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Geotechnical Engineering Report

12th Street Short Plat
428 SW 12th Street
College Place, Washington

Prepared for:
Marc Maiuri
428 SW 12th Street
College Place, Washington 99324

June 25, 2018
PBS Project 67220.000

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1 INTRODUCTION

1.1 General

This report presents results of PBS Engineering and Environmental Inc. (PBS) geotechnical engineering services for the proposed residential development located at 428 SW 12th Street in College Place, Washington (site). The general site location is shown on the Vicinity Map, Figure 1. The locations of PBS' explorations in relation to existing site features are shown on the Site Plan, Figure 2.

1.2 Purpose and Scope

The purpose of PBS' services was to develop geotechnical design and construction recommendations in support of the planned residential development. This was accomplished by performing the following scope of services.

1.2.1 Literature and Records Review

PBS reviewed various published geologic maps of the area for information regarding geologic conditions and hazards at or near the site. PBS also reviewed previously completed reports for the project vicinity.

1.2.2 Subsurface Explorations

PBS excavated five test pits within the proposed development to depths of up to 10 feet below the existing ground surface (bgs). The test pits were logged and representative soil samples collected by a member of the PBS geotechnical engineering staff. Interpreted test pit logs are included as Figures A1 through A5 in Appendix A, Field Explorations.

1.2.3 Field Infiltration Testing

Two open-hole, falling-head field infiltration tests were completed in test pits TP-1 and TP-2 within the proposed development at depths of 4.5 and 4 feet bgs, respectively. Infiltration testing was monitored by PBS geotechnical engineering staff.

1.2.4 Soils Testing

Soil samples were returned to our laboratory and classified in general accordance with the Unified Soil Classification System, Visual-Manual Procedure. Laboratory tests included natural moisture contents and grain-size analyses. Laboratory test results are included in the test pit logs in Appendix A, Field Explorations; and in Appendix B, Laboratory Testing.

1.2.5 Geotechnical Engineering Analysis

Data collected during the subsurface exploration, literature research, and testing were used to develop site-specific geotechnical design parameters and construction recommendations.

1.2.6 Report Preparation

This Geotechnical Engineering Report summarizes the results of our explorations, testing, and analyses, including information relating to the following:

- Field exploration logs and site plan showing approximate exploration locations
- Laboratory test results
- Infiltration test results
- Groundwater levels and considerations
- Liquefaction potential
- Shallow foundation recommendations:

  - Minimum embedment
  - Allowable bearing pressure
  - Estimated settlement
  - Sliding coefficient
- Earthwork and grading, cut, and fill recommendations:
  - Structural fill materials and preparation
  - Utility trench excavation and backfill requirements
  - Slab and pavement subgrade preparation
  - Wet weather considerations
- Seismic design criteria in accordance with the 2015 International Building Code (IBC) with state of Washington amendments
- Asphalt concrete (AC) pavement section recommendations

1.3 Project Understanding

PBS understands the proposed 6-acre residential development will consist of a minimum of two phases. Phase 1 will include the development of the approximately 2.5-acre area west of the single, existing house. The area will be divided into three roughly equal sublots. Phase 2 will include the development of the approximate 2.5-acre area east of the existing house into between 10 and 12 smaller residential parcels. Site improvements of the first phase will likely include private access roads and underground utilities. Site improvements to the second phase will likely include an access road, underground utilities, and stormwater infiltration facilities. PBS anticipates that site cuts and fills will be less than five feet for both phases of development.

2 SITE CONDITIONS

2.1 Surface Description

The site can be divided into two (Phases 1 and 2), roughly rectangular areas adjacent to 12th Street in College Place. The site is bordered by agricultural land to the north, west, and south, with recent residential development to the east. The site has been in use for agricultural cultivation in recent years and is currently vegetated with agricultural grasses used for hay production. The topography of Phase 1 consists of relatively flat land from the roadway proceeding north, transitioning into a 5 percent downhill grade between 100 and 200 feet north of 12th Street. The topography of Phase 2 is relatively flat throughout. Based on available topographic data, the ground surface elevations range from a maximum of 770 feet above mean sea level (amsl), near the center of the property, to a minimum of 760 feet amsl near the northern boundary of Phase 1 (Google Earth). Outside of the site, the ground surface slopes up steeply to the northwest and southeast, approximately 40 feet in elevation above the project site.

2.2 Geologic Setting

Published geologic maps of the area (Derkley, et al., 2006) show the site is mantled by river-deposited alluvium (Qa). This soil likely originated as Touchet bed or loess deposits from the sills surrounding the Walla Walla Valley that were eroded by local streams and carried down into the river bed, where it was deposited and possibly reworked by the moving river. Underlying these deposits is a Miocene-age basalt conglomerate and gravel.

2.3 Subsurface Conditions

The site was explored by excavating five test pits, designated TP-1 through TP-5, to depths up to 10 feet bgs. The test pits were excavated by Clark and Young Excavation using a Kubota U35 track-mounted excavator. All test pits were excavated using a 24-inch-wide, toothed bucket.

PBS has summarized the subsurface units as follows:

TOPSOIL:	Topsoil consisting of silt and fine sand with fine organics was encountered from the ground surface to depths of approximately 3 to 6 inches bgs throughout the project site. The topsoil varied in color from light brown to brown to dark gray, with a relative consistency varying from soft to medium stiff. The fine-grained portion of the topsoil exhibited little to no plasticity. A thicker layer of topsoil may be encountered in small localized areas.
SILT:	Silt with sand was encountered below the topsoil in all five test pits to depths of 6.5 feet bgs to the maximum depth explored. The silt varied in color from light brown to dark brown to dark gray-brown, with consistencies varying from soft to stiff with dynamic cone penetrometer (DCP) blow counts between 4 and 11.
GRAVEL	Poorly graded gravel with silt and sand was encountered in TP-2 at a depth of 6.5 feet bgs to the maximum depth explored. The gravel was generally brown to gray with a relative density of medium dense to dense. The gravel appeared fine- to coarse-grained and rounded to subrounded. Sand encountered within the gravel appeared fine- to medium-grained. The silt encountered appeared to be non-plastic.

2.4 Groundwater

Static groundwater was not encountered during our explorations. Based on a review of regional groundwater logs available from the Washington State Department of Ecology, we anticipate that the static groundwater level is present at a depth greater than 25 feet bgs. Please note that groundwater levels can fluctuate during the year depending on climate, irrigation season, extended periods of precipitation, drought, and other factors.

2.5 Infiltration Testing

PBS completed two open-hole falling head infiltration tests in TP-1 and TP-2 at depths of 4.5 and 4 feet bgs, respectively, within Phase 2 of the development. The infiltration tests were conducted in general accordance with the procedures in the Stormwater Management Manual for Eastern Washington. The test pits were excavated and filled with approximately 2.5 feet of water. After a period of saturation, the water level was then measured initially and at regular, timed intervals. Results of our field infiltration testing are presented in Table 1.

Table 1. Infiltration Test Results

Test Location	Depth (feet bgs)	Field Measured Infiltration Rate (in/hr)	Soil Classification
TP-1	4.5	2	SILT with sand (ML)
TP-2	4	1.5	SILT with sand (ML)

The infiltration rates listed in Table 1 are not permeabilities/hydraulic conductivities, but field-measured rates, and do not include correction factors related to long-term infiltration rates. The design engineer should determine the appropriate correction factors to account for the planned level of pre-treatment, maintenance, vegetation, siltation, etc. Field-measured infiltration rates are typically reduced by a minimum factor of 2 to 4 for use in design. Infiltration testing was performed in soils that typically yield lower infiltration rates than granular soils primarily consisting of gravel and sand.

Soil types can vary significantly over relatively short distances. The infiltration rates noted above are representative of one discrete location and depth. Installation of infiltration systems within the layer the field rate was measured is considered critical to proper performance of the systems.

3 CONCLUSIONS AND RECOMMENDATIONS

3.1 Geotechnical Design Considerations

The subsurface conditions consist of silt and fine-grained sand. Based on our observations and analyses, conventional foundation support on shallow spread footings is feasible for the proposed development. Excavation at the site is feasible using conventional earthwork equipment

The grading and final development plans for the project had not been completed when this report was prepared. Once completed, PBS should be engaged to review the project plans and update our recommendations as necessary.

3.2 Seismic Design Considerations

3.2.1 Code-Based Seismic Design Parameters

According to the Site Class Map of Walla Walla County, Washington (Palmer, 2004), the site is located within an area classified as Site Class D, characterizing the profile as stiff soil. Based on subsurface conditions encountered in our explorations combined with DCP blow counts, Site Class D is appropriate for use in design. The seismic design criteria, in accordance with the 2015 International Building Code IBC with state of Washington amendments, are summarized in Table 2.

Table 2. 2015 IBC Seismic Design Parameters

Parameter	Short Period	1 Second
Maximum Credible Earthquake Spectral Acceleration	S_s = 0.38 g	S_1 = 0.13 g
Site Class	D	
Site Coefficient	F_a = 1.50	F_v = 2.26
Adjusted Spectral Acceleration	S_{MS} = 0.57 g	S_{M1} = 0.30 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.38 g	S_{D1} = 0.20 g
Design Spectral Peak Ground Acceleration	**0.16 g**	

g= Acceleration due to gravity

3.2.2 Liquefaction Potential

Liquefaction is defined as a decrease in the shear resistance of loose, saturated, cohesionless soil (e.g., sand) or low plasticity silt soils, due to the buildup of excess pore pressures generated during an earthquake. This results in a temporary transformation of the soil deposit into a viscous fluid. Liquefaction can result in ground settlement, foundation bearing capacity failure, and lateral spreading of ground.

Based on a review of the Liquefaction Susceptibility Map of Walla Walla County (Palmer, et al., 2004), the site is located within an area shown as having a moderate to high liquefaction susceptibility; however, based on the soil types and depth of groundwater, our current opinion is that the risk of structurally damaging liquefaction settlement at the site is low. Subsequently, the risk of structurally damaging lateral spreading is also low.

3.3 Pavement Design

Pavement recommendations were developed using the American Association of State Highway and Transportation Officials (AASHTO) design methods and references the associated Washington Department of Transportation (WSDOT) specifications for construction. Our evaluation considered a maximum of two trucks per day for a 20-year design life.

The minimum recommended pavement section thicknesses are provided in Table 3. Depending on weather conditions at the time of construction, a thicker aggregate base course section could be required to support construction traffic during preparation and placement of the pavement section.

Table 3. Minimum AC Pavement Sections

Traffic Loading	AC (inches)	Base Course (inches)	Subgrade
Access Roads	3.0	9.0	Stiff subgrade as verified by PBS personnel*

* Subgrade must pass proofroll

The asphalt cement binder should be selected following WSDOT SS 9-02.1(4) – Performance Graded Asphalt Binder. The AC should consist of ½-inch hot mix asphalt (HMA) with a maximum lift thickness of 3 inches. The AC should conform to WSDOT SS 5-04.3(7)A – Mix Design, WSDOT SS 9-03.8(2) – HMA Test Requirements, and WSDOT SS 9-03.8(6) – HMA Proportions of Materials. The AC should be compacted to 91 percent of the maximum theoretical density (Rice value) of the mix, as determined in accordance with ASTM D2041, following the guidelines set in WSDOT SS 5-04.3(10) – Compaction.

Heavy construction traffic on new pavements or partial pavement sections (such as base course over the prepared subgrade) will likely exceed the design loads and could potentially damage or shorten the pavement life; therefore, we recommend construction traffic not be allowed on new pavements, or that the contractor take appropriate precautions to protect the subgrade and pavement during construction.

If construction traffic is to be allowed on newly constructed road sections, an allowance for this additional traffic will need to be made in the design pavement section.

4 CONSTRUCTION RECOMMENDATIONS

4.1 Site Preparation

Construction of the proposed residential development will involve clearing and grubbing of the existing vegetation or demolition of possible existing structures. We anticipate that a minimum of 6 to 12 inches of soil should be cleared from the site prior to general site grading, but thicker topsoil layers may be encountered in small localized areas. Demolition (if any) should include removal of existing pavement, utilities, etc., throughout the proposed new development. Underground utility lines or other abandoned structural elements should also be removed. The voids resulting from removal of foundations or loose soil in utility lines should be backfilled with compacted structural fill. The base of these excavations should be excavated to firm native subgrade before filling, with sides sloped at a minimum of 1H:1V (horizontal to vertical) to allow for uniform compaction. Materials generated during demolition should be transported off site or stockpiled in areas designated by the owner's representative.

4.1.1 Proofrolling/Subgrade Verification

Following site preparation and prior to placing aggregate base for pavement sections, the exposed subgrade should be evaluated either by proofrolling or another method of subgrade verification. The subgrade should be proofrolled with a fully loaded dump truck or similar heavy, rubber-tire construction equipment to identify unsuitable areas. If evaluation of the subgrades occurs during wet conditions, or if proofrolling the subgrades will result in disturbance, they should be evaluated by PBS using a steel foundation probe. We recommend that PBS be retained to observe the proofrolling and perform the subgrade verifications. Unsuitable areas identified during the field evaluation should be compacted to a firm condition or be excavated and replaced with structural fill.

4.1.2 Wet/Freezing Weather and Wet Soil Conditions

Due to the presence of fine-grained silt and sands in the near-surface materials at the site, construction equipment may have difficulty operating on the near-surface soils when the moisture content of the surface soil is more than a few percentage points above the optimum moisture required for compaction. Soils disturbed during site preparation activities, or unsuitable areas identified during proofrolling or probing, should be removed and replaced with compacted structural fill.

Site earthwork and subgrade preparation should not be completed during freezing conditions, except for mass excavation to the subgrade design elevations.

Protection of the subgrade is the responsibility of the contractor. Construction of granular haul roads to the project site entrance may help reduce further damage to the pavement and disturbance of site soils. The actual thickness of haul roads and staging areas should be based on the contractors' approach to site development, and the amount and type of construction traffic. The imported granular material should be placed in one lift over the prepared undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller.

4.2 Excavation

The near-surface soils at the site can be excavated with conventional earthwork equipment. Sloughing and caving should be anticipated. All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor is solely responsible for adherence to the OSHA requirements. Trench cuts should stand relatively vertical to a depth of approximately 4 feet bgs, provided no groundwater seepage is present in the trench walls. Open excavation techniques may be used provided the excavation is configured in accordance with the OSHA requirements, groundwater seepage is not present, and with the understanding that some sloughing may occur. Trenches/excavations should be flattened if sloughing occurs or seepage is present. Use of a trench shield or other approved temporary shoring is recommended if vertical walls are desired for cuts deeper than 4 feet bgs.

4.3 Structural Fill

The extent of site grading is currently unknown; however, PBS estimates that cuts and fills will be on the order of up to 5 feet to raise the grades within the proposed site. Structural fill should be placed over subgrade that has been prepared in conformance with the Site Preparation and Wet/Freezing Weather and Wet Soil Conditions sections of this report. Structural fill material should consist of relatively well-graded soil, or an approved rock product that is free of organic material and debris, and contains particles not greater than 3 inches nominal dimension.

The suitability of soil for use as compacted structural fill will depend on the gradation and moisture content of the soil when it is placed. As the amount of fines (material finer than the US Standard No. 200 Sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and compaction becomes more difficult to achieve. Soils containing more than about 5 percent fines cannot consistently be compacted to a dense, non-yielding condition when the water content is significantly greater (or significantly less) than optimum.

If fill and excavated material will be placed on slopes steeper than 5H:1V, these must be keyed/benched into the existing slopes and installed in horizontal lifts. Vertical steps between benches should be approximately 2 feet.

4.3.1 On-Site Soil

On-site soils encountered in our explorations are generally suitable for placement as structural fill during dry weather when moisture contents can be maintained by air drying and/or addition of water. The fine-grained fraction of the site soils are moisture sensitive, and during wet weather, may become unworkable because of excess moisture content. In order to reduce moisture content, some aerating and drying of fine-grained soils may be required. The material should be placed in lifts with a maximum uncompacted thickness of approximately 8 inches and compacted to at least 92 percent of the maximum dry density, as determined by ASTM D1557 (modified proctor).

4.3.2 Imported Granular Materials

Imported granular material used during periods of wet weather or for haul roads, building pad subgrades, staging areas, etc., should be pit or quarry run rock, crushed rock, or crushed gravel and sand, and should meet the specifications provided in WSDOT SS 9-03.14(2) – Select Borrow. In addition, the imported granular material should be fairly well graded between coarse and fine, and of the fraction passing the US Standard No. 4 Sieve, less than 5 percent by dry weight should pass the US Standard No. 200 Sieve.

Imported granular material should be placed in lifts with a maximum uncompacted thickness of 9 inches and be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557.

4.3.3 Base Aggregate

Base aggregate for floor slabs and beneath pavements should be clean crushed rock or crushed gravel. The base aggregate should contain no deleterious materials, meet specifications provided in WSDOT SS 9-03.9(3) – Crushed Surfacing Base Course, and have less than 5 percent (by dry weight) passing the US Standard No. 200 Sieve. The imported granular material should be placed in one lift and compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

4.3.4 Foundation Base Aggregate

Imported granular material placed at the base of excavations for spread footings, slabs-on-grade, and other below-grade structures should be clean, crushed rock or crushed gravel, and sand that is fairly well graded between coarse and fine. The granular materials should contain no deleterious materials, have a maximum particle size of 1½ inches, and meet WSDOT SS 9-03.12(1)A – Gravel Backfill for Foundations (Class A). The imported granular material should be placed in one lift and compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557.

4.3.5 Trench Backfill

Trench backfill placed beneath, adjacent to, and for at least 2 feet above utility lines (i.e., the pipe zone) should consist of well-graded granular material with a maximum particle size of 1 inch and less than 10 percent by dry weight passing the US Standard No. 200 Sieve and should meet the standards prescribed by WSDOT SS 9-03.12(3) – Gravel Backfill for Pipe Zone Bedding. The pipe zone backfill should be compacted to at least

90 percent of the maximum dry density as determined by ASTM D1557, or as required by the pipe manufacturer or local building department.

Within pavement areas or beneath building pads, the remainder of the trench backfill should consist of well-graded granular material with a maximum particle size of 1½ inches, less than 10 percent by dry weight passing the US Standard No. 200 Sieve and should meet standards prescribed by WSDOT SS 9-03.19 – Bank Run Gravel for Trench Backfill. This material should be compacted to at least 92 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department. The upper 2 feet of the trench backfill should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

Outside of structural improvement areas (e.g., roadway alignments or building pads), trench backfill placed above the pipe zone should consist of excavated material free of wood waste, debris, clods, or rocks greater than 6 inches in diameter and meet WSDOT SS 9-03.14 – Borrow and WSDOT SS 9-03.15 – Native Material for Trench Backfill. This general trench backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department.

4.3.6 Stabilization Material

Stabilization rock should consist of pit or quarry run rock that is well-graded, angular, crushed rock consisting of 4- or 6-inch-minus material with less than 5 percent passing the US Standard No. 4 Sieve. The material should be free of organic matter and other deleterious material. WSDOT SS 9-13.1(5) Quarry Spalls can be used as a general specification for this material with the stipulation of limiting the maximum size to 6 inches.

5 ADDITIONAL SERVICES AND CONSTRUCTION OBSERVATIONS

In most cases, other services beyond completion of a final geotechnical engineering report are necessary or desirable to complete the project. Occasionally, conditions or circumstances arise that require additional work that was not anticipated when the geotechnical report was written. PBS offers a range of environmental, geological, geotechnical, and construction services to suit the varying needs of our clients.

PBS should be retained to review the plans and specifications for this project before they are finalized. Such a review allows us to verify that our recommendations and concerns have been adequately addressed in the design.

Satisfactory earthwork performance depends on the quality of construction. Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. We recommend that PBS be retained to observe general excavation, stripping, fill placement, footing subgrades, and/or pile installation. Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

6 LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their architects and engineers, for aiding in the design and construction of the proposed development and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced, in total or in part, without express written consent of the client and PBS. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials, and contractors to ensure correct implementation of the recommendations.

The opinions, comments, and conclusions presented in this report are based upon information derived from our literature review, field explorations, laboratory testing, and engineering analyses. It is possible that soil, rock, or groundwater conditions could vary between or beyond the points explored. If soil, rock, or groundwater conditions are encountered during construction that differ from those described herein, the client is responsible for ensuring that PBS is notified immediately so that we may reevaluate the recommendations of this report.

Unanticipated fill, soil and rock conditions, and seasonal soil moisture and groundwater variations are commonly encountered and cannot be fully determined by merely taking soil samples or completing explorations such as test pits. Such variations may result in changes to our recommendations and may require additional funds for expenses to attain a properly constructed project; therefore, we recommend a contingency fund to accommodate such potential extra costs.

The scope of work for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the basic project scheme is significantly modified from that assumed, this report should be reviewed to determine the applicability of the conclusions and recommendations presented herein. Land use, site conditions (both on and off site), or other factors may change over time and could materially affect our findings; therefore, this report should not be relied upon after three years from its issue, or in the event that the site conditions change.

7 REFERENCES

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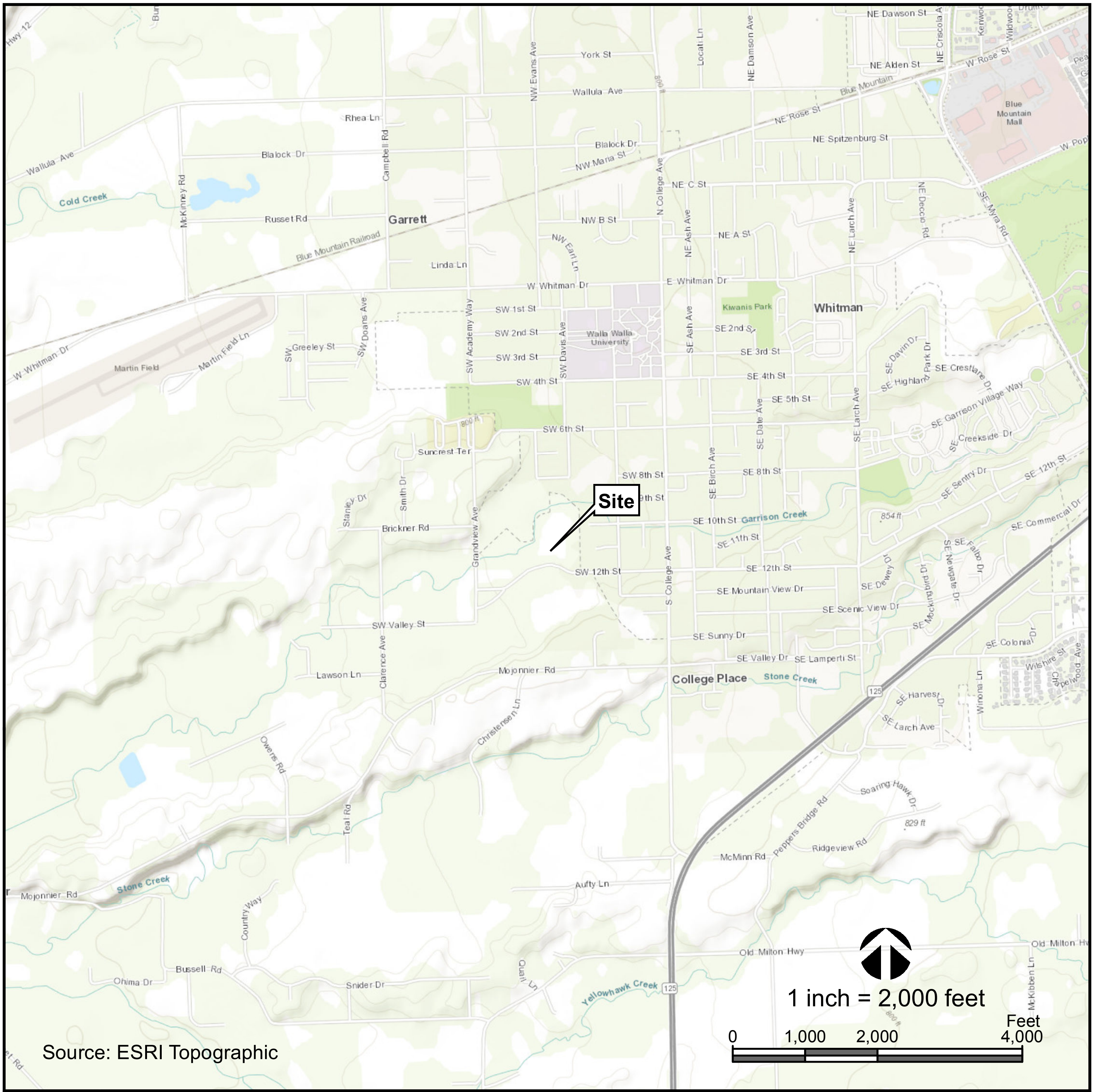
FIGURES



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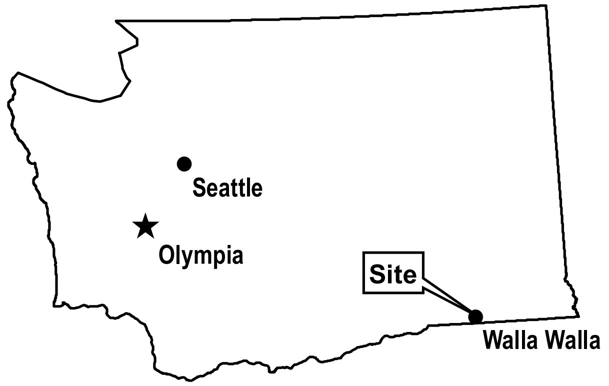

VICINITY MAP

12th STREET SHORT PLAT
COLLEGE PLACE, WASHINGTON

DATE: JUN 2018 · PROJECT: 67220.000

PBS

FIGURE
1

EXPLANATION

⬚ Approximate site boundary

◩ TP-1 - Test pit name and approximate location

SOURCES: Google Earth 2017

1 inch = 100 feet

0 50 100 200'

SITE PLAN

12th STREET SHORT PLAT
COLLEGE PLACE, WASHINGTON

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FIGURE
2

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APPENDIX A

Field Explorations

APPENDIX A: FIELD EXPLORATIONS

A1 GENERAL

PBS explored subsurface conditions at the project site by advancing five test pits to depths up to 10 feet on May 17, 2018. The approximate locations of the explorations are shown on Figure 2, Site Plan. The procedures used to excavate the test pits, collect samples, and other field techniques are described in detail in the following paragraphs. Unless otherwise noted, all soil sampling and classification procedures followed engineering practices in general accordance with relevant ASTM procedures. "General accordance" means that certain local drilling/excavation and descriptive practices and methodologies have been followed.

A2 TEST PITS

A2.1 Excavation

Test pits were excavated using a Kubota U35 excavator with a 24-inch-wide, toothed bucket provided and operated by Clark and Young Excavation of Walla Walla, Washington. The test pits were observed by a member of the PBS geotechnical staff, who maintained a detailed log of the subsurface conditions and materials encountered during the course of the work.

A2.2 Sampling

Representative disturbed samples were taken at selected depths in the test pits. The disturbed soil samples were examined by a member of the PBS geotechnical staff and sealed in plastic bags for further examination.

A2.3 Dynamic Cone Penetration (DCP) Testing

DCP testing was completed at specific depths in the test pit explorations. DCP testing uses a standardized cone driven into the subgrade soils with a 15-pound weight dropped 20 inches. The blow counts recorded for 1¾-inches of penetration are roughly equivalent to the Standard Penetration Test resistance (SPT blow count, i.e., N-value). DCP test results are plotted on the test pit logs presented in Appendix A.

A2.4 Test Pit Logs

The test pit logs show the various types of materials that were encountered in the excavations and the depths where the materials and/or characteristics of these materials changed, although the changes may be gradual. Where material types and descriptions changed between samples, the contacts were interpreted. The types of samples taken during excavation, along with their sample identification number, are shown to the right of the classification of materials.

A3 MATERIAL DESCRIPTION

Initially, samples were classified visually in the field. Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the soil samples were noted. Afterward, the samples were reexamined in the PBS laboratory, various standard classification tests were conducted, and the field classifications were modified where necessary. The terminology used in the soil classifications and other modifiers are defined in Table A-1, Terminology Used to Describe Soil.

Table A-1
Terminology Used to Describe Soil
1 of 2

Soil Descriptions

Soils exist in mixtures with varying proportions of components. The predominant soil, i.e., greater than 50 percent based on total dry weight, is the primary soil type and is capitalized in our log descriptions (SAND, GRAVEL, SILT, or CLAY). Smaller percentages of other constituents in the soil mixture are indicated by use of modifier words in general accordance with the ASTM D2488-06 Visual-Manual Procedure. “General Accordance” means that certain local and common descriptive practices may have been followed. In accordance with ASTM D2488-06, group symbols (such as GP or CH) are applied on the portion of soil passing the 3-inch (75mm) sieve based on visual examination. The following describes the use of soil names and modifying terms used to describe fine- and coarse-grained soils.

Fine-Grained Soils (50% or greater fines passing 0.075 mm, No. 200 sieve)
The primary soil type, i.e., SILT or CLAY is designated through visual-manual procedures to evaluate soil toughness, dilatency, dry strength, and plasticity. The following outlines the terminology used to describe fine-grained soils, and varies from ASTM D2488 terminology in the use of some common terms.

Primary soil NAME, Symbols, and Adjectives			Plasticity Description	Plasticity Index (PI)
SILT (ML & MH)	**CLAY (CL & CH)**	**ORGANIC SOIL (OL & OH)**		
SILT		Organic SILT	Non-plastic	0 – 3
SILT		Organic SILT	Low plasticity	4 – 10
SILT/Elastic SILT	Lean CLAY	Organic SILT/ Organic CLAY	Medium Plasticity	10 – 20
Elastic SILT	Lean/Fat CLAY	Organic CLAY	High Plasticity	20 – 40
Elastic SILT	Fat CLAY	Organic CLAY	Very Plastic	>40

Modifying terms describing secondary constituents, estimated to 5 percent increments, are applied as follows:

Description	% Composition	
With Sand	% Sand ≥ % Gravel	15% to 25% plus No. 200
With Gravel	% Sand < % Gravel	
Sandy	% Sand ≥ % Gravel	≤30% to 50% plus No. 200
Gravelly	% Sand < % Gravel	

Borderline Symbols, for example CH/MH, are used when soils are not distinctly in one category or when variable soil units contain more than one soil type. **Dual Symbols,** for example CL-ML, are used when two symbols are required in accordance with ASTM D2488.

Soil Consistency terms are applied to fine-grained, plastic soils (i.e., PI ≥ 7). Descriptive terms are based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84, as follows. SILT soils with low to non-plastic behavior (i.e., PI < 7) may be classified using relative density.

Consistency Term	SPT N-value	Unconfined Compressive Strength	
		tsf	kPa
Very soft	Less than 2	Less than 0.25	Less than 24
Soft	2 – 4	0.25 – 0.5	24 – 48
Medium stiff	5 – 8	0.5 – 1.0	48 – 96
Stiff	9 – 15	1.0 – 2.0	96 – 192
Very stiff	16 – 30	2.0 – 4.0	192 – 383
Hard	Over 30	Over 4.0	Over 383

Table A-1
Terminology Used to Describe Soil
2 of 2

Soil Descriptions

Coarse - Grained Soils (less than 50% fines)

Coarse-grained soil descriptions, i.e., SAND or GRAVEL, are based on the portion of materials passing a 3-inch (75mm) sieve. Coarse-grained soil group symbols are applied in accordance with ASTM D2488-06 based on the degree of grading, or distribution of grain sizes of the soil. For example, well-graded sand containing a wide range of grain sizes is designated SW; poorly graded gravel, GP, contains high percentages of only certain grain sizes. Terms applied to grain sizes follow.

Material NAME	**Particle Diameter**	
	Inches	**Millimeters**
SAND (SW or SP)	0.003 – 0.19	0.075 – 4.8
GRAVEL (GW or GP)	0.19 – 3	4.8 – 75
Additional Constituents:		
Cobble	3 – 12	75 – 300
Boulder	12 – 120	300 – 3050

The primary soil type is capitalized, and the fines content in the soil are described as indicated by the following examples. Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 percent. Other soil mixtures will have similar descriptive names.

Example: Coarse-Grained Soil Descriptions with Fines

>5% to < 15% fines (Dual Symbols)	**≥15% to < 50% fines**
Well graded GRAVEL with silt: GW-GM	Silty GRAVEL: GM
Poorly graded SAND with clay: SP-SC	Silty SAND: SM

Additional descriptive terminology applied to coarse-grained soils follow.

Example: Coarse-Grained Soil Descriptions with Other Coarse-Grained Constituents

Coarse-Grained Soil Containing Secondary Constituents	
With sand or with gravel	≥ 15% sand or gravel
With cobbles; with boulders	Any amount of cobbles or boulders.

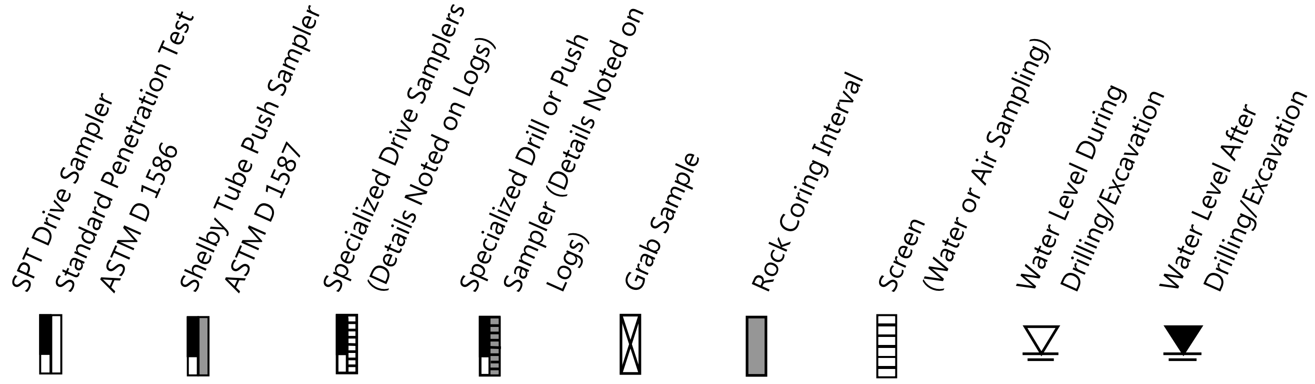
Cobble and boulder deposits may include a description of the matrix soils, as defined above.

Relative Density terms are applied to granular, non-plastic soils based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84.

Relative Density Term	**SPT N-value**
Very loose	0 – 4
Loose	5 – 10
Medium dense	11 – 30
Dense	31 – 50
Very dense	> 50

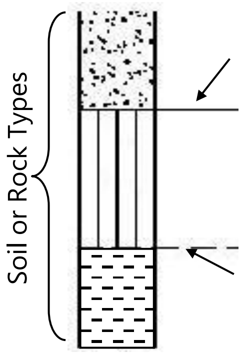
Table A-2
Key To Test Pit and Boring Log Symbols

SAMPLING DESCRIPTIONS



LOG GRAPHICS

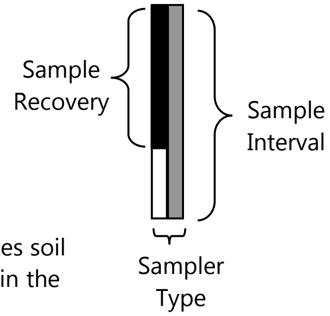
Soil and Rock



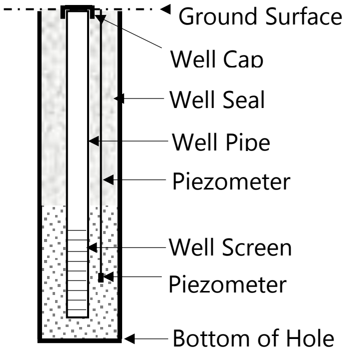
Lithology Boundary: separates distinct units (i.e., Fill, Alluvium, Bedrock) at approximate depths inciated

Soil-type or Material-type Change Boundary: separates soil and material changes within the same lithographic unit at approximate depth indicated

Sampling Symbols



Instrumentation Detail



Geotechnical Testing Acronym Explanations

PP	Pocket Penetrometer	HYD	Hydrometer Gradation
TOR	Torvane	SIEV	Sieve Gradation
DCP	Dynamic Cone Penetrometer	DS	Direct Shear
ATT	Atterberg Limits	DD	Dry Density
PL	Plasticity Limit	CBR	California Bearing Ratio
LL	Liquid Limit	RES	Resilient Modulus
PI	Plasticity Index	VS	Vane Shear
P200	Percent Passing US Standard No. 200 Sieve	bgs	Below ground surface
OC	Organic Content	MSL	Mean Sea Level
CON	Consolidation	HCL	Hydrochloric Acid
UC	Unconfined Compressive Strength		

Details of soil and rock classification systems are available on request.

Rev. 02/2017

12TH STREET SHORT PLAT
COLLEGE PLACE, WASHINGTON

PBS PROJECT NUMBER:
67220.000

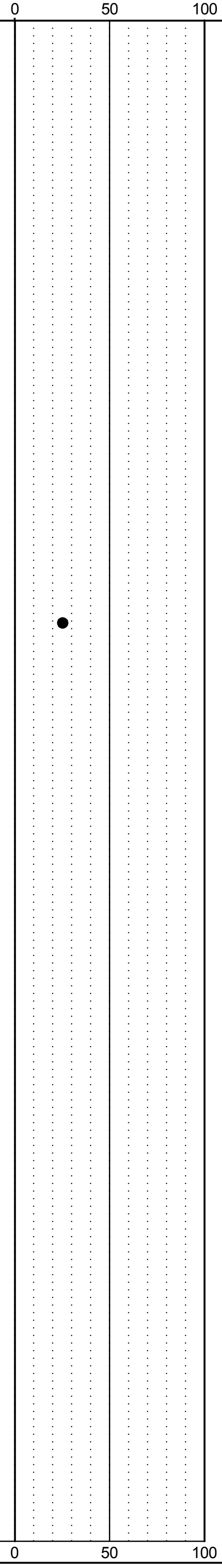
TEST PIT TP-1

APPROX. TEST PIT TP-1 LOCATION:
(See Site Plan)

Lat: 46.038772 Long: -118.394426

DEPTH FEET	MATERIAL DESCRIPTION Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	COMMENTS Surface Conditions: Grass
0.0	TOPSOIL (3 inches)	0.0			
	Dark gray-brown SILT (ML) with sand; non-plastic; fine sand; dry	0.3			
4.0					Infiltration testing completed at 4.5 feet bgs
			P200	☒ S-1	P200 = 60%
	becomes dark brown to brown, sandy				
	Final depth 8.5 feet bgs; test pit backfilled with excavated material to existing ground surface. Groundwater not encountered at time of exploration.	8.5			
12.0					

◆ DYNAMIC CONE PENETROMETER
☒ STATIC PENETROMETER
● MOISTURE CONTENT %



LOGGED BY: A. Swenson
COMPLETED: 5/17/18

EXCAVATED BY: Clark & Young Excavation
EXCAVATION METHOD: Kubota U35

FIGURE A1

12TH STREET SHORT PLAT
COLLEGE PLACE, WASHINGTON

TEST PIT TP-2

PBS PROJECT NUMBER:
67220.000

APPROX. TEST PIT TP-2 LOCATION:
(See Site Plan)

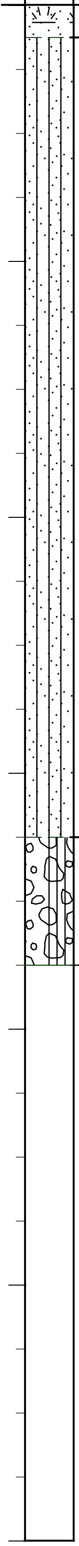
Lat: 46.039437 Long: -118.393963

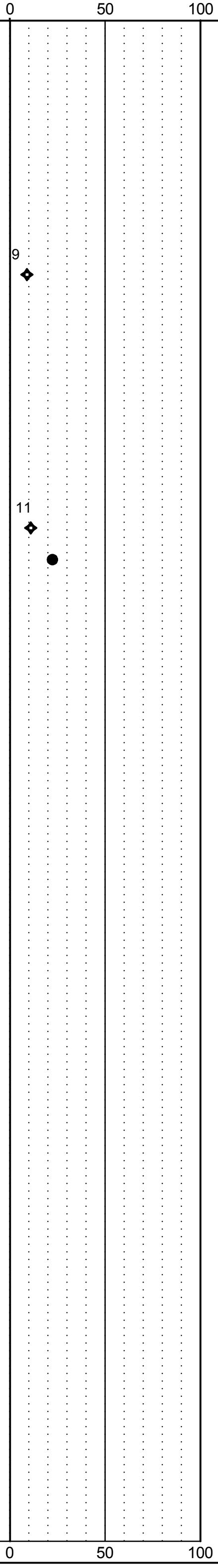
Surface Conditions: Grass

Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

◆ DYNAMIC CONE PENETROMETER
☒ STATIC PENETROMETER
● MOISTURE CONTENT %

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	COMMENTS
0.0	TOPSOIL (3 inches)	0.0			
	Stiff brown SILT (ML) with sand; non-plastic; fine sand; dry	0.3			
2.0	becomes dark gray brown		DCP	S-1	
4.0	becomes sandy, with weak cementation		P200 DCP	S-2	Infiltration testing completed at 4.0 feet bgs P200 = 69%
6.0					
	Brown to gray poorly graded GRAVEL (GP-GM) with silt and sand; non-plastic; fine to medium sand; fine to coarse, rounded to subrounded gravel; dry	6.5			
	Final depth 7.5 feet bgs; test pit backfilled with excavated material to existing ground surface. Groundwater not encountered at time of exploration.	7.5			
8.0					
10.0					
12.0					





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EXCAVATION METHOD: Kubota U35

FIGURE A2

12TH STREET SHORT PLAT
COLLEGE PLACE, WASHINGTON

TEST PIT TP-3

PBS PROJECT NUMBER:
67220.000

APPROX. TEST PIT TP-3 LOCATION:
(See Site Plan)

Lat: 46.040124 Long: -118.394437

Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

Legend: ◆ DYNAMIC CONE PENETROMETER; ☒ STATIC PENETROMETER; ● MOISTURE CONTENT % (scale 0, 50, 100)

COMMENTS

Surface Conditions: Grass

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	DYNAMIC CONE PENETROMETER / STATIC PENETROMETER / MOISTURE CONTENT %
0.0	TOPSOIL (3 inches)	0.0			
	Soft to medium stiff light brown SILT (ML) with sand; non-plastic; fine sand; dry	0.3			
2.0			DCP	☒ S-1	◆ 4
4.0	becomes stiff, brown		DCP	☒ S-2	◆ 11
6.0					
8.0					
	Final depth 9.5 feet bgs; test pit backfilled with excavated material to existing ground surface. Groundwater not encountered at time of exploration.	9.5			
10.0					
12.0					

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COMPLETED: 5/17/18

EXCAVATED BY: Clark & Young Excavation
EXCAVATION METHOD: Kubota U35

FIGURE A3
Page 1 of 1

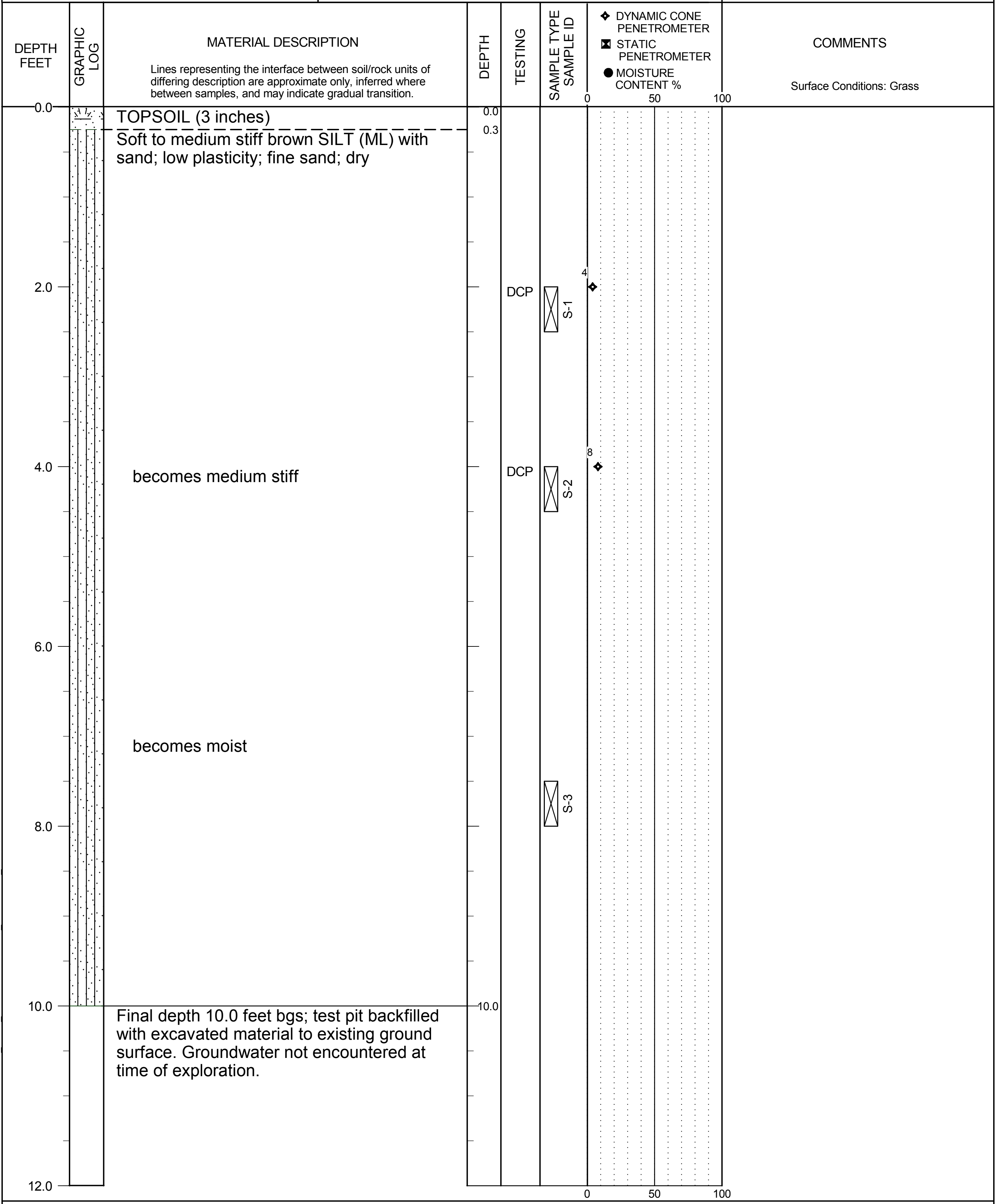
12TH STREET SHORT PLAT
COLLEGE PLACE, WASHINGTON

PBS PROJECT NUMBER:
67220.000

TEST PIT TP-4

APPROX. TEST PIT TP-4 LOCATION:
(See Site Plan)

Lat: 46.039055 Long: -118.395659



Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

Surface Conditions: Grass

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	DYNAMIC CONE PENETROMETER
0.0	TOPSOIL (3 inches)	0.0			
	Soft to medium stiff brown SILT (ML) with sand; low plasticity; fine sand; dry	0.3			
2.0			DCP	S-1	4
4.0	becomes medium stiff		DCP	S-2	8
	becomes moist			S-3	
10.0	Final depth 10.0 feet bgs; test pit backfilled with excavated material to existing ground surface. Groundwater not encountered at time of exploration.	10.0			

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EXCAVATED BY: Clark & Young Excavation
EXCAVATION METHOD: Kubota U35

FIGURE A4
Page 1 of 1

12TH STREET SHORT PLAT
COLLEGE PLACE, WASHINGTON

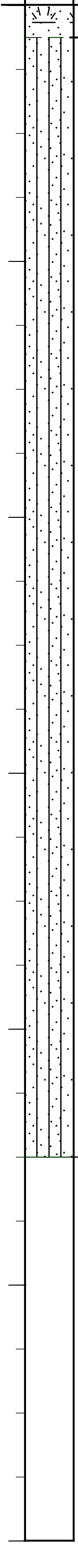
TEST PIT TP-5

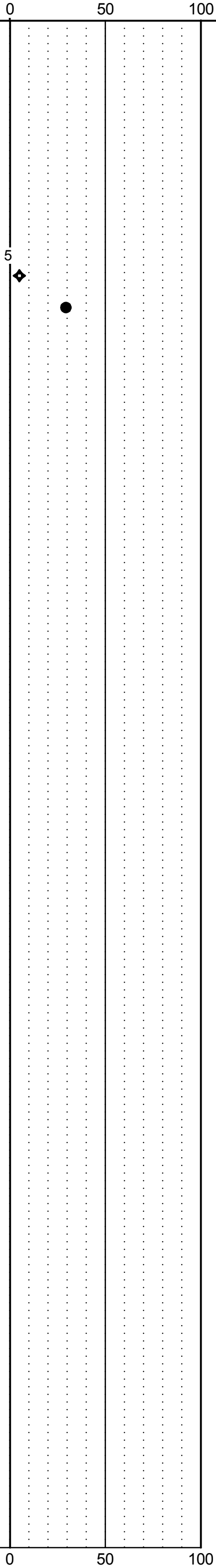
PBS PROJECT NUMBER:
67220.000

APPROX. TEST PIT TP-5 LOCATION:
(See Site Plan)

Lat: 46.038703 Long: -118.396302

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	❖ DYNAMIC CONE PENETROMETER ☒ STATIC PENETROMETER ● MOISTURE CONTENT %	COMMENTS Surface Conditions: Grass
0.0		TOPSOIL (3 inches)	0.0				
		Medium stiff dark gray-brown SILT (ML) with sand; non-plastic; fine sand; dry	0.3				
2.0				P200 DCP	☒ S-1	5 ❖ ●	P200 = 78%
		interbedded with 3- to 6-inch-thick lenses of light brown silt with sand					
4.0							
		occasional pockets of volcanic ash					
6.0							
		becomes gray, brown, and orange mottled					
8.0					☒ S-2		
		Final depth 9.0 feet bgs; test pit backfilled with excavated material to existing ground surface. Groundwater not encountered at time of exploration.	9.0				
10.0							
12.0							





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EXCAVATION METHOD: Kubota U35

FIGURE A5
Page 1 of 1

APPENDIX B

Laboratory Testing

APPENDIX B: LABORATORY TESTING

B1 GENERAL

Samples obtained during the field explorations were examined in the PBS laboratory. The physical characteristics of the samples were noted and field classifications were modified where necessary. During the course of examination, representative samples were selected for further testing. The testing program for the soil samples included standard classification tests, which yield certain index properties of the soils important to an evaluation of soil behavior. The testing procedures are described in the following paragraphs. Unless noted otherwise, all test procedures are in general accordance with applicable ASTM standards. "General accordance" means that certain local and common descriptive practices and methodologies have been followed.

B2 CLASSIFICATION TESTS

B2.1 Visual Classification

The soils were classified in accordance with the Unified Soil Classification System with certain other terminology, such as the relative density or consistency of the soil deposits, in general accordance with engineering practice. In determining the soil type (that is, gravel, sand, silt, or clay) the term that best described the major portion of the sample is used. Modifying terminology to further describe the samples is defined in Table A-1, Terminology Used to Describe Soil, in Appendix A.

B2.2 Moisture (Water) Contents

Natural moisture content determinations were made on samples of the fine-grained soils (that is, silts, clays, and silty sands). The natural moisture content is defined as the ratio of the weight of water to dry weight of soil, expressed as a percentage. The results of the moisture content determinations are presented on the logs of the test pits in Appendix A and on Figure B1, Summary of Laboratory Data, in Appendix B.

B2.3 Grain-Size Analyses (P200 Wash)

Washed sieve analyses (P200) were completed on samples to determine the portion of soil samples passing the No. 200 Sieve (i.e., silt and clay). The results of the P200 test results are presented on the exploration logs in Appendix A and on Figure B1, Summary of Laboratory Data, in Appendix B.

SUMMARY OF LABORATORY DATA

12TH STREET SHORT PLAT
COLLEGE PLACE, WASHINGTON

PBS PROJECT NUMBER:
67220.000

SAMPLE INFORMATION				MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
TP-1	S-1	4.5		25.2				60			
TP-2	S-2	4		22.3				69			
TP-5	S-1	2		29.3				78			

FIGURE B1