PBS
Engineering +
Environmental

February 26, 2016

Crow/Clay and Associates, Inc.
Attn: Chris Gedrose
125 West Central Avenue, Suite 400
Coos Bay, Oregon 97420

Via email: chris@crowclay.com

Re: Feasibility Geotechnical Engineering Services
Port of Port Orford Cannery Redevelopment
300 Dock Road, Port Orford, Oregon
PBS Project No. 90321.000

INTRODUCTION AND BACKGROUND

PBS Engineering and Environmental Inc. (PBS) is pleased to submit this feasibility geotechnical engineering report for the proposed redevelopment of the cannery facility at the Port of Port Orford in Port Orford, Oregon. The site location is shown on the Vicinity Map, Figure 1. The exploration locations in relation to existing and proposed site features are shown on the Site Plan, Figure 2.

PBS understands the Port of Port Orford is planning to redevelop the area surrounding the existing cannery facility. Conceptual project plans presented in the Facility Master Plan (dated April 30, 2009) show a two-story building including the addition of a Live Fish Processing Center to replace the existing Cannery Building. The Fish Processing building plan has an approximate 13,000 square foot (sq. ft.) first floor that includes live tanks, freezers, and restrooms. The second floor is approximately 7,000 sq. ft. with tenant space, storage, Port offices and conference rooms.

The full scope and layout of the improvements is currently being evaluated and will, in part, be based on information developed as part of our geotechnical engineering services.

SCOPE OF SERVICES

This report summarizes the results of our explorations, testing, and of the geotechnical engineering feasibility assessment, including information relating to the following:

- Exploration logs and site plan with exploration locations
- Geologic setting and related hazards
- Seismic setting and related hazards
- Preliminary feasibility recommendations for foundation-types including shallow spread footings and deep foundations
- Groundwater considerations

SITE DESCRIPTION

The proposed Live Fish Processing Center would be located, in part, at the existing cannery building at 300 Dock Road at the Port of Port Orford. The western portion of the building will be constructed in a currently undeveloped parking area.

The building is situated on a flat section built up on artificial fill between hills to the west and north and the beach to the east and south (refer Figure 2). The property elevation ranges from 23 to 25 feet amsl (datum: WGS84 EGM96 Geoid).

GEOLOGIC SETTING

Regional Geology

The project area is located in the northwestern portion of the Klamath Mountains physiographic province that consists of seven separate terranes, which originally formed in an oceanic crust and island arc environment. Following terrane accretion, granitic plutons were locally intruded during the middle to late Mesozoic; these granitic intrusions generally form northeasterly-trending belts[1]. Each terrane is a fault-bounded unit with unique lithology, age, and structure[2]. Individual terranes within the province are generally arcuate in shape and juxtaposed against neighboring terranes along east dipping thrust faults. The project area is located in the Gold Beach, which is a “mélange” or mixture of upper Jurassic Otter Point Formation silts and sands mixed with lavas, breccieas, chert, and even schists.

Local Geology

Locally, the proposed Live Fish Processing Center lies within a complex geologic setting with varied lithologic stratigraphy set between fault traces[3] (Figure 3, Geology and Geologic Hazard Maps). The surficial geology is mapped as artificial fill (af) within the building footprint. North and upslope, the geology is mapped as Quaternary landslide (Qls) and Anthropocene landslide (Als) likely incorporating the sandstone and mudstone unit (KJos) of the Otter Point Formation (KJo). On the ocean side of the Live Fish Processing Center, the geology map shows Anthropocene back-beach dune (Ads) and Anthropocene beach (Abs) deposits.

GEOLOGIC AND SEISMIC HAZARDS

Geologic and seismic hazards are defined as those conditions associated with the geologic and seismic environment that could influence existing and/or proposed improvements. In general, the geologic and seismic hazards most commonly associated with the physical and chemical characteristics of near-surface soil, rock, and groundwater include the following. Those shown in **bold** are the geologic and seismic hazards that could affect the study areas’ development and should be considered during the planning process.

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[1] Orr, E.L. and Orr, W.N., 1999, Geology of Oregon, Kendall/Hunt Publishing Company.

[2] Coleman, R.G., Manning, C.E., Mortimer, N., Donato, M.M., and Hill, L.B., 1988, Tectonic and regional metamorphic framework of the Klamath Mountains and adjacent Coast Ranges, California and Oregon, in Ernst, W. G., ed., Metamorphism and crustal evolution of the western United States (Rubey Volume VII) : Englewood Cliffs, New Jersey, Prentice Hall, p. 1061-1097.

[3] McClaughry, J.D., Ma, L., Jones, C.B., Michelson, K.A., Wiley, T.J., 2013, Geologic Map of the Port Orford OE W 7.5’ Quadrangle, Port Orford 7.5’ Quadrangle, and Part of the Father Mountain 7.5’ Quadrangle, Curry County, Oregon, Oregon Department of Geology and Mineral Industries, Open-File Report O-13-21, Plate 4, 1:24,000.

Geologic Hazards

- **Slope stability**
- Subsurface voids
- Hazardous minerals and gases
- **Adverse soils**
- **Hydrology and drainage**
- **Hydrogeology and groundwater**
- Land subsidence
- Volcanic hazards
- **Erosion and sedimentation**

Seismic Hazards

- **Liquefaction**
- **Ground shaking**
- **Earthquake-induced landslides**
- **Lateral spreading**
- **Tsunamis**
- **Fault ground rupture**
- Seiches

Specific hazards are presented in Table 1 below and illustrated in Figure 3 – Geology and Geologic Hazards and Figure 4 – Seismic Hazards. The “Level of Concern” is a qualitative assessment based on our engineering geology and geotechnical engineering judgment. Where noted with footnotes, the terminology is taken from a specific source (e.g. HazVu Program).

Table 1: Summary of Potential Geologic and Seismic Hazards

Geologic and Seismic Hazard	Examples	Level of Concern
Slope Stability	Landslides and Existing Slope Movements[a]	Moderate to High, upslope terrain is mapped as a landslide and materials may underlie site
Adverse soils	Artificial Fill	High, deposits below building footprint is mapped as artificial fill (af)
	Expansive Soil	Low
	Compressible Soil	None to Low
	Organic-Rich Soil	None to Low
	Sensitive Clay	None to Low
Hydrology and drainage	Flooding[a]	None to Low, not mapped within the FEMA 100-year flood plain
	Seiches or Standing Water	None to Low
	Dam Inundation	Unknown
Erosion and Sedimentation	Coastal Erosion[a]	High, the western portion of the building and shoreline is mapped as “No Data”[c]
Hydrogeology and groundwater	Shallow or artesian groundwater	Moderate
	Seepage	Moderate
	Permeability or percolation	Low
Seismic hazards	Cascadia Earthquake Expected Shaking[a]	Severe to Violent
	Local Fault Rupture[a]	Trace of active fault near east corner of building
	Liquefaction and Lateral Spread[a]	None, no color shown on map
	Seismically-Induced Settlement	Low
	Seismically-Induced Slope Instability	Upslope terrain is mapped as a landslide and materials may underlie site
	Tsunami Inundation[a,b]	Not shown within Senate Bill 379 tsunami inundation line but is within tsunami inundation zone (TMI-CURR-04, 2012)

[a] – HazVu website: http://www.oregongeology.org/hazvu/
[b] – Oregon Department of Geology and Mineral Industries, 2012, Local Source (Cascadia Subduction Zone) Tsunami Inundation Map, Port Orford, Oregon, Tsunami Inundation Map CURR-04, Plate 1, 1:10,000
[c] – “No Data” means coastal erosion is occurring but the impact has not been evaluated

In our current opinion, the primary geologic hazards that require further evaluation during engineering design of the Live Fish Processing Center include undocumented artificial fill, upslope landslide/landslide deposits, shallow groundwater/seepage conditions, and coastal erosion. In addition, though not mapped within FEMA's 100-year flood or the coastal erosion hazard zones, these hazards should potentially be considered, as reasonable, in the design of the Live Fish Processing Center based on the site's proximity to the hazard boundaries and the source – the Pacific Ocean.

Artificial fill can be a mixture of materials with variable engineering properties that may necessitate multiple foundation designs and require ground improvement. The two borings (refer to the subsurface section below) encountered relatively similar artificial fill materials, but conditions can vary between explorations. The landslides (Als and Qls) mapped upslope and adjacent to the site are not mapped as underlying the site. However, depending on the mobility of these landslides, the building could potentially be impacted by upslope slope instabilities. Seepage and near surface groundwater have been described as an issue at the site (communication with Chris Gedrose at Crow/Clay and Associates, February 22, 2016).

The western portion of the proposed Live Fish Processing Center is mapped within the coastal erosion hazard (described as "no data") and the base of the building adjacent to the beach abuts it. Coastal erosion is a natural process that continually affects the Oregon coast. Erosion becomes a hazard when human development or public safety is threatened. Beaches, sand spits, dunes, and bluffs are constantly affected by waves, currents, tides, and storms, resulting in chronic erosion, landslides, and flooding. Changes may be gradual over a season or many years. Changes may also be drastic, occurring during the course of a single storm event. Erosion may be caused by large waves, storm surges, rip cell embayments, high winds, rain, runoff, flooding, or increased water levels and ocean conditions caused by periodic El Ninos. Coastal dunes and bluffs comprised of uplifted marine terrace deposits are especially vulnerable to chronic and catastrophic erosion[4].

The primary seismic hazards that could impact the site are ground shaking from a Cascadia earthquake ("very strong" to "violent"), potential for ground fault rupture from the Battle Rock fault zone, tsunami inundation, and earthquake-induced landslides. In addition, all though not mapped within a significant liquefaction hazard, lateral spread resulting from liquefaction may also need to be further evaluated with the free faces on the south and east sides of the building.

The Cascadia Subduction Zone (CSZ), a major zone of plate convergence located offshore, is located approximately 10 miles west of the site and is the primary seismogenic ground shaking source. The CSZ extends from offshore northern California to southern British Columbia and may have generated at least seven great earthquakes (those of magnitude M8 or greater) in the last 3,500 years, suggesting a recurrence interval of approximately 300 to 600 years. Detailed tsunami records from Japan indicated the last significant CSZ earthquake occurred on January 26, 1700.[5] Atwater and others (2005) estimated the earthquake had a magnitude of between M8.7 and 9.2.

The north-northwest-striking Battle Rock fault zone is shown in the proximity of the Live Fish Processing Center. The location of the fault trace depends on the map source. DOGAMI's map shows the trace about 100 feet east of the building corner. However, the USGS Faults and Folds database shows this trace through the eastern portion of the building. The Battle Rock fault zone is part of a

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[4] Coastal Erosion Hazard: http://oregonexplorer.info/content/coastal-erosion?topic=4129&ptopic=140

[5] Atwater, B.F., Musumi-Rokkaku Satoko, M-R., Kenji, S., Yoshinobu, T., Kazue, U., Yamaguchi, D.K., 2005, The Orphan Tsunami of 1700—Japanese Clues to a Parent Earthquake in North America, U.S. Geological Survey, Professional Paper 1707.

major right-lateral shear zone mapped in Mesozoic bedrock in the northern Klamath Mountains and part of the CSZ. The fault zone is mapped as a high angle fault in Quaternary deposits and the fault may represent Quaternary reactivation of a dextral slip fault zone. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on this fault are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate[6].

The HazVu and Tsunami Inundation Map (TIM) CURR-04 (2012) maps show the regulatory tsunami inundation line (Oregon Revised Statutes 455.446 and 455.447), commonly known as the Senate Bill 379 line. Senate Bill 379 (1995) instructed DOGAMI to establish the area of expected tsunami inundation based on scientific evidence and tsunami modeling in order to prohibit the construction of new essential and special occupancy structures in this tsunami inundation zone (Priest,1995). The proposed Live Fish Processing Center is not within this boundary.

In addition, the TIM CURR-04 (2012) map used computer models representing five selected tsunami scenarios, all of which include the earthquake-produced subsidence and the tsunami-amplifying effects of the splay fault. Each scenario assumed that a tsunami occurs at Mean Higher High Water (MHHW) tide; MHHW is defined as the average height of the higher high tides observed over an 18-year period at the Port Orford tide gauge. The five scenarios are labeled from Small, Medium, Large, Extra Large, to Extra Extra Large (S, M, L, XL, XXL). Based on these models, the project site is located within the tsunami inundation zone for Small (S) CSZ earthquakes with a moment magnitude (Mw) equal to, or greater than, 8.7. The extent of the tsunami inundation zone for varying levels of events (e.g., small, medium, large, etc.) for the area are shown on the Seismic Hazards, Figure 4, and summarized in Table 2.

Table 2: Earthquake Size, Magnitude, Slip Range, and Impact

Earthquake Size	Average Slip Range (ft)	Maximum Slip Range (ft)	Time to Accumulate Slip (yrs)	Earthquake Magnitude
XXL	59 to 72	118 to 144	1,200	~9.1
XL	56 to 72	115 to 144	1,050 to 1,200	~9.1
L	36 to 49	72 to 98	650 to 800	~9.0
M	23 to 30	46 to 62	425 to 525	~8.9
S	13 to 16	30 to 36	300	~8.7

Ground shaking could activate the upslope landslides during an earthquake. Impacts to the facility will depend on the mobility of the landslide.

SUBSURFACE CONDITIONS

Borings were completed on February 18th and 19th, 2016 and advanced to approximately 31.5 feet bgs by Hardcore Drilling, Inc. of Dundee, Oregon, with a CME 75 truck-mounted drill rig using mud rotary techniques. Approximate boring locations are shown on Figure 2, Site Plan. A member of the PBS geotechnical staff observed the explorations and collected soil samples, which were returned to our laboratory for further evaluation. Subsurface conditions encountered are summarized below and in the

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[6] Personius, S.F., compiler, 2002, Fault number 896, Battle Rock fault zone, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults

boring logs included in Attachment A. The subsurface materials and the contact depths will vary on the property.

PBS has summarized these subsurface units as follows:

TOPSOIL:	Topsoil was encountered in the borings and was approximately an inch thick.
ARTIFICIAL FILL (Af)	Brown gray poorly graded SAND (SP) to brown orange silty SAND (SM) with gravel was encountered beneath the topsoil to depths of approximately 10 and 11 feet bgs in the boring B-2 and B-1, respectively. Relative densities varied from loose to medium dense with N-values between 4 and 25 blows per foot (bpf). Below 10 feet in B-2, medium dense (N-values between 11 and 17 blows per foot) poorly graded GRAVEL (GP) with sand was observed to approximately 16 feet bgs.
MUDSTONE AND SANDSTONE UNIT (KJos) – OTTER POINT FORMATION	Below the artificial fill, the borings encountered mudstone and sandstone that has decomposed to clay with gravel. The consistency of the fine-grained soil was medium stiff to hard, with N-values between 6 and 69 bpf.

The soil types are based on visual-manual classifications using ASTM D 2488-09a guidelines. Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the soil were noted. The terminology used in the soil classifications and other modifiers are defined and presented on the attached Table A-1.

Groundwater

Groundwater was not observed while drilling borings B-1 and B-2 due to the use of mud rotary drilling techniques. However, groundwater at the site is likely connected to the Pacific Ocean sea level and changes in the tide. Perched groundwater may be encountered at the project site due to variations in fill, alluvial deposits, and bedrock contact depths and will fluctuate due variations in rainfall, tide, and the season.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Based on our research and preliminary explorations, the site conditions, in our current opinion, are suitable for the proposed development. The geotechnical-related considerations include:

- Artificial fill underlies the proposed building footprint. Additional explorations will be needed to further characterize these materials and contact depths.
- Upslope landslides (Als and Qls) could mobilize and impact the building. A site reconnaissance by a Certified Engineering Geologist (CEG) should be performed to assess the general stability of the slope and rock fall hazard.
- Seepage and near surface groundwater should be controlled and transmitted away from the building.

- According to DOGAMI’s HazVu program, there is “No Data” concerning coastal erosion in the project site area. The “No Data” designates that the area has not been mapped and the rate has not been determined but it is within a zone of ongoing erosion. The hazard should be considered in the building planning and design and may require shoreline protection including rip-rap, rockery walls, sheet piles, or other retaining structures.
- Ground shaking will occur at the site during an earthquake and will be “severe” to “violent” according to DOGAMI’s HazVu program. Based on the type of structure and development plans, structural design using code-based seismic design parameters is likely sufficient.
- The Battle Rock fault zone is within close proximity to the proposed building footprint and its trace is not conclusively known. The likelihood of ground rupture is low but should currently be considered possible.
- The proposed Live Fish Processing Center is not within the Senate Bill 379 line for tsunami inundation and, therefore, should not be precluded from construction. However, more recent work does show the site is within the tsunami inundation zone starting at the Small (S, ~8.7).
- Active landslides are susceptible to movement during a seismic event and the upslope Als and Qls could impact the building. Boulders on the ground surface should also be assessed for potential destabilization during an earthquake.
- The building site is not mapped within the liquefaction hazard zone but lateral spread may occur toward the free face south and east of the building. Measures, similar to coastal erosion, should be further evaluated.

Foundations Considerations

Our current understanding of the planned site development is that it will be used for fish processing. Based on the anticipated building(s) height(s) and subsurface conditions, new structures can likely be supported on shallow spread footings and deep foundations will not be required. Over excavation and recompaction of less than 5 feet below the footing should be anticipated with potentially some deeper localized areas due to the material being undocumented fill. Typical column loads and the estimated allowable soil bearing pressures for these conditions are provided in Table 2.

Table 2: Potential Foundation Type

Foundation Type	Column Load (kips)	Estimated Allowable Soil Bearing Pressure (psf)
Spread Footing	Less than 200	1,500 to 2,500

Seismic Considerations

The 2014 Oregon Structural Specialty code (OSSC), which is based on the 2012 International Building Code methodology, defines six soil categories that are based on average shear-wave velocity in the upper 100 feet (30 meters) of the soil column. The shear-wave velocity is the speed with which a particular type of ground vibration travels through a material, and can be measured directly by several techniques. The six soil categories include Hard Rock (A), Rock (B), Very Dense Soil and Soft Rock (C), Stiff Soil (D), Soft Soil (E), and Special Soils (F) and are described in more detail in Table 3.

Table 3: 2014 OSSC Soil Site Classes

2014 OSSC Soil Site Class
SITE CLASS A, HARD ROCK – a profile with rock characterized by a shear-wave velocity greater than 5,000 feet per second (ft/s).
SITE CLASS B, ROCK – a profile with rock characterized by a shear-wave velocity of 2,500 to 5,000 ft/s.
SITE CLASS C, VERY DENSE SOIL AND SOFT ROCK – a profile characterized by: average soil shear-wave velocity from 1,200 to 2,500 ft/s; average Standard Penetration Resistance, N, greater than 50 blows/ft; and average soil undrained shear strength, Su, greater than 2,000 pounds per square foot (psf).
SITE CLASS D, STIFF SOIL – a profile characterized by: average soil shear-wave velocity less than 600 ft/s; average Standard Penetration Resistance, N, less than 15 blows/ft; average soil undrained shear strength, Su, from 1,000 to 2,000 psf.
SITE CLASS E, SOIL – a profile characterized by: average soil shear-wave velocity from 600 to 1,200 ft/s; average Standard Penetration Resistance, N, of 15 to 50 blows/ft; and average soil undrained shear strength, Su, less than 1,000 psf, or any profile with more than 10 feet of soft clay defined as soil with plasticity index, PI, greater than 20, water content greater than 40 percent and undrained shear strength, Su, less than 500 psf.
SITE CLASS F – a profile for any soils requiring site-specific evaluation, such as: more than 10 feet of peat or highly organic clays; more than 25 feet of very high plasticity clay with plasticity index, PI, greater than 75; or more than 120 feet of soft/ medium stiff clay.

Based on the information above, the project site is considered Site Class D.

LIMITATIONS

Our evaluations and recommendations are based upon limited review of the referenced documents and subsurface explorations were completed during this work to verify the type and depth of fill, soil, bedrock, or depth of groundwater at the site. We should be contacted to review the proposed site development plan to evaluate their possible affect on the site property. A final geotechnical engineering report that includes additional site-specific explorations will be required prior to final design.

We understand, based on our conversations with you that the information provided in this report is only for your information, for use in feasibility planning associated with the site and you will not hold PBS liable in any regard for decisions related to due diligence or design and construction estimating. Additional site-specific exploration and engineering is required in order to refine the general discussion of subsurface conditions provided in this report.

CLOSING

We trust this report meets your current needs. If you have any questions or wish to further discuss our observations, conclusions, and recommendations, please contact PBS’ Project Manager Paul Slater at 541.404.1482 or Mark Swank at 503.417.7738.

Sincerely,
PBS Engineering and Environmental Inc.

CERTIFIED
Exp 4/21/2016
OREGON
Mark Swank
E2217
ENGINEERING GEOLOGIST

Mark Swank, RG, CEG
Senior Engineering Geologist

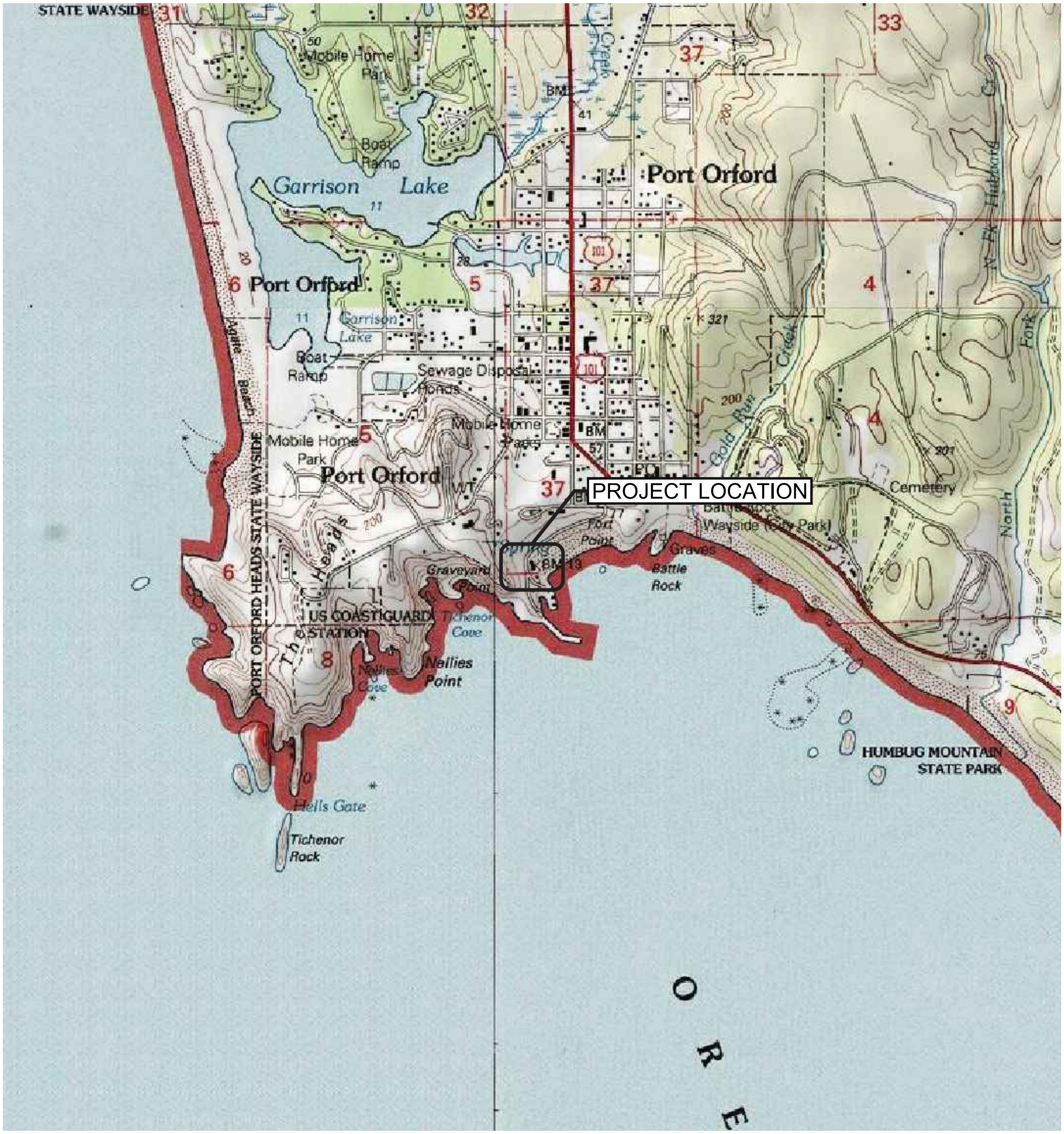
Ryan White, PE, GE
Senior Geotechnical Engineer

TR/MS/rw

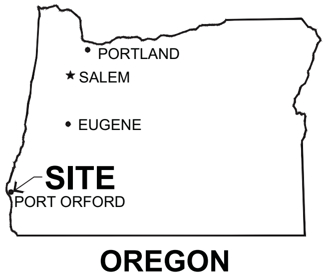
Figures:
Figure 1 – Vicinity Map
Figure 2 – Site Plan
Figure 3 – Geology and Geologic Hazards
Figure 4 – Seismic Hazards

Attachment A:
Table A-1 – Terminology Used to Describe Soil
Table A-2 – Key to Test Pit and Boring Log Symbols
Figure A1 - A2 – Logs for Explorations B-1 and B-2

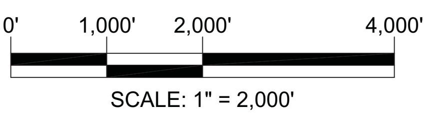
FIGURES



SOURCE: USGS PORT ORFORD OR QUADRANGLE 1988,
PHOTO REVISED 1986.



OREGON



SCALE: 1" = 2,000'

PREPARED FOR: CROW/CLAY AND ASSOCIATES

PBS	PROJECT # 90321.000	VICINITY MAP PORT OF PORT ORFORD CANNERY REDEVELOPMENT 300 DOCK ROAD PORT ORFORD, OREGON	FIGURE 1
	DATE FEB 2016		

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SOURCE: © 2016 GOOGLE EARTH PRO
BUILDING FOOTPRINT PROVIDED
BY CROW/CLAY AND ASSOCIATES

LEGEND

⊕ B-1 BORING NUMBER AND APPROXIMATE LOCATION

0' 40' 80' 160'

SCALE: 1" = 80'

PREPARED FOR: CROW/CLAY AND ASSOCIATES

PBS

PROJECT #
90321.000

DATE
FEB 2016

SITE PLAN

PORT OF PORT ORFORD CANNERY REDEVELOPMENT
300 DOCK ROAD
PORT ORFORD, OREGON

FIGURE
2

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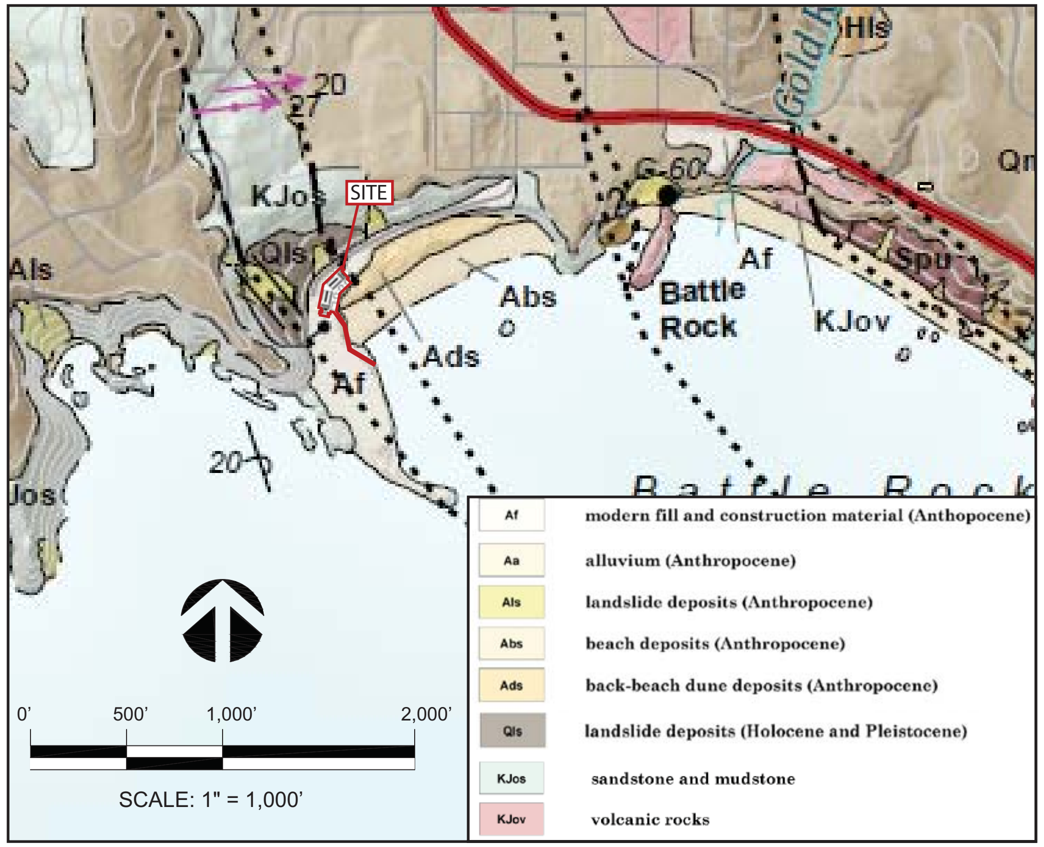
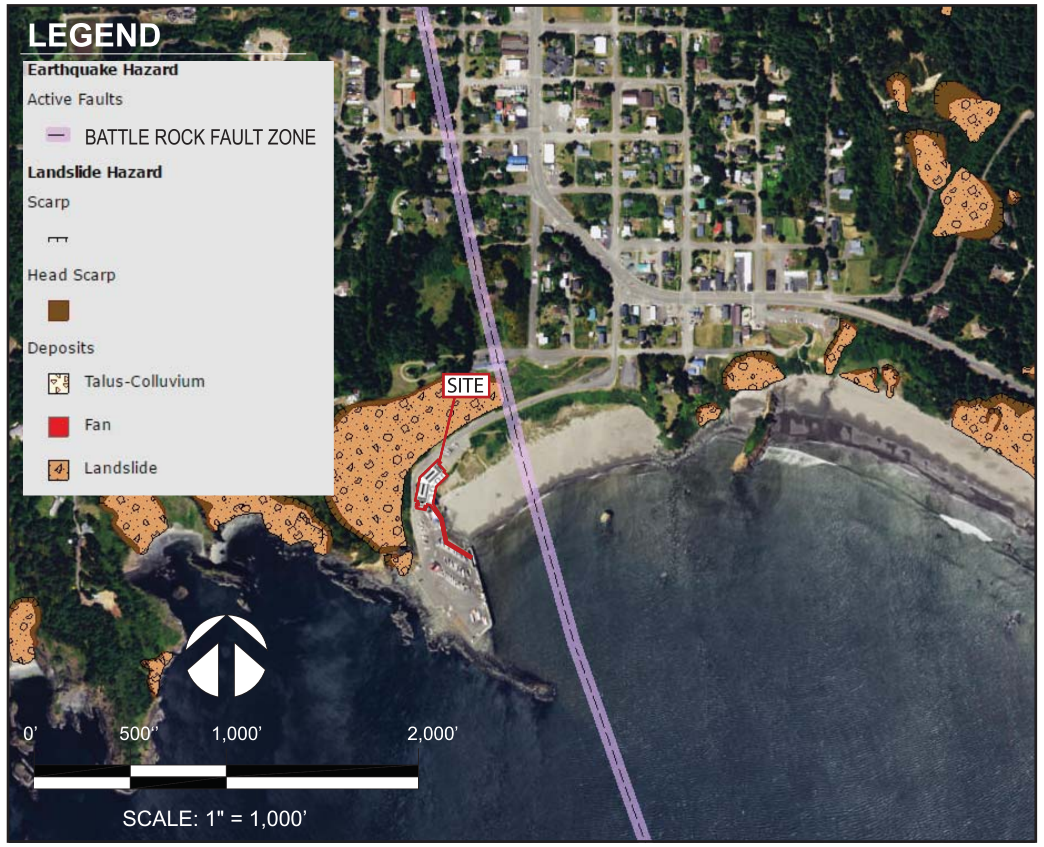
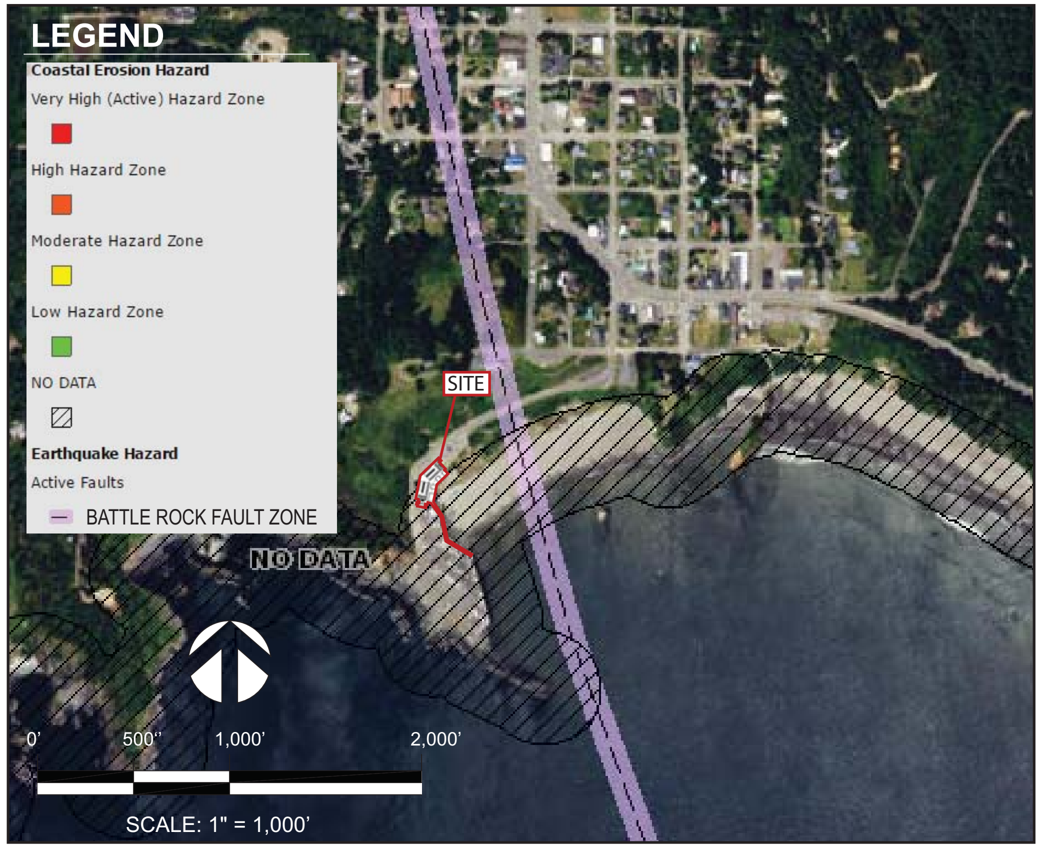
GEOLOGY MAP



LANDSLIDE MAP



COASTAL EROSION HAZARD MAP



FLOOD HAZARD MAP

SOURCES: MCCLAUGHRY, J.D., MA, L., JONES, C.B., MICHELSON, K.A., WILEY, T.J., 2013, GEOLOGIC MAP OF THE PORT ORFORD OE W 7.5' QUADRANGLE, PORT ORFORD 7.5' QUADRANGLE, AND PART OF THE FATHER MOUNTAIN 7.5' QUADRANGLE, CURRY COUNTY, OREGON, OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES, OPEN-FILE REPORT O-13-21, PLATE 4, 1:24,000

OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES HAZARD VIEWER PROGRAM http://www.oregongeology.org/sub/hazvu/

GEOLOGY AND GEOLOGIC HAZARDS

PREPARED FOR: CROW/CLAY AND ASSOCIATES

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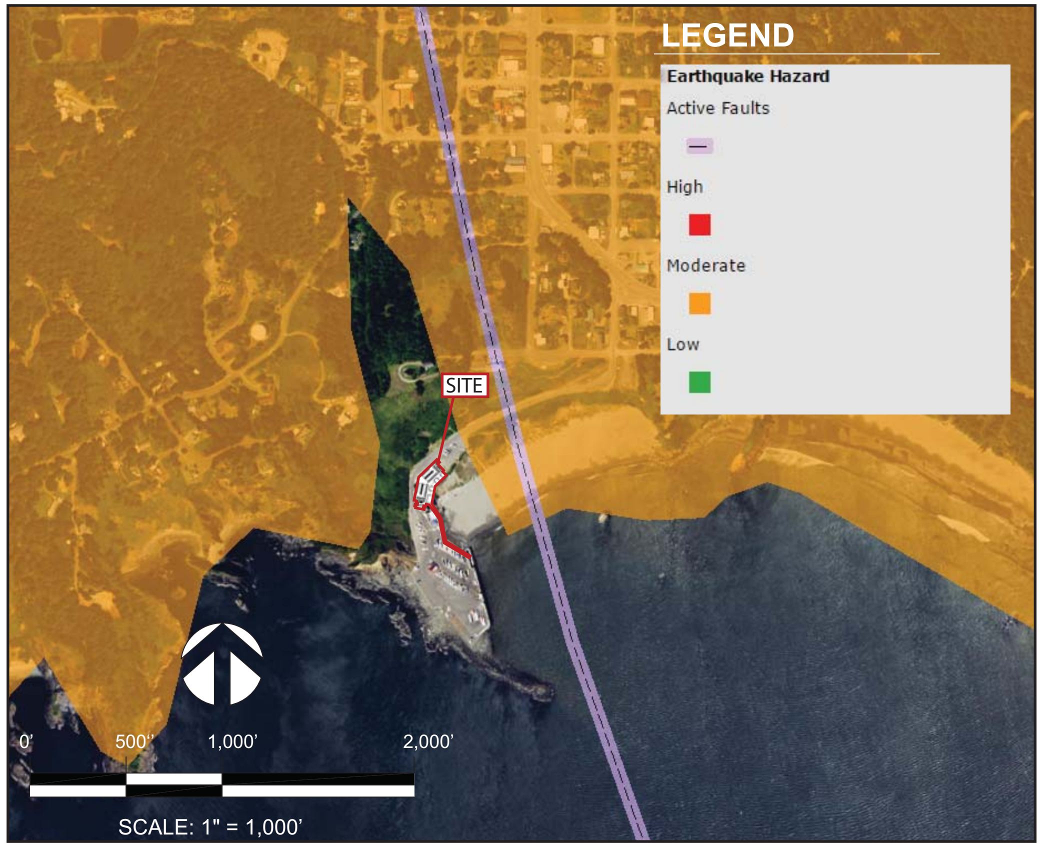
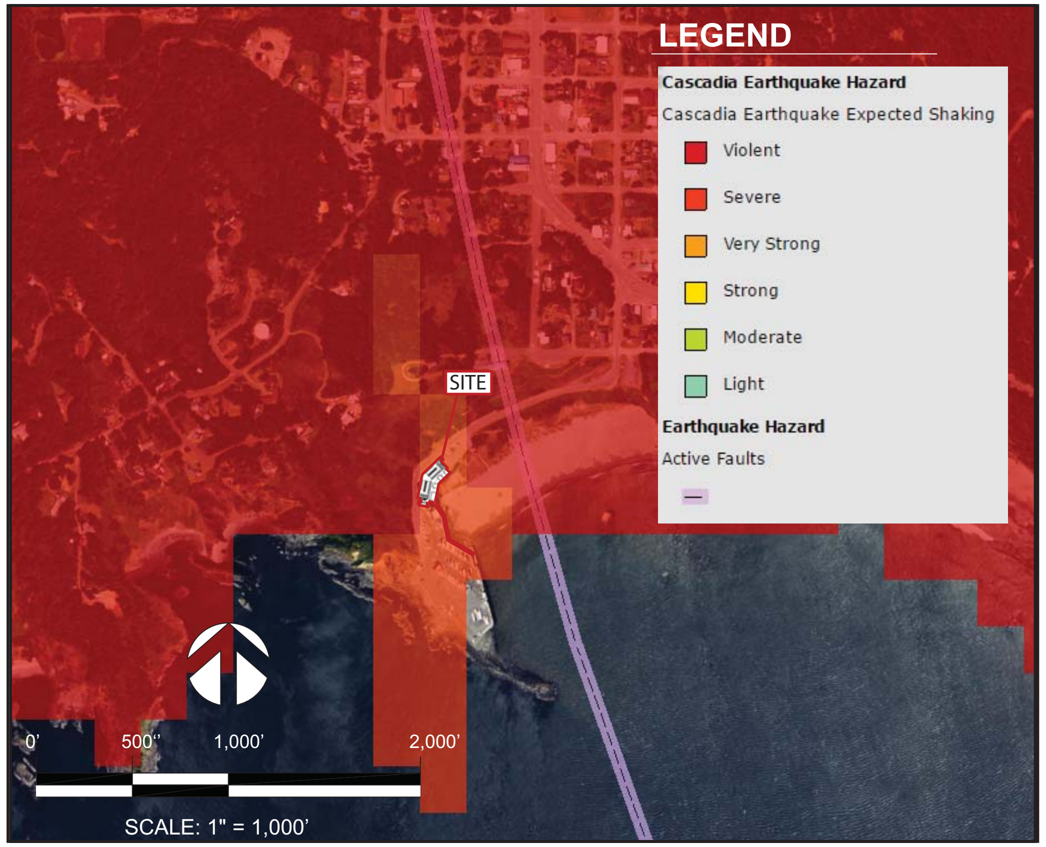
PORT OF PORT ORFORD
CANNERY REDEVELOPMENT
300 DOCK ROAD
PORT ORFORD, OREGON

PROJECT: 90321.000
DATE: FEBRUARY 2016
FIGURE: 3

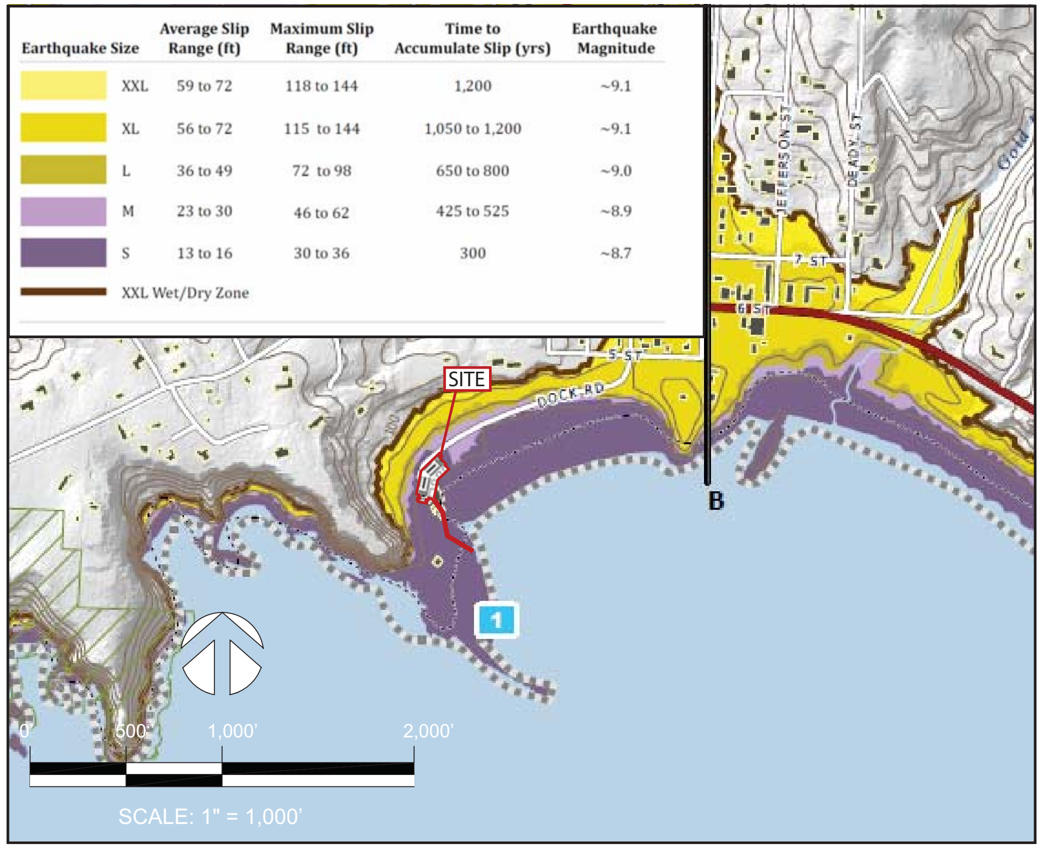
LIQUEFACTION HAZARD MAP



CASCADIA EQ GROUND SHAKING HAZARD HAZARD MAP



TSUNAMI HAZARD HAZARD MAP



Earthquake Size		Average Slip Range (ft)	Maximum Slip Range (ft)	Time to Accumulate Slip (yrs)	Earthquake Magnitude
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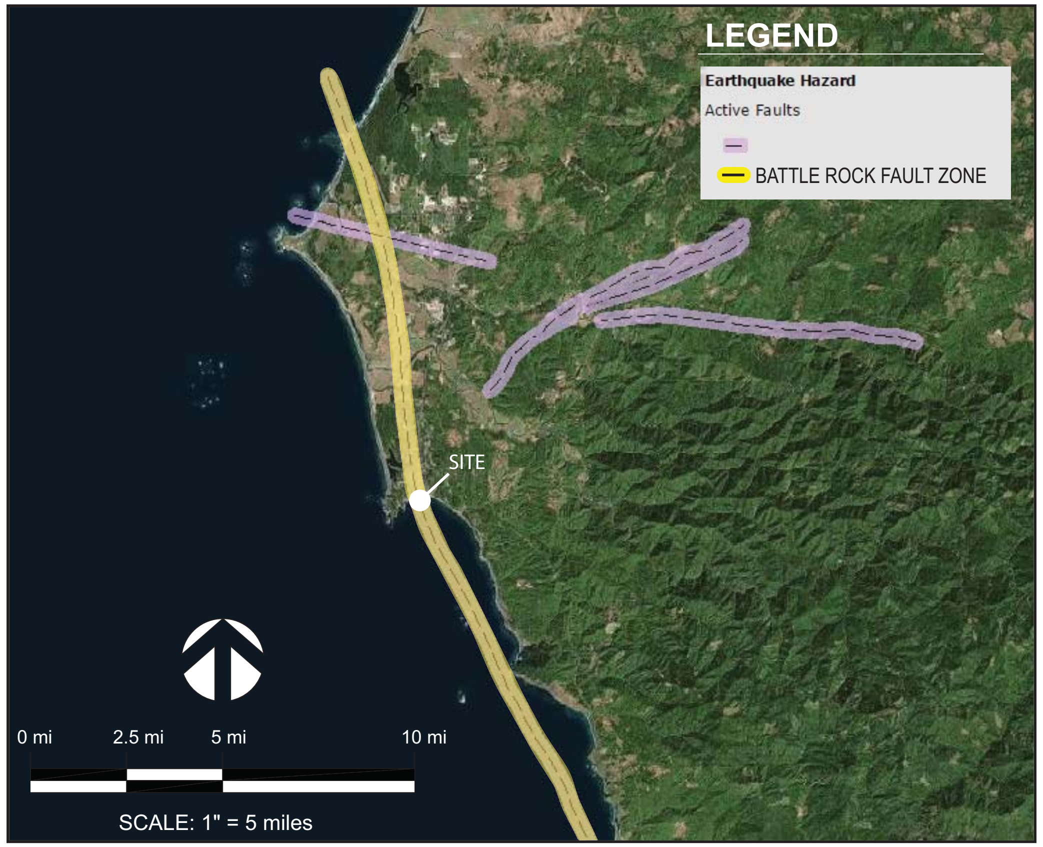
🟨	XL	56 to 72	115 to 144	1,050 to 1,200	~9.1
🟨	L	36 to 49	72 to 98	650 to 800	~9.0
🟪	M	23 to 30	46 to 62	425 to 525	~8.9
🟪	S	13 to 16	30 to 36	300	~8.7
▬	XXL Wet/Dry Zone				

ACTIVE FAULT MAP



SOURCES: OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
HAZARD VIEWER PROGRAM http://www.oregongeology.org/sub/hazvu/

OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
LOCAL SOURCE (CASCADIA SUBDUCTION ZONE) TSUNAMI INUNDATION
MAP, PORT ORFORD, OREGON, TSUNAMI INUNDATION MAP CURR-04,
TSUNAMI INUNDATION MAPS FOR PORT ORFORD, CURRY COUNTY, OREGON,
PLATE 1, 1:10,000.

SEISMIC HAZARDS

PREPARED FOR: CROW/CLAY AND ASSOCIATES

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Environmental
4412 SW Corbett Ave
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PORT OF PORT ORFORD
CANNERY REDEVELOPMENT

300 DOCK ROAD
PORT ORFORD, OREGON

PROJECT: 90321.000
DATE: FEBRUARY 2016
FIGURE: 4

ATTACHMENT A

PBS

Table A-1
Terminology Used to Describe Soil

Soil Descriptions

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

Fine - Grained Soils (More than 50% fines passing 0.075 mm, #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 describes the terminology used to describe fine - grained soils, and varies from ASTM 2488 terminology in the use of some common terms.

Primary soil NAME, adjective and symbols			Plasticity Description	Plasticity Index (PI)
SILT ML & MH	**CLAY** CL & CH	**ORGANIC SILT & CLAY** OL & OH		
SILT		Organic SILT	Non-plastic	0 - 3
SILT		Organic SILT	Low plasticity	4 - 10
SILT / Elastic SILT	Lean CLAY	Organic clayey SILT	Medium Plasticity	10 – 20
Elastic SILT	Lean/Fat CLAY	Organic silty 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; with gravel (combined total greater than 15% but less than 30%, modifier is whichever is greater)	15% to 30%
Sandy; or gravelly (combined total greater than 30% but less than 50%, modifier is whichever is greater)	30% to 50%

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

Soil Consistency. 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. Note, SILT soils with low to non-plastic behavior (i.e. PI < 7) are 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

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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 that portion of materials passing a 3-inch (75mm) sieve. Coarse-grained soil group symbols are applied in accordance with ASTM D2488-06 based upon 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	Particle Diameter	
	Inches	Millimeters
Sand (S)	0.003 - 0.19	0.075 - 4.8
Gravel (G)	0.19 - 3.0	4.8 - 75
	Additional Constituents	
Cobble	3.0 - 12	75 - 300
Boulder	12 - 120	300 - 3050

The primary soil type is capitalized, and the amount of fines in the soil are described as indicated by the following examples. Other soil mixtures will provide similar descriptive names.

Example: Coarse-Grained Soil Descriptions with Fines

5% to less than 15% fines (Dual Symbols)	15% to less than 50% fines
GRAVEL with silt, GW-GM	Silty GRAVEL: GM
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.

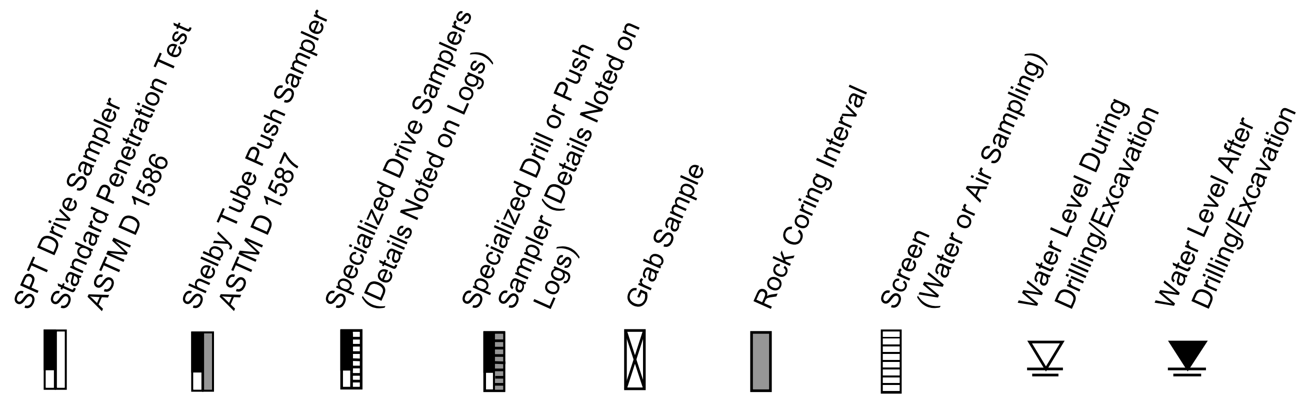
Cobble and boulder deposits may include a description of the matrix soils, as defined above.

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

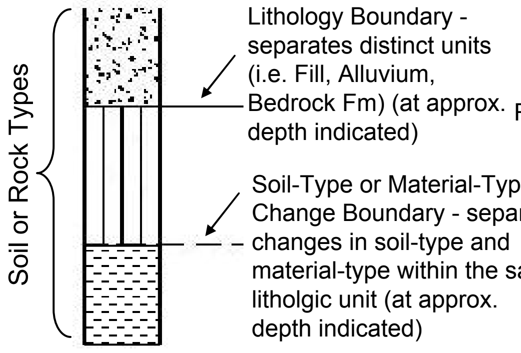
Table A-2
Key To Test Pit and Boring Log Symbols

SAMPLING DESCRIPTIONS[1]

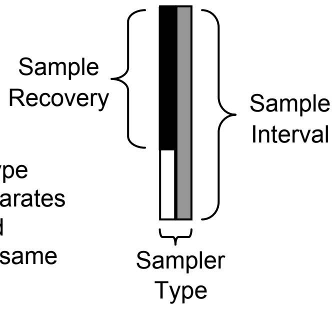


LOG GRAPHICS

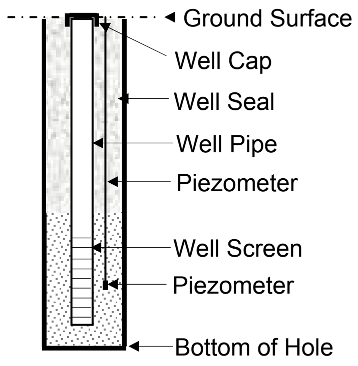
Soil and Rock



Sampling Symbols



Instrumentation Detail



Geotechnical Testing/Acronym Explanations

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

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[1] Note: Details of soil and rock classification systems are available on request.

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PBS PROJECT NUMBER:
90321.000

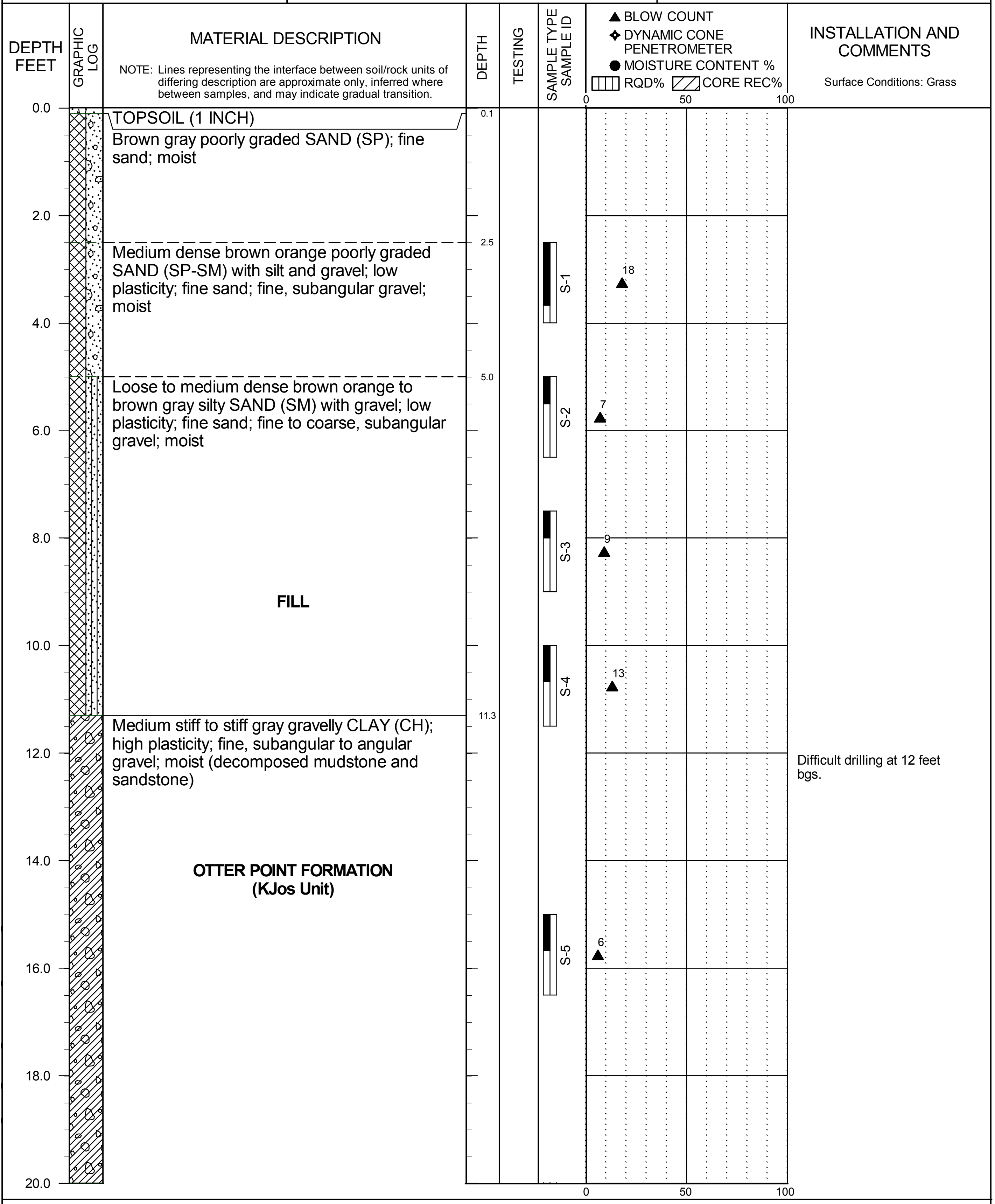
BORING B-1

APPROX. BORING B-1 LOCATION:
42.74063, -124.49970

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

Legend: ▲ BLOW COUNT; ✥ DYNAMIC CONE PENETROMETER; ● MOISTURE CONTENT %; ▥ RQD%; ▨ CORE REC%

Surface Conditions: Grass



DEPTH	MATERIAL DESCRIPTION	SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
0.1	TOPSOIL (1 INCH)			
	Brown gray poorly graded SAND (SP); fine sand; moist			
2.5	Medium dense brown orange poorly graded SAND (SP-SM) with silt and gravel; low plasticity; fine sand; fine, subangular gravel; moist	S-1	18	
5.0	Loose to medium dense brown orange to brown gray silty SAND (SM) with gravel; low plasticity; fine sand; fine to coarse, subangular gravel; moist **FILL**	S-2 S-3 S-4	7 9 13	
11.3	Medium stiff to stiff gray gravelly CLAY (CH); high plasticity; fine, subangular to angular gravel; moist (decomposed mudstone and sandstone) **OTTER POINT FORMATION (KJos Unit)**	S-5	6	Difficult drilling at 12 feet bgs.

DRILLING METHOD: Mud Rotary
DRILLED BY: Hard Core Drilling
LOGGED BY: T. Rikli

BIT DIAMETER: 5.0 in
HAMMER EFFICIENCY PERCENT: 72
LOGGING COMPLETED: 2/18/16

FIGURE A1

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BORING B-1
(continued)

APPROX. BORING B-1 LOCATION:
42.74063, -124.49970

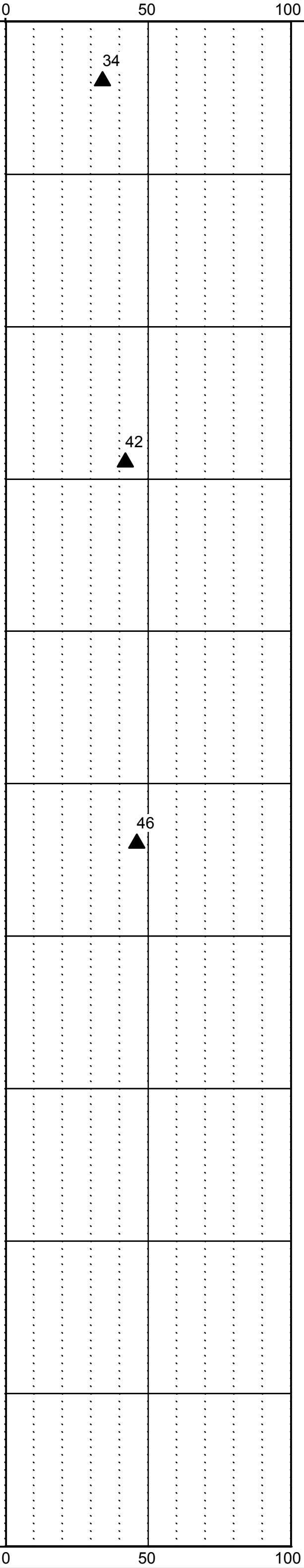
NOTE: Lines representing the interface between soil/rock units of differing description are approximate only, inferred where between samples, and may indicate gradual transition.

▲ BLOW COUNT
✥ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD% ▨ CORE REC%

INSTALLATION AND COMMENTS

Surface Conditions: Grass

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT
20.0	Hard gray gravelly CLAY (CH); high plasticity; fine, subangular to angular gravel; moist (decomposed mudstone and sandstone)	20.0		S-6	34
22.0					
24.0					
26.0				S-7	42
28.0	**OTTER POINT FORMATION (KJos Unit)**				
30.0				S-8	46
32.0	Boring completed at 31.5 feet bgs; boring backfilled with bentonite chips to existing ground surface. Groundwater was not observed due to the use of mud rotary drilling techniques.	31.5			
34.0					
36.0					
38.0					
40.0					



DRILLING METHOD: Mud Rotary
DRILLED BY: Hard Core Drilling
LOGGED BY: T. Rikli

BIT DIAMETER: 5.0 in
HAMMER EFFICIENCY PERCENT: 72
LOGGING COMPLETED: 2/18/16

FIGURE A1

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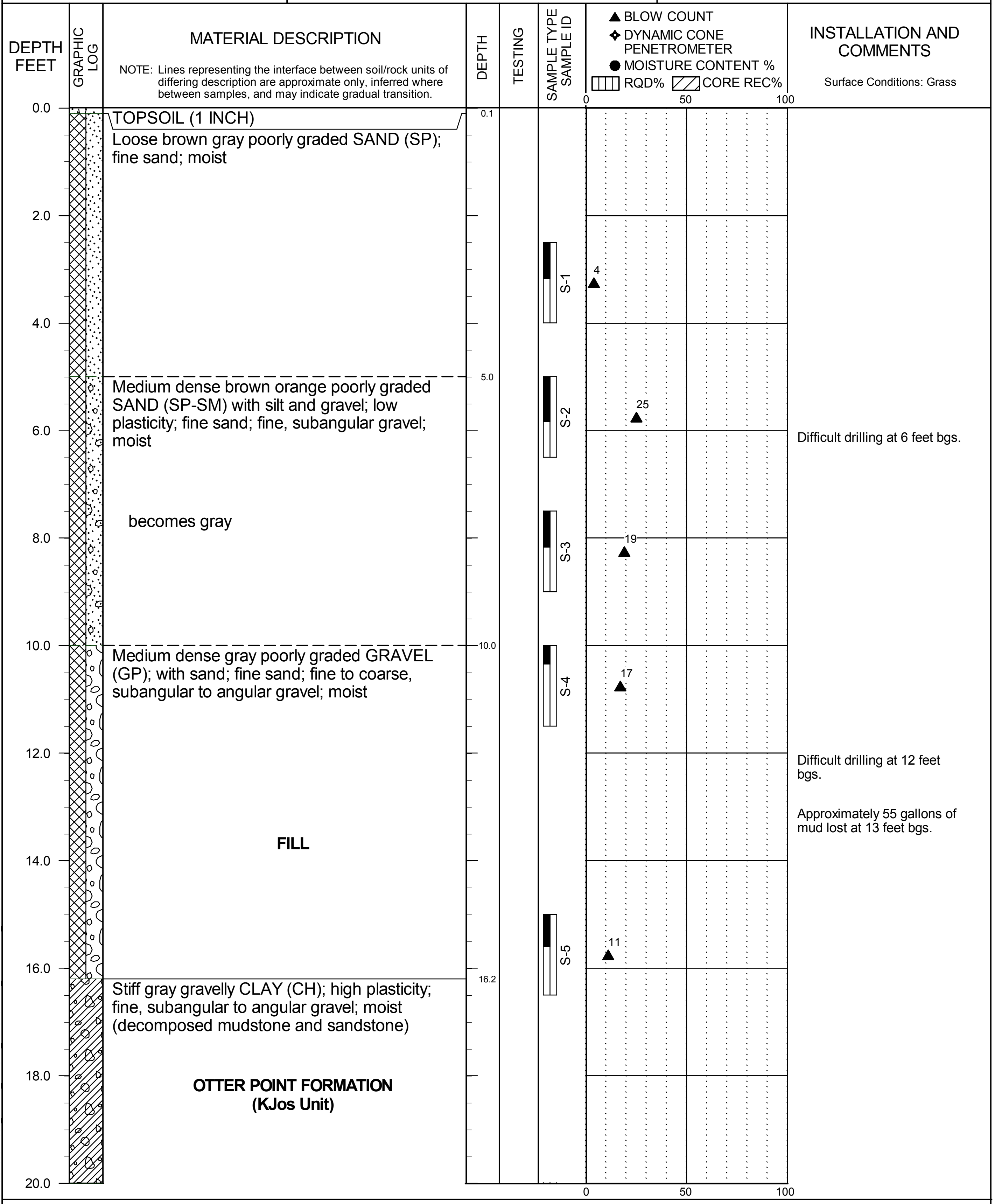
BORING B-2

APPROX. BORING B-2 LOCATION:
42.74100, -124.49929



MATERIAL DESCRIPTION

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

INSTALLATION AND COMMENTS

Surface Conditions: Grass

TOPSOIL (1 INCH)

Loose brown gray poorly graded SAND (SP); fine sand; moist

Medium dense brown orange poorly graded SAND (SP-SM) with silt and gravel; low plasticity; fine sand; fine, subangular gravel; moist

Difficult drilling at 6 feet bgs.

becomes gray

Medium dense gray poorly graded GRAVEL (GP); with sand; fine sand; fine to coarse, subangular to angular gravel; moist

Difficult drilling at 12 feet bgs.

Approximately 55 gallons of mud lost at 13 feet bgs.

FILL

Stiff gray gravelly CLAY (CH); high plasticity; fine, subangular to angular gravel; moist (decomposed mudstone and sandstone)

OTTER POINT FORMATION
(KJos Unit)

DRILLING METHOD: Mud Rotary
DRILLED BY: Hard Core Drilling
LOGGED BY: T. Rikli

BIT DIAMETER: 5.0 in
HAMMER EFFICIENCY PERCENT: 72
LOGGING COMPLETED: 2/19/16

FIGURE A2

BORING B-2
(continued)

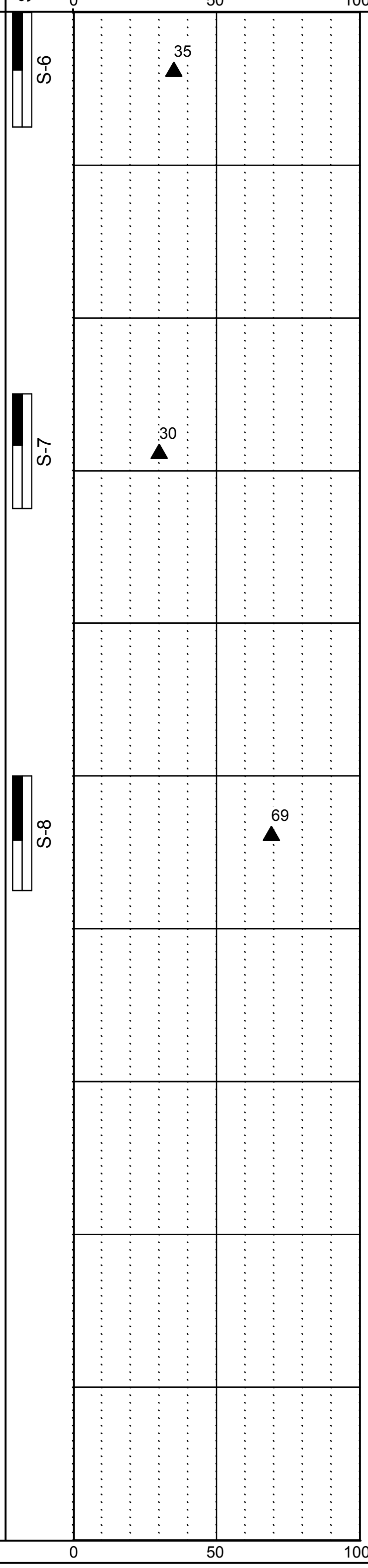
APPROX. BORING B-2 LOCATION:
42.74100, -124.49929

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

▲ BLOW COUNT
✥ DYNAMIC CONE PENETROMETER
● MOISTURE CONTENT %
▥ RQD%
▨ CORE REC%

Surface Conditions: Grass

DEPTH FEET	MATERIAL DESCRIPTION	DEPTH	TESTING	SAMPLE TYPE SAMPLE ID	BLOW COUNT	INSTALLATION AND COMMENTS
20.0	Hard gray gravelly CLAY (CH); high plasticity; fine, subangular to angular gravel; moist (decomposed mudstone and sandstone) **OTTER POINT FORMATION (KJos Unit)**	20.0		S-6	35	
25.0				S-7	30	Difficult drilling at 25 feet bgs.
30.0				S-8	69	
31.5	Boring completed at 31.5 feet bgs; boring backfilled with bentonite chips to existing ground surface. Groundwater was not observed due to the use of mud rotary drilling techniques.	31.5				



DRILLING METHOD: Mud Rotary
DRILLED BY: Hard Core Drilling
LOGGED BY: T. Rikli

BIT DIAMETER: 5.0 in
HAMMER EFFICIENCY PERCENT: 72
LOGGING COMPLETED: 2/19/16

FIGURE A2