

Technical Memorandum

TO: Brandon Smith, Milestone Companies West Bay Development Group, LLC
FROM: Daniel Simpson, PE, and Calvin McCaughan, PE
DATE: August 27, 2020
RE: **Preliminary Geotechnical Engineering Recommendations
West Bay Yards
Olympia, Washington
Project No. 1912001.010.011**

Introduction

This memorandum summarizes the results of geotechnical engineering services provided by Landau Associates, Inc. (LAI) in support of the West Bay Yards project, located at 1210 West Bay Drive Northwest in Olympia, Washington (site; Figure 1). LAI's findings will be used to facilitate selection of a foundation type.

Based on the subsurface data collected during LAI's geotechnical investigation, the site is underlain by liquefiable soil, soft soil, and wood debris. The geotechnical implications of these findings are as follows:

- Seismically induced soil liquefaction could cause 5 to 10 feet (ft) of lateral spreading. This degree of ground displacement is more than shallow or deep foundations, alone, typically can withstand. Without mitigation, lateral spreading could result in structural collapse.
- To mitigate the effects of soil liquefaction and lateral spreading, structures could be supported by deep foundations coupled with limited ground improvement (GI) or by shallow foundations coupled with site-wide GI.
- LAI has provided parameters for estimating costs associated with foundation support and GI. A GI contractor also should be consulted.
- Before a GI contractor is consulted, the performance objective for GI (limit lateral spreading to 12 inches and vertical seismic settlement to 1 inch) should be reviewed with the structural engineer.
- Wood debris in site soils could lead to continued long-term settlement, which could cause rigid site features to crack or tilt. Site-wide GI could mitigate this risk.
- Without GI or pile support, wood debris and soft soil are likely to cause significant static settlement of heavily loaded shallow foundations.

Site and Project Description

Milestone Companies West Bay Development Group, LLC (project owner) proposes to develop the site with ten six-story, mixed-use buildings; a single-level, daylight-basement parking garage; a public plaza; and an esplanade. Construction will be performed in multiple phases. LAI understands that the

first phase will include general site improvements as well as construction of the parking garage and two mixed-use buildings.

The site elevation is approximately 12 ft lower than the elevation of the main access point (i.e., West Bay Drive Northwest). The finished floor elevation of the new buildings will approximate the elevation of West Bay Drive Northwest. Two to three feet of fill will be used to raise site grades, and the daylight parking garage (daylighted on the side of the site nearest Budd Inlet) will make up the difference.

The site consists of approximately 6.7 acres of upland and 11.1 acres of tideland. Between 1924 and 1951, the site was occupied by various logging and timber companies. The most recent tenant was a plywood manufacturing business. In 1996, nearly all infrastructure at the site was destroyed in a fire. The site was the subject of a 2007 agreed order between the Washington State Department of Ecology (Ecology) and the former owner, Hardel Mutual Plywood Corporation. A site cleanup was completed in 2010; during the cleanup, contaminated site soils were excavated and replaced with fill (Greylock Consulting LLC 2007). Ecology issued a no further action determination in 2012.

Surface Conditions

The site is generally level and is situated at an elevation of 13 to 14 ft North American Vertical Datum of 1988 (NAVD88; the elevation datum used herein). The site is bordered by industrial development to the north and south, by West Bay Drive Northwest and residential development to the west, and by Budd Inlet to the east.

West Bay Drive is situated at an elevation of 23 to 24 ft. The roadway embankment slopes at approximately 1.75 horizontal to 1 vertical (1.75H:1V) and meets a former rail spur grade, located approximately 2 ft below the site grade. The rail spur parallels West Bay Drive; former concrete railcar loading docks are located along the east side of the spur.

The remainder of the site is surfaced with construction/demolition debris, aggregate, asphalt, sparse vegetation, and occasional abandoned concrete foundations. The west edge of the site consists of a riprap (approximately one-man boulder and smaller)-protected, 2H:1V slope. The slope meets a tide flat, located at an approximate elevation of 0 ft. The tide flat is assumed to slope approximately 5 percent to the west, based on bathymetric data provided by the U.S. Army Corps of Engineers (2019). Mean sea level (MSL) near the site is 4.32 ft; mean highest high water (MHHW) is 10.53 ft; and mean lowest low water (MLLW) is -4.03 ft (NOAA; accessed May 18, 2020).

Subsurface Conditions

LAI explored site subsurface conditions on May 4 through May 6, 2020 by advancing eight test pits, two hollow-stem auger borings, and four cone penetration tests (CPTs). The approximate locations of

the explorations are shown on Figure 2. Representative soil samples were collected from the explorations and transported to LAI's soils laboratory for further examination and testing. Details about the field explorations are included in Attachment 1; details about the geotechnical laboratory testing program are included in Attachment 2.

Generalized site subsurface conditions are shown on Figure 3 and include the following engineering stratigraphic units (ESUs):

- **ESU 1:** undocumented fill;
- **ESU 2:** wood debris;
- **ESU 3:** very soft to soft, fine-grained, cohesive/plastic native soil;
- **ESU 4:** very loose to loose, non-plastic silt or sandy native soil; and
- **ESU 5:** very dense glacially consolidated soil.

ESU 1. The site is capped with approximately 8 to 12 ft of undocumented fill. During the 2010 site cleanup, soils in contamination hotspots were excavated and replaced with fill that consisted of sandy gravel to gravelly sand. Based on site observations and cleanup documentation, some of the fill also consisted of crushed concrete. Surface fill that was not placed during the 2010 site cleanup generally consists of silt or sand with gravel and debris. This fill was also found to contain occasional larger debris, such as concrete blocks and timber piles. Typical ESU 1 spoils from the test pit excavations are shown on Figures 4a through 4j.

ESU 2. An approximately 4- to 18-ft-thick layer of wood debris was encountered beneath ESU 1. This layer was encountered in all explorations that extended beyond the bottom of ESU 1. The wood debris generally consisted of sawdust- to wood chip-sized particles, mixed with mineral soil. Samples of ESU 2 typically could not be collected with a standard split-spoon sampler, but were recovered with a modified California sampler. Typical ESU 2 material is shown on Figures 5a and 5b.

ESU 3. Soils beneath the wood debris are interpreted to be native to the site. ESU 3 was classified based on a normalized soil behavior-type index (I_c , Robertson 2010). ESU 3 is interpreted to be a very soft to soft, clay-like (plastic fines) material ($I_c \approx 3$) with occasional interbeds of silty or sandy material.

ESU 4. ESU 4 consists of very loose to loose, non-plastic silt and sand mixtures ($I_c \approx 2.4$) with occasional interbeds of medium dense silt, sand, and gravel mixtures. ESU 4 was classified based on I_c and on split-spoon samples collected from borings B-1 and B-2. The split-spoon samples contained shell fragments and occasional wood debris.

ESU 5. ESU 5 is interpreted to be very dense glacially consolidated soil. This unit is the likely cause of the refusal encountered in all four CPT soundings.

The groundwater gradient at the site is oriented west to east (Greylock Consulting LLC 2007). LAI's site observations corroborate this orientation. At the time of LAI's field investigation, surface water was accumulating within the depressed rail spur along the west edge of the site. Groundwater in this area likely fluctuates between MSL and a few feet below ground surface, depending on the season. Groundwater in areas closer to Budd Inlet is likely influenced by tidal stage.

Seismic Design Parameters

LAI performed a ground motion hazard analysis (GMHA) in general accordance with Chapter 21 of the American Society of Civil Engineers' *Minimum Design Loads for Buildings and Other Structures* (ASCE-7; 2011). The results of the GMHA were used to estimate seismic design parameters for a 2018 International Building Code-level earthquake (2 percent in 50-year probability of exceedance). The design parameters are summarized in the following table. Because a GMHA was performed, the exceptions for Site Class E, noted in Section 11.4.8 of ASCE 7, need not be observed.

Site-adjusted maximum considered earthquake peak ground acceleration (PGA_M)	0.67 g
Site-specific, risk-targeted maximum considered earthquake (MCE_R) short-period spectral ordinate (S_{MS})	1.35 g
Site-specific, MCE_R 1-second spectral ordinate (S_{M1})	1.68 g
Recommended MCE_R moment magnitude	7.95

Liquefaction Considerations

Liquefaction is a seismic hazard in which ground shaking causes saturated sands and low-plasticity silts to lose shear strength. Liquefaction can lead to bearing capacity failures, ground settlement, and lateral ground displacement (lateral spreading). LAI evaluated liquefaction susceptibility using the Bray and Sancio (2006) plasticity criteria and an I_c liquefaction cutoff ($I_{c,liq}$) of 2.8 (based on a correlation between site-specific and regional plasticity testing and measured I_c). Based on these criteria, ESU 1 and ESU 4 are susceptible to liquefaction. LAI used the Boulanger and Idriss (2014) empirical method to determine the safety factor against liquefaction for the maximum considered earthquake ground motion parameters (peak ground acceleration and moment magnitude). LAI completed Newmark sliding block analyses to estimate lateral spreading displacements.

The results of LAI's analyses indicate that liquefaction is likely to occur in the saturated portions of ESU 1 and ESU 4 during a design-level earthquake. Thin to medium dense lenses in ESU 4 may not liquefy during a design-level earthquake. Soil liquefaction could cause approximately 2 to 10 inches of free-field vertical ground settlement (increasing toward Budd Inlet) as well as 5 to 10 ft of lateral spreading near the eastern edge of the proposed buildings.

Foundation Support

LAI concludes that lateral spreading is likely to cause deep foundation elements to yield beyond the limits set forth in Section 12.13.9 of ASCE 7-16. Therefore, GI is recommended. Deep, large-diameter drilled shafts could be used to support structures, but are unlikely to be as cost-effective as GI. Foundation support could be provided with one of the two methods described below.

GI buttress with deep foundations. With this approach, GI would be installed along a swath, approximately 50 to 75 ft wide and 700 to 800 ft long. The swath would be located along the upland area of the site, immediately adjacent to Budd Inlet. GI would be used to buttress the site and reduce lateral spreading. Structures would likely require deep foundations, such as driven piles, to mitigate static and liquefaction settlement. For the purpose of cost-estimating, LAI has assumed that open-end pipe piles, with 16-inch diameters and $\frac{3}{8}$ -inch-thick walls, will be driven 10 ft into ESU 5 and will have an allowable bearing capacity of 250 kips. (Refer to Figure 3 for estimated pile lengths.)

Site-wide GI with shallow foundations. With this approach, GI would be installed across most of the site to reduce the risk of lateral spreading, vertical liquefaction settlement, and static settlement. Structures could be founded on shallow spread footings or slabs-on-grade, and GI could be concentrated under heavily loaded columns to increase bearing capacity locally. Allowable bearing capacities on the order of 3 to 4 kips per square foot could be achievable.

Ground Improvement Overview

There are many types of generic and proprietary GI, each suited to particular site conditions and performance objectives. LAI recommends consulting GI or foundation contractors to determine cost-effective GI methods for this project. With a typical design-build project, a GI design is completed by a specialty contractor and reviewed by the geotechnical engineer of record. LAI can complete a GI design if a traditional design-bid-build approach is desired.

Types of GI include the drainage type (which decreases soil pore drainage length to prevent liquefaction), the densification type (which densifies soil to make it stronger and prevent liquefaction), and the reinforcement type (which reinforces soil with stiff elements to mitigate the effects of liquefaction).

Considering the high fines content of the liquefiable soil layers, reinforcement is likely the only applicable GI type for the site. In soils with high fines content, drainage is not a reliable method for long-term liquefaction mitigation. Densification is typically unsuccessful in soils with a significant fines content.

The following GI-reinforcement methods could be implemented at the site: rigid inclusions (typically drilled piles filled with unreinforced grout), soil mixing (soil mixed with cement using a mechanical

tool), and jet grouting (a soil-cement mixture created with a subterranean, rotating jet of grout). Rigid inclusions and soil mixing could be implemented throughout the site to mitigate the effects of liquefaction and provide a relatively high bearing capacity for shallow foundation support. Jet grouting, coupled with deep foundations, could be used to buttress the site.

Based on conversations with Pioneer Technologies (project environmental consultant), LAI understands that soils cleanup levels for unrestricted land use have been achieved. Pioneer Technologies should be included in discussions with GI contractors to determine the cost implications, if any, of disposing of spoils.

Ground Improvement Design

The following preliminary information is intended to facilitate GI design; it will be updated after the geotechnical engineering report has been completed:

1. Performance objectives:
 - a. Allowable bearing capacity: Minimum 4 kips per square foot beneath footings, less than 1 inch of settlement at the allowable load.
 - b. Seismic displacements: Limit lateral spreading to 12 inches or less at the leading edge of the buildings. Limit seismic differential settlement to the thresholds in Table 12.13-3 of ASCE 7-16 (assume multi-story structure with concrete or masonry wall systems).
2. Minimum extents:
 - a. At least 30 percent of the building height beyond the edge of foundations, except at the west edge of the property (may be less along the west edge due to geologic conditions and property constraints).
3. Design constraints:
 - a. $I_{c,liq}$ (liquefaction cut-off I_c) should be taken as 2.8, unless additional site-specific plasticity or cyclic simple shear testing indicates otherwise.
 - b. ESU 2 (wood debris) should be assumed to have a unit weight of 65 pounds per cubic foot, a friction angle of 30 degrees, and no cohesion. A considerable amount of strain would be required to reach peak strength. ESU 2 is considered non-liquefiable.
 - c. Soil densification and accelerated drainage methods should not be considered.
 - d. Assume a design groundwater elevation of 10 ft NAVD88 at the western property line, sloping to MSL (4.3 ft NAVD88) at the eastern property line. The design groundwater elevation could differ from actual groundwater elevations during construction.
 - e. When using empirical liquefaction triggering calculations, soil deeper than 80 ft bgs can be excluded from potential liquefaction.

Use of This Technical Memorandum

Landau Associates has prepared this technical memorandum for the exclusive use of the Milestone Companies West Bay Development Group, LLC and the project design team for specific application to the West Bay Yards project in Olympia, Washington. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Reuse of the information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates shall be at the user's sole risk. Landau Associates warrants that, within the limitations of scope, schedule, and budget, its services have been provided in a manner consistent with that level of skill and care ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. Landau Associates makes no other warranty, either express or implied.

Closing

We trust that this memorandum provides you with the information needed to proceed with the project. If you have questions or comments, please call the undersigned at (360) 791-3178.

LANDAU ASSOCIATES, INC.

Daniel Simpson, PE
Associate



Calvin McCaughan, PE
Principal

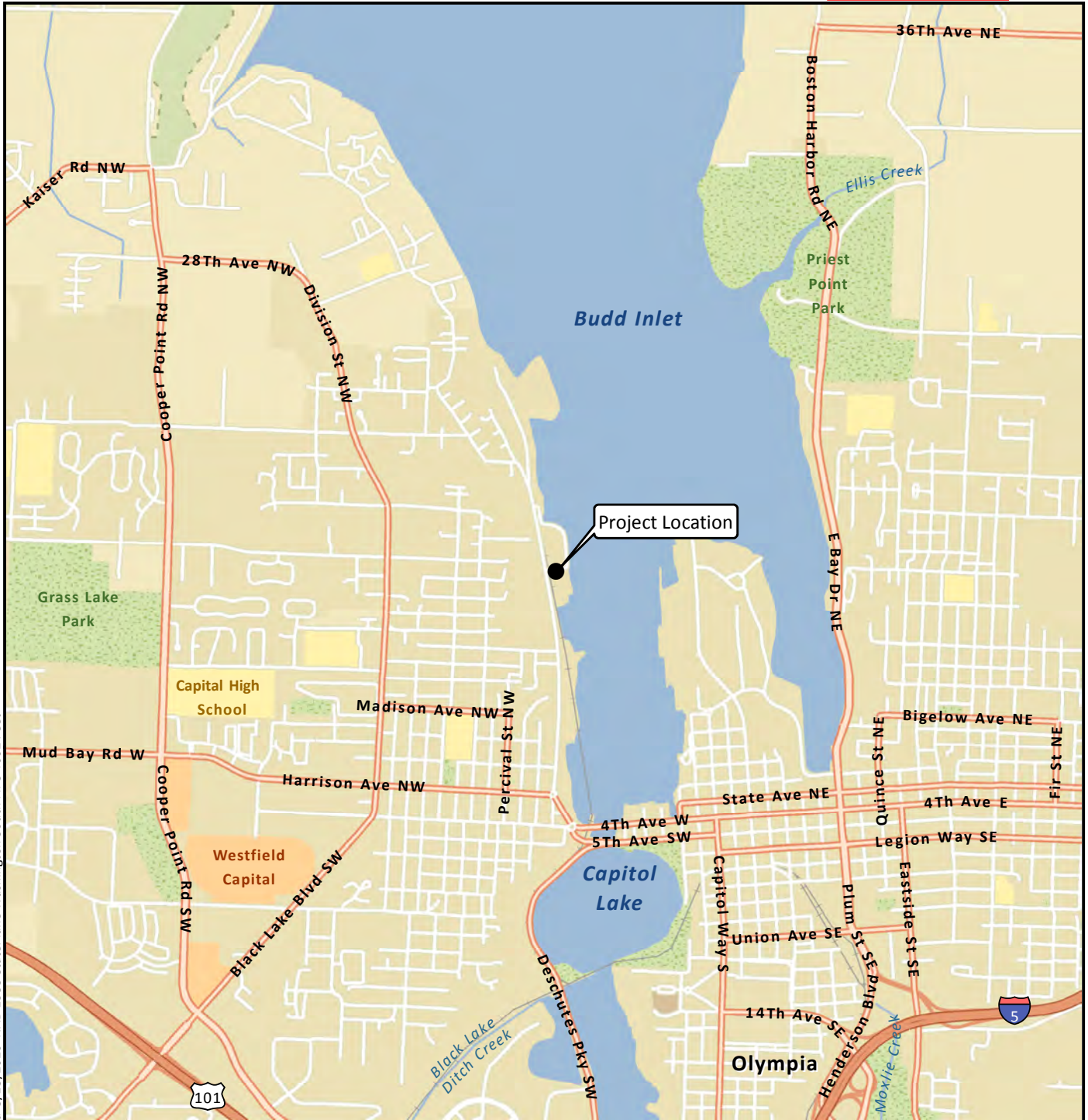
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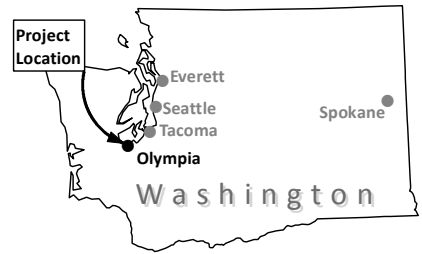
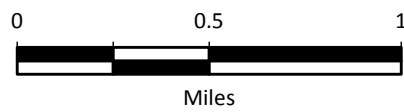
Attachments: Figure 1. Vicinity Map
Figure 2. Site and Exploration Plan
Figure 3. Geologic Cross-Section A-A'
Figures 4a through 4j. Selected Site Photographs – Test Pit Explorations
Figures 5a and 5b. Selected Site Photographs – Wood Debris
Attachment 1. Field Explorations
Attachment 2. Laboratory Testing

References

- ASCE. 2011. Minimum Design Loads for Buildings and Other Structures. ASCE/SEI 7-10. American Society of Civil Engineers/Structural Engineering Institute.
- Boulanger, R.W., and I.M. Idriss. 2014. CPT- and SPT-based Liquefaction Triggering Procedures. Report No. UCD/CGM-14, 1.
- Bray, J.D., and R.B. Sancio. 2006. Assessment of the Liquefaction Susceptibility of Fine-Grained Soils. *Journal of Geotechnical and Geoenvironmental Engineering*. 132(9):1165–1177.
- Greylock Consulting, LLC. 2007. Draft Remedial Investigation Report: Former Hardel Plywood Site, 1210 West Bay Drive NW, Olympia, Washington. December 17.
- NOAA. Tides & Currents. Tides/Water Levels: Datums for 9446969, Olympia, Bud Inlet, Puget Sound, WA. National Oceanic and Atmospheric Administration. Accessed May 18, 2020. Available online at:
<https://tidesandcurrents.noaa.gov/datums.html?datum=NAVD88&units=0&epoch=0&id=9446969&name=OLYMPIA%2C+BUD+INLET%2C+PUGET+SOUND&state=WA>.
- Robertson, P.K. 2010. Soil Behaviour Type from the CPT: An Update. 2nd International Symposium on Cone Penetration Testing. Huntington Beach, CA.
- USACE. 2019. Drawing Set: Olympia Harbor, Federal Channel and Turning Basin. U.S. Army Corps of Engineers Seattle District. March 22.



G:\Projects\1912\001\010\0111\F01 VicinityMap.mxd 5/13/2020 NAD 1983 StatePlane Washington South FIPS 4602 Feet



Data Source: Esri 2012

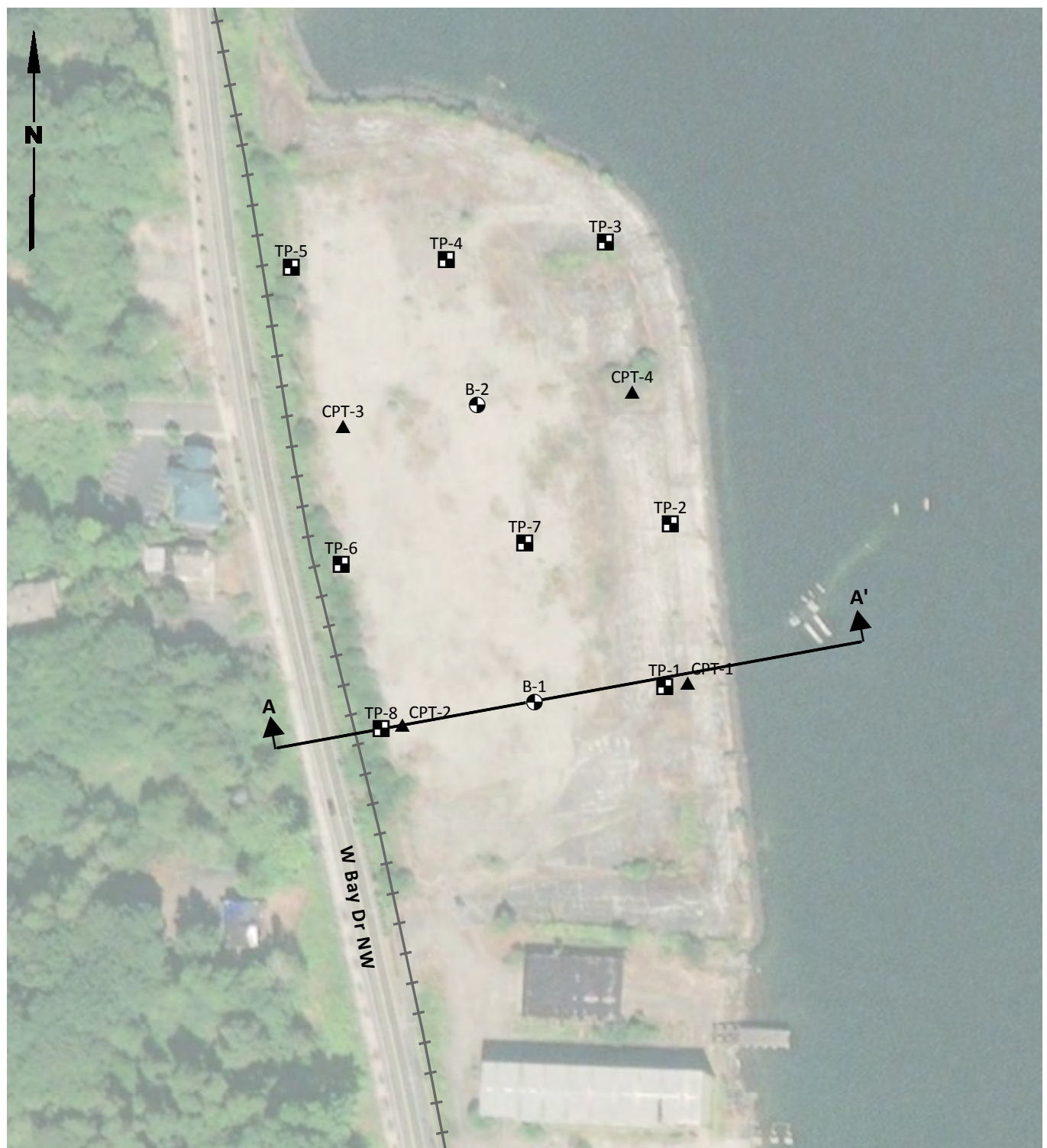


West Bay Yards
Olympia, Washington

Vicinity Map

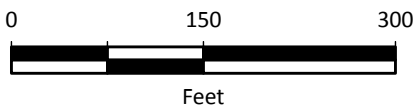
Figure
1

G:\Projects\1912\001\010\11\F02_SiteExpPlan.mxd 5/22/2020 NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend

- Cross Section
- Boring
- Cone Penetration Test
- Test Pit



Note
 1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

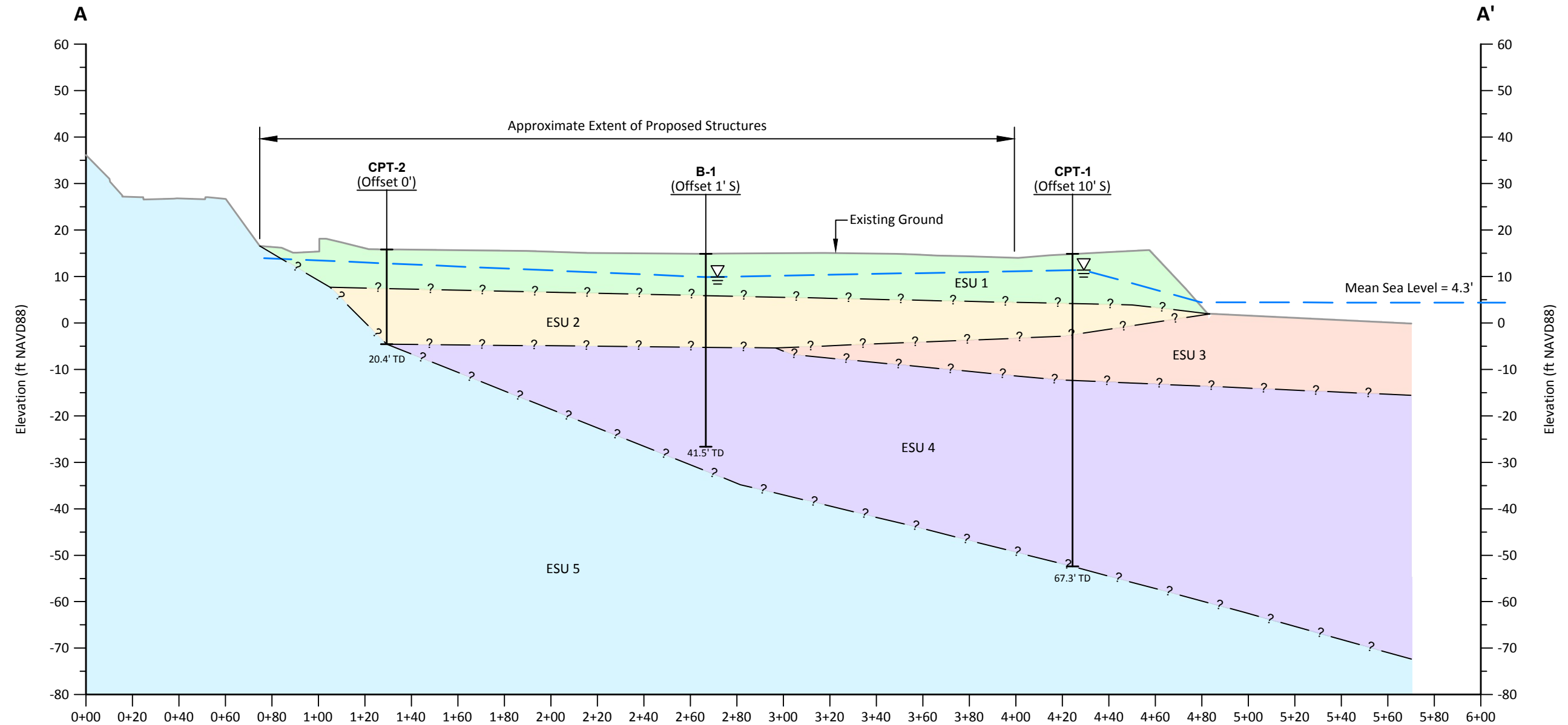
Data Source: Esri 2012



West Bay Yards
 Olympia, Washington

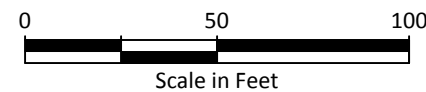
Site and Exploration Plan

Figure
2



Geologic Cross Section A-A'

Horizontal Scale in Feet: 1"=50'
Vertical Scale in Feet: 1"=25'



Legend

- MW-1 — Project Exploration Designation
- (Offset 160' W) — Offset Distance in Feet and Direction
- Top of Exploration
- Groundwater Level (At time of drilling)
- Design Groundwater Table
- Inferred Geologic Contact
- Bottom of Exploration
- 14' TD — Total Depth of Exploration

- ESU 1 Loose to Medium Dense Undocumented Fill
- ESU 2 Wood Debris
- ESU 3 Very Soft to Soft Plastic/Cohesive Fine-grained Soil
- ESU 4 Very Loose to Medium Dense Non-plastic Silt and Sand
- ESU 5 Glacially Consolidated Soil

Notes

1. Refer to report text for complete interpretation of subsurface conditions.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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West Bay Yards Olympia, Washington	Geologic Cross Section A-A'	Figure 3
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3. Test pit TP-1.



4. Test pit TP-1.

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5. Test pit TP-2.



6. Test pit TP-2.

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7. Test pit TP-3.



8. Test pit TP-3.

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9. Test pit TP-4.



10. Test pit TP-4.

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11. Test pit TP-4.



12. Test pit TP-4.

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13. Test pit TP-4.



14. Test pit TP-5.

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15. Test pit TP-5.



16. Test pit TP-6.

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17. Test pit TP-7.



18. Test pit TP-7.

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19. Test pit TP-7.

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1. Wood debris from boring B-1.



2. Wood debris from boring B-2.

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3. Wood debris from boring B-1.



4. Wood debris from boring B-2.

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ATTACHMENT 1

Field Explorations

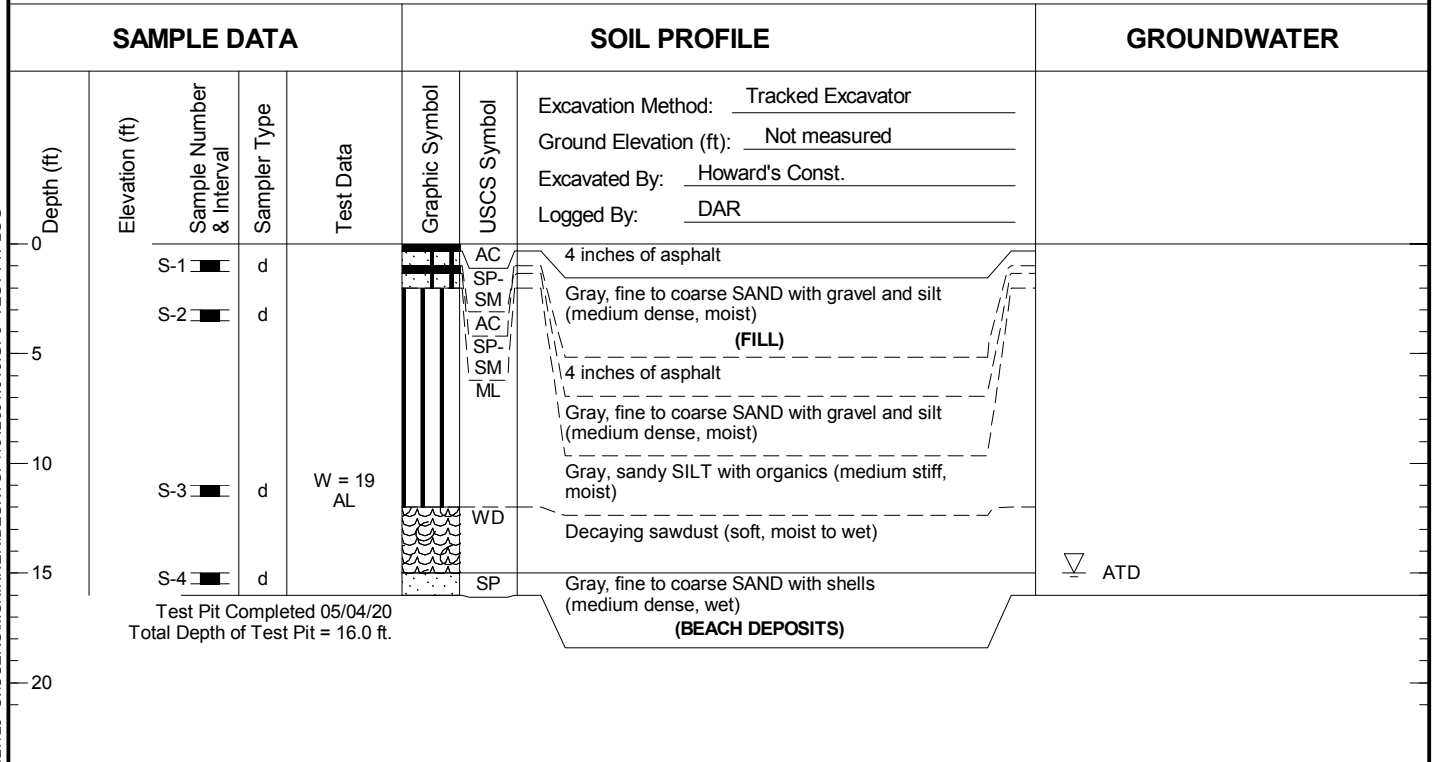
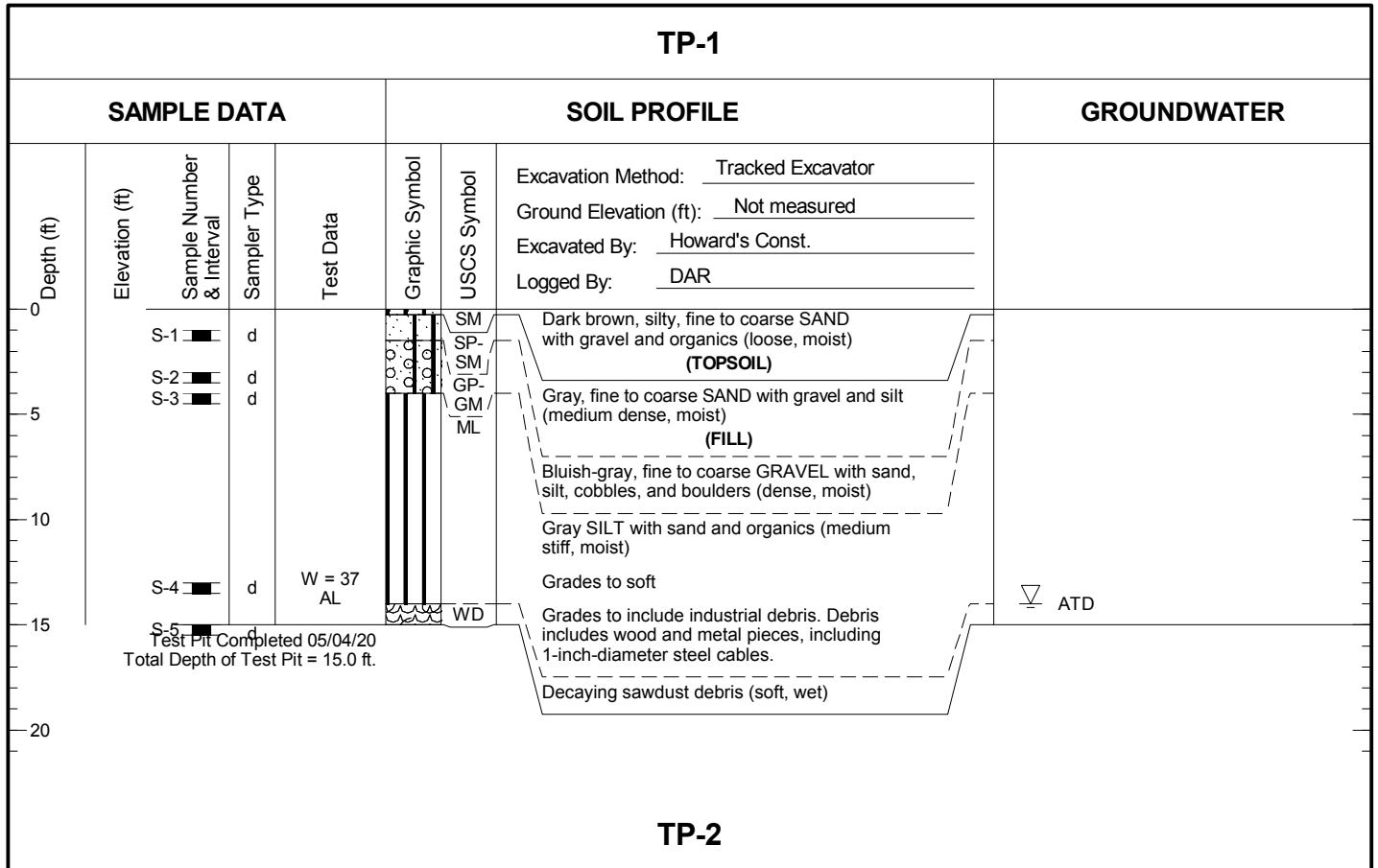
Soil Classification System

	MAJOR DIVISIONS		GRAPHIC SYMBOL	USCS LETTER SYMBOL ⁽¹⁾	TYPICAL DESCRIPTIONS ⁽²⁾⁽³⁾
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GP GM GC	Poorly graded gravel; gravel/sand mixture(s); little or no fines Silty gravel; gravel/sand/silt mixture(s) Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SP	Poorly graded sand; gravelly sand; little or no fines
				SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)		ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity	
			CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay	
			OL	Organic silt; organic, silty clay of low plasticity	
	SILT AND CLAY (Liquid limit greater than 50)		MH	Inorganic silt; micaceous or diatomaceous fine sand	
			CH	Inorganic clay of high plasticity; fat clay	
			OH	Organic clay of medium to high plasticity; organic silt	
	HIGHLY ORGANIC SOIL		PT	Peat; humus; swamp soil with high organic content	

	OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
	PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
	ROCK		RK	Rock (See Rock Classification)
	WOOD		WD	Wood, lumber, wood chips
	DEBRIS		DB	Construction debris, garbage

- Notes:
- USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
 - Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
 - Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:
 - Primary Constituent: > 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
 - Secondary Constituents: > 30% and < 50% - "very gravelly," "very sandy," "very silty," etc.
 - > 15% and < 30% - "gravelly," "sandy," "silty," etc.
 - Additional Constituents: > 5% and < 15% - "with gravel," "with sand," "with silt," etc.
 - < 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.
 - Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key		Field and Lab Test Data	
SAMPLER TYPE	SAMPLE NUMBER & INTERVAL	Code	Description
Code	Description		
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon	PP = 1.0	Pocket Penetrometer, tsf
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon	TV = 0.5	Torvane, tsf
c	Shelby Tube	PID = 100	Photoionization Detector VOC screening, ppm
d	Grab Sample	W = 10	Moisture Content, %
e	Single-Tube Core Barrel	D = 120	Dry Density, pcf
f	Double-Tube Core Barrel	-200 = 60	Material smaller than No. 200 sieve, %
g	2.50-inch O.D., 2.00-inch I.D. WSDOT	GS	Grain Size - See separate figure for data
h	3.00-inch O.D., 2.375-inch I.D. Mod. California	AL	Atterberg Limits - See separate figure for data
i	Other - See text if applicable	GT	Other Geotechnical Testing
1	300-lb Hammer, 30-inch Drop	CA	Chemical Analysis
2	140-lb Hammer, 30-inch Drop		
3	Pushed		
4	Vibrocore (Rotasonic/Geoprobe)		
5	Other - See text if applicable		
Groundwater			
			Approximate water level at time of drilling (ATD)
			Approximate water level at time after drilling/excavation/well



- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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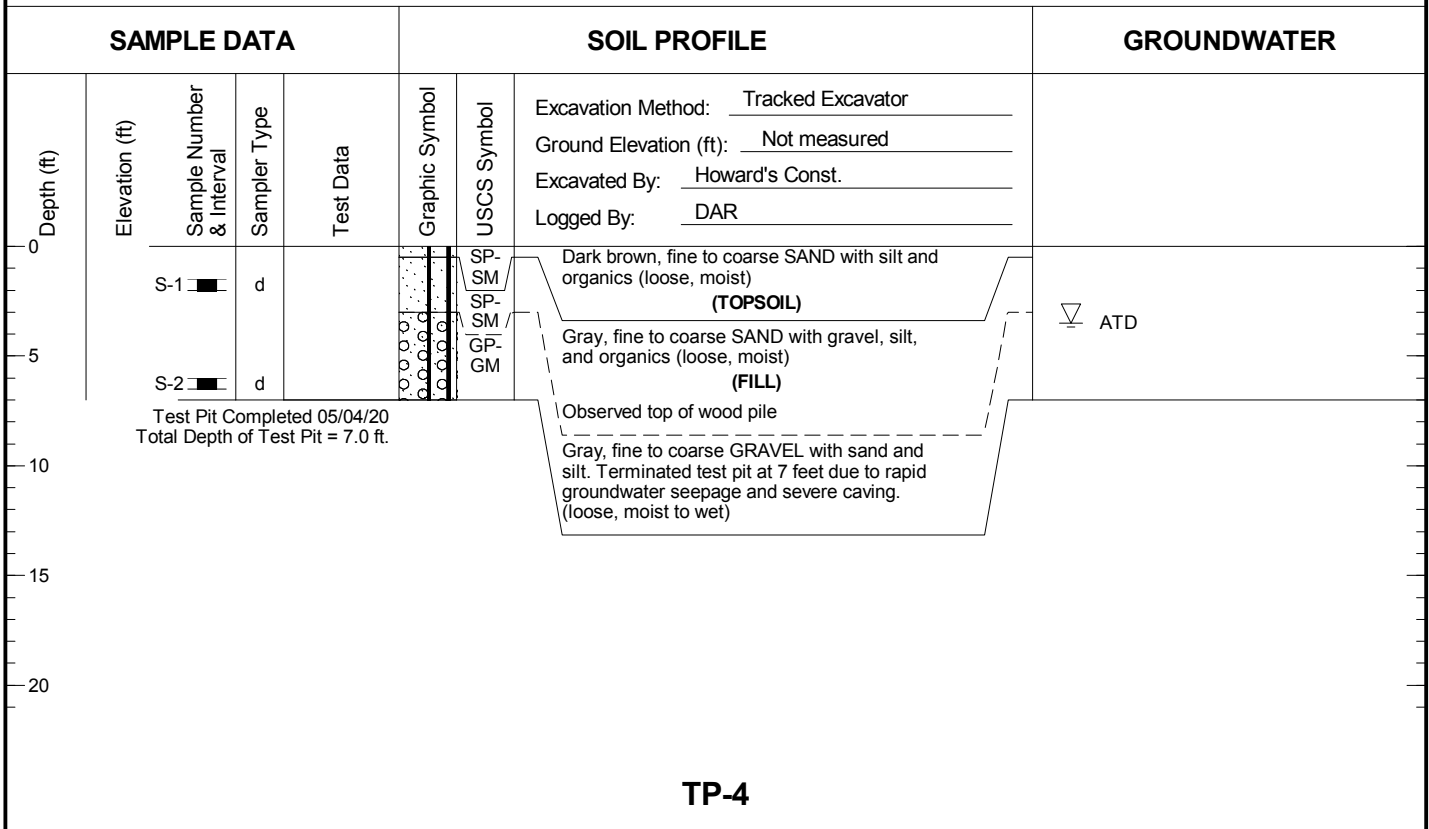


West Bay Yards
Olympia, Washington

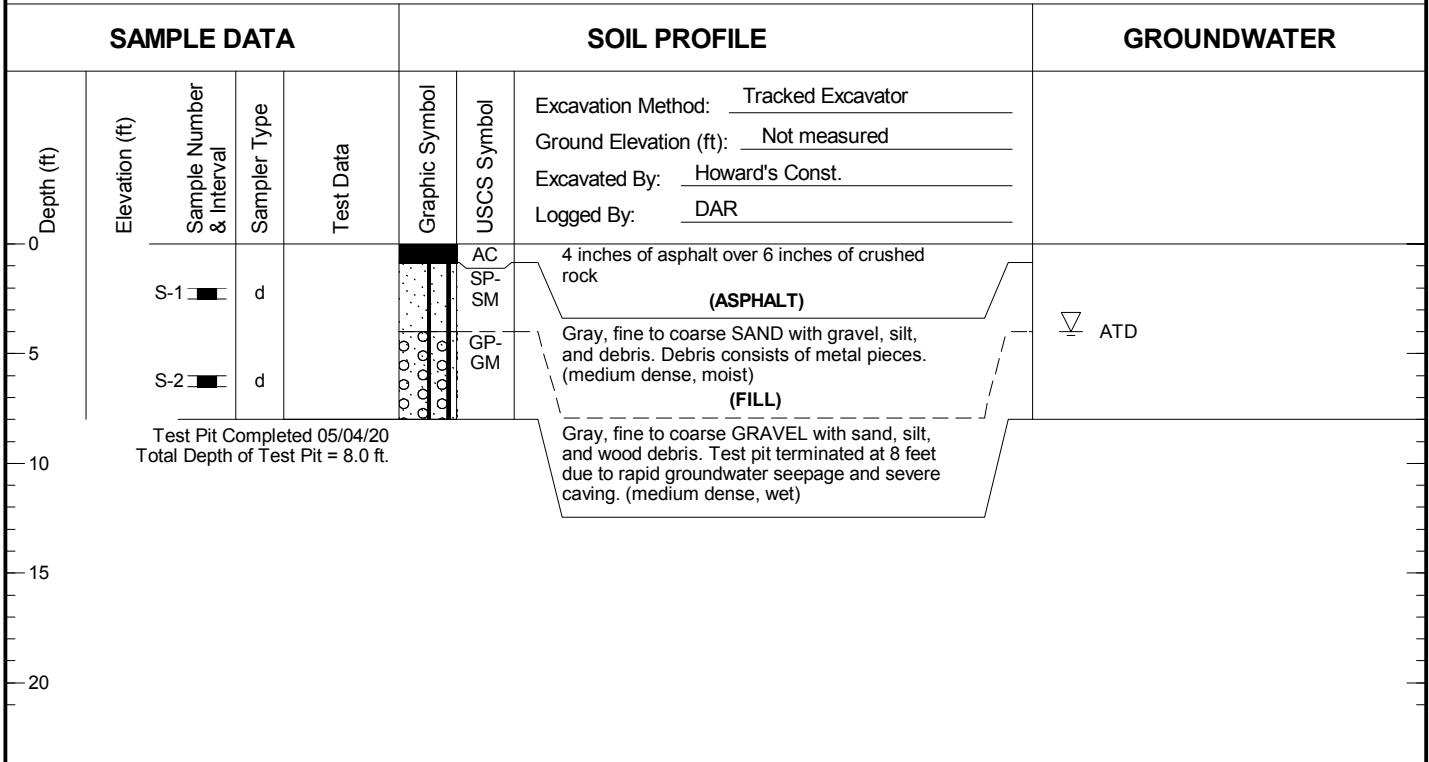
Log of Test Pits

Figure
1-2

TP-3



TP-4



- Notes:
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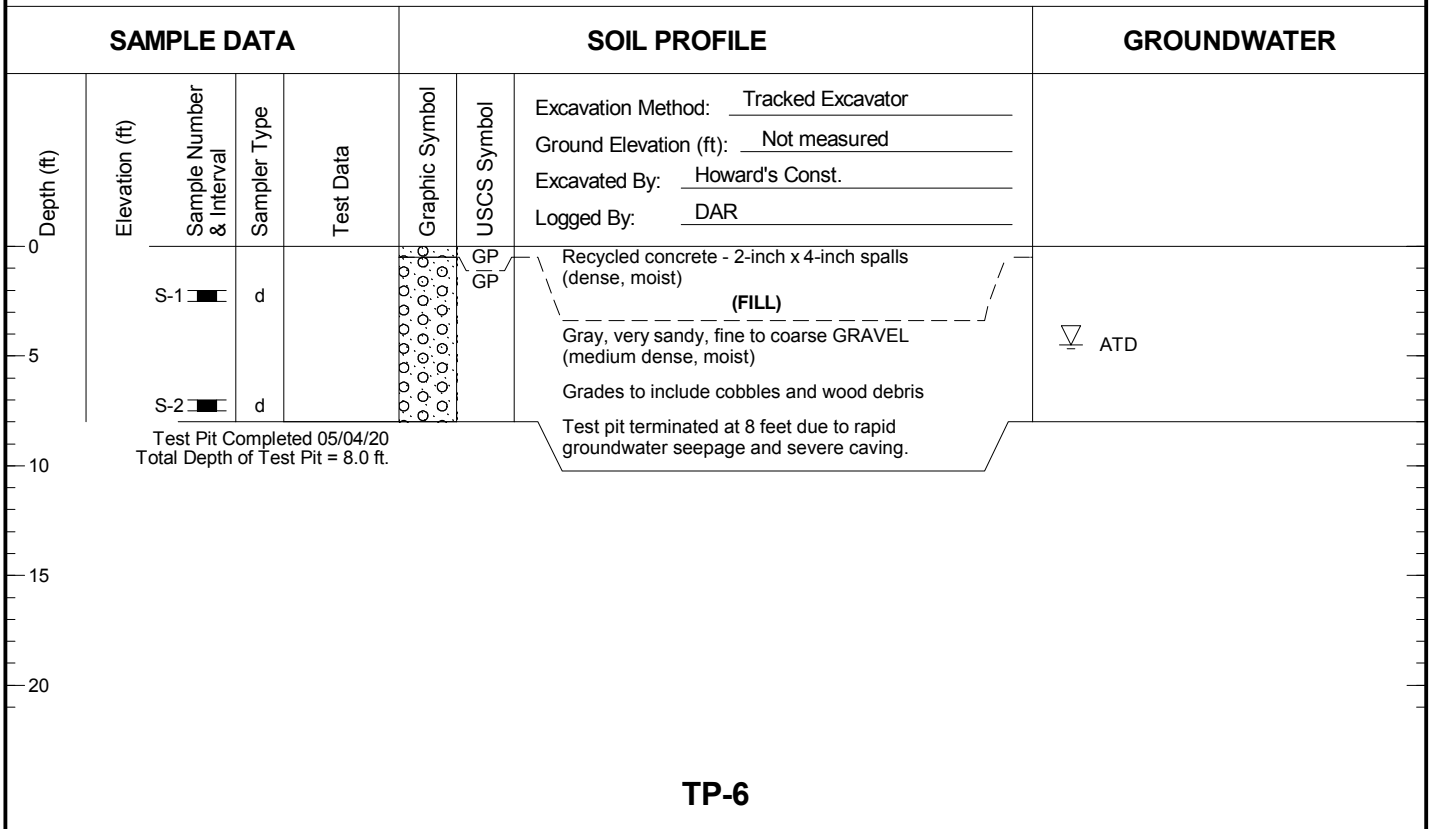


West Bay Yards
Olympia, Washington

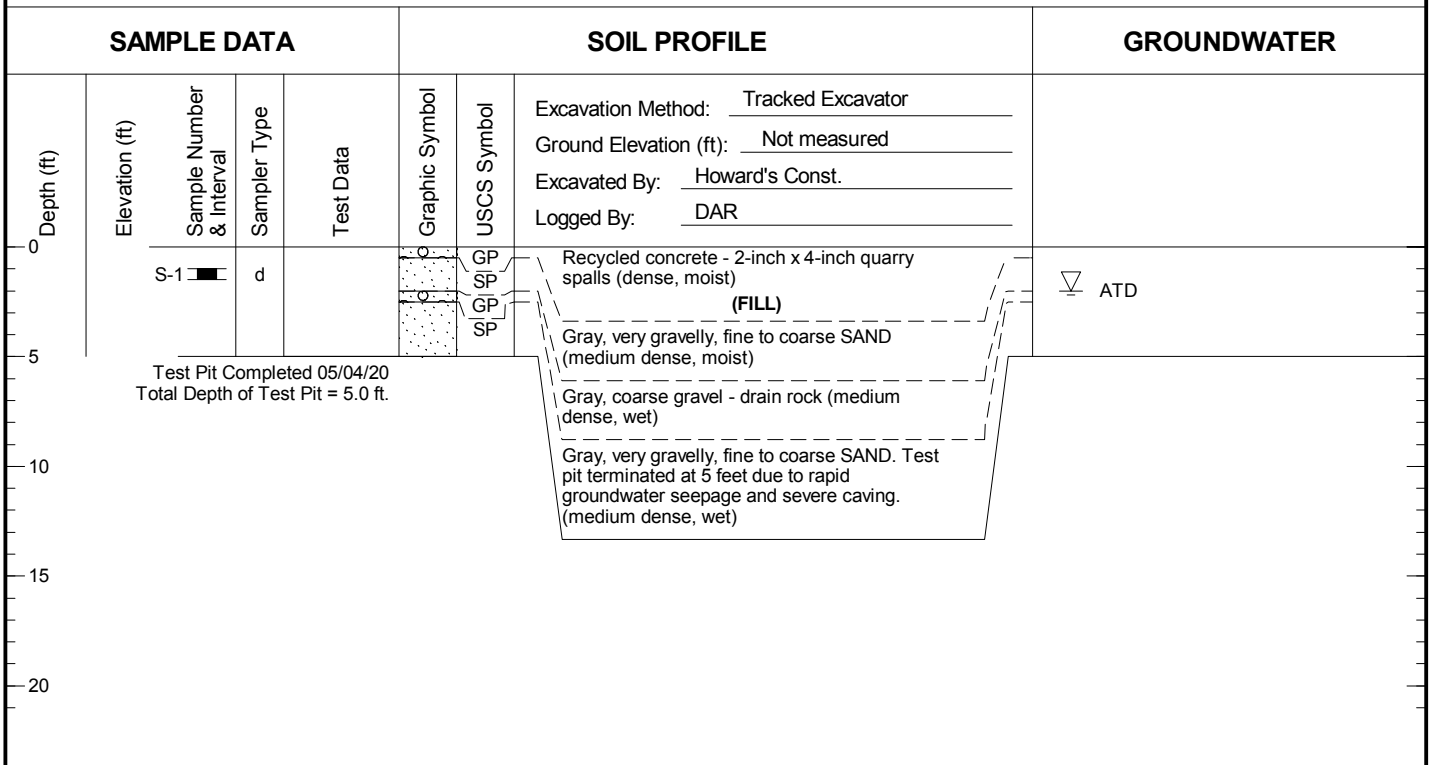
Log of Test Pits

Figure
1-3

TP-5



TP-6



- Notes:
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 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1912001.01 8/27/20 C:\USERS\MSK\IN\DESK\TOP\1912001.010.GPJ TEST PIT LOG

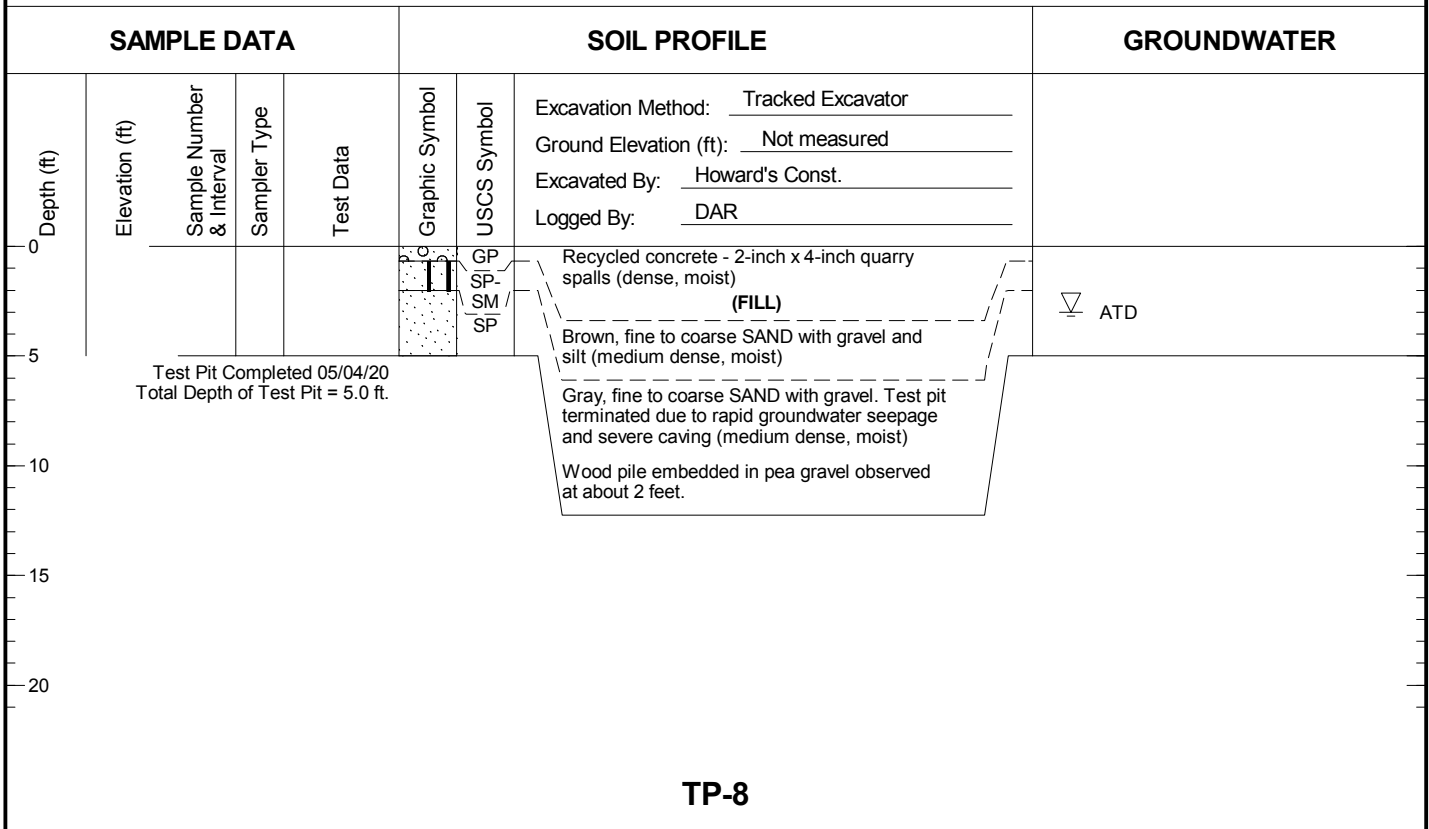


West Bay Yards
Olympia, Washington

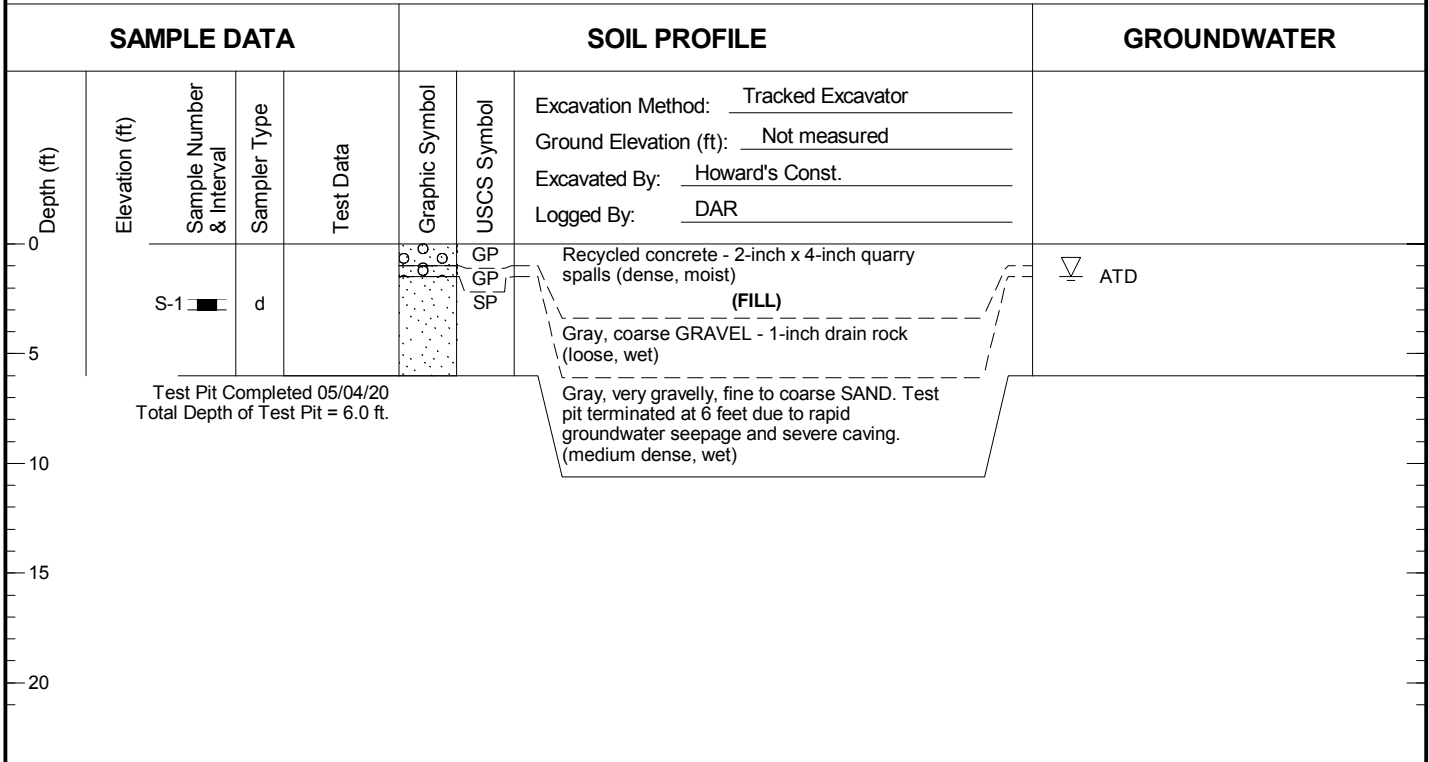
Log of Test Pits

Figure
1-4

TP-7



TP-8



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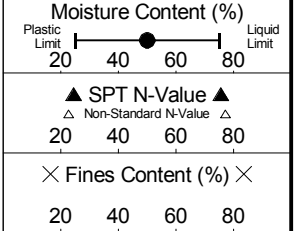
1912001.01 8/27/20 C:\USERS\MSK\IN\NERIDESK\TOP\1912001.010.GPJ TEST PIT LOG

B-1

LAI Project No: 1912001.010

SAMPLE DATA

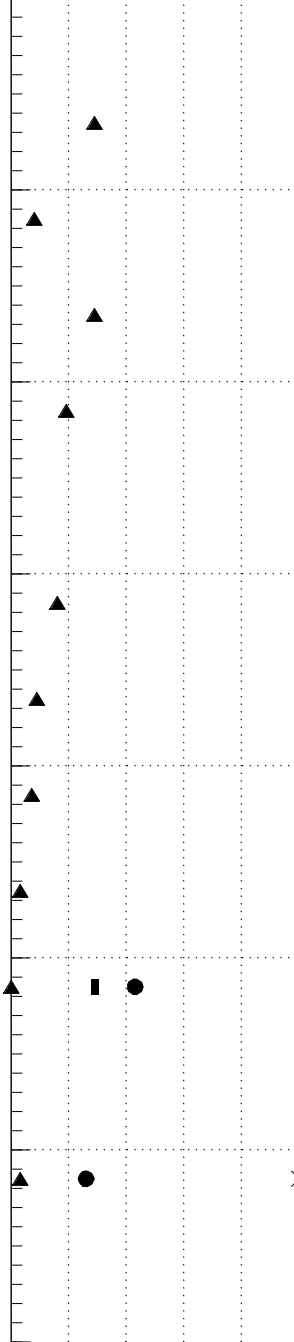
SOIL PROFILE



Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Description
0						GP, GP-, GM		Recycled concrete - 2-inch x 4-inch quarry spalls (dense, moist) (FILL)
0 - 1		S-1	b2	29				Gray, very sandy, fine to coarse GRAVEL with silt (medium dense, moist to wet)
1 - 2		S-2	b2	8			SP	Gray, fine to coarse SAND with shells (loose, wet)
2 - 3		S-3	b2	29				Grades to include wood debris
3 - 4		S-4	b2	19				
4 - 5								
5 - 6		S-5	b2	16			WD	Wood debris (medium dense, wet) Resampled 15-foot interval using a Modified California split spoon.
6 - 7		S-6	b2	9				Grades to loose. Resampled the 17.5-foot interval using a Modified California split spoon.
7 - 8		S-7	b2	7				
8 - 9		S-8	b2	3			ML	Gray SILT with shells (soft, wet) (GLACIOMARINE DEPOSITS)
9 - 10		S-9	b2	0	W = 43 AL			Gray silt with wood debris. Resampled the 25-foot interval using a Modified California split spoon. (very soft, wet)
10 - 11								
11 - 12		S-10	b2	3	W = 26 GS AL			Grades to include sand and shells

Groundwater

5.0 ft ATD



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1912001.01 8/27/20 C:\USERS\SKINNER\DESKTOP\1912001.010.GPJ SOIL BORING LOG WITH GRAPH



West Bay Yards
Olympia, Washington

Log of Boring B-1

Figure
1-6
(1 of 2)

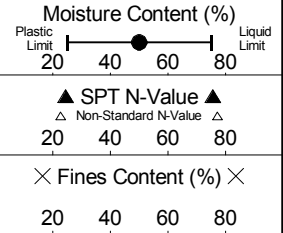
B-1

LAI Project No: 1912001.010

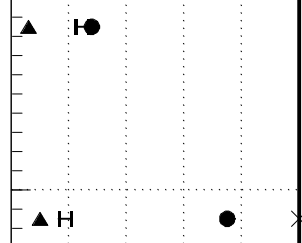
SAMPLE DATA

SOIL PROFILE

Groundwater



Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Soil Profile Description
35		S-11	b2	6	W = 28 AL		ML	Gray SILT with shells (soft, wet) (GLACIOMARINE DEPOSITS) Gray SILT with wood debris (medium stiff, wet)
40		S-12	b2	10	W = 75 GS AL			Gray SILT (stiff, wet)



Boring Completed 05/06/20
Total Depth of Boring = 41.5 ft.

1912001.01_8/27/20 C:\USERS\MSK\IN\NER\DESK\TOP\1912001.010.GPJ SOIL BORING LOG WITH GRAPH

- Notes:
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West Bay Yards
Olympia, Washington

Log of Boring B-1

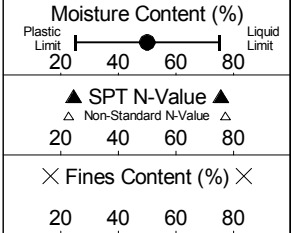
Figure
1-6
(2 of 2)

B-2

LAI Project No: 1912001.010

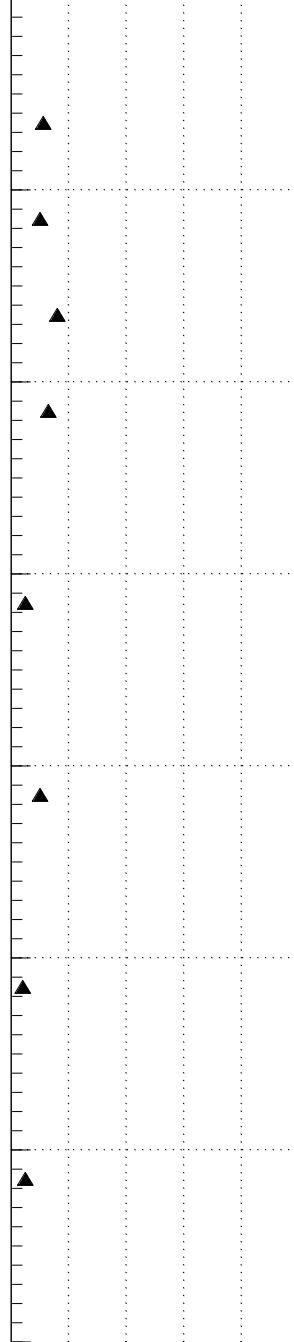
SAMPLE DATA

SOIL PROFILE



Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-Stem Auger	
								Ground Elevation (ft): Not measured	
								Drilled By: Holocene Drilling Inc.	
								Logged By: DAR Date: 05/06/20	
0						GP		Recycled concrete - 2-inch x 4-inch quarry spalls (dense, moist)	
		S-1	b2	11				(FILL)	
								Brown, fine to coarse GRAVEL with sand (medium dense, wet)	
		S-2	b2	10			SP	Brown, fine to coarse SAND with gravel (medium dense, wet)	
5								Resampled the 5-foot interval using a Modified California split spoon.	
		S-3	b2	16				Grades to without gravel	
		S-4	b2	13				Grades to include shells and wood debris	
10									
		S-5	b2	5			WD	Wood debris. Resampled the 15-foot interval using a Modified California split spoon. (loose, wet)	
15									
		S-6	b2	10				Grades to medium dense	
20									
		S-7	b2	4				Grades to loose. Resampled the 25-foot interval using a Modified California split spoon.	
25									
		S-8	b2	5				Grades to with silt	
30							ML	Gray SILT (stiff, wet)	
35								(GLACIOMARINE DEPOSITS)	

2.0 ft. ATD Groundwater



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1912001.01 8/27/20 C:\USERS\SKINNER\DESKTOP\1912001.010.GPJ SOIL BORING LOG WITH GRAPH



West Bay Yards
Olympia, Washington

Log of Boring B-2

Figure
1-7
(1 of 2)

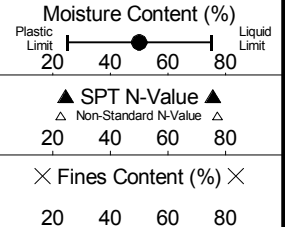
B-2

LAI Project No: 1912001.010

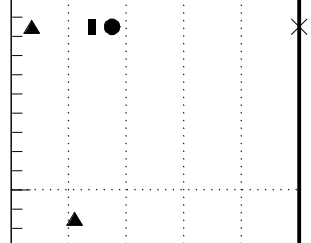
SAMPLE DATA

SOIL PROFILE

Groundwater



Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Soil Description
35		S-9	b2	7	W = 35 GS AL		ML	Gray SILT (stiff, wet) (GLACIOMARINE DEPOSITS)
40		S-10	b2	22				Grades to very stiff and with gravel



Boring Completed 05/06/20
Total Depth of Boring = 41.5 ft.

1912001.01_8/27/20 C:\USERS\MSK\IN\NERIDESKTOP\1912001.010.GPJ SOIL BORING LOG WITH GRAPH

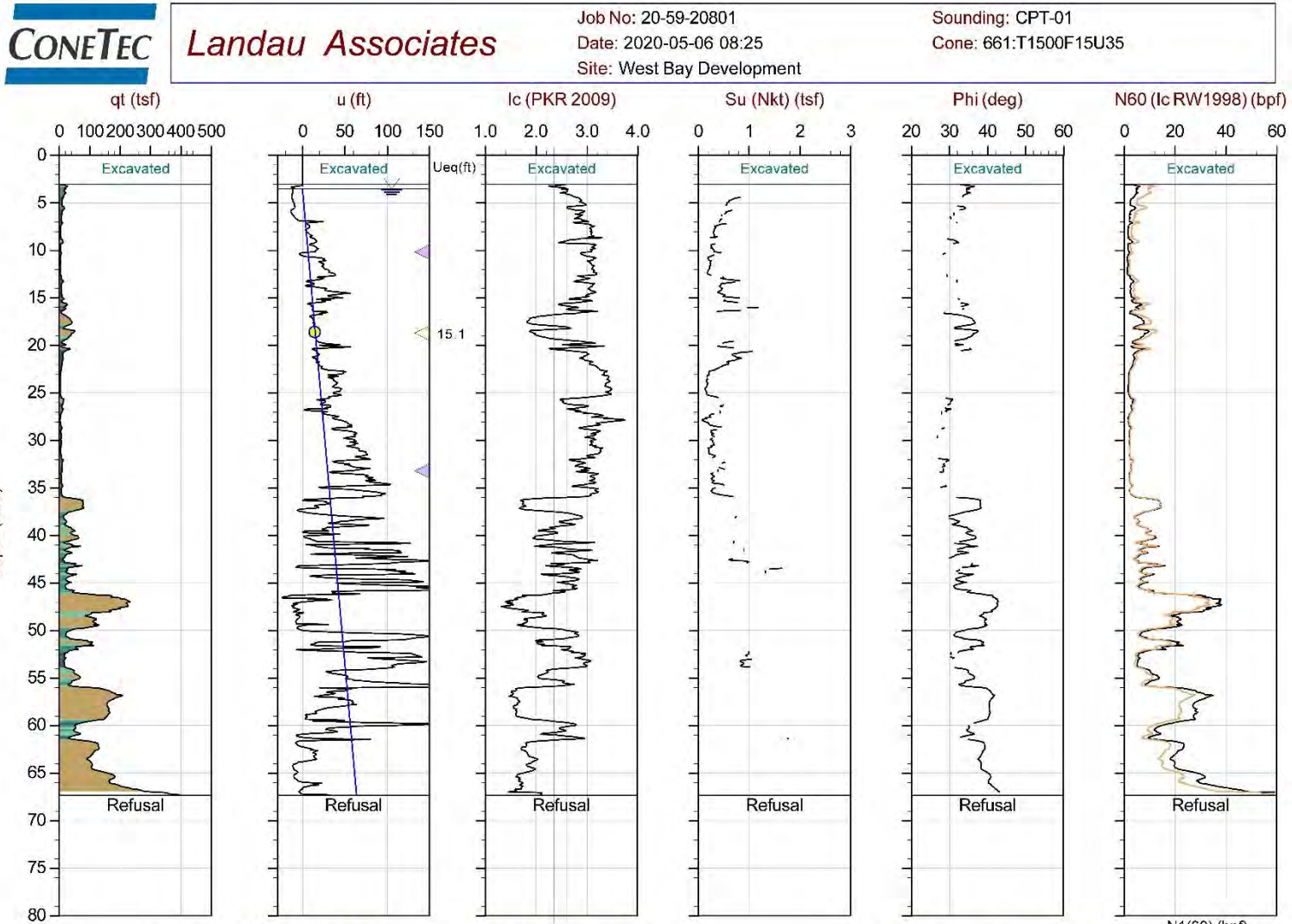
- Notes:
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West Bay Yards
Olympia, Washington

Log of Boring B-2

Figure
1-7
(2 of 2)



Max Depth: 20.525 m / 67.34 ft
 Depth Inc: 0.025 m / 0.082 ft
 Avg Int: Every Point

File: 20-59-20801_SP01.COR
 Unit Wt: SBTQtn (PKR2009)
 Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
 Coords: Lat: 47.05736 Long: -122.91301

△ Dissipation with estimated Ueq value △ Dissipation, equilibrium not achieved ● Equilibrium Pore Pressure (Ueq) — Hydrostatic Line
 The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



West Bay Yards
 Olympia, Washington

Sounding CPT-01

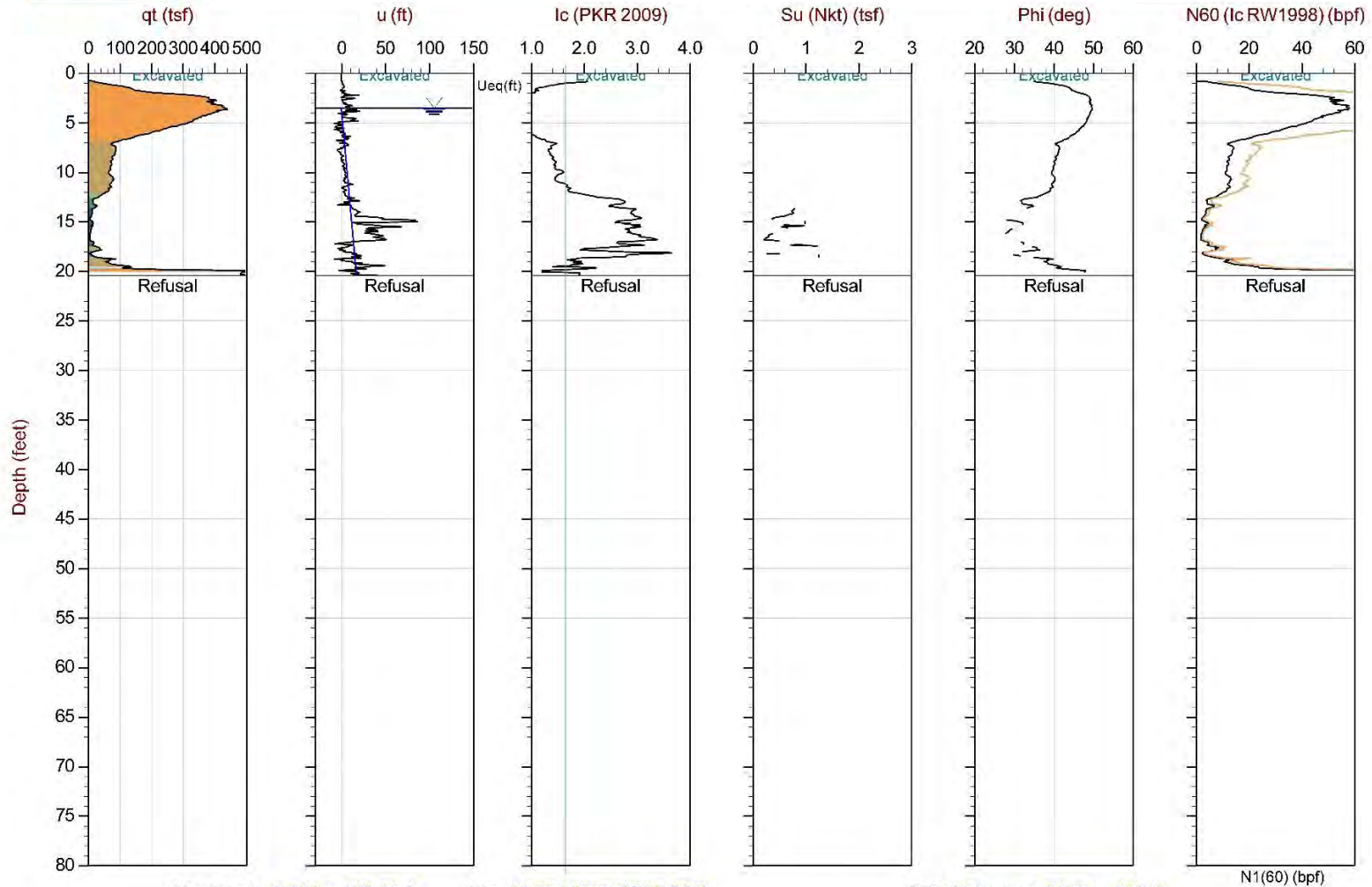
Figure
 1-8



Landau Associates

Job No: 20-59-20801
 Date: 2020-05-06 11:31
 Site: West Bay Development

Sounding: CPT-02
 Cone: 661:T1500F15U35



Max Depth: 6.225 m / 20.42 ft
 Depth Inc: 0.025 m / 0.082 ft
 Avg Int: Every Point

File: 20-59-20801_CP02.COR
 Unit Wt: SBTQtn (PKR2009)
 Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
 Coords: Lat: 47.05723 Long: -122.91401

△ Dissipation with estimated Ueq value △ Dissipation, equilibrium not achieved ● Equilibrium Pore Pressure (Ueq) — Hydrostatic Line
 The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

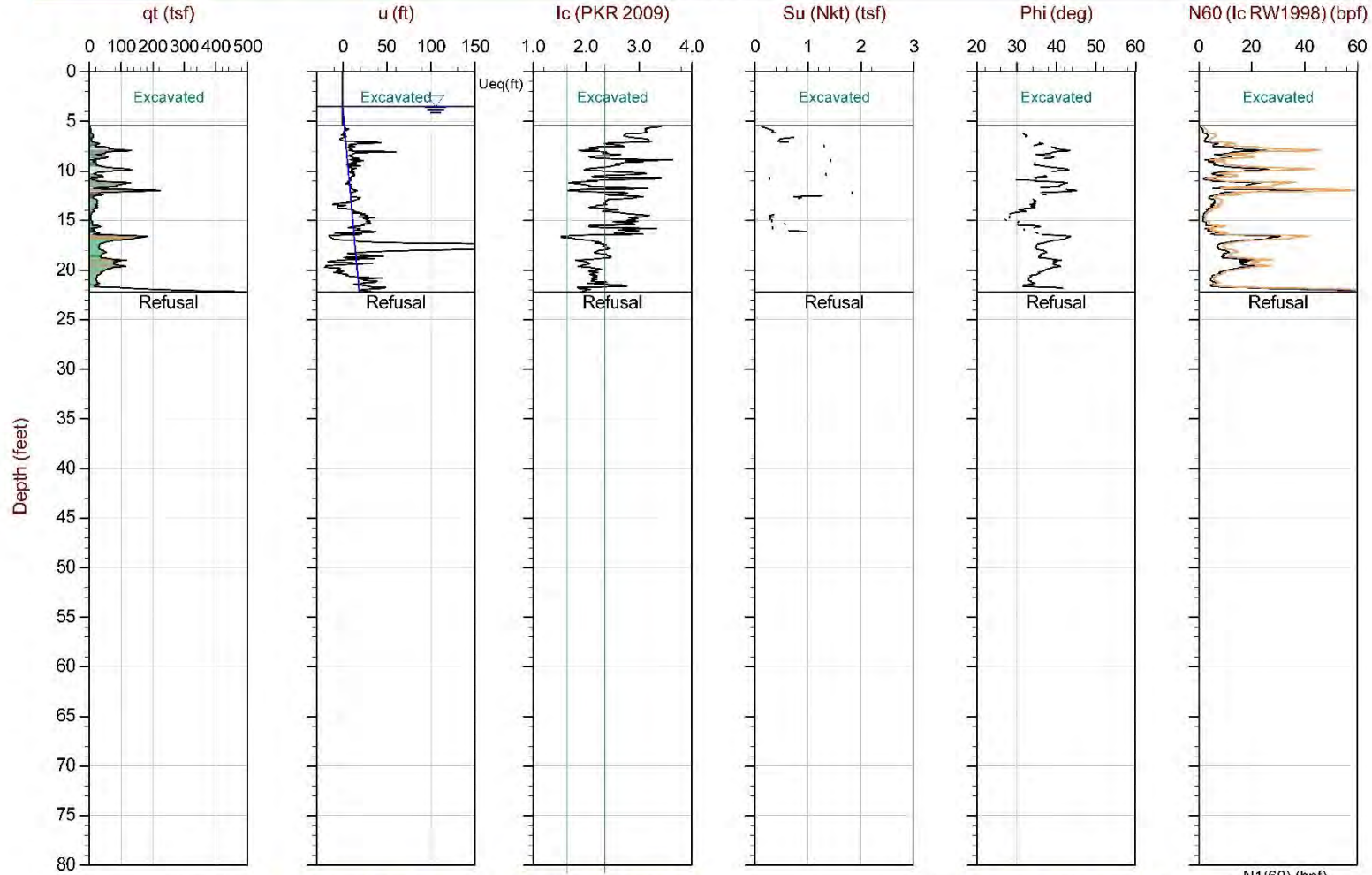


West Bay Yards
 Olympia, Washington

Sounding CPT-02

Figure
 1-9

CONETEC *Landau Associates* Job No: 20-59-20801 Sounding: CPT-03
 Date: 2020-05-06 12:12 Cone: 661:T1500F15U35
 Site: West Bay Development



Max Depth: 6.775 m / 22.23 ft
 Depth Inc: 0.025 m / 0.082 ft
 Avg Int: Every Point

File: 20-59-20801_CP03.COR
 Unit Wt: SBTQtn (PKR2009)
 Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
 Coords: Lat: 47.05803 Long: -122.91436

△ Dissipation with estimated Ueq value △ Dissipation, equilibrium not achieved ● Equilibrium Pore Pressure (Ueq) — Hydrostatic Line
 The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



West Bay Yards
 Olympia, Washington

Sounding CPT-03

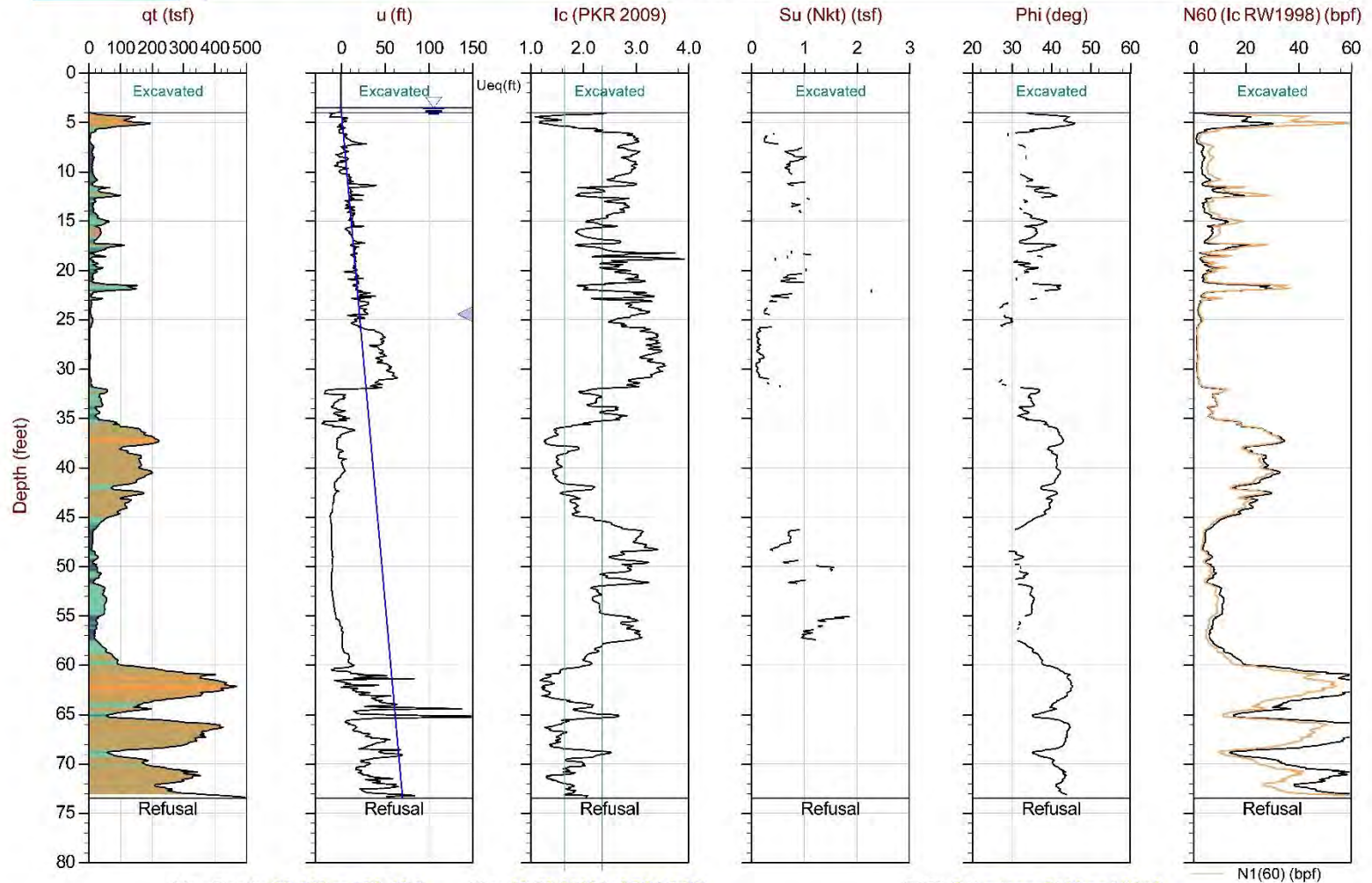
Figure
 1-10



Landau Associates

Job No: 20-59-20801
 Date: 2020-05-06 12:56
 Site: West Bay Development

Sounding: CPT-04
 Cone: 661:T1500F15U35



Max Depth: 22.400 m / 73.49 ft
 Depth Inc: 0.025 m / 0.082 ft
 Avg Int: Every Point

File: 20-59-20801_CP04.COR
 Unit Wt: SBTQtn (PKR2009)
 Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
 Coords: Lat: 47.05820 Long: -122.91317

△ Dissipation with estimated Ueq value △ Dissipation, equilibrium not achieved ● Equilibrium Pore Pressure (Ueq) — Hydrostatic Line
 The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

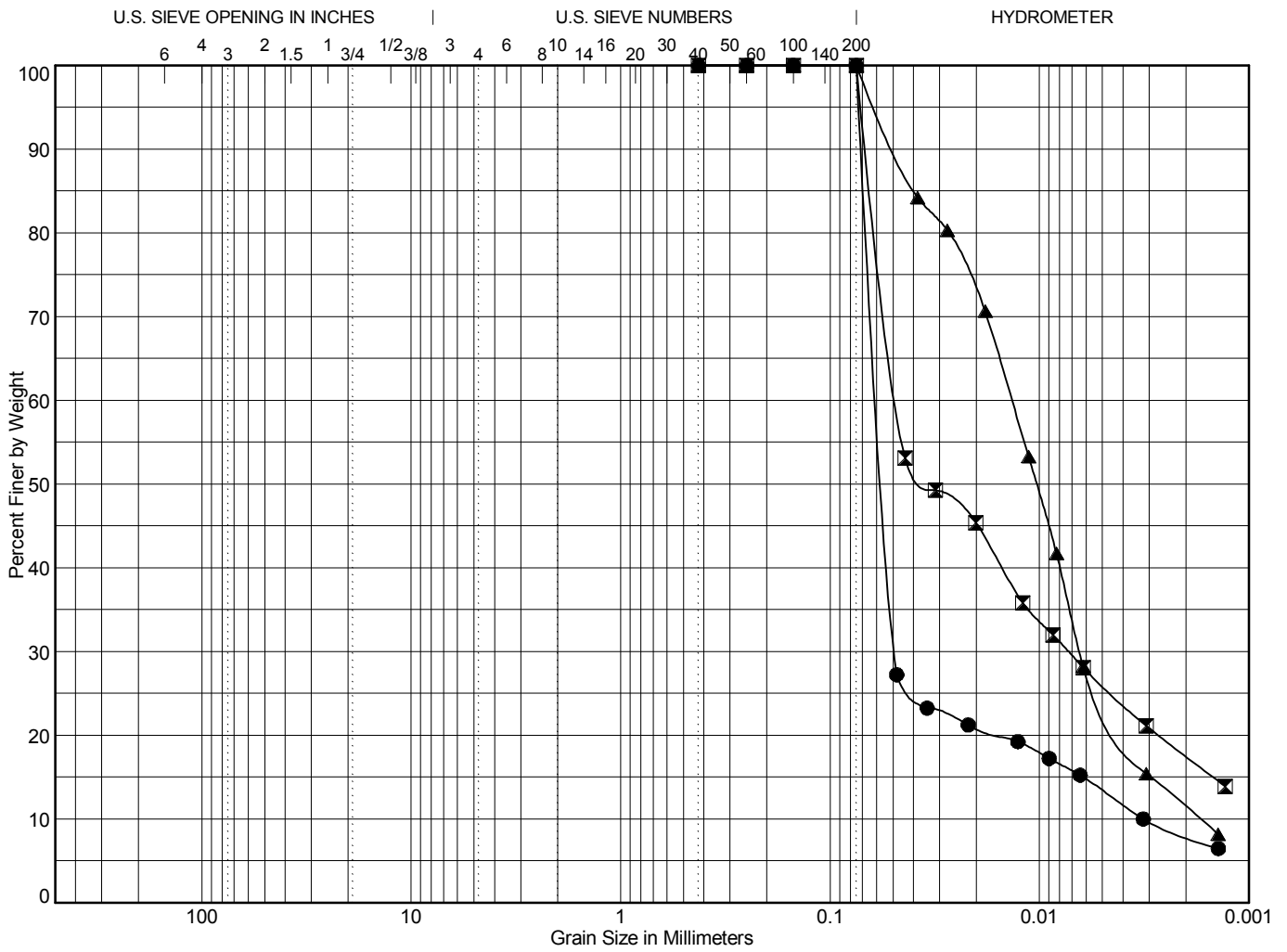


West Bay Yards
 Olympia, Washington

Sounding CPT-04

Figure
 1-11

Laboratory Testing



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point	Depth	Classification	LL	PL	PI	C _c	C _u
●	B-1 30.0	SILT (ML)	25	25	NP	12.76	18.41
☒	B-1 40.0	Clayey SILT (CL-ML)	21	17	4		
▲	B-2 35.0	SILT (ML)	29	27	2	1.79	7.95

Point	Depth	D ₁₀₀	D ₆₀	D ₅₀	D ₃₀	D ₁₀	% Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	B-1 30.0	0.425	0.059	0.055	0.049	0.003	0.0	0.0	0.0	0.0	0.0	100.0
☒	B-1 40.0	0.425	0.047	0.033	0.007		0.0	0.0	0.0	0.0	0.0	100.0
▲	B-2 35.0	0.425	0.014	0.01	0.006	0.002	0.0	0.0	0.0	0.0	0.0	100.0

$$C_c = D_{30}^2 / (D_{60} * D_{10})$$

$$C_u = D_{60} / D_{10}$$

To be well graded: $1 < C_c < 3$ and $C_u > 4$ for GW or $C_u > 6$ for SW

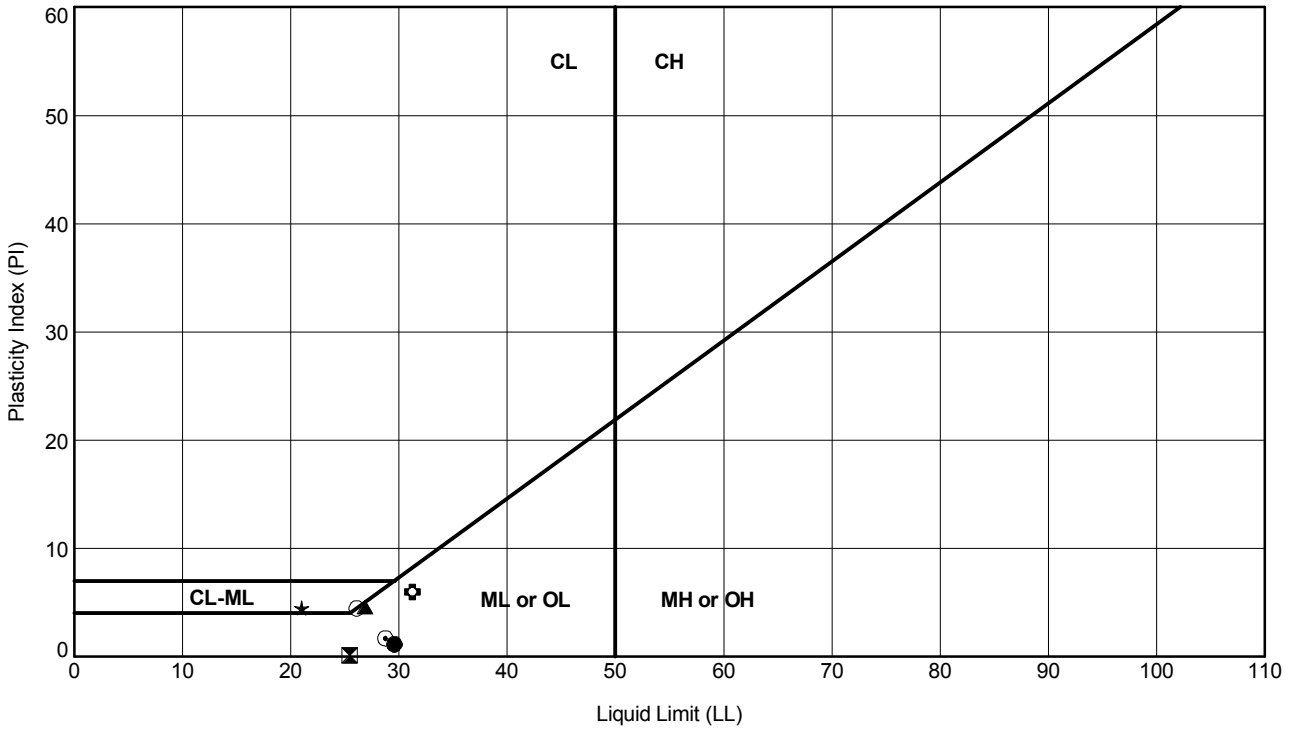
1912001.01 8/27/20 C:\USERS\SKINNER\DESKTOP\1912001.01\10.GPJ GRAIN SIZE W\STATS



West Bay Yards
Olympia, Washington

Grain Size Test Data

Figure
2-1



ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-9	25.0	30	28	2	43	SILT	ML
⊠	B-1	S-10	30.0	25	25	0	26	SILT	ML
▲	B-1	S-11	35.0	27	22	5	28	SILT	ML
★	B-1	S-12	40.0	21	17	4	75	Clayey SILT	CL-ML
⊙	B-2	S-9	35.0	29	27	2	35	SILT	ML
⊕	TP-1	S-4	13.0	31	25	6	37	SILT	ML
○	TP-2	S-3	11.0	26	22	4	19	Clayey SILT	CL-ML

ASTM D 4318 Test Method

1912001.01 8/27/20 C:\USERS\MSKINNER\DESKTOP\1912001.010.GPJ ATTERBERG LIMITS FIGURE_PRINTS.NP