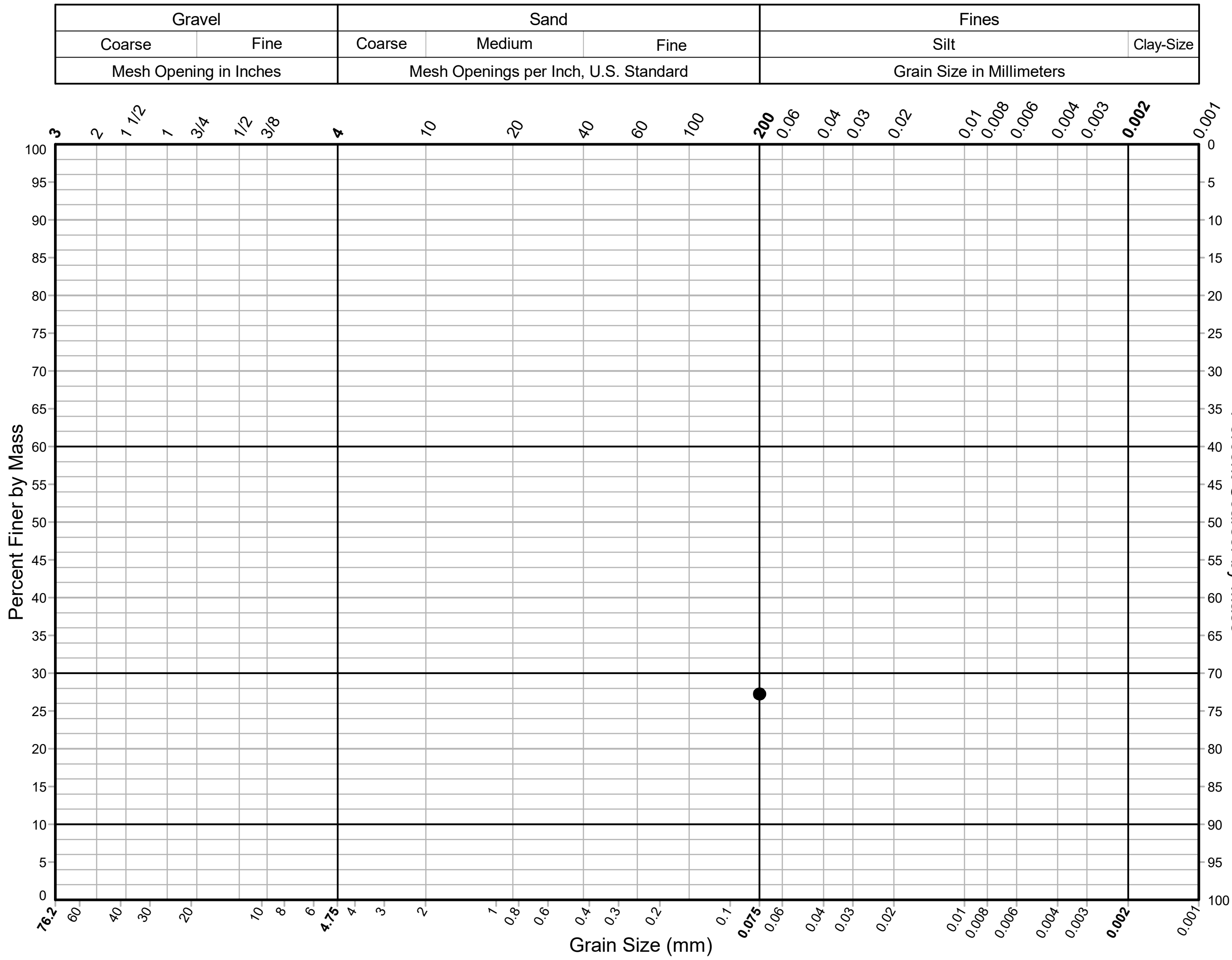
*[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, and <2um% values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.*

SHANNON & WILSON

# GRAIN SIZE DISTRIBUTION PLOT

**Legislative Campus Modernization**
**Newhouse Building**
**Olympia, Washington**

## BORING B-4A




| Sample Identification | Depth (ft) | USCS Group Symbol | USCS Group Name | Gravel % | Sand % | Fines % | < 20µm % | < 2µm % | WC % | Tested By | Review By | ASTM Std. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● B-4A, S-14 | 50.0 | SM | Silty Sand | | | 27 | | | 17.3 | KCV | MXM | D1140 |

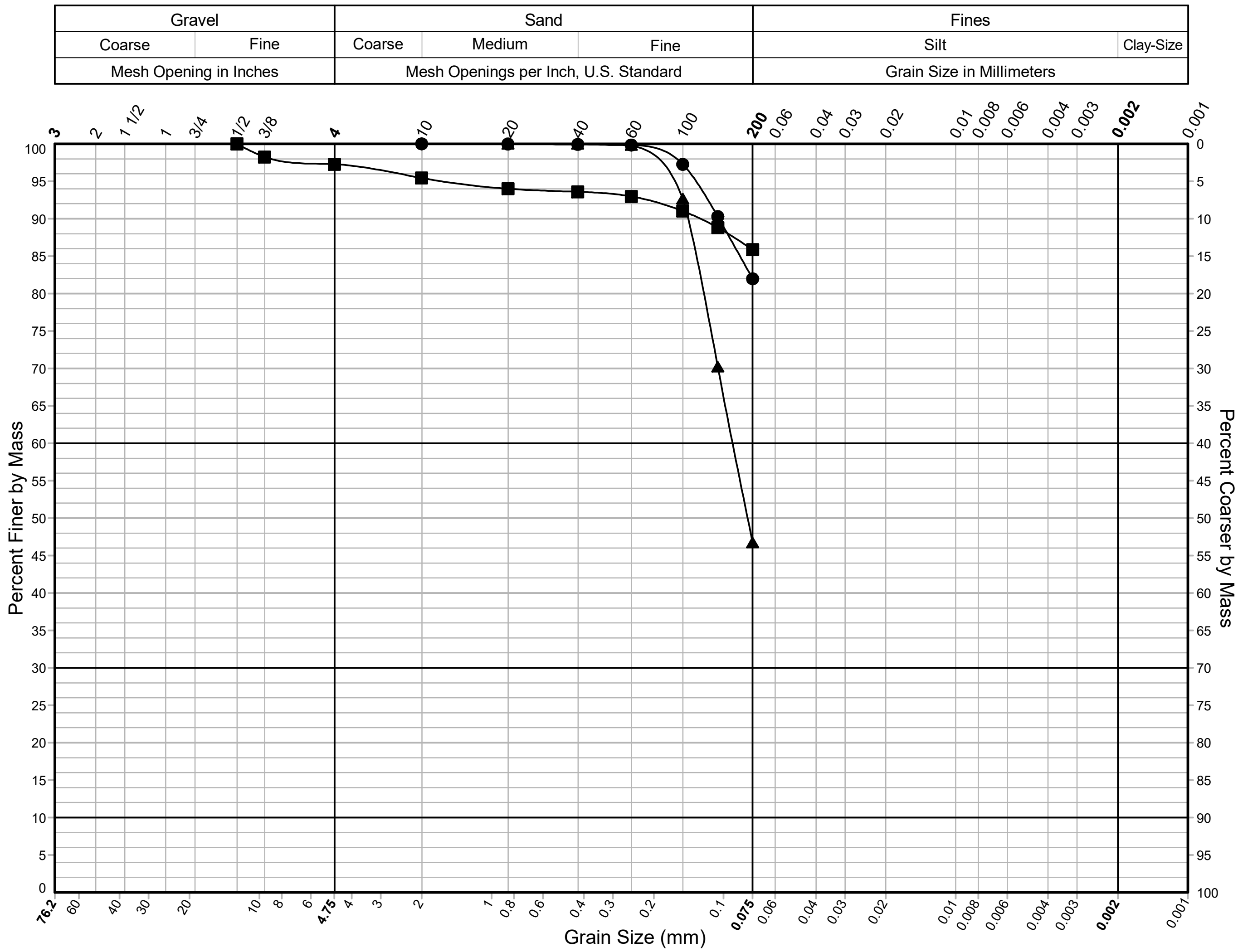
*[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, and <2um% values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.*

**SHANNON & WILSON, INC.**

# GRAIN SIZE DISTRIBUTION PLOT

**Legislative Campus Modernization**
**Newhouse Building**
**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 | AKV | D6913 |
| ■ SW-1, S-13* | 45.0 | CL-ML | Silty Clay | 3 | 11 | 86 | | | 25.6 | MXC | AKV | D6913 |
| ▲ SW-1, S-22 | 90.0 | SM | Silty Sand | | 53 | 47 | | | 24.8 | MXC | AKV | D6913 |

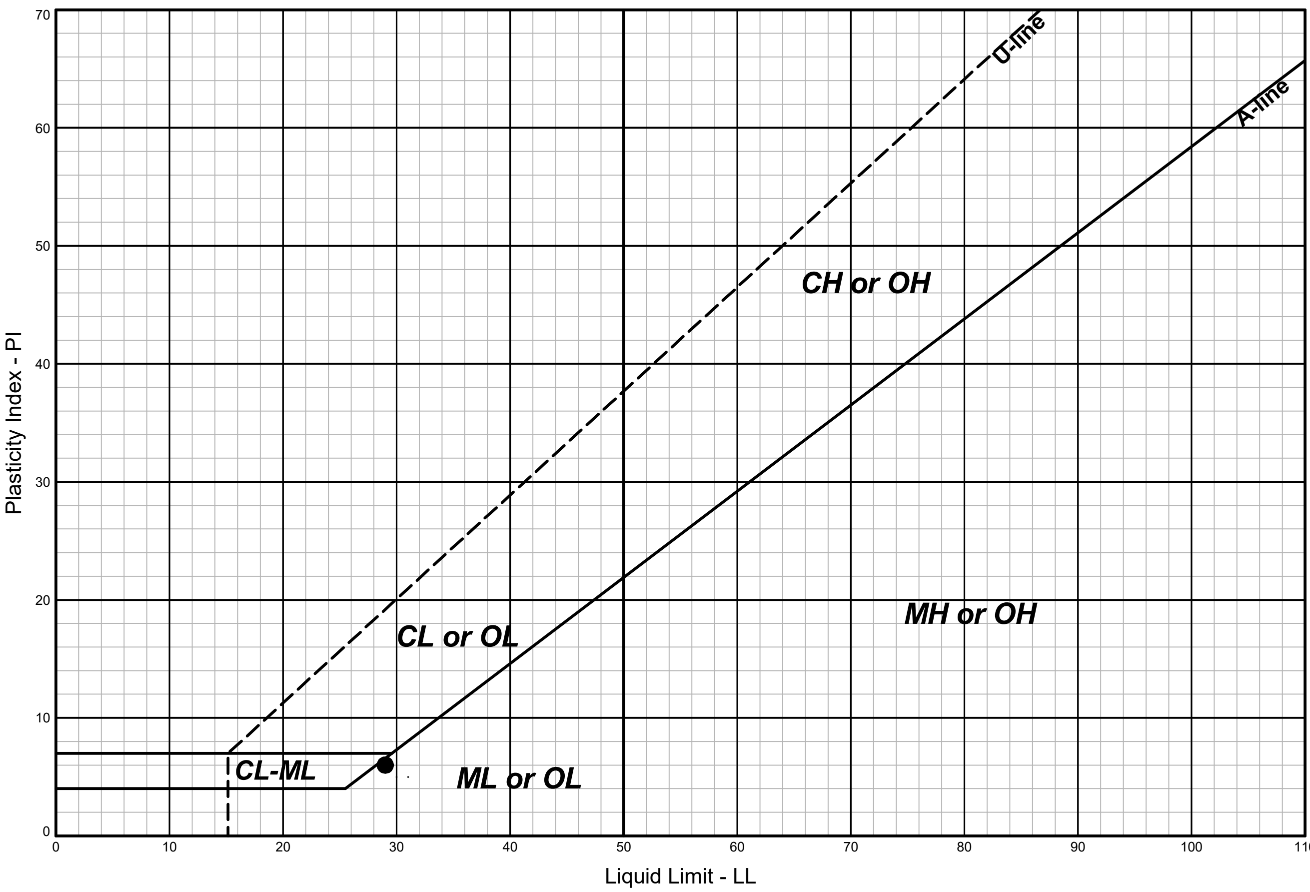
* *Test specimen did not meet minimum mass recommendations.*

SHANNON & WILSON

# PLASTICITY CHART

**Legislative Campus Modernization**
**Newhouse Building**
**Olympia, Washington**

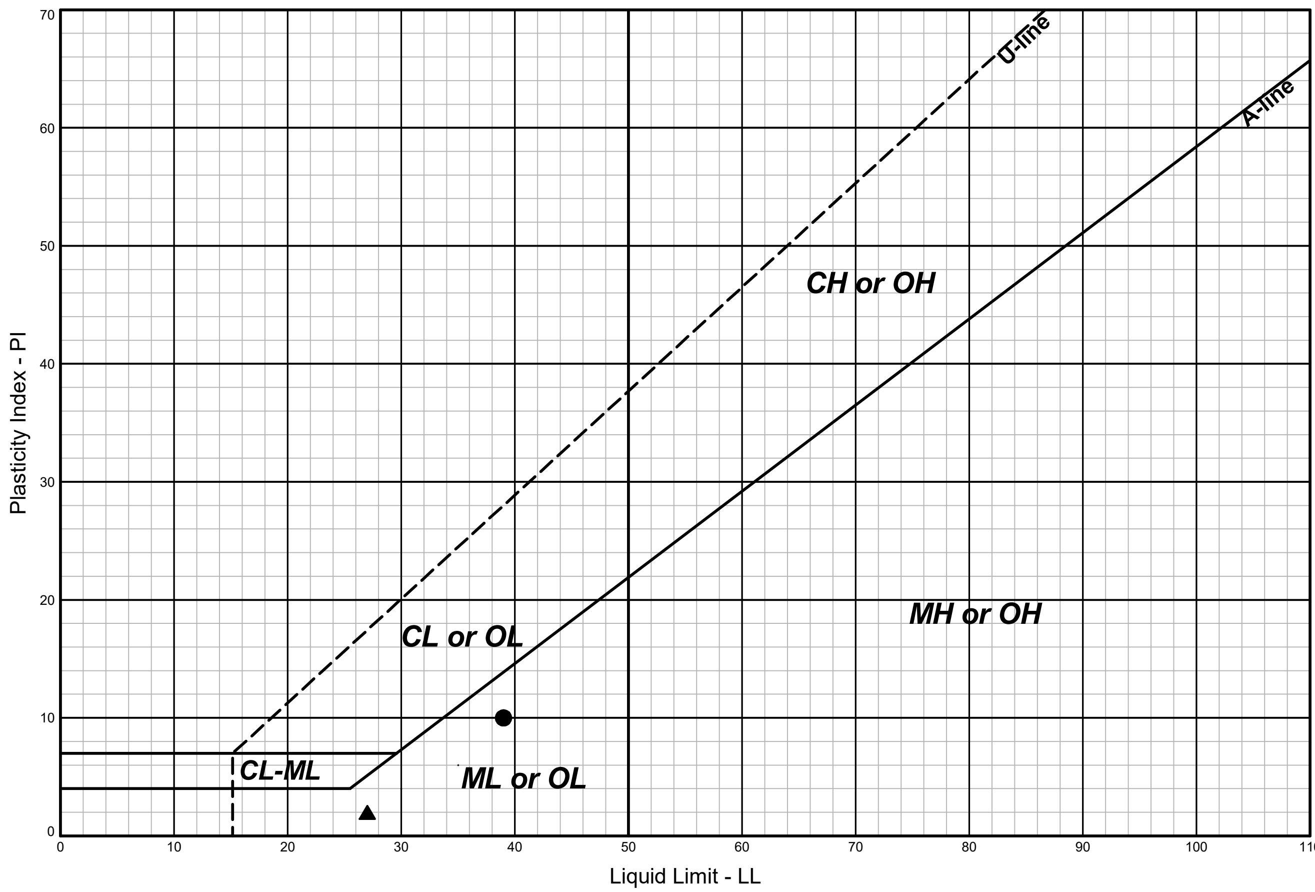
## BORING B-1




| Sample Identification | Depth (ft) | USCS Group Symbol | USCS Group Name | LL | PL | PI | WC % | Gravel % | Sand % | Fines % | < 2µm % | Tested By | Review By | ASTM Std. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● B-1, S-8 | 20.0 | ML | Silt | 29 | 23 | 6 | 29.3 | | | | | SJD | MXM | D4318 |
| ■ B-1, S-13 | 45.0 | ML | Silt | 30 | 25 | **NP** | 36.6 | | | | | SJD | MXM | D4318 |
| ▲ B-1, S-18 | 70.0 | ML | Silt | 31 | 26 | **NP** | 34.7 | | | | | KCV | MXM | D4318 |

Legislative Campus Modernization
Newhouse Building
Olympia, Washington

## BORING B-2

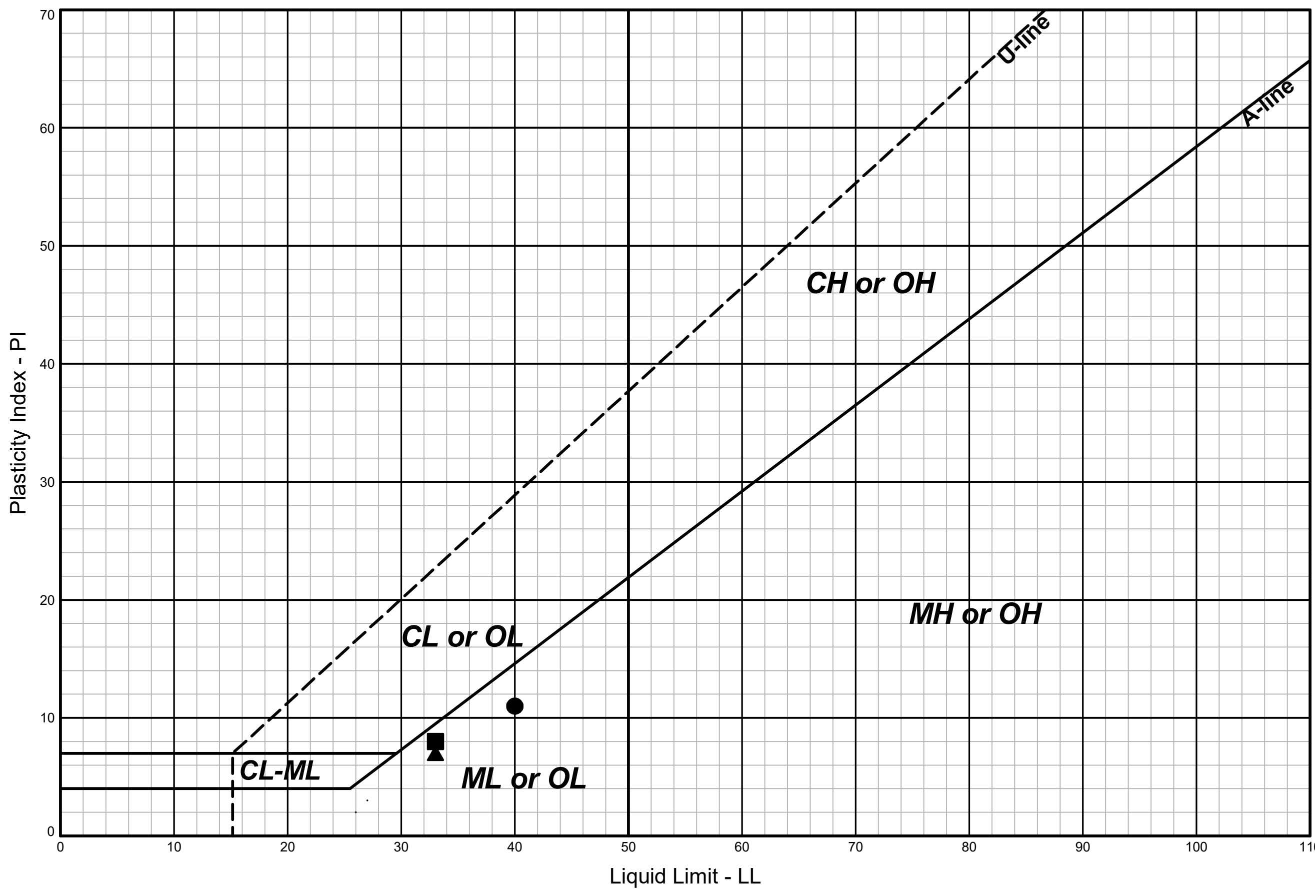



| Sample Identification | Depth (ft) | USCS Group Symbol | USCS Group Name | LL | PL | PI | WC % | Gravel % | Sand % | Fines % | < 2µm % | Tested By | Review By | ASTM Std. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● B-2, S-4 | 10.0 | ML | Silt | 39 | 29 | 10 | 58.6 | | | | | SJD | MXM | D4318 |
| ■ B-2, S-8B | 20.5 | ML | Silt | 35 | 29 | **NP** | 40.6 | | | | | SJD | MXM | D4318 |
| ▲ B-2, S-15B | 48.0 | ML | Silt | 27 | 25 | 2 | 28.6 | | | | | SJD | MXM | D4318 |
| ◆ B-2, S-18 | 60.0 | ML | Silt | 30 | 26 | **NP** | 29.8 | | | | | SJD | MXM | D4318 |

# PLASTICITY CHART

Legislative Campus Modernization
Newhouse Building
Olympia, Washington

## BORING B-3

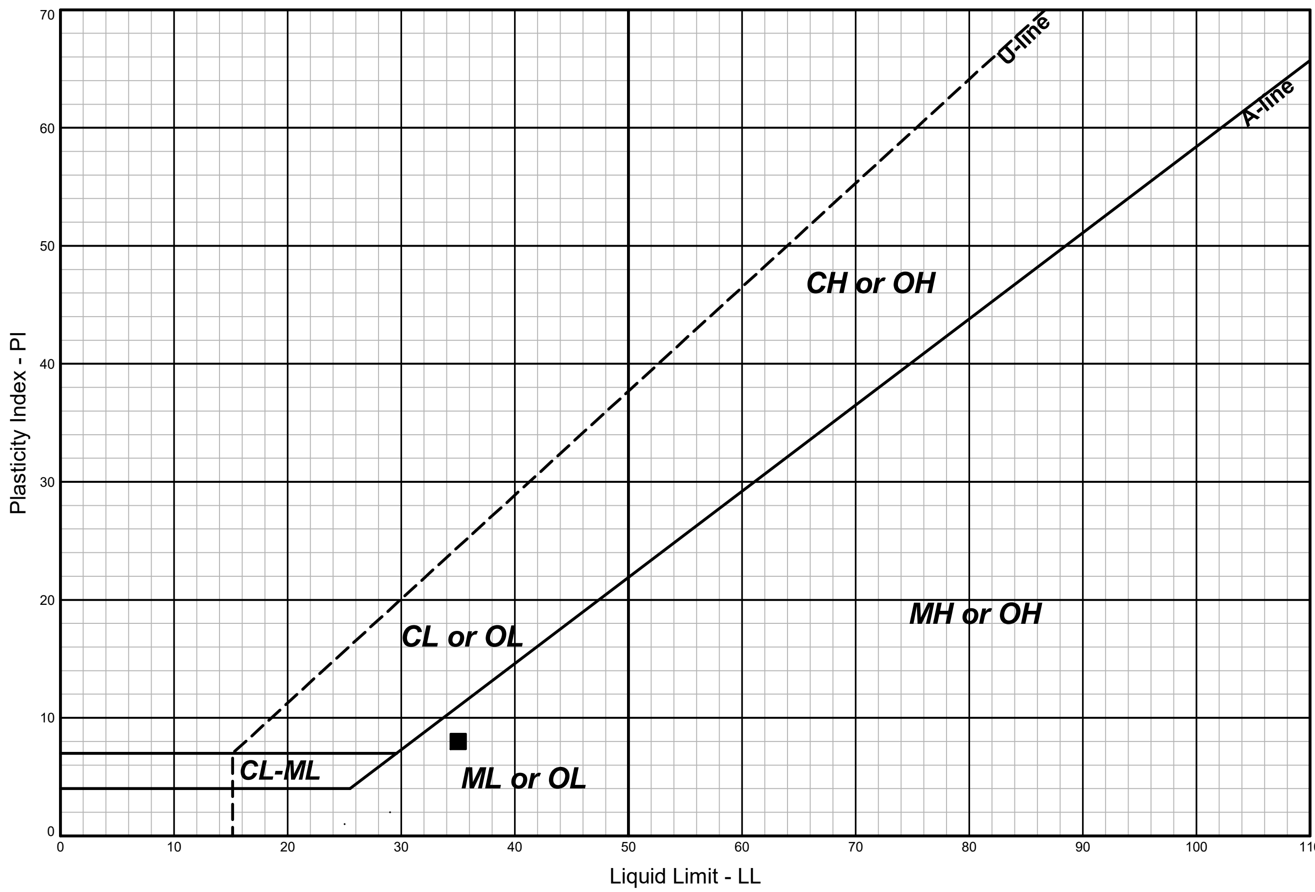



| Sample Identification | Depth (ft) | USCS Group Symbol | USCS Group Name | LL | PL | PI | WC % | Gravel % | Sand % | Fines % | < 2µm % | Tested By | Review By | ASTM Std. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● B-3, S-5 | 12.5 | ML | Silt | 40 | 29 | 11 | 42.3 | | | | | SJD | MXM | D4318 |
| ■ B-3, S-9 | 25.0 | ML | Silt | 33 | 25 | 8 | 36.9 | | | | | SJD | MXM | D4318 |
| ▲ B-3, S-11 | 35.0 | ML | Silt | 33 | 26 | 7 | 38.8 | | | | | SJD | MXM | D4318 |
| ◆ B-3, S-13 | 45.0 | ML | Silt | 27 | 24 | **NP** | 32.3 | | | | | SJD | MXM | D4318 |
| ○ B-3, S-17 | 65.0 | ML | Silt | 26 | 24 | **NP** | 30.6 | | | | | SJD | MXM | D4318 |

# PLASTICITY CHART

**Legislative Campus Modernization**
**Newhouse Building**
**Olympia, Washington**

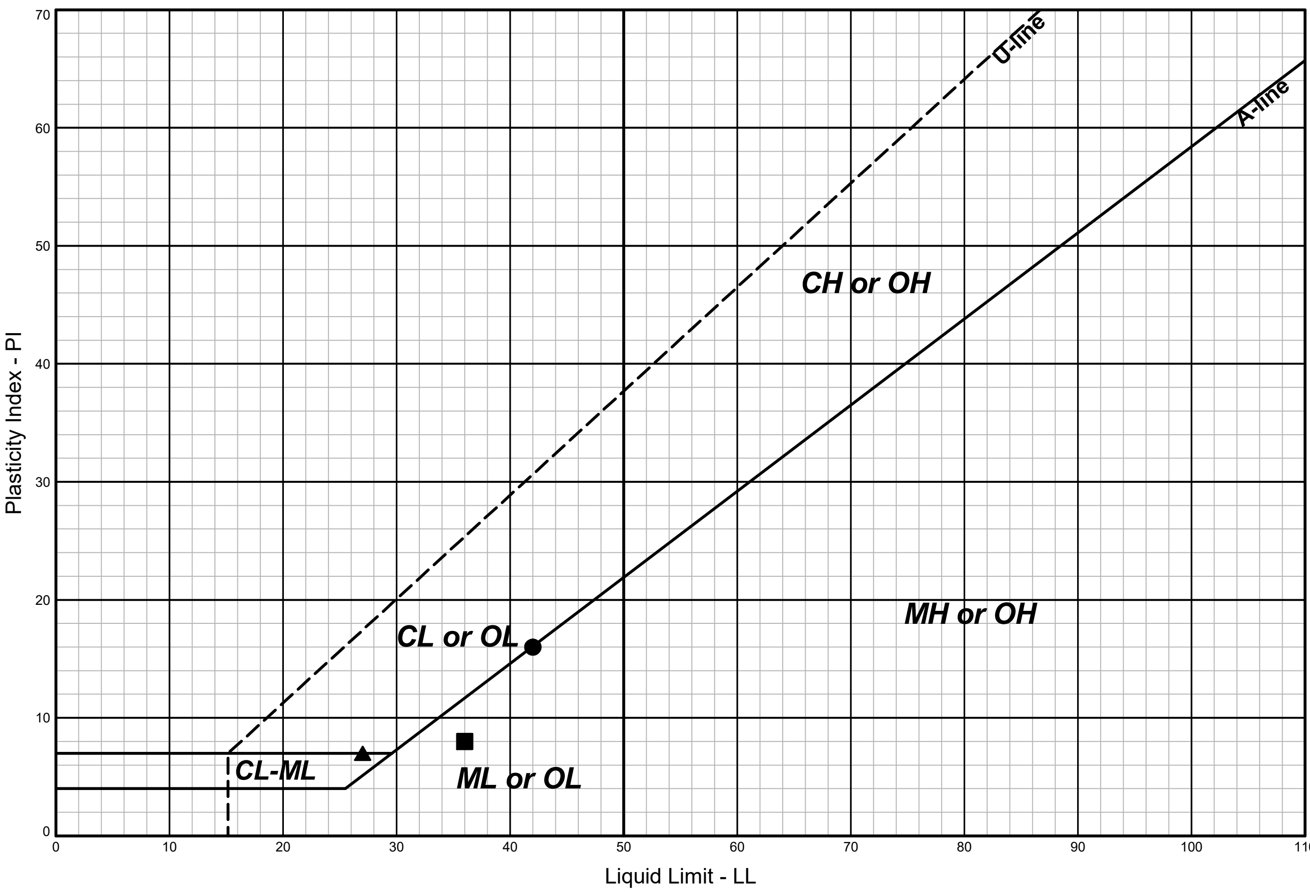
## BORING B-4A




| Sample Identification | Depth (ft) | USCS Group Symbol | USCS Group Name | LL | PL | PI | WC % | Gravel % | Sand % | Fines % | < 2µm % | Tested By | Review By | ASTM Std. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● B-4A, S-4 | 10.0 | ML | Silt | 25 | 24 | **NP** | 29.6 | | | | | BXK | MXM | D4318 |
| ■ B-4A, S-7 | 17.5 | ML | Silt | 35 | 27 | 8 | 37.8 | | | | | KCV | MXM | D4318 |
| ▲ B-4A, S-13 | 45.0 | ML | Silt | 29 | 27 | **NP** | 34.9 | | | | | BXK | MXM | D4318 |

Legislative Campus Modernization
Newhouse Building
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 | AKV | D4318 |
| ■ SW-1, S-7 | 17.5 | ML | Silt | 36 | 28 | 8 | 40.1 | | | | | MRH | AKV | D4318 |
| ▲ SW-1, S-13 | 45.0 | CL-ML | Silty Clay | 27 | 20 | 7 | 25.6 | 3 | 11 | 86 | | AKV | AKV | D4318 |

# Analytical Report

Fremont Analytical

Work Order: **2202003**
Date Reported: **2/4/2022**

**CLIENT:** Shannon & Wilson
**Project:** Newhouse building- Legislative Campus

**Lab ID:** 2202003-001 **Collection Date:** 1/31/2022
**Client Sample ID:** **S-1 Boring B-3** **Matrix:** Soil

| Analyses | Result | RL | Qual | Units | DF | Date Analyzed |
|---|---|---|---|---|---|---|
| **Cation Exchange Capacity by EPA 9081** | | | | Batch ID: R73028 | | Analyst: EH |
| Cation Exchange Capacity | 3.05 | 1.00 | | meq/100g | 1 | 2/3/2022 2:18:44 PM |
| **Organic Matter of Organic Soils by ASTM D2974** | | | | Batch ID: R72996 | | Analyst: SLL |
| Organic Matter | 3.48 | 0.500 | | % | 1 | 2/1/2022 1:00:00 PM |

**Lab ID:** 2202003-002 **Collection Date:** 1/31/2022
**Client Sample ID:** **S-2 Boring B-1** **Matrix:** Soil

| Analyses | Result | RL | Qual | Units | DF | Date Analyzed |
|---|---|---|---|---|---|---|
| **Cation Exchange Capacity by EPA 9081** | | | | Batch ID: R73028 | | Analyst: EH |
| Cation Exchange Capacity | 3.11 | 1.00 | | meq/100g | 1 | 2/3/2022 2:23:00 PM |
| **Organic Matter of Organic Soils by ASTM D2974** | | | | Batch ID: R72996 | | Analyst: SLL |
| Organic Matter | 3.89 | 0.500 | | % | 1 | 2/1/2022 1:00:00 PM |

IMPORTANT INFORMATION

# Important Information

## About Your Geotechnical/Environmental Report

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

IMPORTANT INFORMATION

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