Design Study
Terminal 3 & 4 Backlands Redevelopment – Gate Complex
Port of Tacoma, Tacoma, Washington

Prepared for
Moffatt & Nichol

September 22, 2017
19308-00
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Prepared by
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Terminal 3 & 4 Backlands Redevelopment – Gate Complex
Port of Tacoma, Tacoma, Washington

PURPOSE, SCOPE, AND USE OF THIS REPORT

The purpose of our work is to provide KPFF Consulting Engineers (KPFF) and its design and construction consultants with subsurface information, along with our interpretation and geotechnical engineering recommendations to support the design for the Pier 4 Reconfiguration Project.

Our scope of work for this project included:

- Assessing subsurface conditions using existing geotechnical data from historical geotechnical reports;
- Provide recommendations for design of new:
  - Shallow foundations,
  - RTG runway grade beams,
  - Underground utilities,
  - Pavement sections,
  - Light poles/luminaires, etc.,
  - Grading and backfilling with structural fill,
  - General dewatering recommendations; and
- Producing a geotechnical engineering design report.

We prepared this report for the exclusive use of Moffatt & Nichol for specific application to this project and site location. We completed the work according to generally accepted geotechnical practices in the same or similar localities, related to the nature of the work accomplished, at the time the services were accomplished. We make no other warranty, express or implied.

PROJECT UNDERSTANDING

The purpose of this project is to construct a new gate complex and reconfigure the backland container handling yard within Terminal 3 and 4 to align with the Pier 4 reconfiguration that is currently under construction.
SITE DESCRIPTION

Terminals 3 and 4 are located in the Port of Tacoma, within the General Central Peninsula (GCP) terminal complex. The site vicinity is shown on Figure 1 and the site location and existing soil boring locations are shown on Figure 2.

Site horizontal datum is Washington State Plane Coordinate System, South Zone, NAD 83/2007. Site vertical datum is Mean Lower Low Water (MLLW) based on Tide 22 Benchmark at the NE corner of 11th Street Bridge and Milwaukee Way at elevation 19.39 feet.

Existing ground surface is paved with asphalt or concrete. The existing ground surface elevation in the vicinity of the project is approximately elevation 17 feet.

SUBSURFACE CONDITIONS

Soil Conditions

The locations of historical borings in the site vicinity are shown on Figure 2. Generally, the site soils include interbedded zones of silt and sand of varying density. The soil density varies typically from loose, near the ground surface, to dense with increasing depth; however, there are zones of less dense and very dense soil scattered throughout the subsurface.

For structures founded within 10 feet below ground surface (bgs) the soil is expected to consist of sand to silty sand with assumed uniform total unit weight of 115 pounds per cubic foot (pcf) and internal angle of friction of 30 degrees.

Groundwater Conditions

Groundwater elevation in the upland area is expected to vary from about elevation 6 to 11 feet MLLW, or about 6 to 11 feet below planned ground surface (elevation 17 feet MLLW).

SEISMIC CONSIDERATIONS

Seismic Setting

The site is in a seismically active area. In this section, we describe the seismic setting at the project site, identify the seismic basis of design, provide our recommended design response spectra based on our site-specific seismic response analysis, and discuss the seismic hazards at the site.

The seismicity of Western Washington is dominated by the Cascadia Subduction Zone, in which the offshore Juan de Fuca Plate subducts beneath the continental North American Plate (Figure 3). Three types of earthquakes are associated with subduction zones: intraslab subduction, interface subduction, and crustal earthquakes.

Subduction Zone Sources are caused by the offshore Juan de Fuca Plate subducting below the North American Plate. This causes two distinct types of events. Large magnitude interface subduction
earthquakes occur at shallow depths near the Washington coast at the interface between the two plates (e.g., the 1700 earthquake, with magnitude of approximately 9.0). A deeper zone of seismicity is associated with bending and breaking of the Juan de Fuca Plate below the Puget Sound Region, which produces intraslab subduction earthquakes at depths of 40 to 70 kilometers (e.g., the 1949, 1965, and 2001 earthquakes). The intraslab events can produce earthquakes with magnitudes as large as 7.5. Figure 4 depicts the Cascadia Subduction Zone and the various types of earthquakes it can produce.

Recent fault trenching and seismic records in the Puget Sound area indicate a distinct shallow zone of crustal seismicity (e.g., Seattle and Tacoma Faults), which may have surficial expressions and can extend 25 to 30 kilometers deep. Figure 4 shows the position of the Puget Sound crustal faults in relation to the project site.

**Site Class and IBC Response Spectrum**

A downhole shear wave velocity survey was previously done in support of the Pier 4 reconfiguration (Hart Crowser 2015). The survey was conducted in Boring HC12-B5 (Hart Crowser 2014). The measured profile had a $V_{S30}$ (weighted average shear wave velocity in the upper 30 meters [100 feet]) of 495 feet per second, which corresponds to Site Class E. However, because the site contains potentially liquefiable soil, the site soils are classified as Site Class F.

The 2012 International Building Code (IBC; International Code Council 2012) requires a site-specific analysis to determine seismic parameters for Site Class F soils if the period of the structure is greater than 0.5 seconds. For structures with periods of vibration less than 0.5 seconds, the following code-based parameters may be used:

- Latitude = 47.27269 degrees;
- Longitude = -122.41085 degrees;
- Site Class: E;
- Mapped MCE$_R$, site class adjusted peak ground acceleration, $\text{PGA}_M = 0.45g$;
- Mapped MCE$_R$ spectral response acceleration at short periods, $S_S = 1.297 \, g$; and
- Mapped MCE$_R$ spectral response acceleration at 1-second periods, $S_1 = 0.503 \, g$.

**Liquefaction Potential**

Liquefaction is a phenomenon caused by a rapid increase in porewater pressure that reduces the effective stress between soil particles, resulting in the sudden loss of shear strength in the soil. Granular soils that rely on inter-particle friction for strength are susceptible to liquefaction until the excess pore pressures can dissipate. Sand boils and flows observed at the ground surface after an earthquake are the result of excess pore pressures dissipating upward, carrying soil particles with the draining water. In general, loose, saturated sandy soils with low silt and clay contents are the most susceptible to liquefaction. Silty soils with low plasticity are moderately susceptible to liquefaction under relatively higher levels of ground shaking. For any soil type, the soil must be saturated for liquefaction to occur. Liquefaction can cause ground surface settlement and lateral spreading.
In general, we anticipate widespread liquefaction between the groundwater table and approximately elevation –30 feet, and limited or localized zones of liquefaction below elevation –30 feet. Some explorations indicate that localized zones of soft or loose liquefiable deposits are present at depths as great as 220 feet bgs. However, the depth of potential liquefaction is often limited to 80 feet bgs, following guidance in WSDOT Geotechnical Design Manual (WSDOT 2014). WSDOT has historically adopted an 80-foot limit because simplified procedures for estimating liquefaction potential, such as Idriss and Boulanger, are only calibrated for depths down to approximately 50 to 60 feet, and observations of liquefaction suggest that the effects of liquefaction become less significant as the depth of the liquefiable layer increases. It is also difficult and expensive to mitigate and design against liquefaction at these great depths.

**Post-Liquefaction Vertical Settlement**

Post-liquefaction settlement occurs because liquefiable soils are redistributed and become denser after an earthquake. The ground surface settlement is not typically uniform across the area, and can result in significant differential settlement.

A previous study (Hart Crowser 2015) calculated liquefaction induced settlement in the vicinity of the Pier 4 reconfiguration and estimated settlement on the order of 4 to 20 inches across the site. In our opinion, the soil conditions across the site are such that this range of potential settlement is also representative of the breadth of Terminal 3 and 4. Note, this estimate only includes strains in the upper 80 feet of soil. This is a reasonable assumption for ground surface settlement, because research has shown that volumetric contractions at depths greater than 60 feet may not manifest as surface settlement (Cetin et al. 2009).

Because these are broad ranges of settlement, we recommend that structures being designed to withstand the design earthquake be specifically addressed based on the nearest available boring data.

**Fault Surface Rupture**

Terminals 3 and 4 are approximately 10 miles southeast of the easternmost splay of the east–west Tacoma fault, as mapped by Brocher et al. (2004). Figure 4 is a map of the Tacoma fault and other known faults in the region. The last known rupture of the Tacoma fault occurred approximately 1,000 years ago. Based on current knowledge, the hazard of surface rupture at the site is considered to be very low.

**DESIGN RECOMMENDATIONS**

**Shallow Foundation Soil Capacities**

These recommendations are applicable to lightly loaded structures bearing on shallow spread footings including the following structures:

- Radiation Portal Monitor
- Optical Character Recognition system
- Gate arm pedestal
• Intercom pedestal
• Guard platform slab
• Transformer and switchgear pads
• USCBP booth
• Camera bridge
• TWIC booth.

We recommend the following:

■ Shallow footings should bear directly on a minimum 2-foot-thick layer of well-compacted structural fill material. This two foot zone can consist of overexcavated and backfilled material or recompaction (as necessary) of the material encountered at the base of the footing excavation.

■ Use a maximum allowable bearing pressure of 1.5 kips per square foot (ksf)

■ The bottom of foundation should be buried at least 1.5 feet below the lowest adjacent grade.

■ The allowable soil bearing pressure may be increased up to one-third for loads of short duration, such as those caused by wind or seismic forces.

■ Lateral loads may be resisted by passive earth pressure and base friction; however, we recommend ignoring the upper 2 feet of soil unless that soil is protected from erosion by permanent hardscaping. For foundations placed directly against the existing soil, use an allowable equivalent fluid passive earth pressure of 230 pcf (105 pcf below the water table) and an allowable base sliding coefficient of friction of 0.35. These allowable values include a factor of safety of 1.5.

■ Lateral soil loads from adjacent, existing soil may be applied as an active earth pressure with an equivalent fluid unit weight of 38 pcf (18 pcf below the groundwater table). Use of an active earth pressure presumed that the wall is able to laterally deflect at least 0.001H, where H is the buried height of the wall.

■ Unless permanently drained, structures should be designed for full hydrostatic groundwater pressure. If permanent drainage is provided, then full hydrostatic ground pressure need only be applied below the bottom of the permanent drainage.

■ The bottom of footings should be located outside of an imaginary 45-degree plane projected upward from the bottom edge of any adjacent footings or utility trenches. For footings inside this plane, loads may be transferred through the soil to the deeper footing and the combined load could be in excess of the design allowable bearing capacity and/or an adjacent structure needs to be designed for the lateral load caused by the footing. When footings cannot be located outside of the 45-degree plane, consult with Hart Crowser to assess potential design implications.
Vertical Modulus of Subgrade Reaction for Shallow Foundations

Use a modulus of subgrade reaction based on a 1-foot-by-1-foot square plate \([k_{(1\times1)}]\) of 200 pounds per cubic inch. Use the equations below to calculate the appropriate modulus of subgrade reaction for different foundation sizes and shapes:

For a square foundation of size \(B \times B\):

\[
k_{(B \times B)} = k_{(1\times1)} \frac{(B+1)^2}{4B^2} \quad \text{for footings where } B \leq 20 \text{ feet}
\]

\[
k_{(B \times B)} = k_{(1\times1)} \frac{(B+1)^2}{2B^2} \quad \text{for footings where } B \geq 40 \text{ feet}
\]

For footings where \(20 < B < 40\), perform linear interpolation using the two equations above.

For a rectangular foundation of size \(B \times L\):

\[
k = k_{(B \times B)} \frac{(1+0.5\frac{B}{L})}{1.5}
\]

Where:

- \(k\) = modulus of subgrade reaction of rectangular footing;
- \(k_{(B \times B)}\) = modulus of subgrade reaction of square footing;
- \(k_{(1\times1)}\) = modulus of subgrade reaction of footing with dimensions of 1 foot by 1 foot;
- \(B\) = footing width; and
- \(L\) = footing length.

Truck Scale Foundation

We understand that the scale manufacturer requires a minimum 2,500 psf allowable bearing capacity and does not provide a modulus of subgrade reaction requirement. We recommend that the areas under the scale footings be overexcavated at least 3.0 feet and then backfilled as previously recommended in the recommendations for shallow foundations section of this report.

Short Mast Light Poles

Design of short mast light poles may be designed using an allowable equivalent fluid passive earth pressure of 150 pcf above the water table and 65 pcf below the water table. If applicable, a lateral base sliding coefficient of friction of 0.25 may also be used. These allowable values include a factor of safety of 2.0.
Foundation design within 10 feet of sloping ground steeper than 2H:1V should be reviewed by Hart Crowser.

**High Mast Luminaire**

High mast luminaires are expected to consist of light poles up to 110 feet tall. We understand that these light poles may have approximately 900 kip-ft of moment, 10 kips of shear force, and 9 kips of axial force (unfactored).

The locations of new High Mast Luminaires are not finalized; therefore, for this report, we are providing preliminary design values. Also, for final design, we recommend doing new soil borings at the locations of the new High Mast Luminaires.

Based on our experience and on standard practice for similar projects, we recommend using deep foundations, typically 4-foot-diameter drilled shafts, to support the luminaires. We recommend a minimum shaft embedment of 25 feet bgs. The vertical capacity is well in excess of the anticipated vertical loads; therefore, we do not anticipate that vertical loads will control the design. For lateral capacity design, we preliminarily recommend the LPILE soil parameters in Table 1.

To avoid lateral group effects, drilled shaft center-to-center spacing should be greater than five times the shaft diameter.

Drilled shaft foundation design within 10 feet of sloping ground steeper than 2H:1V should be reviewed by Hart Crowser.

**Table 1 – LPILE Soil Profile for High Mast Luminaire Deep Foundations**

<table>
<thead>
<tr>
<th>Elevation in feet (MLLW)</th>
<th>Soil Type</th>
<th>Effective Unit Weight in pcf</th>
<th>Friction Angle in degrees</th>
<th>P-multiplier $m_p$</th>
<th>P-Y Modulus (k) in pci</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 to 8</td>
<td>API Sand</td>
<td>115</td>
<td>30</td>
<td>1</td>
<td>43</td>
</tr>
<tr>
<td>8 to -20</td>
<td>API Sand</td>
<td>53</td>
<td>30</td>
<td>1 [0.1]</td>
<td>32</td>
</tr>
</tbody>
</table>

a. For liquefied conditions, the P-multiplier in [ ] should be applied in the LPILE analysis.

**Pavement**

**Pavement Basis of Design**

From our review of the Draft Basis of Design document (Moffatt & Nichol 2017), we understand that a formal pavement assessment was not included in the scope of work for this initial effort. Without knowledge of existing pavement conditions, pavement section thicknesses, subgrade conditions, and load magnitude and repetition data, calculations for pavement thickness and estimated service life is possible.

The goal of new paving work in this project will be to restore damaged areas to a serviceable condition. Full depth repairs will be provided with the intent that the repaired pavement have performance characteristics similar to the existing pavement in the vicinity of improvements that require demolition,
trenching, minor regrading, or other construction operations. These pavements are expected to perform similar to existing pavements that are remaining in service. We understand that this approach to pavement repair is acceptable to the owner and their tenants.

It should be noted that based on past historical practice in heavy container cargo areas the Port has typically used an asphalt pavement section consisting of 8 inches of asphaltic concrete over 12 inches of crushed base course.

We recommend that, at a minimum, observing the as-built construction of the existing pavement sections and using that information as a basis for the proposed pavement sections.

**Pavement Design Recommendations**

These recommendations assume a minimum of 2 feet of structural fill or equivalent existing fill subgrade. Recommendations for over-excavation and replacement as previously noted for foundations is also applicable for pavement subgrade.

**Asphalt**

Asphalt pavement design may assume a subgrade resilient modulus of 10,000 psi.

**Concrete**

Design for concrete pavement may use a modulus of subgrade reaction of 260 psi, assuming that the concrete will be placed on a compacted structural fill subgrade.

**Utilities**

In general, we recommend that utility trench cut design be the contractor’s responsibility. For shallow trench excavations, less than 4 feet deep, open cutting is not prohibited. Temporary shoring may be necessary if deeper excavation is required for utility placement or if the soils are unstable. The contractor should verify the condition of the side slopes during construction, and lay back trench cuts as necessary to conform to current standards of practice. We can provide additional recommendations as required.

**Buried Structures**

The following recommendations are for design and construction of proposed stormwater structures, manholes, catch basins, and similar underground structures extending less than 10 feet bgs:

- Lateral active earth pressure of 38 pcf above the gwt and 18 pcf below the gwt
- Lateral at-rest earth pressure of 55 pcf above the gwt and 24 pcf below the gwt
- Lateral allowable passive earth pressure of 230 pcf above the gwt and 105 pcf below the gwt
- Lateral allowable base sliding coefficient of 0.35
Lateral seismic earth pressure increment of 9·H psf, where H is the buried wall height, applied as a uniform, rectangular pressure distribution.

For structures bearing above the groundwater table, overexcavation may be required if soft or loose material is encountered during footing excavation. A Hart Crowser field representative should determine the need for, and extents of, overexcavation. If the overexcavated soil is suitable for recompaction, it can be reused.

For foundation subgrades below the groundwater table, we expect that soft or loose conditions will be encountered when excavations reach planned foundation elevations and may require overexcavation. The need for overexcavation should be determined in the field during construction by a Hart Crowser representative. For planning, assume that overexcavation will extend 3 feet below the design foundation subgrade elevation. The overexcavation should be backfilled with free draining quarry spalls (or similar) and the quarry spalls should be wrapped in a geotextile fabric. The quarry spalls should be compacted by thoroughly tamping with the heel of an excavator bucket or by using a similar procedure. A minimum of 6-inch thickness of crushed surfacing base course (CSBC) should then be placed on top of the quarry spalls up to plan foundation subgrade elevation. The geotextile fabric needs to be of sufficient toughness to withstand quarry spalls being dropped from the height of the max excavation depth.

**Dewatering Recommendations**

Structures extending below the water table will require dewatering to maintain a safe and workable excavation. To provide a workable subgrade, the dewatering should lower the water at least 2 feet below the bottom of planned excavation (including potential over-excavation).

For planning purposes, assume the groundwater table is located 6 feet below ground surface.

**CONSTRUCTION RECOMMENDATIONS**

**Structural Fill**

Soil placed beneath structures, surrounding utilities, or below paved areas should be considered structural fill. In these fill areas, we recommend the following:

- For imported soil to be used as structural fill, use a clean, well-graded sand or sand and gravel with less than 5 percent by weight passing the No. 200 mesh sieve (based on the minus 3/4-inch fraction) for wet-weather grading. Compaction of material containing more than about 5 percent fine material may be difficult if the material is wet or becomes wet during rainy weather. During dry weather grading, the fines content may be increased provided that the soil is compacted near its optimum moisture content.

- For structural fill placed as crushed surfacing base course below pavement and sidewalks, use material that meets the requirements of WSDOT Standard Specification 9-03.9[3].
Place structural fill only on a dense and non-yielding subgrade.

Place and compact all structural fill in lifts with a loose thickness no greater than 10 inches. If small, hand-operated compaction equipment is used to compact structural fill, lifts should not exceed 6 inches in loose thickness.

Control the moisture content of the fill to within 2 percent of the optimum moisture (the moisture content corresponding to the maximum modified Proctor dry density).

Require compaction of at least 95 percent below all structures, slabs-on-grade, pavement, or sidewalks. The minimum dry densities recommended here are a percentage of the modified Proctor maximum dry density as determined by the ASTM D1557 test procedure.

If wet subgrade areas are encountered during foundation or pavement section preparation, clean material with a gravel content (material coarser than a US No. 4 sieve) of at least 30 to 35 percent may be necessary.

Have a Hart Crowser geotechnical engineer or engineering geologist verify the compacted densities of each lift.

Before fill control can begin, the compaction characteristics must be determined from representative samples of the structural and drainage fill. Samples should be obtained as soon as possible. A study of compaction characteristics should include determination of optimum and natural moisture content, maximum dry density, and gradation of the soil.

**Use of On-Site Soil as Structural Fill**

The suitability of excavated site soil for use as compacted structural fill depends on the gradation and moisture content of the soil when it is placed. As the amount of fines (the portion passing the No. 200 sieve) increases, the soil becomes increasingly sensitive to small changes in moisture content, and adequate compaction becomes more difficult to achieve. Soil containing more than about 5 percent fines cannot be consistently compacted to a dense non-yielding condition when the water content is greater than about 2 percent above or below optimum. To be reusable, soil must also be free of organic and other compressible materials.

Based on our prior experience at the Port of Tacoma, the on-site soil likely has a fines content great enough to make it moisture-sensitive when wet. It is possible that the soil could be used as fill during the drier summer construction season, especially if the material can be aerated using dozers or discs. During periods of wet weather, it will be more difficult to use these materials. Earthwork operations would need to be scheduled for periods of dry weather to keep the moisture content of the material near its optimum level.
Shallow Foundation Construction

- Before placing concrete for footings, subgrade soil should be in a very dense, non-yielding condition. Any disturbed soil should be removed. Also, mud mats may be necessary to protect silty subgrade soil from being disturbed during construction after it is exposed.

- Have our representative observe exposed subgrades before footing construction to verify design assumptions about subsurface conditions and subgrade preparation.

- The exposed subgrade should be carefully prepared and protected before concrete placement. Any loosening of the materials during construction could result in more settlement. It is important that foundation excavations be cleaned of loose or disturbed soil before placing any concrete and that there is no standing water in any foundation excavation. These conditions should be observed by our representative.

- Maintain groundwater levels at least 2 feet below the base grade of the footing excavation at all times to prevent the risk of heave, piping, boiling, and other loss or disturbance of subgrade material. This groundwater level should be maintained until after the footing steel and concrete are placed.

- Any loose to medium dense sand and soft to medium stiff silt that occurs naturally or is disturbed during construction, should be overexcavated and replaced with lean concrete for footings. Any visible organic and other unsuitable material should be removed from the exposed subgrade.

Temporary Cuts

Because of the variables involved, actual slope grades required for stability in temporary cut areas can only be estimated before construction. We recommend that stability of the temporary slopes used for construction be the sole responsibility of the contractor, since the contractor is in control of the construction operation and is continuously at the site to observe the nature and condition of the subsurface. Excavations should be made in accordance with all local, state, and federal safety requirements.

For planning purposes, temporary slopes constructed in fill soils above the water table should be constructed no steeper than 1.5H:1V. Flatter slopes may be necessary where seepage or sloughing is observed or to conform to safety requirements.

The stability and safety of open trenches and cut slopes depend on a number of factors, including:

- Type and density of the soil;

- Presence and amount of any seepage;

- Depth of cut;

- Proximity of the cut to any surcharge loads near the top of the cut, such as stockpiled material, traffic loads, structures, etc.;
Duration of the open excavation; and

Care and methods used by the contractor.

Based on these factors, we recommend:

- No traffic, construction equipment, stockpiles or building supplies be allowed within at least 5 feet from the top of the cut.

- Exposed soil should be protected from surface erosion using plastic sheeting, shotcrete, etc.

- Limit the duration of open excavations as much as possible.

- Surface water should be diverted away from exposed soil.

- The condition of soil, slopes, and open cuts should be re-evaluated throughout construction by a Competent Person.

RECOMMENDATIONS FOR CONTINUING GEOTECHNICAL SERVICES

Throughout this report, we have provided recommendations where we believe it is appropriate for Hart Crowser to provide additional geotechnical input to the design and construction process. Many of these recommendations and some additional recommendations are summarized in this section.

Continuing Design and Consultation Services

Before construction begins, we recommend that Hart Crowser:

- Continue to meet with the design team as needed to address geotechnical questions that may arise throughout the remainder of the design process;

- Drill new geotechnical borings at the High Mast Luminaire locations and provide revised geotechnical recommendations for foundation design;

- Review the project plans and specifications to see that the geotechnical engineering recommendations are properly interpreted.

Construction Services

During the construction phase of the project, we recommend retaining Hart Crowser to:

- Review applicable submittals;

- Observe installation of piles and ground improvement;

- Observe shallow foundation subgrade conditions;
■ Observe installation of deep foundations;

■ Consult with the construction team as needed; and

■ Respond to other geotechnical engineering considerations that may arise during construction.

REFERENCES


Figure 3

Terminal 3 & 4 Backlands Redevelopment - Gate Complex
Tacoma, Washington

Cascadia Subduction Zone Earthquake Sources
19308-00

Note: Base map prepared from drawing provided by USGS and the University of Washington, 2001.

<table>
<thead>
<tr>
<th>Source</th>
<th>Maximum Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascadia Subduction Zone - Interface</td>
<td>9.0</td>
</tr>
<tr>
<td>Cascadia Subduction Zone - Intraslab</td>
<td>7.5</td>
</tr>
<tr>
<td>Crustal Faults</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Regional Fault Zones

Tacoma, Washington

Terminal 3 & 4 Backlands Redevelopment - Gate Complex

0 10 20
Scale in Miles

Utsalady Point Fault Zone
South Whidbey Island Fault Zone
Seattle Fault Zone
Hood Canal Fault Zone
Saddle Mountain Fault Zone
Tacoma Fault Zone
Puget Sound
Seattle
Port of Tacoma
APPENDIX A
Historical Subsurface Data
APPENDIX A

Historical Subsurface Data

We collected historical subsurface data from geotechnical reports completed by Hart Crowser and others for past projects at Terminal 3 and 4. These data are compiled in this appendix. The approximate locations of the boring logs from these data are shown on Figure 2 of the main report, actual locations may differ from those shown.
Geotechnical Engineering Design Study
Terminals 3 and 4 Redevelopment
Port of Tacoma, Washington

Prepared for
BERGER/ABAM Engineers

April 27, 2005
17100-00

Prepared by
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Site and Exploration Plan

Exploration Location and Number

HC05-03  Boring (Hart Crowser, 2005)
HC04-01  Boring (Hart Crowser, 2004)
HC04-02  Boring (Hart Crowser, 2003)
S1B-2  Boring (Hart Crowser, 2000)
HC-103  Boring (Hart Crowser, 2000)

T3B-12  Boring (Hart Crowser, 1987)
T3B-6  Boring (Hart Crowser, 1986)
T3P-6  Probe (Hart Crowser, 1986)
MW1S-00  Boring (Conestayo-Rovers, 2000)

Cross Section Location and Designation

0  300  600
Scale in Feet

Figure 2
APPENDIX A
FIELD EXPLORATIONS METHODS AND ANALYSIS

This appendix documents the processes Hart Crowser used in determining the nature of the soils underlying the project site addressed by this report. The discussion includes information on the following subjects:

- Explorations and Their Location;
- The Use of Auger Borings;
- The Use of Mud Rotary Borings;
- Standard Penetration Test (SPT) Procedures;
- Use of Shelby Tubes; and
- The Use of Cone Penetrometer Probes.

Explorations and Their Location

Subsurface explorations for this project include fourteen hollow-stem auger borings and four mud rotary boring. Existing subsurface explorations completed by Hart Crowser in the project area include six hollow-stem auger borings and four cone penetrometer probes. The exploration logs within this appendix show our interpretation of the drilling, sampling, and testing data. They indicate the depth where the soils change. Note that the change may be gradual. In the field, we classified the samples taken from the explorations according to the methods presented on Figure A-1 - Key to Exploration Logs. This figure also provides a legend explaining the symbols and abbreviations used in the logs.

Location of Explorations. Figure 2 shows the location of explorations, located by hand taping or pacing from existing physical features. The ground surface elevations at these locations were estimated from known elevations at adjacent locations. Previous explorations were located in the field by differential Global Positioning System (DGPS) or by hand pacing or taping from existing physical structures. Hydrographic survey techniques were used to estimate the mudline surface elevations for offshore explorations. The method used determines the accuracy of the location and elevation of the explorations.

The Use of Auger Borings

With depths ranging from 11.5 to 100.0 feet below the ground surface, fourteen hollow-stem auger borings (designated HC04-01 and HC04-03 through HC04-15), were drilled from August 19 to August 27, 2004. Borings S1B-1, S1B-2, HC-104, T3B-12, T3B-6, and T3B-9 were drilled during previous studies and have depths ranging from 42.5 to 161.5 feet below the ground surface. The borings used a 3-3/8-inch inside diameter hollow-stem auger and were advanced
with a truck-mounted drill rig subcontracted by Hart Crowser. The drilling was continuously observed by an engineering geologist from Hart Crowser. Detailed field logs were prepared of each boring. Using the Standard Penetration Test (SPT), we obtained samples at 2-1/2- to 5-foot-depth intervals.

The boring logs are presented on Figures A-5 and A-7 through A-30 at the end of this appendix.

**The Use of Mud Rotary Borings**

With a depth of 129.0 to 150.5 feet below the ground surface, four mud rotary borings, designated HC04-02, HC05-01, HC05-02, and HC05-03 were drilled on August 24, 2004, and February 18 through 24, 2005. The boring used a 4-7/8-inch-diameter drag bit and was advanced with a truck-mounted drill rig subcontracted by Hart Crowser. The drilling was continuously observed by a geotechnical engineer from Hart Crowser. A detailed field log was prepared of the boring. Using the SPT, we obtained samples at 2-1/2- to 5-foot-depth intervals.

The boring logs are presented on Figures A-2 through A-4 and A-6 at the end of this appendix.

**Standard Penetration Test (SPT) Procedures**

This test is an approximate measure of soil density and consistency. To be useful, the results must be used with engineering judgment in conjunction with other tests. The SPT (as described in ASTM D 1586) was used to obtain disturbed samples. This test employs a standard 2-inch outside diameter split-spoon sampler. Using a 140-pound hammer, free-falling 30 inches, the sampler is driven into the soil for 18 inches. The number of blows required to drive the sampler the last 12 inches only is the Standard Penetration Resistance. This resistance, or blow count, measures the relative density of granular soils and the consistency of cohesive soils. The blow counts are plotted on the boring logs at their respective sample depths.

Soil samples are recovered from the split-barrel sampler, field classified, and placed into water-tight jars. They are then taken to Hart Crowser's laboratory for further testing.

**In the Event of Hard Driving**

Occasionally very dense materials preclude driving the total 18-inch sample. When this happens, the penetration resistance is entered on logs as follows:
Penetration less than 6 inches. The log indicates the total number of blows over the number of inches of penetration.

Penetration greater than 6 inches. The blow count noted on the log is the sum of the total number of blows completed after the first 6 inches of penetration. This sum is expressed over the number of inches driven that exceed the first 6 inches. The number of blows needed to drive the first 6 inches are not reported. For example, a blow count series of 12 blows for 6 inches, 30 blows for 6 inches, and 50 (the maximum number of blows counted within a 6-inch increment for SPT) for 3 inches would be recorded as 80/9.

The Use of Cone Penetrometer Probes

As part of work previously completed for Terminal 3, Hart Crowser used a cone penetrometer to probe the subgrade soils. Completed by Subterranean, Inc., of Gig Harbor, the probes (designated T3P-1, T3P-5, T3P-6 and T3P-8) were advanced to depths ranging from 75 to 105 feet below the ground surface. They used a Begemann type cone (see Figure A-23). The system was mounted on a truck or barge that provided the necessary reaction for the applied loads.

The cone and its sleeve provide information by which we can interpret the density and consistency of the soils. A direct correlation exists between the point of resistance of the cone and the bearing capacity in the soil. Another direct correlation exists between the friction registered on the sleeve and the friction characteristics of the soil. We use the penetrometer results in conjunction with the soil classification chart developed by Schmertmann (1978) (see Figure A-23).

Friction Values and Soil Type. Generally, a friction ratio less than 2 indicates sand; a ratio between 2 and 4 indicates a silt-sand mixture, clayey sand, or silt; and ratios greater than 4 indicate a clayey silt or clay.

Logs of cone penetrometer probes are presented on Figures A-24 through A-27.
Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

### Density/Consistency
Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

<table>
<thead>
<tr>
<th>SAND or GRAVEL</th>
<th>Standard Penetration Resistance (N) in Blows/Foot</th>
<th>SILT or CLAY</th>
<th>Standard Penetration Resistance (N) in Blows/Foot</th>
<th>Approximate Shear Strength in TSF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td></td>
<td>Consistency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very loose</td>
<td>0 - 4</td>
<td>Very soft</td>
<td>0 - 2</td>
<td>&lt;0.125</td>
</tr>
<tr>
<td>Loose</td>
<td>4 - 10</td>
<td>Soft</td>
<td>2 - 4</td>
<td>0.125 - 0.25</td>
</tr>
<tr>
<td>Medium dense</td>
<td>10 - 30</td>
<td>Medium stiff</td>
<td>4 - 8</td>
<td>0.25 - 0.5</td>
</tr>
<tr>
<td>Dense</td>
<td>30 - 50</td>
<td>Stiff</td>
<td>8 - 15</td>
<td>0.5 - 1.0</td>
</tr>
<tr>
<td>Very dense</td>
<td>&gt;50</td>
<td>Very stiff</td>
<td>15 - 30</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard</td>
<td>&gt;30</td>
<td>&gt;2.0</td>
</tr>
</tbody>
</table>

### Moisture

- **Dry**  Little perceptible moisture
- **Damp** Some perceptible moisture, probably below optimum
- **Moist** Probably near optimum moisture content
- **Wet**  Much perceptible moisture, probably above optimum

### Minor Constituents

- Not identified in description 0 - 5
- Slightly (clayey, silty, etc.) 5 - 12
- Clayey, silty, sandy, gravelly 12 - 30
- Very (clayey, silty, etc.) 30 - 50

### Sampling Test Symbols

**Boring Samples**
- Split Spoon
- Shelby Tube
- Cuttings
- Core Run

**Test Pit Samples**
- Grab (Jar)
- Bag
- Shelby Tube

**Legends**
- * No Sample Recovery
- P  Tube Pushed, Not Driven

### Groundwater Observation Wells

- Monument
- Surface Seal
- Gravel Backfill
- Riser Pipe
- Bentonite
- Water Level on Date or at Time of Drilling (ATD)
- Well Screen
- Sand Pack
- Native Material
- Groundwater Seepage (Test Pits)

### Test Symbols

- GS  Grain Size Classification
- CN  Consolidation
- UU  Unconsolidated Undrained Triaxial
- CU  Consolidated Undrained Triaxial
- CD  Consolidated Drained Triaxial
- QU  Unconfined Compression
- DS  Direct Shear
- K   Permeability
- PP  Pocket Penetrometer
- TV  Approximate Compressive Strength in TSF
- Torvane
- CBR  California Bearing Ratio
- MD  Moisture Density Relationship
- AL  Atterberg Limits
  - Water Content in Percent
  - Liquid Limit
  - Natural Plastic Limit
- PID  Photoionization Detector Reading
- CA  Chemical Analysis
- WOR  Weight of Rod
- WOH  Weight of Hammer

**Figure A-1**
Boring Log HC05-01

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 15

Medium dense, wet, brown, sandy GRAVEL. (FILL)
- Becomes slightly sandy.

Becomes slightly silty and sandy.

Loose, wet, dark gray-brown, gravelly, fine to medium SAND. (FILL)

Medium dense, wet, dark gray, slightly sandy GRAVEL. (FILL)
- Becomes GRAVEL.

Becomes sandy.

Note: Blow count may not be representative of actual densities due to presence of gravels and cobbles.

Very stiff, wet, dark gray, very sandy SILT with sheen and strong petroleum-like odor.
- Grades to loose to medium dense, silty, fine SAND.

Grades to slightly silty.

---

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC05-01

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 15

Very stiff, wet, dark gray, very sandy SILT with sheen and strong petroleum-like odor.

Loose to medium dense, wet, dark gray, silty, fine SAND.

Grades to slightly silty.

Grades to silty.

Grades to very silty.

Becomes slightly silty.

Bottom of Boring at 149.0 Feet.
Completed 02/18/05.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC05-02

Soil Descriptions

Approximate Ground Surface Elevation in Feet: 15

- Very dense, wet, gray-brown, slightly silty, very sandy GRAVEL. (FILL)

- Loose to very dense, wet, brown, gravelly, medium to coarse SAND. (FILL)

- Loose to very dense, wet, brown, very sandy GRAVEL. (FILL)

- Becomes sandy.

- Becomes slightly silty and very sandy.

- Very dense, wet, brown, fine to medium SAND with trace gravel. (FILL)

  Note: Blow count may not be representative of actual densities due to presence of gravels and cobbles.

- Stiff, wet, dark gray, slightly sandy SILT.

- Grades to very sandy SILT to very silty SAND.

- Grades to slightly silty, fine to medium SAND.

- Medium stiff to stiff, wet, dark gray, slightly clayey SILT with trace sand.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC05-02

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 15

Medium stiff to stiff, wet, dark gray, slightly clayey SILT with trace sand.
Grades to slightly sandy SILT.

Medium dense, wet, dark gray, slightly silty, fine SAND with trace shell fragments.
Grades to very silty.

Stiff, wet, dark gray, slightly clayey, sandy SILT.

Medium dense to dense, wet, dark gray, silty, fine SAND.
1-foot seam of slightly clayey, sandy SILT.

Grades to slightly silty.

Trace shell fragments.

Bottom of Boring at 150.5 Feet.
Completed 02/22/05.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC05-03

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 15

Loose to very dense, damp, light gray, sandy GRAVEL. (FILL)

Becomes wet, gray-brown, gravelly SAND.

Becomes very gravelly SAND to very sandy GRAVEL.

Becomes sandy GRAVEL.

Medium dense to dense, wet, brown, slightly gravelly SAND. (FILL)

Becomes slightly sandy GRAVEL.

Becomes slightly gravelly SAND.

Medium dense, wet, dark gray, silty, fine SAND with trace shell fragments.

5-inch sandy SILT seam.

Very soft, wet, dark gray SILT with trace sand.

Becomes slightly clayey.

Trace shell fragments.

Becomes slightly sandy.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC05-03

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 15

Very soft, wet, dark gray SILT with trace sand.

5-foot zone of very silty SAND to very sandy SILT.

Becomes slightly sandy.

Medium dense to dense, wet, dark gray, silty, fine SAND.
2-foot zone of sandy SILT.

Grades to very silty.

Soft, wet, dark gray, slightly clayey, slightly sandy SILT.

Medium dense to dense, wet, dark gray, very silty, fine SAND.

Bottom of Boring at 150.0 Feet.
Completed 02/24/05.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC04-01

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 15

- Medium dense, moist, brown, slightly silty, gravelly SAND with cobbles
- Very loose to medium dense, moist, brown, very gravelly SAND.
- Becomes wet.
- Grades to gray-brown, very sandy GRAVEL.
- Petroleum odor
- Grades to very gravelly SAND.
- Grades to very sandy GRAVEL.
- Medium dense, wet, brown, gravelly SAND.
- Very loose to loose, wet, dark gray, very silty fine SAND.

STANDARD PENETRATION RESISTANCE

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
17100-00 08/04
Figure A-5 1/2
Boring Log HC04-01

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 15

Very loose to loose, wet, dark gray, very silty fine SAND.

Grades to very silty.

Grades to silty

Medium dense, wet, dark gray, sandy SILT.

Bottom of Boring at 100.0 Feet. Completed 08/19/04.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC04-02

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

Medium dense, moist, brown, very gravelly SAND.

Very loose to loose, wet, dark brown, slightly silty SAND with traces of wood debris.

Medium dense, wet, black slightly silty SAND with shell fragments.

Very loose to loose, wet, gray to black, silty SAND with shell fragments and wood debris.

Medium dense, wet, gray to black silty SAND with shell fragments.

Medium dense, wet, black SAND with shell fragments.

STANDARD PENETRATION RESISTANCE

LAB TESTS

Sample
△ Blows per Foot

1  2  5  10  20  50  100

· Water Content in Percent

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

Medium dense, wet, dark gray brown, silty to slightly silty SAND with occasional shell fragments.

Bottom of Boring at 129.0 Feet.
Completed 08/24/04.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC04-03

Soil Descriptions

Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement
- Medium dense, damp, brown, slightly silty, gravelly SAND. (ROAD BASE)
- Dense, damp, brown, slightly silty, very gravelly SAND.
- Medium dense, wet, brown, very gravelly SAND.
- Loose, wet, brown, very gravelly SAND.

Bottom of Boring at 11.5 Feet.
Completed 08/20/04.

STANDARD PENETRATION RESISTANCE

LAB TESTS

Sample | Blows per Foot
--- | ---
G-1 | 3
S-1 | 2
*S-2 | 1
S-3 | 2
S-4 | 3

Water Content in Percent

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log HC04-04**

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement.
  - Medium dense, damp, brown, very gravelly SAND. (ROAD BASE)
- Loose, moist to wet, dark brown SAND.
- Very loose, wet, dark brown SAND with trace wood debris.

Bottom of Boring at 11.5 Feet.
Completed 08/20/04.

---

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement.
- Medium dense, damp, brown, slightly silty, very gravelly SAND (ROAD BASE)
  - Loose to medium dense, moist, dark brown SAND.
- Loose, wet, dark brown, slightly silty SAND.
- Loose, wet, dark brown, well sorted SAND with shell fragments.

Bottom of Boring at 11.5 Feet.
Completed 08/20/04.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

Figure A-9
Boring Log HC04-06

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement
  - Medium dense, moist, brown, slightly silty, gravelly SAND. (ROAD BASE)
  - Medium dense, damp, gray-brown SAND with trace wood and shells.
  - Very loose to loose, moist to wet, gray-brown SAND.

Bottom of Boring at 11.5 Feet.
Completed 08/20/04.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC04-07

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

Asphalt pavement
Medium dense, damp, brown, silty, very gravelly SAND. (ROAD BASE)
Loose, moist to wet, gray-brown, silty SAND.

Very loose, wet, black, silty SAND.

Bottom of Boring at 11.5 Feet.
Completed 08/23/04.

STANDARD PENETRATION RESISTANCE

LAB TESTS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC04-08

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement: Dense to very dense, moist, gray, silty, gravelly SAND. (ROAD BASE)
- Loose, wet, light gray, slightly gravelly, silty SAND.

Bottom of Boring at 11.5 Feet. Completed 08/23/04.

STANDARD PENETRATION RESISTANCE

<table>
<thead>
<tr>
<th>Sample</th>
<th>Blows per Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-1</td>
<td></td>
</tr>
<tr>
<td>S-1</td>
<td></td>
</tr>
<tr>
<td>S-2</td>
<td></td>
</tr>
<tr>
<td>S-3</td>
<td></td>
</tr>
<tr>
<td>S-4</td>
<td></td>
</tr>
</tbody>
</table>

Water Content in Percent

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

Figure A-12

17100-00  08/04
Boring Log HC04-09

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement
- Medium dense, moist, brown, silty, gravelly SAND (ROAD BASE)
  - Loose to medium dense, moist to wet, gray-brown, SAND to silty SAND

Bottom of Boring at 11.5 Feet.
Completed 08/23/04.

STANDARD PENETRATION RESISTANCE

<table>
<thead>
<tr>
<th>Sample</th>
<th>Blows per Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-1</td>
<td></td>
</tr>
<tr>
<td>S-1</td>
<td></td>
</tr>
<tr>
<td>S-2</td>
<td></td>
</tr>
<tr>
<td>S-3</td>
<td></td>
</tr>
<tr>
<td>S-4</td>
<td></td>
</tr>
</tbody>
</table>

LAB TESTS

- GS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC04-10

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement
- Medium dense, damp, brown, slightly silty, gravelly SAND. (ROAD BASE)
- Medium dense, moist, brown SAND.
- Loose, moist to wet, gray-brown SAND.

Bottom of Boring at 11.5 Feet.
Completed 08/23/04.

STANDARD PENETRATION RESISTANCE

LAB TESTS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Soil Descriptions
Approximate Ground Surface Elevation in Feet: 18

- Asphalt pavement.
  - Loose, damp to moist, dark brown with orange stain lenses, very silty SAND.
- Very loose, wet, dark brown, silty SAND with trace shell fragments.

Bottom of Boring at 11.5 Feet.
Completed 08/23/04.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC04-12

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement
  - Medium dense, damp, gray-brown, slightly silty SAND.
- Loose, damp, gray-brown SAND.

Bottom of Boring at 11.5 Feet.
Completed 08/23/04.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Soil Descriptions**

**Approximate Ground Surface Elevation in Feet:** 16

<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth in Feet</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>0-5</td>
<td>Asphalt pavement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium dense, damp, brown SAND.</td>
</tr>
<tr>
<td>S-2</td>
<td>5-10</td>
<td>Loose, moist, brown, gravelly SAND with organics, petroleum-like odor and lens of light brown clayey silt.</td>
</tr>
<tr>
<td>S-3</td>
<td>10-15</td>
<td>Loose, wet, gray to dark brown, slightly silty SAND.</td>
</tr>
<tr>
<td>S-4</td>
<td>15-20</td>
<td>Medium dense, wet, gray-brown SAND with shell fragments.</td>
</tr>
<tr>
<td>S-5</td>
<td>20-25</td>
<td>Medium dense, wet, gray, silty SAND with trace shell fragments and organic material.</td>
</tr>
<tr>
<td>S-6</td>
<td>25-30</td>
<td>Medium stiff, moist to wet, slightly sandy, slightly clayey SILT with trace organic material.</td>
</tr>
<tr>
<td>S-7</td>
<td>30-35</td>
<td>Dense, wet, gray to dark brown, silty SAND with lenses of slightly sandy, slightly clayey SILT.</td>
</tr>
<tr>
<td>S-9</td>
<td>40-45</td>
<td></td>
</tr>
<tr>
<td>S-10</td>
<td>45-65</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65</td>
<td></td>
</tr>
</tbody>
</table>

**STANDARD PENETRATION RESISTANCE**

- Blows per Foot

**LAB TESTS**

- ATO
- GS
- AL

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Soil Descriptions
Approximate Ground Surface Elevation in Feet: 17

- Asphalt pavement
- Medium dense, damp, gray, very sandy GRAVEL (ROAD BASE)
- Medium dense, damp, gray-brown SAND with shell fragments.
- Loose, wet, dark brown, slightly silty SAND with shell fragments.

- Medium dense, wet, dark brown, slightly silty SAND with shell fragments.

- Medium stiff, moist to wet, gray, clayey, very sandy SILT with shell fragments.

- Medium dense, wet, dark brown, slightly silty SAND with shell fragments.

- Very loose to loose, moist to wet, gray to brown, silty SAND.

- Bottom of Boring at 39.0 Feet. Completed 08/26/04.

STANDARD PENETRATION RESISTANCE

<table>
<thead>
<tr>
<th>Sample</th>
<th>Blows per Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-1</td>
<td>1 2 5 10 20 50 100</td>
</tr>
<tr>
<td>S-1</td>
<td></td>
</tr>
<tr>
<td>S-2</td>
<td></td>
</tr>
<tr>
<td>S-3</td>
<td></td>
</tr>
<tr>
<td>S-4</td>
<td></td>
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<tr>
<td>S-5</td>
<td></td>
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<td>S-6</td>
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<td>S-7</td>
<td></td>
</tr>
<tr>
<td>S-8</td>
<td></td>
</tr>
<tr>
<td>S-9</td>
<td></td>
</tr>
</tbody>
</table>

LAB TESTS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

Figure A-18
Boring Log HC04-15

Soil Descriptions
Approximate Ground Surface Elevation in Feet: 19

- Asphalt pavement
  Medium dense, damp, brown, SAND with shell fragments.

- Very loose, wet, gray, silty, SAND with shell and wood fragments.

- Loose, wet, gray, silty, SAND with shell fragments.

- Very loose, wet, gray, silty, SAND.

- Very soft, wet, gray, slightly sandy, clayey SILT with shell fragments.

- Medium dense, gray, silty SAND.

- Loose, wet, gray, silty SAND with clayey silt lenses.

- Dense, wet, gray, silty SAND with clay and silt lenses.

- Medium dense, wet, gray, SAND with clay and silt lenses.

- Bottom of Boring at 54.0 Feet. Completed 08/27/04.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log S1B-1

Soil Descriptions

Approximate Ground Surface Elevation in Feet: 18

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Sample</th>
<th>Standard Penetration Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>S-1</td>
<td>A Blows per Foot</td>
</tr>
<tr>
<td>5</td>
<td>S-2</td>
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<tr>
<td>10</td>
<td>S-3</td>
<td></td>
</tr>
<tr>
<td>15</td>
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<tr>
<td>20</td>
<td>S-5</td>
<td></td>
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<td>25</td>
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<td>30</td>
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<td>45</td>
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<td></td>
<td>S-20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S-21</td>
<td></td>
</tr>
</tbody>
</table>

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
# Boring Log S1B-1

## Soil Descriptions

Approx. Ground Surface Elevation in Feet: 18

**Medium dense to dense, wet, gray, slightly silty to silty, fine SAND.**

Trace shell fragments.

**Very soft, wet, gray, sandy SILT grading to very loose to medium dense, wet, gray, silty, fine SAND.**

**Very dense, wet, gray to black, fine SAND with occasional sandy Silt layers and shell fragments.**

Bottom of Boring at 149.0 Feet. Completed 3/17/00.

---

## STANDARD PENETRATION RESISTANCE

<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-22</td>
<td>90</td>
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<tr>
<td>S-23</td>
<td>95</td>
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<tr>
<td>S-24</td>
<td>100</td>
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<td>S-25</td>
<td>105</td>
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<td>S-26</td>
<td>110</td>
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<td>S-27</td>
<td>115</td>
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<td>S-28</td>
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<td>S-29</td>
<td>125</td>
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<td>S-30</td>
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<td>S-31</td>
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<tr>
<td></td>
<td>175</td>
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<td></td>
<td>180</td>
</tr>
</tbody>
</table>

### Blows per Foot

- Water Content in Percent

---

### LAB TESTS

Collected 5/01

---

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log S1B-2

Soil Descriptions

Approx. Ground Surface Elevation in Feet: 18

- Cobbly, gravely SAND inferred from drill action and cuttings over medium dense, wet, dark gray, sandy GRAVEL.

- Very loose to medium dense, wet, gray, slightly silty, fine SAND.
  
  Trace shell fragments.

- Very soft to medium stiff, moist, gray to black, sandy SILT.

- Medium dense wet, dark gray and brown, silty, fine SAND.

- Very loose to medium dense, wet, silty to very silty, fine SAND with Silt interbeds.

- Very soft to (medium stiff), wet, dark gray SILT.

STANDARD PENETRATION
RESISTANCE

△ Blows per Foot

LAB TESTS

- Water Content in Percent

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (AFTD) or for date specified. Level may vary with time.
Boring Log S1B-2

Soil Descriptions

Approx. Ground Surface Elevation in Feet - 18

- Very soft to (medium stiff), wet, dark gray Silt.

- Medium dense to dense, wet, dark gray, slightly silty to silty, fine SAND with trace shell fragments.

- Very soft, moist, dark gray Silt.

- Hard, wet, dark gray, slightly sandy Silt.

- Dense to very dense, moist to wet, black, slightly silty to silty, fine SAND.

- Loose, moist, dark gray Silt layer.

- Bottom of Boring at 161.5 Feet. Completed 3/30/00.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC-103

Soil Descriptions

Approx. Ground Surface Elevation in Feet: -44.7

Very soft, wet, gray, sandy SILT with Sand interbeds.

Very loose to loose, wet, dark gray, slightly silty to silty SAND with sandy SILT interbeds and occasional scattered shell fragments.

1 foot of heave.

Medium stiff to very stiff, wet, dark gray, very sandy SILT.

Stiff to medium stiff, dark gray, sandy SILT with interbedded Sand layers.

Loose, wet, gray, silty, fine SAND.

Very soft to soft, wet, gray, slightly sandy SILT with silty Sand interbeds.

Medium dense, wet, slightly silty to very silty SAND with medium Sand interbeds.

Very stiff, wet, dark gray, slightly sandy SILT.

Dense to medium dense, wet, dark gray, slightly silty SAND.

Bottom of Boring 77.5 Feet.
Completed 5/4/00.

STANDARD PENETRATION RESISTANCE

<table>
<thead>
<tr>
<th>Blows per Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>GS</td>
</tr>
<tr>
<td>AL</td>
</tr>
</tbody>
</table>

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ABD) or for date specified. Level may vary with time.
4. Penetrated under weight of rods.

HARTCROWSER

J-4965-01  5/01

Figure A-22
SOIL DESCRIPTIONS

Ground Surface Elevation in Feet -22 (MLLW)

Strong chemical odor noted in samples from mudline to bottom of boring.

- Very soft, wet, black, clayey SILT with shells and slag debris. Wire rope noted throughout zone.

Dense, wet, dark gray, slightly silty SAND with some gravel. (FILL?)

Hard, wet, dark gray, sandy SILT. (FILL?)

Dense, wet, dark gray, slightly silty to silty, fine SAND with occasional wood fragments, roots and wire fragments. (FILL?)

Medium dense, wet, gray, slightly silty SAND.

Bottom of Boring at 42.5 Feet. Completed 2/21/87.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (AID) or for date specified. Level may vary with time.

J-1682-01 February 1987
HART-CROWSER & associates, inc.

Figure A-23
Boring Log T3B-6

SOIL DESCRIPTIONS

Ground Surface Elevation in Feet -37.6

Soft to stiff, wet, black to gray, slightly sandy SILT with sandy SILT and clayey SILT interbeds.

Stiff to hard, wet, gray, very sandy SILT with very silty SAND interbeds.

J-1681 March 1986
HART-CROWSER & associates, inc.
Sheet 1 of 2 Figure A-24
Boring Log T3B-6

SOIL DESCRIPTIONS

Ground Surface Elevation in Feet - 37.6

Stiff to hard, wet, grey, very sandy SILT with very silty SAND interbeds.

Depth
in Feet
60
65
70
75
80
85
90
95
100
105
110
115
120

Sample
S-15
S-16
S-17
S-19
S-20
S-21
S-22
S-23
S-24

STANDARD PENETRATION RESISTANCE

Blows per Foot

LAB TESTS

Water Content in Percent

Bottom of Boring at 105.5 Feet.
Completed 3/15/86.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (AHD) or for date specified. Level may vary with time.

J-1681 March 1986
HART-CROWSER & associates, inc.
Sheet 2 of 2 Figure A-24
SOIL DESCRIPTIONS

Ground Surface Elevation in Feet -3

Very loose to loose, wet, dark gray, slightly silty, medium to fine SAND.

Medium dense, wet, gray, silty, medium to fine SAND with scattered very silty SAND interbeds and shell fragments.

STANDARD PENETRATION RESISTANCE

J-1680 March 1986
HART-CROWSER & associates, inc.
Sheet 1 of 2 Figure A-25
**SOIL DESCRIPTIONS**

Ground Surface Elevation in Feet -3

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S-14</td>
</tr>
<tr>
<td></td>
<td>S-15</td>
</tr>
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</tr>
<tr>
<td></td>
<td>S-23</td>
</tr>
<tr>
<td></td>
<td>S-24</td>
</tr>
</tbody>
</table>

Medium dense to dense, wet, gray, silty, medium to fine SAND with sandy SILT interbeds.

Very stiff, wet, gray, slightly clayey, sandy SILT.

Bottom of Boring at 118.0 Feet. Completed 3/1/86.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

J-1680 March 1986
HART-CROWSER & associates, inc.
Sheet 2 of 2 Figure A-25
**Principle of Cone Penetrometer**

**Procedure**
1. The cone as shown in position 1 is pushed down by the inner rod for a depth of 4 cm and the point resistance measured.
2. From position 2 the point is again pushed 4 cm and the combined point resistance and side friction is measured by causing the sleeve to be lowered as shown in position 3.
3. The total system is then advanced 20 cm by pushing the outer casing to position 4 from which the next test is accomplished.

**Notes:**
1. The cone apex angle = 60°
2. Section area = 10 cm
3. Length of friction sleeve = 13 cm
4. Diameter = 36 mm

**Dutch Cone Soil Classification Chart**

Note: Except some overlap in the type zones noted below, local correlations are preferable.

Friction Ratio - (Sleeve Friction/Cone Bearing) in %

HARTCROWSER
J-7278-04
Figure A-26
Probe Log T3P-1

Approximate Surface Elevation in Feet -35
(MLLW=0)

Cone Penetration Resistance in tsf

--- Measured
------- Corrected

Sleeve Friction in tsf

Friction Ratio, percent

Depth Below Surface in feet

0 100 200 300 400

0 .5 1 1.5 2 6

J-1680 October 1986
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-27
**Probe Log T3P-1**

<table>
<thead>
<tr>
<th>Pore Pressure in tsf</th>
<th>Dyn. Pore Pressure Ratio</th>
<th>Soil Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 10 15</td>
<td>-.5</td>
<td>Soft to stiff, clayey, sandy SILT.</td>
</tr>
<tr>
<td></td>
<td>.5</td>
<td>Medium dense, silty SAND.</td>
</tr>
<tr>
<td>70</td>
<td>90</td>
<td>Medium dense to very dense, silty SAND.</td>
</tr>
<tr>
<td>90</td>
<td>100</td>
<td>Loose to medium dense, silty SAND.</td>
</tr>
<tr>
<td>100</td>
<td>110</td>
<td>Medium dense to dense, very silty SAND.</td>
</tr>
<tr>
<td>110</td>
<td>120</td>
<td>Stiff to very stiff, sandy SILT.</td>
</tr>
<tr>
<td>120</td>
<td>130</td>
<td>Bottom of Probe at 101.4 Feet.</td>
</tr>
<tr>
<td>130</td>
<td>140</td>
<td>Completed 4/11/86.</td>
</tr>
</tbody>
</table>

Bottom of Probe at 101.4 Feet. Completed 4/11/86.
Probe Log T3P-5

Approximate Surface Elevation in Feet -37 (MLLW=0)

Cone Penetration Resistance in tsf
--- Measured
--- Corrected

Sleeve Friction in tsf

Friction Ratio, percent

Depth Below Surface in feet

0 100 200 300 400 0 .5 1 1.5 2 0 2 4 6
Probe Log T3P-5

Pore Pressure in tsf

Dyn. Pore Pressure Ratio

Soil Interpretation

Medium stiff to stiff, sandy SILT with silty SAND interbeds.

Medium dense, silty SAND.

Medium stiff to stiff, sandy SILT.

Medium dense to dense, silty SAND with scattered sandy SILT interbeds.

Bottom of Probe at 90.0 Feet. Completed 3/15/86.
Probe Log T3P-6

Approximate Surface Elevation in Feet -39
(MLLW=0)

Cone Penetration Resistance in tsf
---Measured
---Corrected

Sleeve Friction in tsf

Friction Ratio, percent

Depth Below Surface in feet

J-1681 August 1986
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-29
Probe Log T3P-6

Soil Interpretation

Soft to stiff, sandy SILT.

Medium stiff to stiff, sandy SILT with scattered SILT interbeds.

Medium dense, silty SAND.

Medium stiff to stiff, sandy SILT.

Medium dense to dense, silty SAND with sandy SILT interbeds.

Bottom of Probe at 101.5 Feet.
Completed 3/15/86.
Probe Log T3P-8

Approximate Surface Elevation in Feet -33
(MLLW=0)

Cone Penetration Resistance in tsf
--- Measured
--- Corrected

Sleeve Friction in tsf

Friction Ratio, percent

Depth Below Surface in feet
0 100 200 300 400 0 .5 1 1.5 2 0 2 4 6
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140

J-1681 August 1986
HART-CROWSER & associates inc.
Sheet 1 of 2 Figure A-30
Probe Log T3P-8

Pore Pressure in tsf

Dyn. Pore Pressure Ratio

Soil Interpretation

<table>
<thead>
<tr>
<th>Depth</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Medium dense to dense, silty SAND.</td>
</tr>
<tr>
<td>10</td>
<td>Medium stiff to stiff, sandy SILT with numerous silty SAND interbeds.</td>
</tr>
<tr>
<td>15</td>
<td>Medium dense to dense, silty SAND with sandy SILT interbeds.</td>
</tr>
<tr>
<td>30</td>
<td>Bottom of Probe at 75.1 Feet. Completed 3/16/86.</td>
</tr>
</tbody>
</table>

J-1681  August 1986
HART-CROWSER & associates inc.
Sheet 2 of 2  Figure A-30
APPENDIX B
LABORATORY TESTING PROGRAM
APPENDIX B
LABORATORY TESTING PROGRAM

A laboratory testing program was performed for this study to evaluate the basic index and geotechnical engineering properties of the site soils. Disturbed samples were tested. The tests performed and the procedures followed are outlined below.

Soil Classification

Field Observation and Laboratory Analysis. Soil samples from the explorations were visually classified in the field and then taken to our laboratory where the classifications were verified in a relatively controlled laboratory environment. Field and laboratory observations include density/consistency, moisture condition, and grain size and plasticity estimates.

The classifications of selected samples were checked by laboratory tests such as Atterberg limits determinations and grain size analyses. Classifications were made in general accordance with the Unified Soil Classification (USC) System, ASTM D 2487, as presented on Figure B-1.

Water Content Determinations

Water contents were determined for most samples recovered in the explorations in general accordance with ASTM D 2216, as soon as possible following their arrival in our laboratory. Water contents were not determined for very small samples nor samples where large gravel contents would result in values considered unrepresentative. The results of these tests are plotted at the respective sample depth on the exploration logs. In addition, water contents are routinely determined for samples subjected to other testing. These are also presented on the exploration logs.

Atterberg Limits (AL)

We determined Atterberg limits for selected fine-grained soil samples. The liquid limit and plastic limit were determined in general accordance with ASTM D 4318-84. The results of the Atterberg limits analyses and the plasticity characteristics are summarized in the Liquid and Plastic Limits Test Report, Figure B-2. This relates the plasticity index (liquid limit minus the plastic limit) to the liquid limit. The results of the Atterberg limits tests are shown graphically on the boring logs as well as where applicable on figures presenting various other test results.
Grain Size Analysis (GS)

Grain size distribution was analyzed on representative samples in general accordance with ASTM D 422. Wet sieve analysis was used to determine the size distribution greater than the U.S. No. 200 mesh sieve. The size distribution for particles smaller than the No. 200 mesh sieve was determined by the hydrometer method for a selected number of samples. The results of the tests are presented as curves on Figures B-3 through B-8 plotting percent finer by weight versus grain size.
# Unified Soil Classification (USC) System

## Soil Grain Size

<table>
<thead>
<tr>
<th>Size of Opening in Inches</th>
<th>Number of Mesh per Inch (US Standard)</th>
<th>Grain Size in Millimetres</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2</td>
<td>3.0</td>
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<tr>
<td>8</td>
<td>4</td>
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<tr>
<td>0.5</td>
<td>64</td>
<td>0.6</td>
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</tbody>
</table>

Grain Size in Millimetres

<table>
<thead>
<tr>
<th>COBBLES</th>
<th>GRAVEL</th>
<th>SAND</th>
<th>SILT and CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse-Grained Soils</td>
<td>Fine-Grained Soils</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Coarse-Grained Soils

<table>
<thead>
<tr>
<th>GW</th>
<th>GP</th>
<th>GM</th>
<th>GC</th>
<th>SW</th>
<th>SP</th>
<th>SM</th>
<th>SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean GRAVEL &lt;5% fines</td>
<td>GRAVEL with &gt;12% fines</td>
<td>Clean SAND &lt;5% fines</td>
<td>SAND with &gt;12% fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRAVEL &gt;50% coarse fraction larger than No. 4</td>
<td></td>
<td>SAND &gt;50% coarse fraction smaller than No. 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coarse-Grained Soils >50% larger than No. 200 sieve

\[
G W \text{ and } S W \quad \frac{D_{60}}{D_{10}} > 4 \text{ for } G W \quad \frac{D_{60}}{D_{10}} > 6 \text{ for } S W \quad 1 \leq \frac{(D_{30})^2}{D_{10} \times D_{60}} \leq 3
\]

G P and S P | Clean GRAVEL or SAND not meeting requirements for G W and S W

G M and S M | Atterberg limits below A line with PI <4
G C and S C | Atterberg limits above A Line with PI >7

* Coarse-grained soils with percentage of fines between 5 and 12 are considered borderline cases requiring use of dual symbols.

D_{10}, D_{30}, and D_{60} are the particles diameter of which 10, 30, and 60 percent, respectively, of the soil weight are finer.

## Fine-Grained Soils

<table>
<thead>
<tr>
<th>ML</th>
<th>CL</th>
<th>OL</th>
<th>MH</th>
<th>CH</th>
<th>OH</th>
<th>Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILT</td>
<td>CLAY</td>
<td>Organic</td>
<td>SILT</td>
<td>CLAY</td>
<td>Organic</td>
<td>Highly Organic Soils</td>
</tr>
</tbody>
</table>

Soils with Liquid Limit <50% | Soils with Liquid Limit >50%

Fine-Grained Soils >50% smaller than No. 200 sieve

![Plasticity Index vs. Liquid Limit Diagram](image)

**Figure B-1**

**HARCROWSER**

17100-00

9/04
### LIQUID AND PLASTIC LIMITS TEST REPORT

Dashed line indicates the approximate upper limit boundary for natural soils.

### Location + Description

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample No.</th>
<th>Elev./Depth</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>-200</th>
<th>USCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC04-13</td>
<td>S-9</td>
<td>32.5'</td>
<td>31</td>
<td>28</td>
<td>3</td>
<td></td>
<td>ML</td>
</tr>
<tr>
<td>HC04-13</td>
<td>S-10</td>
<td>37.5</td>
<td>30</td>
<td>27</td>
<td>3</td>
<td></td>
<td>ML</td>
</tr>
<tr>
<td>HC04-14</td>
<td>S-6</td>
<td>22.5'</td>
<td>28</td>
<td>24</td>
<td>4</td>
<td>62.7</td>
<td>ML</td>
</tr>
<tr>
<td>HC04-14</td>
<td>S-8</td>
<td>32.5'</td>
<td>25</td>
<td>26</td>
<td>NP</td>
<td></td>
<td>ML</td>
</tr>
<tr>
<td>HC04-15</td>
<td>S-7B</td>
<td>28.5'</td>
<td>31</td>
<td>24</td>
<td>7</td>
<td></td>
<td>ML</td>
</tr>
</tbody>
</table>

### Remarks:
- 
- 
- 
- 
- 

### Project:
Terminal 3 and Terminal 4 Redevelopment

### Client:
BERGER/ABAM Engineers, Inc.

### Location:
Tacoma, WA

---

DRAFT
1710000
9/22/2004
Figure No. B-2
Particle Size Distribution Report

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS.</td>
<td>FINE</td>
<td>CRS.</td>
</tr>
<tr>
<td>○</td>
<td>0.0</td>
<td>5.1</td>
<td>20.3</td>
</tr>
<tr>
<td>□</td>
<td>0.0</td>
<td>4.0</td>
<td>33.6</td>
</tr>
<tr>
<td>△</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D85</th>
<th>D60</th>
<th>D50</th>
<th>D30</th>
<th>D15</th>
<th>D10</th>
<th>Cc</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>10.0</td>
<td>3.16</td>
<td>2.48</td>
<td>1.32</td>
<td>0.587</td>
<td>0.415</td>
<td>1.33</td>
<td>7.60</td>
<td></td>
</tr>
<tr>
<td>□</td>
<td>14.3</td>
<td>4.44</td>
<td>3.55</td>
<td>2.40</td>
<td>1.52</td>
<td>0.909</td>
<td>1.43</td>
<td>4.88</td>
<td></td>
</tr>
<tr>
<td>△</td>
<td>0.142</td>
<td>0.0899</td>
<td>0.0771</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATERIAL DESCRIPTION

○ Gravelly SAND
□ Very gravelly, medium to coarse SAND
△ Very silty, fine SAND

Remarks:
○ Small sample size
□ Small sample size
△ Small sample size

Project: Terminal 3 and Terminal 4 Redevelopment

Client: BERGER/ABAM Engineers, Inc.

○ Source: HC04-01 Sample No.: S-3 Elev./Depth: 8.5'
□ Source: HC04-01 Sample No.: S-8 Elev./Depth: 21.0'
△ Source: HC04-01 Sample No.: S-25 Elev./Depth: 68.5'

1710000 9/22/2004

HARTCROWER

Figure No. B-3
## Particle Size Distribution Report

### Material Description

<table>
<thead>
<tr>
<th>Sandy SILT</th>
<th>Silty, medium to fine SAND</th>
<th>Slightly silty, medium to fine SAND</th>
</tr>
</thead>
</table>

### Test Results

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS.</td>
<td>FINE</td>
<td>CRS.</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
<td>0.9</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.7</td>
</tr>
</tbody>
</table>

### Additional Information

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D85</th>
<th>D60</th>
<th>D50</th>
<th>D30</th>
<th>D15</th>
<th>D10</th>
<th>Cc</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.109</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.679</td>
<td>0.375</td>
<td>0.299</td>
<td>0.175</td>
<td>0.0836</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.540</td>
<td>0.321</td>
<td>0.272</td>
<td>0.186</td>
<td>0.115</td>
<td>0.0839</td>
<td>1.28</td>
<td>3.82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Project Information

**Client:** BERGER/ABAM Engineers, Inc.

**Source:**
- HC04-01 Sample No.: S-32 Elev./Depth: 98.5'
- HC04-02 Sample No.: S-7 Elev./Depth: 17.5'
- HC04-05 Sample No.: S-1 Elev./Depth: 2.5'

**Terminal 3 and Terminal 4 Redevelopment**

**Remarks:**

- Sandy SILT
- Silty, medium to fine SAND
- Slightly silty, medium to fine SAND

**USCS:**
- ML: 32%
- SM: 26%
- SP-SM: 5%

**NAT. MOIST.:**

- 1710000 9/22/2004

**Figure No.:** B-4
### Particle Size Distribution Report

**Diagram:**
- **Percent Finer:** Vertical axis (y-axis)
- **Grain Size - mm:** Horizontal axis (x-axis)

**Table: % Cobble, % Gravel, % Sand, % Fines**

<table>
<thead>
<tr>
<th>% Cobble</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>% Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS.</td>
<td>FINE</td>
<td>CRS.</td>
</tr>
<tr>
<td>□</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>□</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>△</td>
<td>0.0</td>
<td>3.7</td>
<td>14.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% Fines</th>
<th>SILT</th>
<th>CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>28.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19.1</td>
</tr>
</tbody>
</table>

**MATERIAL DESCRIPTION**

- □ Slightly silty, medium to fine SAND
- □ Silty, medium to fine SAND
- △ Gravelly, silty SAND

#### USCS
- SP-SM
- SM

#### NAT. MOIST.
- 4%
- 15%
- 7%

**Remarks:**
- □
- △ Small sample size

**Project:** Terminal 3 and Terminal 4 Redevelopment

- **Client:** BERGER/ABAM Engineers, Inc.
- **Source:** HC04-06 Sample No.: S-1 Elev./Depth: 2.5'
- **Source:** HC04-07 Sample No.: S-1 Elev./Depth: 2.5'
- **Source:** HC04-08 Sample No.: S-1 Elev./Depth: 2.5'

**Figure No.: B-5**

1710000
9/22/2004
Particle Size Distribution Report

% COBBLES % GRAVEL % SAND % FINES

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS.</td>
<td>FINE</td>
<td>CRS.</td>
</tr>
<tr>
<td>○</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>□</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>△</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

LL PI D_85 D_50 D_50 D_30 D_15 D_10 Cc Cu

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D_85</th>
<th>D_50</th>
<th>D_50</th>
<th>D_30</th>
<th>D_15</th>
<th>D_10</th>
<th>Cc</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td></td>
<td>0.369</td>
<td>0.223</td>
<td>0.187</td>
<td>0.115</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□</td>
<td></td>
<td>0.521</td>
<td>0.304</td>
<td>0.254</td>
<td>0.165</td>
<td>0.0891</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>△</td>
<td></td>
<td>0.196</td>
<td>0.0991</td>
<td>0.0762</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATERIAL DESCRIPTION

- ○ Silty, medium to fine SAND
- □ Silty, medium to fine SAND
- △ Very silty, fine SAND

USCS NAT. MOIST.

- SM 9%
- SM 7%
- SM 24%

Remarks:

- ○
- □
- △

Project: Terminal 3 and Terminal 4 Redevelopment

Client: BERGER/ABAM Engineers, Inc.

- ○ Source: HC04-09 Sample No.: S-1 Elev./Depth: 2.5'
- □ Source: HC04-10 Sample No.: S-1 Elev./Depth: 2.5'
- △ Source: HC04-11 Sample No.: S-1 Elev./Depth: 2.5'

HARTCROWSER

1710000 9/22/2004
Figure No. B-6
Particle Size Distribution Report

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS.</td>
<td>FINE</td>
<td>CRS.</td>
</tr>
<tr>
<td>○</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>□</td>
<td>0.0</td>
<td>0.0</td>
<td>3.8</td>
</tr>
<tr>
<td>△</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D&lt;sub&gt;85&lt;/sub&gt;</th>
<th>D&lt;sub&gt;50&lt;/sub&gt;</th>
<th>D&lt;sub&gt;30&lt;/sub&gt;</th>
<th>D&lt;sub&gt;15&lt;/sub&gt;</th>
<th>D&lt;sub&gt;10&lt;/sub&gt;</th>
<th>C&lt;sub&gt;C&lt;/sub&gt;</th>
<th>C&lt;sub&gt;u&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td></td>
<td>0.733</td>
<td>0.439</td>
<td>0.366</td>
<td>0.248</td>
<td>0.129</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□</td>
<td></td>
<td>0.675</td>
<td>0.379</td>
<td>0.324</td>
<td>0.231</td>
<td>0.151</td>
<td>0.112</td>
<td>1.26</td>
</tr>
<tr>
<td>△</td>
<td></td>
<td>0.574</td>
<td>0.308</td>
<td>0.253</td>
<td>0.165</td>
<td>0.103</td>
<td>0.0821</td>
<td>1.07</td>
</tr>
</tbody>
</table>

MATERIAL DESCRIPTION

○ Slightly silty, medium to fine SAND
□ Slightly silty, medium to fine SAND
△ Slightly silty, medium to fine SAND

USCS | NAT. MOIST. | SP-SM | 5%
     |             | SP-SM | 23%
     |             | SP-SM | 23%

Remarks:
○
□
△

Project: Terminal 3 and Terminal 4 Redevelopment

Client: BERGER/ABAM Engineers, Inc.

○ Source: HC04-12  Sample No.: S-1  Elev./Depth: 2.5'
□ Source: HC04-13  Sample No.: S-5  Elev./Depth: 12.5'
△ Source: HC04-14  Sample No.: S-3  Elev./Depth: 7.5'

1710000  9/22/2004
Figure No. B-7
## Particle Size Distribution Report

### Material Description

<table>
<thead>
<tr>
<th></th>
<th>USCS</th>
<th>Nat. Moist.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy Silt</td>
<td>ML</td>
<td>30%</td>
</tr>
<tr>
<td>Silty, medium to fine SAND</td>
<td>SM</td>
<td>30%</td>
</tr>
<tr>
<td>Silty, medium to fine SAND</td>
<td>SM</td>
<td>24%</td>
</tr>
</tbody>
</table>

### Table

<table>
<thead>
<tr>
<th>% Cobble</th>
<th>% Gravel</th>
<th>% Sand</th>
<th>% Fines</th>
<th>Silty</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS.</td>
<td>FINE</td>
<td>CRS.</td>
<td>MEDIUM</td>
<td>FINE</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>3.6</td>
<td>4.9</td>
<td>11.3</td>
<td>17.5</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>8.1</td>
<td>69.7</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
<td>4.2</td>
<td>33.5</td>
<td>45.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D_{85}</th>
<th>D_{60}</th>
<th>D_{50}</th>
<th>D_{30}</th>
<th>D_{15}</th>
<th>D_{10}</th>
<th>C_{c}</th>
<th>C_{u}</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>4</td>
<td>0.608</td>
<td>0.327</td>
<td>0.192</td>
<td>0.161</td>
<td>0.0990</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.854</td>
<td>0.408</td>
<td>0.328</td>
<td>0.197</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**
- +# 40 material mostly shells
- □
- △

**Project:** Terminal 3 and Terminal 4 Redevelopment

**Client:** BERGER/ABAM Engineers, Inc.

- ○ Source: HC04-14 Sample No.: S-6 Elev./Depth: 22.5'
- □ Source: HC04-15 Sample No.: S-4 Elev./Depth: 12.5'
- △ Source: HC04-15 Sample No.: S-5 Elev./Depth: 17.5'
APPENDIX C
EXPLORATIONS BY OTHERS
<table>
<thead>
<tr>
<th>DEPTH ft BGS</th>
<th>STRATIGRAPHIC DESCRIPTION &amp; REMARKS</th>
<th>ELEV. ft MLLW</th>
<th>ELEV. 18.18</th>
<th>SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.3</td>
<td>ASPHALT</td>
<td>18.3</td>
<td>CONCRETE SEAL</td>
<td>18.3</td>
</tr>
<tr>
<td>18.3</td>
<td>FILL-COARSE GRAVEL</td>
<td>18.3</td>
<td>BENTONITE</td>
<td>18.3</td>
</tr>
<tr>
<td>12.5</td>
<td>FILL-SAND, brown, dry</td>
<td>12.5</td>
<td>2&quot; PVC RISER PIPE</td>
<td>12.5</td>
</tr>
<tr>
<td>15.0</td>
<td>SW-SAND (NATIVE), fine to medium grained, black, trace red and white grains, wet</td>
<td>15.0</td>
<td>SAND PACK</td>
<td>15.0</td>
</tr>
<tr>
<td>17.5</td>
<td>trace shells</td>
<td>17.5</td>
<td>WELL SCREEN</td>
<td>17.5</td>
</tr>
<tr>
<td>20.0</td>
<td>ML/SW-SILT and SAND, fine grained, gray, wet</td>
<td>20.0</td>
<td>8&quot; BOREHOLE</td>
<td>20.0</td>
</tr>
<tr>
<td>22.5</td>
<td>END OF HOLE @ 25.01 ft BGS</td>
<td>22.5</td>
<td>NATIVE MATERIAL</td>
<td>22.5</td>
</tr>
<tr>
<td>25.0</td>
<td></td>
<td>25.0</td>
<td></td>
<td>25.0</td>
</tr>
<tr>
<td>27.5</td>
<td></td>
<td>27.5</td>
<td></td>
<td>27.5</td>
</tr>
<tr>
<td>30.0</td>
<td></td>
<td>30.0</td>
<td></td>
<td>30.0</td>
</tr>
<tr>
<td>32.5</td>
<td></td>
<td>32.5</td>
<td></td>
<td>32.5</td>
</tr>
</tbody>
</table>

**NOTES:** MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ☑  STATIC WATER LEVEL ☑

**SCREEN DETAILS**
- Screened interval: 14.0 to 24.01 ft BGS
- Length: 10.01 ft
- Diameter: 2"
- Slot Size: #10
- Material: PVC Sand Pack
- #20 Silica Sand
### Stratigraphic and Instrumentation Log (Overburden)

**Project Name:** Port of Tacoma - Slip 1  
**Project Number:** 15403-20  
**Client:** Port of Tacoma/OCC  
**Location:** Tacoma, WA  
**Hole Designation:** MW2S-00  
**Date Completed:** February 8, 2000  
**Drilling Method:** HSA  
**CRA Supervisor:** J. Vander Linden

<table>
<thead>
<tr>
<th>Depth (ft BGS)</th>
<th>Stratigraphic Description &amp; Remarks</th>
<th>Elev. (ft MSL)</th>
<th>Monitor Installation</th>
<th>Sample</th>
</tr>
</thead>
</table>
|                | Ground Surface Reference Point (Top of Riser) | 17.6  
17.30 | | | |
| -2.5           | Asphalt                           |                | CONCRETE SEAL       | 1SS     |
| -5.0           | Fill-Sand, brown                   |                | BENTONITE           | 2SS     |
| -7.5           | ML-Silt, gray, laminated           | 12.1  
11.5    | 2" Ø PVC RISER PIPE                | 4SS     |
| -10.0          | SW-Sand, medium grained, brown, moist | 10.5 | | |
| -12.5          | SW/ML-Silt and sand (Native), fine grained, gray, trace red and white sand grains, wet | 3.6 | SAND PACK | 5SS |
| -15.0          | SW-Sand, little silt, fine grained, black, trace red and white sand grains, wet | -2.9 | WEL SCREEN | 6SS |
| -17.5          | ML-Silt, trace fine sand, trace shells, gray, wet | -4.0 | 8" Ø BOREHOLE | 7SS |
| -20.0          | SW/ML-Silt and sand, fine grained, gray, wet | | | |
| -22.5          | SW-Sand, medium grained, black, trace red and white sand grains, wet | | | |
| -25.0          | ML-Silt, trace fine sand, trace shells, gray | -7.4 | 8" Ø BOREHOLE | 8SS |
| -27.5          | END OF HOLE @ 25.0 ft BGS          |                | NATIVE MATERIAL     | 6SS     |
| -30.0          |                                   |                |                     | | |
| -32.5          |                                   |                |                     | | |

**Screen Details:**  
- Screened interval: 14.0 to 24.0 ft BGS  
- Length: 10.0 ft  
- Diameter: 2"  
- Slot Size: #10  
- Material: PVC  
- Sand Pack: 12.0 to 24.0 ft BGS  
- Material: #20 Silica Sand

**Notes:** Measuring point elevations may change, refer to current elevation table.  
WATER FOUND: yes  
STATIC WATER LEVEL: 7

---

**DRAFT**
### STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

<table>
<thead>
<tr>
<th>DEPTH (ft BGS)</th>
<th>STRATIGRAPHIC DESCRIPTION &amp; REMARKS</th>
<th>ELEV. (ft MLLW)</th>
<th>MONITOR INSTALLATION</th>
<th>SAMPLE</th>
</tr>
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<tbody>
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<td></td>
<td>GROUND SURFACE REFERENCE POINT (Top of Riser)</td>
<td>18.4 18.16</td>
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<tr>
<td>-2.5</td>
<td>ASPHALT</td>
<td>17.9 17.4</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>FILL-GRAVEL, coarse grained, dry</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>FILL-SAND, gravel, brown, dry</td>
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<td>-5.0</td>
<td>SW-SAND (NATIVE), medium grained, brown, trace red and white grains, trace shells, dry - moist</td>
<td>14.4</td>
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<td>-7.5</td>
<td>ML-SILT, gray, laminated</td>
<td>12.0</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>- wet</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- trace shells, black</td>
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<td></td>
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<td>-15.0</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>-17.5</td>
<td>SW-SAND, trace shells, medium grained, black, trace red and white grains, wet</td>
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</tr>
<tr>
<td>-22.5</td>
<td>SW-SAND, black, trace red and white grains, wet</td>
<td>-2.8</td>
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<tr>
<td>-25.0</td>
<td>ML-SILT, little fine sand, gray, wet</td>
<td>-4.4</td>
<td></td>
<td></td>
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<tr>
<td>-27.5</td>
<td>SW-SAND, medium to coarse grained, black, trace red and white grains, wet</td>
<td>-7.5  -8.1</td>
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<td></td>
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<tr>
<td></td>
<td>SP-SAND, trace shells, fine to medium grained, black, trace red and white grains, wet</td>
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<td></td>
</tr>
<tr>
<td>-30.0</td>
<td>SP/MW-SILT and SAND, trace shells and wood pieces, fine grained, gray</td>
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<tr>
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<td>-13.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes
- Measuring point elevations may change, refer to current elevation table.
- Water found:  
  - Static water level:  

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DRAFT
STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: PORT OF TACOMA - SLIP 1
PROJECT NUMBER: 15403-20
CLIENT: PORT OF TACOMA/OCC
LOCATION: TACOMA, WA

HOLE DESIGNATION: MW3D-00
DATE COMPLETED: FEBRUARY 9, 2000
DRILLING METHOD: HSA
CRA SUPERVISOR: J. VANDER LINDEN

DEPTH

<table>
<thead>
<tr>
<th>STRATIGRAPHIC DESCRIPTION &amp; REMARKS</th>
<th>ELEV. (ft. MSLN)</th>
<th>MONITOR INSTALLATION</th>
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<tbody>
<tr>
<td>-37.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- more silt</td>
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<td></td>
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<tr>
<td>-67.5</td>
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</tbody>
</table>

- ML-SILT, gray, wet
- SW-SAND, medium to fine grained, black, trace red and white grains, wet

-47.5
-48.5
-48.8

- SW-SAND, medium to fine grained, black, trace red and white grains, wet
- ML-SILT, gray, wet

-27SS  >50
-28SS  >50
-29SS  31
-30SS  >50
-31SS  60
-32SS  37
-33SS  22

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE, REFER TO CURRENT ELEVATION TABLE
WATER FOUND T  STATIC WATER LEVEL Y
### STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

**PROJECT NAME:** PORT OF TACOMA - SLIP 1  
**PROJECT NUMBER:** 15403-20  
**CLIENT:** PORT OF TACOMA/0CC  
**LOCATION:** TACOMA, WA  
**HOLE DESIGNATION:** MW3D-00  
**DATE COMPLETED:** FEBRUARY 9, 2000  
**DRILLING METHOD:** HSA  
**CRA SUPERVISOR:** J. VANDER LINDEN

<table>
<thead>
<tr>
<th>DEPTH ft. BGS</th>
<th>STRATIGRAPHIC DESCRIPTION &amp; REMARKS</th>
<th>ELEV. ft. MLLW</th>
<th>MONITOR INSTALLATION</th>
<th>SAMPLE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SW-SAND, medium to fine grained, black, trace red and white grains, wet</td>
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<td>WELL SCREEN</td>
<td>35SS1</td>
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<tr>
<td></td>
<td>ML-SILT, gray, wet</td>
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<td>SAND PACK</td>
<td>34SS</td>
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<td></td>
<td>SW/ML-SILT and SAND, fine grained, gray, wet</td>
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<td>3&quot; BOREHOLE</td>
<td>35SS</td>
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<tr>
<td>END OF HOLE @ 75.0 ft BGS</td>
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<td>NATIVE MATERIAL</td>
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<tr>
<td>-102.5</td>
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</tbody>
</table>

**SCREEN DETAILS**  
- Screened interval: 64.0 to 74.0 ft BGS  
- Length: 12 ft  
- Diameter: 2"  
- Slot Size: #10  
- Material: PVC  
- Sand Pack: 61.0 to 74.0 ft BGS  
- Material: #20 Silica Sand

**NOTES:** MEASURING POINT ELEVATIONS MAY CHANGE, REFER TO CURRENT ELEVATION TABLE  
WATER FOUND: 7  STATIC WATER LEVEL: 1
STRATIGRAPHIC AND INSTRUMENTATION LOG
(overburden)

Project Name: Port of Tacoma - Slip 1
Project Number: 15403-20
Client: Port of Tacoma/OCC
Location: Tacoma, WA

Hole Designation: MW45-00
Date Completed: February 8, 2000
Drilling Method: HSA
CRA Supervisor: J. Vander Linden

Depth
(l. BGS) | Stratigraphic Description & Remarks | ELEV. | Monitor | Sample
| | Ground Surface | | Installation |
| | Reference Point (Top of Riser) | 17.9 | CONCRETE | NUMBER | STATE |
| | | 17.63 | SEAL | NF VALUE | PID |
| -2.5 | Asphalt | 17.4 | | | |
| -5.0 | Fill-sand and gravel, coarse grained, dry | 12.9 | BENTONITE | | |
| -7.5 | Fill-sand and gravel, brown, dry | 10.9 | 2" @ PVC Riser Pipe | | |
| -7.5 | Fill-sand, some fine gravel, coarse grained, black, wet | | SAND PACK | | |
| -12.5 | | | WELL SCREEN | | |
| -15.0 | SP-Sand (NATIVE), trace wood pieces, coarse to medium grained, black, trace red and white grains, wet: | 4.0 | 8" @ Borehole | | |
| -17.5 | -trace shells, medium to fine grained | | | | |
| -20.0 | -trace silt | | | | |
| -22.5 | | | | | |
| -25.0 | | | | | |
| -27.5 | ML-Silt, trace to little fine sand, gray | -7.7 | NATIVE MATERIAL | | |
| -27.5 | End of Hole @ 28.0 ft BGS | -2.1 | | | |

Notes: Measuring point elevations may change. Refer to current elevation table.
Water Found: 2
Static Water Level: 7

Screen Details:
- Screens interval: 14.0 to 24.0 ft BGS
- Length: 12.0 ft
- Diameter: 2"
- Slot Size: #10
- Material: PVC
- Sand Pack: 12.0 to 24.0 ft BGS
- Material: #20 Silica Sand
Geotechnical Data Report

Port of Tacoma: Pier 4 Reconfiguration
Tacoma, Washington

Prepared for
KPFF Consulting Engineers

September 18, 2014
17916-01

Prepared by
Hart Crowser, Inc.

Garry E. Horvitz, PE, LEG
Senior Principal
Geotechnical Engineer

Megan K. Higgins, PE
Project
Geotechnical Engineer

Douglas D. Lindquist, PE, LEED AP
Senior Associate
Geotechnical Engineer
ATTACHMENT 2
Shear Wave Velocity Test Report
September 15, 2014

Hart Crowser, Inc.
1700 Westlake Avenue North, Suite 200
Seattle, WA 98109-3056

Attention: Mr. Doug Lindquist

RE: REPORT ON THE SUSPENSION LOGGING FOR PORT OF TACOMA PIER

Dear Mr. Lindquist:

Global Geophysics conducted borehole suspension loggings in boreholes B5 at Port of Tacoma in January, 2013. This boring is 250 ft in depth, which were drilled with mud rotary and cased with 3 inch PVC pipes.

The objective of the geophysical investigation is to calculate the s-wave velocities using the suspension logging.

METHODOLOGY AND INSTRUMENTATION

Suspension soil velocity measurements were performed using the suspension PS logging system, manufactured by OYO Corporation, and their subsidiary, Robertson Geologging. This system directly determines the average velocity of a 3.3 feet high segment of the soil column surrounding the boring of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The receivers that detect the wave, and the source that generates the wave, are moved as a unit in the boring producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear wave source (SH) and compressional-wave source (P), joined to two biaxial receivers by a flexible isolation cylinder. The separation of the two receivers is 3.28 feet, allowing average wave velocity in the region between the receivers to be determined by inversion of the wave travel time between the two receivers. The total length of the probe as used in these surveys is 21 feet. The probe receives control signals from, and sends the receiver signals to, instrumentation on the surface via an armored 4-conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 1.3-foot circumference sheave fitted with a digital rotary encoder.
The entire probe is suspended in the boring by the cable, therefore, source motion is not coupled directly to the boring walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the boring and surrounding the source. This pressure wave is converted to P and SH-waves in the surrounding soil and rock as it passes through the casing and grout annulus and impinges upon the wall of the boring. These waves propagate through the soil and rock surrounding the boring, in turn causing a pressure wave to be generated in the fluid surrounding the receivers as the soil waves pass their location.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:
1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal receivers situated parallel to the axis of motion of the source are recorded.
2. The source is fired again in the opposite direction and the horizontal receiver signals are recorded.
3. The source is fired again and the vertical receiver signals are recorded. The repeated source pattern facilitates the picking of the P and SH-wave arrivals; reversal of the source changes the polarity of the SH-wave pattern but not the P-wave pattern.

RESULTS

The compressional and shear wave velocities are presented in the table below.

<table>
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<th>Depth (ft)</th>
<th>S-wave velocity (ft/s)</th>
<th>p-wave velocity (ft/s)</th>
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</tr>
<tr>
<td>180.4</td>
<td>772</td>
<td>5376</td>
</tr>
<tr>
<td>183.7</td>
<td>764</td>
<td>5205</td>
</tr>
<tr>
<td>187.0</td>
<td>764</td>
<td>5376</td>
</tr>
<tr>
<td>190.2</td>
<td>781</td>
<td>5468</td>
</tr>
<tr>
<td>193.5</td>
<td>720</td>
<td>5291</td>
</tr>
<tr>
<td>196.8</td>
<td>728</td>
<td>5468</td>
</tr>
<tr>
<td>200.1</td>
<td>772</td>
<td>5291</td>
</tr>
<tr>
<td>203.4</td>
<td>682</td>
<td>5291</td>
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<tr>
<td>206.6</td>
<td>699</td>
<td>5127</td>
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<tr>
<td>209.9</td>
<td>728</td>
<td>5127</td>
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<tr>
<td>213.2</td>
<td>705</td>
<td>5127</td>
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<tr>
<td>216.5</td>
<td>745</td>
<td>5291</td>
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<tr>
<td>219.8</td>
<td>772</td>
<td>5291</td>
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<tr>
<td>223.0</td>
<td>790</td>
<td>5205</td>
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<tr>
<td>226.3</td>
<td>810</td>
<td>5376</td>
</tr>
<tr>
<td>229.6</td>
<td>810</td>
<td>5753</td>
</tr>
</tbody>
</table>
S-wave velocity (ft/s)

Velocity (ft/s)

Depth (ft)

S-wave velocity (ft/s)
LIMITATIONS OF THE GEOPHYSICAL METHODS

Global geophysics services are conducted in a manner consistent with the level of care and skill ordinarily exercised by other members of the geophysical community currently practicing under similar conditions subject to the time limits and financial and physical constraints applicable to the services. Suspension logging is a remote sensing geophysical method that may not detect all subsurface layer changes.

Sincerely,

Global Geophysics

John Liu, Ph.D., R.G.
Principal Geophysicist
APPENDIX A
Boring Logs – Current Study
**Key to Exploration Logs**

**Sample Description**
Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

### Density/Consistency
Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits and probes is estimated based on visual observation and is presented parenthetically on the logs.

### Sampling Test Symbols
- 1.5" I.D. Split Spoon
- Grab (Jar)
- 3.0" I.D. Split Spoon
- Shelby Tube (Pushed)
- Bag
- Cuttings
- Core Run

### Soil Classification Chart

<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYMBOLS</th>
<th>TYPICAL DESCRIPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coarse Gravelly Soils</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 50% of coarse fraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>retained on no. 4 sieve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand and Sandy Soils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 50% of coarse fraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>passing on no. 4 sieve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine Gravelly Soils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 50% of material is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>smaller than no. 200 sieve size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silts and Clays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid limit less than 50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid limit greater than 50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly Organic Soils</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Soil Density/Consistency**
- **Very loose**
  - 0 to 4
- **Loose**
  - 4 to 10
- **Medium dense**
  - 10 to 30
- **Dense**
  - 30 to 50
- **Very dense**
  - >50

**Penetration Resistances**
- **Standard Penetration Resistance (N) in Blows/Foot**
  - Very soft: 0 to 2
  - Stiff: 8 to 15
  - Hard: >30
- **Estimated Penetration Resistance (N) in Blows/Foot**
  - Soft: 2 to 4
  - Medium stiff: 4 to 8
  - Stiff: 8 to 15

**Approximate In Situ Shear Strength in TSF**
- Very soft: <0.125
- Soft: 0.125 to 0.25
- Medium stiff: 0.25 to 0.5
- Stiff: 0.5 to 1.0
- Hard: 1.0 to 2.0

**Laboratory Test Symbols**
- **GS** Grain Size Classification
- **CN** Consolidation
- **UU** Unconsolidated Undrained Triaxial
- **CU** Consolidated Undrained Triaxial
- **CD** Consolidated Drained Triaxial
- **QU** Unconfined Compression
- **DS** Direct Shear
- **K** Permeability
- **PP** Pocket Penetrometer
- **TV** Torvane
- **MD** Moisture Density Relationship
- **AL** Atterberg Limits
- **OT** Test by Others

**Groundwater Indicators**
- **Groundwater Level on Date (ATD) or Time of Drilling**
- **Groundwater Seepage**
- **Sample Key**
  - Sample Type
  - Sample Recovery
  - Sample Number
  - Blows per 6 inches
  - Sample Description

**Moisture**
- **Dry**
  - Little perceptible moisture
- **Damp**
  - Some perceptible moisture, likely above optimum
- **Moist**
  - Likely near optimum moisture content
- **Wet**
  - Much perceptible moisture, likely above optimum

<table>
<thead>
<tr>
<th>Minor Constituents</th>
<th>Estimated Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Slightly (clayey, silty, etc.)</td>
<td>5 - 12</td>
</tr>
<tr>
<td>Clayey, silty, sandy, gravelly</td>
<td>12 - 30</td>
</tr>
<tr>
<td>Very (clayey, silty, etc.)</td>
<td>30 - 50</td>
</tr>
</tbody>
</table>

**Groundwater Indicators**
- **1.5" I.D. Split Spoon**
- **Grab (Jar)**
- **3.0" I.D. Split Spoon**
- **Shelby Tube (Pushed)**
- **Bag**
- **Cuttings**
- **Core Run**
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC14-B1

Location: N 103673.45 E 1249275.92
Approximate Ground Surface Elevation: 18 Feet
Horizontal Datum: Washington State Plane
Vertical Datum: MLLW

Drill Equipment: Mobile B-29/Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: W. McDonald    Reviewed By: B. Cook

USCS Graphic Class Log  Soil Descriptions

SW-SM  Medium dense to dense, moist to wet, black, slightly silty, fine to medium SAND; shell fragments, red sand grains. (cont'd)

   - Occasional wood past 65 feet.

SP-SM  Dense to very dense, wet, dark gray, slightly silty, fine SAND.

   - Very silty SAND laminations at 80 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Dense to very dense, wet, dark gray, slightly silty, fine SAND. (cont'd)

Silt partings observed at 95 feet.

Occasional wood past 110 feet.

Hard, moist to wet, gray-brown, sandy SILT.

Dense, moist to wet, black, fine to medium SAND; trace silt and red sand grains.

Occasional 1/2-inch silt seams past 125 feet.

Interbedded silt layers past 130 feet.
Interbedded layers of dense to very dense, wet, black to dark gray, silty, fine SAND and slightly silty, fine SAND; trace silt. (cont'd)

Silt seams at 170 feet.

Hard, moist, gray-brown, slightly sandy SILT; grades to a very sandy SILT.
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC14-B2

Location: N 103491.36 E 1249568.71
Approximate Ground Surface Elevation: 17 Feet
Horizontal Datum: Washington State Plane
Vertical Datum: MLLW

Drill Equipment: Mobile B-59/Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: W. McDonald  Reviewed By: C. de la Torre

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Slightly silty SAND zone observed.

3-inch-thick layer of SILT observed.

Very stiff to hard, moist, gray, slightly fine sandy to clayey SILT with occasional silty, fine SAND seams, and shell and wood fragments.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log HC14-B2**

Location: N 103491.36 E 1249568.71  
Approximate Ground Surface Elevation: 17 Feet  
Horizontal Datum: Washington State Plane  
Vertical Datum: MLLW  

Drill Equipment: Mobile B-59/Mud Rotary  
Hammer Type: SPT w/140 lb. Automatic hammer  
Hole Diameter: 6 inches  
Logged By: W. McDonald  
Reviewed By: C. de la Torre  

---

**USCS Graphic Log**

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Soil Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dense to very dense, wet, gray to black, fine to medium SAND with trace silt and red sand grains; occasional wood debris (&lt;1/2 inch).</td>
</tr>
<tr>
<td></td>
<td>Silty sand to silt seams observed.</td>
</tr>
<tr>
<td></td>
<td>1-inch-thick silt layer observed.</td>
</tr>
<tr>
<td></td>
<td>Grades to slightly silty.</td>
</tr>
<tr>
<td></td>
<td>Grades to trace silt.</td>
</tr>
<tr>
<td></td>
<td>2-inch-thick clayey silt layer observed.</td>
</tr>
</tbody>
</table>

---

**Standard Penetration Resistance**

- Sample S-17: [Blows per Foot](#)  
- Sample S-18: [Blows per Foot](#)  
- Sample S-19: [Blows per Foot](#)  
- Sample S-20: [Blows per Foot](#)  
- Sample S-21: [Blows per Foot](#)  
- Sample S-22: [Blows per Foot](#)  
- Sample S-23: [Blows per Foot](#)  
- Sample S-24: [Blows per Foot](#)  
- Sample S-25: [Blows per Foot](#)

---

**Soil Descriptions**

- **ML**: Dense to very dense, wet, gray to black, fine to medium SAND with trace silt and red sand grains; occasional wood debris (<1/2 inch).
- **SP**: Silty sand to silt seams observed.
- **Grades**: Grades to slightly silty.
- **GS**: Grades to trace silt.
- **GS**: 2-inch-thick clayey silt layer observed.

---

1. Refer to Figure A-1 for explanation of descriptions and symbols.  
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.  
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).  
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC14-B2

Location: N 103491.36 E 1249568.71
Approximate Ground Surface Elevation: 17 Feet
Horizontal Datum: Washington State Plane
Vertical Datum: MLLW

Drill Equipment: Mobile B-59/Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: W. McDonald Reviewed By: C. de la Torre

Geological Log

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Soil Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>135</td>
<td>Dense to very dense, wet, gray to black, fine to medium SAND with trace silt and red sand grains; occasional wood debris (&lt;1/2 inch). (cont'd)</td>
</tr>
<tr>
<td>140</td>
<td>Grades to very dense.</td>
</tr>
<tr>
<td></td>
<td>Dense to very dense, moist, dark gray, very silty, fine SAND with occasional silt zones.</td>
</tr>
<tr>
<td></td>
<td>Silt laminations observed.</td>
</tr>
<tr>
<td></td>
<td>Sandy silt zone observed.</td>
</tr>
<tr>
<td>145</td>
<td>Very dense, moist to wet, dark gray to black, slightly silty, fine SAND.</td>
</tr>
<tr>
<td>150</td>
<td>Very stiff to hard/dense, moist to wet, gray, sandy SILT to very silty, fine SAND.</td>
</tr>
<tr>
<td>155</td>
<td>Very dense, moist, dark gray, very sandy SILT with occasional wood fragments.</td>
</tr>
</tbody>
</table>

Graphical Log

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC14-B2

Location: N 103491.36 E 1249568.71
Approximate Ground Surface Elevation: 17 Feet
Horizontal Datum: Washington State Plane
Vertical Datum: MLLW

Drill Equipment: Mobile B-59/Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: W. McDonald    Reviewed By: C. de la Torre

Soil Descriptions

SM
Very dense, moist, dark gray, very sandy SILT with occasional wood fragments.
(cont’d)

Bottom of Boring at 186.5 Feet.
Started 06/20/14.
Completed 06/25/14.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
# Boring Log HC14-B3

**Location:** N 103288.78 E 1249918.83  
**Approximate Ground Surface Elevation:** 18 Feet  
**Horizontal Datum:** Washington State Plane  
**Vertical Datum:** MLLW

**Drill Equipment:** Mobile B-59/Mud Rotary  
**Hammer Type:** SPT w/140 lb. Automatic hammer  
**Hole Diameter:** 6 inches  
**Logged By:** W. McDonald  
**Reviewed By:** C. Valdez

## Soil Descriptions

<table>
<thead>
<tr>
<th>USCS Graphic Log</th>
<th>Soil Descriptions</th>
<th>Depth in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-SM</td>
<td>Brown, gravelly, slightly silty SAND with cobbles. (FILL)</td>
<td>0</td>
</tr>
<tr>
<td>SP-SM</td>
<td>Loose to medium dense, wet, gray-brown to black, slightly silty, fine to medium SAND; red sand grains, and occasional shell fragments.</td>
<td>-5</td>
</tr>
<tr>
<td></td>
<td>~Vacuum excavated to 9 feet.</td>
<td></td>
</tr>
</tbody>
</table>

- Frequent sandy SILT layers observed.

## Standard Penetration Resistance

<table>
<thead>
<tr>
<th>Sample</th>
<th>Blows per Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td></td>
</tr>
<tr>
<td>S-2</td>
<td></td>
</tr>
<tr>
<td>S-3</td>
<td></td>
</tr>
<tr>
<td>S-4</td>
<td></td>
</tr>
<tr>
<td>S-5</td>
<td></td>
</tr>
<tr>
<td>S-6</td>
<td></td>
</tr>
<tr>
<td>S-7</td>
<td></td>
</tr>
</tbody>
</table>

## Water Content in Percent

- 0 10 20 30 40 50+  
- 0 20 40 60 80 100+

1. Refer to Figure A-1 for explanation of descriptions and symbols.  
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.  
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).  
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Loose to medium dense, wet, gray-brown to black, slightly silty, fine to medium SAND; red sand grains, and occasional shell fragments. (cont’d)

Medium dense to dense, black, fine SAND with trace silt to slightly silty, fine SAND with occasional silt lenses.

Medium dense, wet, dark gray, fine SAND to very silty, fine SAND with silt seams, occasional shell fragments and trace wood.

Dense to very dense, wet, black, fine to medium SAND with red sand grains and shell fragments.

Refer to Figure A-1 for explanation of descriptions and symbols.

Soil descriptions and stratum lines are interpretive and actual changes may be gradual.

USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).

Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC14-B3

Location: N 103288.78 E 1249918.83
Approximate Ground Surface Elevation: 18 Feet
Horizontal Datum: Washington State Plane
Vertical Datum: MLLW

Drill Equipment: Mobile B-59/Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: W. McDonald    Reviewed By: C. Valdez

USCS Graphic
Class    Log    Soil Descriptions    Depth in Feet
ML       Very stiff, moist to wet, dark gray, fine sandy SILT to SILT. (cont'd)
SP       Dense, moist to wet, dark gray, slightly silty to silty SAND.
ML       Very stiff, moist to wet, dark gray, fine slightly sandy SILT.
SP-SM    Dense to very dense, moist, dark gray, fine SAND to silty fine SAND with occasional silt lens.
ML       Very stiff, moist, gray SILT with trace fine sand.
SP-SM    Dense to very dense, moist to wet, dark gray, slightly silty, fine SAND with frequent silt lenses.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

NEW BORING LOG  1791601-BL.GPJ  HC_CORP.GDT  9/17/14

DRAFT
Boring Log HC14-B3

Location: N 103288.78 E 1249918.83
Approximate Ground Surface Elevation: 18 Feet
Horizontal Datum: Washington State Plane
Vertical Datum: MLLW

Drill Equipment: Mobile B-59/Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: W. McDonald    Reviewed By: C. Valdez

USCS Graphic
Class Log Soil Descriptions

SP-SM      Bottom of Boring at 181.5 Feet. Started 06/20/14. Completed 07/01/14.

Depth in Feet
0 10 20 30 40 50+

StANDARD PENETRATION RESISTANCE LAB TESTS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC12-B1

Location: See Figure 2.
Approximate Ground Surface Elevation: -42 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

USCS Graphic Class Log Soil Descriptions Depth in Feet

| S-1 | GP-GM | (Very loose), sandy GRAVEL and gravelly SAND inferred from drill action. (FILL) |
| S-2 | SP    | Medium dense, wet, dark gray, fine to medium SAND with trace silt. |
| S-3 | SP    | Loose, sandy GRAVEL to gravelly SAND inferred from drill action. |
| S-4 | SP    | Medium dense, wet, dark gray, silty, fine SAND. |
| S-5 | SP    | Medium dense, wet, dark gray, fine to medium SAND with trace silt, grades to slightly silty, fine to medium SAND. |

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Medium dense, wet, dark gray, silty, fine SAND with sandy silt laminations and partings. (cont'd)

Scattered organic material, and wood debris at 51 feet.

Medium dense to to very dense, wet, dark gray, fine to medium SAND with trace silt.

Scattered silt partings and sandy silt zones between 66 and 73 feet.

Stiff, wet, gray SILT with interbedded dark gray, fine to medium SAND layers and fine sandy SILT laminations.

Dense, wet, dark gray, slightly silty, fine to medium SAND with silt seams.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log HC12-B1**

Location: See Figure 2.
Approximate Ground Surface Elevation: -42 Feet

Horizontal Datum: Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

**USCS Graphic Log**

<table>
<thead>
<tr>
<th>USCS Class</th>
<th>Depth in Feet</th>
<th>Soil Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>90</td>
<td>Medium dense to dense, wet, dark gray, fine to medium SAND with trace silt. (cont'd)</td>
</tr>
<tr>
<td>ML</td>
<td>110</td>
<td>Stiff to very stiff, wet, gray SILT with fine sandy silt zones and occasional fine sand seams.</td>
</tr>
<tr>
<td>SM</td>
<td>120</td>
<td>Dense, wet, dark gray, slightly silty to silty, fine SAND with scattered silt seams.</td>
</tr>
<tr>
<td>ML</td>
<td>130</td>
<td>Very stiff, wet, dark gray SILT and fine sandy SILT with zones of very silty, fine SAND.</td>
</tr>
</tbody>
</table>

**Depth Chart**

- Scattered silt seams past 106 feet.
- Silt has blocky texture at 116 feet.
- Numerous pores within soil matrix at 121 feet.

**Standard Penetration Resistance ( Blow  per Foot )**

- Water Content in Percent

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log HC12-B1**

Location: See Figure 2.
Approximate Ground Surface Elevation: -42 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

---

**USCS Graphic Log**

<table>
<thead>
<tr>
<th>Depth in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>135</td>
</tr>
<tr>
<td>140</td>
</tr>
<tr>
<td>145</td>
</tr>
<tr>
<td>150</td>
</tr>
<tr>
<td>155</td>
</tr>
</tbody>
</table>

**Soil Descriptions**

**ML**
- Very stiff, wet, dark gray SILT and fine sandy SILT with zones of very silty, fine SAND.
  (cont’d)

**SM**
- Dense, wet, dark gray, silty, fine SAND with fine sandy silt zones and laminations.

**SP-SMT**
- Dense, wet, dark gray, slightly silty, fine to medium SAND.

**Bottom of Boring at 147.5 Feet.**
- Started 02/19/13.
- Completed 02/20/13.

---

**Graphical Log**

**Soil Descriptions**

**USCS Class**

- ML
- SM
- SP-SMT

**Graphic Log**

**Depth in Feet**

- 135
- 140
- 145
- 150
- 155

**Sample**

- S-27
- S-28
- S-29

---

**Standard Penetration Resistance**

- 0
- 10
- 20
- 30
- 40
- 50+

**Water Content in Percent**

- 0
- 20
- 40
- 60
- 80
- 100+

---

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC12-B2

Location: See Figure 2.
Approximate Ground Surface Elevation: -39 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

<table>
<thead>
<tr>
<th>USCS Class</th>
<th>Graphic Log</th>
<th>Soil Descriptions</th>
<th>Depth in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-SM</td>
<td></td>
<td>Very loose, wet, very dark gray, silty fine SAND to fine sandy SILT. (FILL)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trace to scattered shell fragments and gravels from 5.5 to 15 feet.</td>
<td>5</td>
</tr>
<tr>
<td>SM</td>
<td></td>
<td>Dense to very dense, wet, dark gray, trace to slightly silty, fine to medium SAND.</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scattered organic zones at 23 feet.</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dense to very dense, wet, dark gray, silty, fine SAND with silt and fine sandy silt seams.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trace shell fragments at 38 feet.</td>
<td>25</td>
</tr>
</tbody>
</table>

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified.  Level may vary with time.
**Boring Log HC12-B2**

**Location:** See Figure 2.
**Approximate Ground Surface Elevation:** -39 Feet
**Horizontal Datum:**
**Vertical Datum:** MLLW

**Drill Equipment:** Mud Rotary
**Hammer Type:** SPT w/140 lb. Automatic hammer
**Hole Diameter:** 6 inches
**Logged By:** B. McDonald  
**Reviewed By:** B. Cook

---

**USCS Graphic Log**

**Soil Descriptions**

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Sample</th>
<th>Penetration Resistance</th>
<th>Water Content in Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-17</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC12-B2

Location: See Figure 2.
Approximate Ground Surface Elevation: -39 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC12-B2

Location: See Figure 2.
Approximate Ground Surface Elevation: -39 Feet
Horizontal Datum:
Vertical Datum: MLLW

Dense, wet, gray, very silty, fine SAND with scattered silt laminations.

Dense, very moist, dark gray, slightly silty, fine SAND.

Bottom of Boring at 149.5 Feet.
Started 02/11/13.
Completed 02/13/13.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log HC12-B4**

Location: See Figure 2.
Approximate Ground Surface Elevation: -43 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>USCS Class</th>
<th>Graphic Log</th>
<th>Soil Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>SM</td>
<td>(Very loose), silty, fine SAND inferred. (FILL)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SM</td>
<td>Drilling action and drilling mud return interpreted as Wood with possible Rip Rap, Gravel and/or Concrete. (FILL)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SM</td>
<td>Dense, very moist to wet, dark gray, silty, fine to medium SAND with scattered shell fragments in upper 10 feet.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>SM</td>
<td>Scattered fine sandy SILT and SILT laminations and layers with trace organic material past 23 feet.</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>SM</td>
<td>Medium dense, wet, dark gray, slightly silty to silty, fine to medium SAND.</td>
<td></td>
</tr>
</tbody>
</table>

**STANDARD PENETRATION RESISTANCE LAB TESTS**

- **Sample Blows per Foot**
  - S-1: 23, 19, 18
  - S-2: 31, 30, 30
  - S-3: 16, 18, 18
  - S-4: 9, 13, 20
  - S-5: 16, 20, 20
  - S-6: 15, 17, 17
  - S-7: 8, 10, 10
  - S-8: 12, 13, 13

- **Water Content in Percent**
  - GS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC12-B4

Location: See Figure 2.
Approximate Ground Surface Elevation: -43 Feet
Horizontal Datum:
Vertical Datum: MLLW

Soil Descriptions

- **SP-SM**: Dense, wet, dark gray, fine to medium SAND.
- **SP**: Medium dense to dense, wet, dark gray, slightly silty, fine to medium SAND with occasional silt seams.
- **SP** + **SM**: Dense, wet, dark gray, fine to medium SAND with scattered shell fragments and interbedded layers of slightly silty to silty, fine to medium SAND.
- **SM**: Dense, wet, dark gray, very silty, fine SAND.
- **SP**: Dense, wet, dark gray, fine to medium SAND with trace silt.

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald  Reviewed By: B. Cook

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
### Soil Descriptions

<table>
<thead>
<tr>
<th>USCS Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>Stiff, wet, gray, fine sandy SILT to silty, fine SAND; grades to a medium stiff, wet, gray, fine sandy SILT.</td>
</tr>
<tr>
<td>SM</td>
<td>Dense, wet, dark gray, very silty, fine SAND.</td>
</tr>
<tr>
<td>ML</td>
<td>Very stiff, wet, gray SILT and fine sandy SILT with very silty, fine sand zones.</td>
</tr>
<tr>
<td>SM/ML</td>
<td>Fine sandy SILT zones past 113 feet.</td>
</tr>
</tbody>
</table>

#### Drill Equipment
- **Hammer Type**: SPT w/140 lb. Automatic hammer
- **Hole Diameter**: 6 inches

#### Boring Log Details
- **Logged By**: B. McDonald
- **Reviewed By**: B. Cook

---

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC12-B4

Location: See Figure 2.
Approximate Ground Surface Elevation: -43 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Soil Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dense, wet, dark gray, silty, fine SAND with occasional fine sandy silt seams.</td>
</tr>
<tr>
<td></td>
<td>Medium stiff, wet, gray SILT with trace sand.</td>
</tr>
<tr>
<td></td>
<td>Dense, very moist, dark gray, very silty, fine SAND.</td>
</tr>
</tbody>
</table>

Bottom of Boring at 149.5 Feet.
Started 02/14/13.
Completed 02/15/13.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

NEW BORING LOG 17916-01-BL.GPJ  HC_CORP.GDT  9/17/14
DRAFT
**Boring Log/Construction Data for Shear Wave Well HC12-B5**

**Location:** See Figure 2.  
**Approximate Ground Surface Elevation:** 17 Feet  
**Horizontal Datum:**  
**Vertical Datum:** MLLW

**Drill Equipment:** Mud Rotary  
**Hammer Type:** SPT w/140 lb. Automatic hammer  
**Hole Diameter:** 6 inches  
**Logged By:** B. McDonald  
**Reviewed By:** B. Cook

<table>
<thead>
<tr>
<th>USCS Class</th>
<th>Graphic Log</th>
<th>Soil Descriptions</th>
<th>Depth in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP</td>
<td>Asphalt.</td>
<td>Dense, moist, gray, sandy, crushed GRAVEL.</td>
<td></td>
</tr>
<tr>
<td>GW</td>
<td>Asphalt.</td>
<td>Sandy GRAVEL (Pit Run).</td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>Loose, wet, brown, slightly silty, fine to medium SAND.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>Loose, wet, dark gray, fine to medium SAND, scattered ash fragments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>Loose, wet, gray SILT and clayey SILT with very silty fine SAND zones, scattered wood fragments and organic material.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML</td>
<td>Very soft to soft, wet, gray SILT and clayey SILT with very silty fine SAND zones, scattered wood fragments and organic material.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>Loose, wet, gray to dark gray, silty, fine SAND, scattered fine sandy silt zones.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Well Construction:**  
Flush mount monument  
Concrete  
3" PVC Casing  
Cement/Bentonite Grout

**STANDARD PENETRATION RESISTANCE LAB TESTS**

1. Refer to Figure A-1 for explanation of descriptions and symbols.  
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.  
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).  
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log/Construction Data for Shear Wave Well HC12-B5

Location: See Figure 2.
Approximate Ground Surface Elevation: 17 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

USCS Graphic Log | Soil Descriptions | Depth in Feet | Well Construction Sample
---|---|---|---
SM | Loose, wet, gray to dark gray, silty, fine SAND, scattered fine sandy silt zones. (cont’d) | 45 | S-10
SP | Medium dense, wet, dark gray, fine to medium SAND. | 50 | S-11
GP | Sandy, fine GRAVEL. | 55 | S-12
SP | Medium dense to dense, wet, gray to dark gray, fine to medium SAND with silty, fine SAND and sandy SILT zones/seams, trace shell and ash fragments. | 60 | S-13

STANDARD PENETRATION RESISTANCE LAB TESTS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log/Construction Data for Shear Wave Well HC12-B5**

**Location:** See Figure 2.
**Approximate Ground Surface Elevation:** 17 Feet
**Horizontal Datum:**
**Vertical Datum:** MLLW

**Drill Equipment:** Mud Rotary
**Hammer Type:** SPT w/140 lb. Automatic hammer
**Hole Diameter:** 6 inches
**Logged By:** B. McDonald    **Reviewed By:** B. Cook

**Soil Descriptions:**
- **SP:** Dense, wet, dark gray, slightly silty to silty, fine SAND.
- **SM:** Trace shell and ash fragments at 115 feet.

**Sample Blows per Foot**

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

**NEW BORING LOG  1791601-BL.GPJ  HC_CORP.GDT  9/17/14**

**Figure A-8**
Boring Log/Construction Data for Shear Wave Well HC12-B5

Location: See Figure 2.
Approximate Ground Surface Elevation: 17 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

**USCS Graphic Log**

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Well Construction</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>135</td>
<td>S-25</td>
<td></td>
</tr>
<tr>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>145</td>
<td></td>
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<td>150</td>
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<tr>
<td>155</td>
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<td>160</td>
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<td>170</td>
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<tr>
<td>175</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Soil Descriptions**

- **SM**: Dense, wet, dark gray, slightly silty to silty, fine SAND. (cont'd)
- **SM**: Dense, wet, gray, silty to very silty, fine SAND with fine sandy SILT and clayey SILT laminations, scattered organic material.
- **ML**: Soft, wet, gray SILT and clayey SILT.
- **SM**: Dense, wet, gray, silty to very silty, fine SAND, interbedded fine sandy SILT and clayey SILT.

**Graphical Log**

- **Well Construction**
- **Sample**
- **Water Content in Percent**
- **Blows per Foot**
- **Standard Penetration Resistance**
- **Lab Tests**

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Location: See Figure 2.
Approximate Ground Surface Elevation: 17 Feet
Horizontal Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald
Reviewed By: B. Cook

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log/Construction Data for Shear Wave Well HC12-B5

Location: See Figure 2.
Approximate Ground Surface Elevation: 17 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald    Reviewed By: B. Cook

USCS Graphic Class Log Soil Descriptions

**SM**
Dense to very dense, wet, dark gray, silty fine SAND with interbedded SILT and fine sandy SILT layers/partings. (cont'd)

**ML**
Very soft to stiff, wet, gray, clayey SILT.

**SP**
Dense, wet, dark gray, slightly silty, fine to medium SAND.

Bottom of Boring at 260.0 Feet.
Started 12/17/12.
Completed 12/19/12.

---

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
### Soil Descriptions

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Sample Blows per Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
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<td>15</td>
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<tr>
<td>20</td>
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<td>25</td>
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<tr>
<td>35</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
</tr>
<tr>
<td>50+</td>
<td></td>
</tr>
<tr>
<td>100+</td>
<td></td>
</tr>
</tbody>
</table>

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC12-B6

Location: See Figure 2.
Approximate Ground Surface Elevation: 19 Feet
Horizontal Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald Reviewed By: B. Cook

Soil Descriptions

- SP
  Medium dense to dense, wet, dark gray, fine to medium SAND, zones of scattered shell fragments. (cont'd)

- SM
  Medium dense to dense, wet, gray, silty to very silty, fine SAND with fine sandy SILT zones.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log HC12-B6**

**Location:** See Figure 2.
**Approximate Ground Surface Elevation:** 19 Feet
**Horizontal Datum:**
**Vertical Datum:** MLLW

**Drill Equipment:** Mud Rotary
**Hammer Type:** SPT w/140 lb. Automatic hammer
**Hole Diameter:** 6 inches
**Logged By:** B. McDonald  
**Reviewed By:** B. Cook

---

**USCS Graphic Log**

<table>
<thead>
<tr>
<th>USCS Class</th>
<th>Soil Descriptions</th>
<th>Depth in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>Medium dense to dense, wet, gray, silty to very silty, fine SAND with fine sandy SILT zones. (cont’d)</td>
<td></td>
</tr>
<tr>
<td>SF</td>
<td>Dense, wet, gray to dark gray, fine to medium SAND, scattered shell fragments.</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>Medium dense to dense, wet, gray, slightly silty to silty, fine SAND with very silty, fine SAND zones.</td>
<td></td>
</tr>
<tr>
<td>ML</td>
<td>Medium stiff to very stiff, wet, gray SILT and clayey SILT with fine sandy SILT zones.</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>Medium dense, wet, gray, silty, fine SAND with fine sandy SILT zones.</td>
<td></td>
</tr>
<tr>
<td>ML</td>
<td>Stiff, wet, gray SILT with clayey SILT zones.</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Soil Descriptions**

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
Boring Log HC12-B6

Location: See Figure 2.
Approximate Ground Surface Elevation: 19 Feet
Horizontal Datum:
Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald Reviewed By: B. Cook

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log HC12-B6**

Location: See Figure 2.
Approximate Ground Surface Elevation: 19 Feet
Horizontal Datum: Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald Reviewed By: B. Cook

- **USCS Graphic Log**
- **Soil Descriptions**
- **Depth in Feet**
- **Sample Blows per Foot**
- **Standard Penetration Resistance**
- **Lab Tests**

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
**Boring Log HC12-B6**

Location: See Figure 2.
Approximate Ground Surface Elevation: 19 Feet
Horizontal Datum: Vertical Datum: MLLW

Drill Equipment: Mud Rotary
Hammer Type: SPT w/140 lb. Automatic hammer
Hole Diameter: 6 inches
Logged By: B. McDonald Reviewed By: B. Cook

---

**USCS Graphic Log**

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Soil Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>225</td>
<td>Dense to very dense, wet, gray to dark gray, silty, fine SAND with clayey SILT layers interbedded, scattered shell fragments.</td>
</tr>
</tbody>
</table>

**Bottom of Boring at 251.5 Feet.**
Started 12/12/12.
Completed 12/15/12.

---

**STANDARD PENETRATION RESISTANCE LAB TESTS**

Sample

Blows per Foot

0 10 20 30 40 50+

**Soil Descriptions**

USCS Class

- **ML**
- **SM**

**Location:** See Figure 2.
**Ground Surface Elevation:** 19 Feet

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
APPENDIX B
Laboratory Test Results
Unified Soil Classification (USC) System

Soil Grain Size

<table>
<thead>
<tr>
<th>Size of Opening In Inches</th>
<th>Number of Mesh per Inch (US Standard)</th>
<th>Grain Size in Millimetres</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>6</td>
<td>200</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>400</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>600</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>800</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>1000</td>
</tr>
</tbody>
</table>

Grain Size in Millimetres

<table>
<thead>
<tr>
<th>COBBLES</th>
<th>GRAVEL</th>
<th>SAND</th>
<th>SILT and CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coarse-Grained Soils

<table>
<thead>
<tr>
<th>G W</th>
<th>G P</th>
<th>G M</th>
<th>G C</th>
<th>S W</th>
<th>S P</th>
<th>S M</th>
<th>S C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean GRAVEL &lt;5% fines</td>
<td>GRAVEL with &gt;12% fines</td>
<td>Clean SAND &lt;5% fines</td>
<td>SAND with &gt;12% fines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GRAVEL >50% coarse fraction larger than No. 4.
SAND >50% coarse fraction smaller than No. 4.

Coarse-Grained Soils >50% larger than No. 200 sieve

G W and S W
D_{60} \leq 6 \text{ for } S W
D_{10} \geq 4 \text{ for } G W

D_{10} \leq \frac{(D_{30})^2}{D_{10} \times D_{60}} \leq 3

G P and S P
Clean GRAVEL or SAND not meeting requirements for G W and S W

G M and S M
Atterberg limits below A line with PI <4
G C and S C
Atterberg limits above A Line with PI >7

* Coarse-grained soils with percentage of fines between 5 and 12 are considered borderline cases requiring use of dual symbols.

Fine-Grained Soils

<table>
<thead>
<tr>
<th>M L</th>
<th>C L</th>
<th>O L</th>
<th>M H</th>
<th>C H</th>
<th>O H</th>
<th>Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILT</td>
<td>CLAY</td>
<td>Organic</td>
<td>SILT</td>
<td>CLAY</td>
<td>Organic</td>
<td>Highly Organic Soils</td>
</tr>
</tbody>
</table>

Soils with Liquid Limit <50% | Soils with Liquid Limit >50%

Fine-Grained Soils >50% smaller than No. 200 sieve

---

**Figure B-1**

<table>
<thead>
<tr>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liquid Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
</tr>
<tr>
<td>90</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>70</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

C L - M L

M L or O L

C H

A Line

M H or O H
Particle Size Distribution Test Report

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>0.0</td>
<td>0.0</td>
<td>90.4</td>
<td>9.6</td>
</tr>
<tr>
<td>■</td>
<td>0.0</td>
<td>0.0</td>
<td>88.5</td>
<td>11.5</td>
</tr>
<tr>
<td>▲</td>
<td>0.0</td>
<td>0.0</td>
<td>83.1</td>
<td>16.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>0.793</td>
<td>0.509</td>
<td>0.426</td>
<td>0.277</td>
<td>0.153</td>
<td>0.079</td>
<td>1.91</td>
<td>6.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>■</td>
<td>0.732</td>
<td>0.566</td>
<td>0.511</td>
<td>0.387</td>
<td>0.166</td>
<td>5.55</td>
<td>11.91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td>0.53</td>
<td>0.303</td>
<td>0.253</td>
<td>0.157</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATERIAL DESCRIPTION
- slightly silty SAND
- slightly silty SAND
- silty SAND

USCS | NAT. MOIST.
---|-----|
SW-SM | 22.7%
SP-SM | 26.5%
SM | 23.5%

Remarks:

Project: Port of Tacoma Pier 4 Reconfiguration

Client:
- Source: HC14-B1 Sample No.: S-11 Depth: 60.0 to 61.5
- Source: HC14-B1 Sample No.: S-19 Depth: 100.0 to 101.5
- Source: HC14-B1 Sample No.: S-24 Depth: 125.0 to 126.5

17916-01 6/14
Figure B-2
Particle Size Distribution Test Report

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>88.0</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>77.7</td>
<td>22.3</td>
<td></td>
</tr>
<tr>
<td>0.0</td>
<td>0.4</td>
<td>91.8</td>
<td>7.8</td>
<td></td>
</tr>
</tbody>
</table>

MATERIAL DESCRIPTION

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D$_{60}$</th>
<th>D$_{50}$</th>
<th>D$_{30}$</th>
<th>D$_{15}$</th>
<th>D$_{10}$</th>
<th>C$_c$</th>
<th>C$_u$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.546</td>
<td>0.283</td>
<td>0.186</td>
<td>0.094</td>
<td>1.64</td>
<td>5.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.328</td>
<td>0.175</td>
<td>0.101</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.596</td>
<td>0.282</td>
<td>0.189</td>
<td>0.116</td>
<td>0.085</td>
<td>1.25</td>
<td>3.91</td>
</tr>
</tbody>
</table>

Remarks:

- Slightly silty SAND
- Silty SAND
- Slightly silty SAND

Project: Port of Tacoma Pier 4 Reconfiguration

Client:

- Source: HC14-B1 Sample No.: S-29 Depth: 150.0 to 151.5
- Source: HC14-B1 Sample No.: S-35 Depth: 180.0 to 181.5
- Source: HC14-B2 Sample No.: S-2 Depth: 15.0 to 16.5
Particle Size Distribution Test Report

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ 0.0</td>
<td>0.0</td>
<td>86.5</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>■ 0.0</td>
<td>0.0</td>
<td>79.2</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td>▲ 0.0</td>
<td>0.0</td>
<td>46.0</td>
<td>54.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D₉₅</th>
<th>D₆₀</th>
<th>D₅₀</th>
<th>D₃₀</th>
<th>D₁₅</th>
<th>D₁₀</th>
<th>Cᵥ</th>
<th>Cₛ</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪</td>
<td>0.397</td>
<td>0.263</td>
<td>0.222</td>
<td>0.158</td>
<td>0.081</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>■</td>
<td>0.266</td>
<td>0.176</td>
<td>0.151</td>
<td>0.094</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td>0.133</td>
<td>0.084</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATERIAL DESCRIPTION

- silty SAND
- silty SAND
- very sandy SILT

USCS | NAT. MOIST.
-----|--------
SM   | 24.9%  
SM   | 27.4%  
ML   | 26.9%  

Remarks:

- ▪
- ■
- ▲

Project: Port of Tacoma Pier 4 Reconfiguration

Client:
- Source: HC14-B2 Sample No.: S-13 Depth: 70.0 to 71.5
- Source: HC14-B2 Sample No.: S-20 Depth: 105.0 to 106.5
- Source: HC14-B2 Sample No.: S-28 Depth: 145.0 to 146.5
Particle Size Distribution Test Report

% COBBLES | % GRAVEL | % SAND | % SILT | % CLAY
---|---|---|---|---
• 0.0 | 0.0 | 16.9 | | 83.1
■ 0.0 | 1.2 | 91.8 | | 7.0
▲ 0.0 | 0.1 | 72.1 | | 27.8

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D₆₅</th>
<th>D₅₀</th>
<th>D₄₀</th>
<th>D₃₀</th>
<th>D₁₅</th>
<th>D₁₀</th>
<th>Cᵣ</th>
<th>Cₒ</th>
</tr>
</thead>
</table>
• 0.083 | | | | | | | | | |
■ 1.282 | 0.602 | 0.492 | 0.307 | 0.177 | 0.117 | 1.34 | 5.13 |
▲ 0.546 | 0.288 | 0.228 | 0.092 | | | | |

MATERIAL DESCRIPTION

- sandy SILT
- slightly silty SAND, trace gravel
- silty SAND

Remarks:

Project: Port of Tacoma Pier 4 Reconfiguration

Client:
- Source: HC14-B2 Sample No.: S-34 Depth: 175.0 to 176.5
- Source: HC14-B3 Sample No.: S-3 Depth: 20.0 to 21.5
- Source: HC14-B3 Sample No.: S-9 Depth: 50.0 to 51.5
Particle Size Distribution Test Report

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>0.0</td>
<td>88.3</td>
<td></td>
<td>11.7</td>
</tr>
<tr>
<td>■</td>
<td>0.0</td>
<td>43.7</td>
<td></td>
<td>56.3</td>
</tr>
<tr>
<td>▲</td>
<td>0.0</td>
<td>62.1</td>
<td></td>
<td>37.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D60</th>
<th>D90</th>
<th>D95</th>
<th>D15</th>
<th>D10</th>
<th>Cc</th>
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<tbody>
<tr>
<td>●</td>
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<td>0.348</td>
<td>0.223</td>
<td>0.195</td>
<td>0.147</td>
<td>0.085</td>
<td>1.37</td>
<td>3.18</td>
</tr>
<tr>
<td>■</td>
<td></td>
<td>0.142</td>
<td>0.081</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td></td>
<td>0.179</td>
<td>0.109</td>
<td>0.092</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATERIAL DESCRIPTION

- slightly silty SAND
- very sandy SILT
- very silty SAND

USCS | NAT. MOIST.
-----|----------
SP-SM | 24.6%
ML    | 27.4%
SM    | 29.9%

Remarks:

- ●
- ■
- ▲

Project: Port of Tacoma Pier 4 Reconfiguration

Client:

- ● Source: HC14-B3 Sample No.: S-13 Depth: 70.0 to 71.5
- ■ Source: HC14-B3 Sample No.: S-19 Depth: 100.0 to 101.5
- ▲ Source: HC14-B3 Sample No.: S-22 Depth: 115.0 to 116.5

Figure B-6
## Particle Size Distribution Test Report

### Client:

- **1-1/2 in.**

### Project:

- Port of Tacoma Pier 4 Reconfiguration

### Depth:

- 170.0 to 171.5

### Remarks:

- Source: HC14-B3
- Sample No.: S-33
- Depth: 170.0 to 171.5

### Material Description

<table>
<thead>
<tr>
<th>USCS</th>
<th>NAT. MOIST.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML</td>
<td>28.7%</td>
</tr>
</tbody>
</table>

### Grain Size

<table>
<thead>
<tr>
<th>GRAIN SIZE (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 in.</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>0.001</td>
</tr>
</tbody>
</table>

### Particle Size Distribution

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>28.5</td>
<td>71.5</td>
<td></td>
</tr>
</tbody>
</table>

### LL, PI

<table>
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<tr>
<th>LL</th>
<th>PI</th>
<th>D₈₅</th>
<th>D₆₀</th>
<th>D₅₀</th>
<th>D₃₀</th>
<th>D₁₅</th>
<th>D₁₀</th>
<th>Cₑ</th>
<th>Cₒ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Remarks:

- Sandy SILT

---

**Client:** HC14-B3

**Sample No.:** S-33

**Depth:** 170.0 to 171.5

---

**Project:** Port of Tacoma Pier 4 Reconfiguration

---

**Remarks:**

- Source: HC14-B3
- Sample No.: S-33
- Depth: 170.0 to 171.5
**Particle Size Distribution Test Report**

### Project:
Port of Tacoma Pier 4 Reconfiguration

### Client:
- Source: HC12-B1
  - Sample No.: S-4
  - Depth: 21.0 to 22.5
- Source: HC12-B1
  - Sample No.: S-8
  - Depth: 41.0 to 42.5
- Source: HC12-B1
  - Sample No.: S-19
  - Depth: 96.0 to 97.5

### Remarks:

#### MATERIAL DESCRIPTION

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>93.6</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>81.6</td>
<td>18.4</td>
<td></td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>92.3</td>
<td>7.7</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D&lt;sub&gt;60&lt;/sub&gt;</th>
<th>D&lt;sub&gt;50&lt;/sub&gt;</th>
<th>D&lt;sub&gt;30&lt;/sub&gt;</th>
<th>D&lt;sub&gt;15&lt;/sub&gt;</th>
<th>D&lt;sub&gt;10&lt;/sub&gt;</th>
<th>C&lt;sub&gt;c&lt;/sub&gt;</th>
<th>C&lt;sub&gt;v&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td>0.55</td>
<td>0.334</td>
<td>0.291</td>
<td>0.206</td>
<td>0.147</td>
<td>0.099</td>
<td>1.28</td>
<td>3.35</td>
</tr>
<tr>
<td>▲</td>
<td>0.714</td>
<td>0.443</td>
<td>0.373</td>
<td>0.268</td>
<td>0.164</td>
<td>0.103</td>
<td>1.58</td>
<td>4.31</td>
</tr>
</tbody>
</table>

#### Source Details:
- SP-SM: 27.5%
- SM: 31.6%
- SP-SM: 27.5%

**Remarks:**

- •
- ◊
- ▲

**Figure B-8**
**Particle Size Distribution Test Report**

**MATERIAL DESCRIPTION**

<table>
<thead>
<tr>
<th>USCS</th>
<th>NAT. MOIST.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>22.2%</td>
</tr>
<tr>
<td>SM</td>
<td>31.5%</td>
</tr>
<tr>
<td>ML</td>
<td>31.6%</td>
</tr>
</tbody>
</table>

**Remarks:**

- silty SAND
- very silty SAND
- very sandy SILT

**Project:** Port of Tacoma Pier 4 Reconfiguration

**Client:**

- Source: HC12-B2  
  Sample No.: S-3  
  Depth: 18.0 to 19.5
- Source: HC12-B2  
  Sample No.: S-12  
  Depth: 63.0 to 64.5
- Source: HC12-B2  
  Sample No.: S-19  
  Depth: 98.0 to 99.5

**Source:** HC12-B2

---

**Figure B-9**
# Particle Size Distribution Test Report

## Project:
Port of Tacoma Pier 4 Reconfiguration

## Client:
- Source: HC12-B4  
  Sample No.: S-6  
  Depth: 33.0 to 34.5
- Source: HC12-B4  
  Sample No.: S-10  
  Depth: 53.0 to 54.5
- Source: HC12-B4  
  Sample No.: S-27  
  Depth: 138.0 to 139.5

## Table:

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td>0.0</td>
<td>60.6</td>
<td>39.4</td>
<td></td>
</tr>
<tr>
<td>●</td>
<td>0.0</td>
<td>87.5</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td>0.0</td>
<td>79.6</td>
<td>20.4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D&lt;sub&gt;95&lt;/sub&gt;</th>
<th>D&lt;sub&gt;60&lt;/sub&gt;</th>
<th>D&lt;sub&gt;50&lt;/sub&gt;</th>
<th>D&lt;sub&gt;30&lt;/sub&gt;</th>
<th>D&lt;sub&gt;15&lt;/sub&gt;</th>
<th>D&lt;sub&gt;10&lt;/sub&gt;</th>
<th>C&lt;sub&gt;c&lt;/sub&gt;</th>
<th>C&lt;sub&gt;s&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>●</td>
<td></td>
<td>0.208</td>
<td>0.118</td>
<td>0.095</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>■</td>
<td></td>
<td>0.392</td>
<td>0.252</td>
<td>0.213</td>
<td>0.153</td>
<td>0.084</td>
<td></td>
<td>1.38</td>
<td>3.73</td>
</tr>
<tr>
<td>▲</td>
<td></td>
<td>0.357</td>
<td>0.214</td>
<td>0.18</td>
<td>0.106</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MATERIAL DESCRIPTION

- **very silty SAND**  
- **slightly silty SAND**  
- **silty SAND**

### Remarks:

- ●
- ■
- ▲

### Source:
- HC12-B4  
  Sample No.: S-6  
  Depth: 33.0 to 34.5
- HC12-B4  
  Sample No.: S-10  
  Depth: 53.0 to 54.5
- HC12-B4  
  Sample No.: S-27  
  Depth: 138.0 to 139.5
Particle Size Distribution Test Report

**% COBBLES** | **% GRAVEL** | **% SAND** | **% SILT** | **% CLAY**
---|---|---|---|---
• 0.0 | 0.3 | 85.2 | 14.5 |
■ 0.0 | 0.5 | 52.8 | 46.7 |
▲ 0.0 | 0.0 | 89.7 | 10.3 |

**LL** **PI** | **D₉₅** | **D₆₀** | **D₅₀** | **D₃₀** | **D₁₅** | **D₁₀** | **Cₑ** | **Cₒ**
---|---|---|---|---|---|---|---|---
• 0.399 | 0.252 | 0.209 | 0.138 | 0.076 |
■ 0.234 | 0.112 | 0.083 |
▲ 0.604 | 0.351 | 0.299 | 0.198 | 0.107 | 1.52 | 4.78 |

**MATERIAL DESCRIPTION**

- **SP-SM**
- **SM**
- **SP-SM**

**Remarks:**
- •
- ■
- ▲

**Project:** Port of Tacoma Pier 4 Reconfiguration

**Client:**
- • Source: HC12-B5  Sample No.: S-10  Depth: 45.0 to 46.5
- ■ Source: HC12-B5  Sample No.: S-14  Depth: 65.0 to 66.5
- ▲ Source: HC12-B5  Sample No.: S-24  Depth: 125.0 to 126.5

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**Figure B-11**
### Particle Size Distribution Test Report

#### Project:
Port of Tacoma Pier 4 Reconfiguration

#### Client:
- Source: HC12-B5  Sample No.: S-27  Depth: 155.0 to 156.5
- Source: HC12-B5  Sample No.: S-32  Depth: 185.0 to 186.5
- Source: HC12-B5  Sample No.: S-35  Depth: 215.0 to 216.5

#### Remarks:
- 

#### Material Description

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td>0.0</td>
<td>52.4</td>
<td>47.6</td>
<td></td>
</tr>
<tr>
<td>■</td>
<td>0.0</td>
<td>63.4</td>
<td>36.6</td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td>0.0</td>
<td>79.8</td>
<td>20.2</td>
<td></td>
</tr>
</tbody>
</table>

#### Grain Size - mm

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D_65</th>
<th>D_50</th>
<th>D_10</th>
<th>D_15</th>
<th>Cc</th>
<th>Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td></td>
<td>0.173</td>
<td>0.097</td>
<td>0.079</td>
<td>0.039</td>
<td>0.011</td>
<td>0.005</td>
</tr>
<tr>
<td>■</td>
<td></td>
<td>0.214</td>
<td>0.125</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td></td>
<td>0.241</td>
<td>0.165</td>
<td>0.139</td>
<td>0.092</td>
<td>0.057</td>
<td>0.03</td>
</tr>
</tbody>
</table>

#### Remarks:

- 

### Table:

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td>0.0</td>
<td>52.4</td>
<td>47.6</td>
<td></td>
</tr>
<tr>
<td>■</td>
<td>0.0</td>
<td>63.4</td>
<td>36.6</td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td>0.0</td>
<td>79.8</td>
<td>20.2</td>
<td></td>
</tr>
</tbody>
</table>

#### Notes:

- Source: HC12-B5
- Sample No.: S-27
- Depth: 155.0 to 156.5
- Source: HC12-B5
- Sample No.: S-32
- Depth: 185.0 to 186.5
- Source: HC12-B5
- Sample No.: S-35
- Depth: 215.0 to 216.5

---

**Figure B-12**
### Particle Size Distribution Test Report

#### Material Description

- **Silty sand, trace gravel**
- **Slightly silty sand**
- **Very sandy silt**

#### Remarks

- ****
- **■**
- **▲**

#### Project

Port of Tacoma Pier 4 Reconfiguration

#### Client

- Source: HC12-B6  
  Sample No.: S-5  
  Depth: 30.0 to 31.5
- Source: HC12-B6  
  Sample No.: S-10  
  Depth: 55.0 to 56.5
- Source: HC12-B6  
  Sample No.: S-20  
  Depth: 105.0 to 106.5

---

### Table

<table>
<thead>
<tr>
<th>% COBBLES</th>
<th>% GRAVEL</th>
<th>% SAND</th>
<th>% SILT</th>
<th>% CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>****</td>
<td>0.0</td>
<td>1.1</td>
<td>82.9</td>
<td>16.1</td>
</tr>
<tr>
<td><strong>■</strong></td>
<td>0.0</td>
<td>0.0</td>
<td>93.7</td>
<td>6.3</td>
</tr>
<tr>
<td><strong>▲</strong></td>
<td>0.0</td>
<td>0.0</td>
<td>41.9</td>
<td>58.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D₉₅</th>
<th>D₆₀</th>
<th>D₅₀</th>
<th>D₃₀</th>
<th>D₁₅</th>
<th>D₁₀</th>
<th>Cᵢ</th>
<th>Cₒ</th>
</tr>
</thead>
<tbody>
<tr>
<td>****</td>
<td>0.695</td>
<td>0.369</td>
<td>0.291</td>
<td>0.173</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>■</strong></td>
<td>0.692</td>
<td>0.44</td>
<td>0.377</td>
<td>0.281</td>
<td>0.184</td>
<td>0.145</td>
<td>1.23</td>
<td>3.03</td>
<td></td>
</tr>
<tr>
<td><strong>▲</strong></td>
<td>0.141</td>
<td>0.078</td>
<td>0.695</td>
<td>0.692</td>
<td>0.141</td>
<td>0.184</td>
<td>1.23</td>
<td>3.03</td>
<td></td>
</tr>
</tbody>
</table>

#### Project:

Port of Tacoma Pier 4 Reconfiguration

#### Client:

- Source: HC12-B6  
  Sample No.: S-5  
  Depth: 30.0 to 31.5
- Source: HC12-B6  
  Sample No.: S-10  
  Depth: 55.0 to 56.5
- Source: HC12-B6  
  Sample No.: S-20  
  Depth: 105.0 to 106.5

---

**HARTCROWER**

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**Figure B-13**
# COBBLES   | % GRAVEL | % SAND | % SILT | % CLAY
---|---|---|---|---
● | 0.0 | 0.0 | 66.7 | 33.3
■ | 0.0 | 0.0 | 80.2 | 19.8
▲ | 0.0 | 0.0 | 76.0 | 24.0

<table>
<thead>
<tr>
<th>LL</th>
<th>PI</th>
<th>D₉⁵</th>
<th>D₆⁰</th>
<th>D₅₀</th>
<th>D₃⁰</th>
<th>D₁₅</th>
<th>D₁₀</th>
<th>Cᵝ</th>
<th>Cₛ</th>
</tr>
</thead>
</table>
● | 0.217 | 0.131 | 0.107 | 0.065 | 0.027 | 0.012 | 2.68 | 11.02 |
■ | 0.302 | 0.191 | 0.165 | 0.101 |  |  |  |  |
▲ | 0.205 | 0.14 | 0.118 | 0.083 | 0.051 | 0.017 | 2.86 | 8.08 |

MATERIAL DESCRIPTION
- very silty SAND
- silty SAND
- silty SAND

Remarks:

Project: Port of Tacoma Pier 4 Reconfiguration

Client:
- Source: HC12-B6 Sample No.: S-30 Depth: 150.0 to 151.5
- Source: HC12-B6 Sample No.: S-36 Depth: 180.0 to 181.5
- Source: HC12-B6 Sample No.: S-49 Depth: 245.0 to 246.5

Source: HC12-B6

Figure B-14
**Liquid and Plastic Limits Test Report**

Dashed line indicates the approximate upper limit boundary for natural soils.

### Location + Description

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample No.</th>
<th>Depth</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>USCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: HC14-B1 sandy SILT</td>
<td>S-6</td>
<td>35</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>ML</td>
</tr>
<tr>
<td>Source: HC14-B1 sandy SILT</td>
<td>S-22</td>
<td>115</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>ML</td>
</tr>
<tr>
<td>Source: HC14-B2 SILT</td>
<td>S-4</td>
<td>25</td>
<td>34</td>
<td>25</td>
<td>9</td>
<td>ML</td>
</tr>
<tr>
<td>Source: HC14-B2 CLAY</td>
<td>S-7</td>
<td>40</td>
<td>35</td>
<td>24</td>
<td>11</td>
<td>CL</td>
</tr>
<tr>
<td>Source: HC14-B2 SILT</td>
<td>S-16</td>
<td>85</td>
<td>26</td>
<td>23</td>
<td>3</td>
<td>ML</td>
</tr>
</tbody>
</table>

### Remarks:
- granular, non-plastic
- granular, non-plastic
- ▲
- ◆
- ▼

### Project:
Port of Tacoma Pier 4 Reconfiguration

### Client:

### Location:

---

**Figure B- 15**

---

**Source:** HC14-B1

---

**Liquid and Plastic Limits Test Report**

---

**Source:** HC14-B2

---

**CL-ML**

---

**DRAFT**

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**17916-01**

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**HARTCROWSER**

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**17916-01**

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**HARTCROWSER**

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**Figure B- 15**
### Liquid and Plastic Limits Test Report

Dashed line indicates the approximate upper limit boundary for natural soils.

#### Location + Description

<table>
<thead>
<tr>
<th>Source: HC14-B3</th>
<th>Sample No.: S-28</th>
<th>Depth: 145</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>-200</th>
<th>USCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILT</td>
<td></td>
<td></td>
<td>30</td>
<td>28</td>
<td>2</td>
<td>-200</td>
<td>ML</td>
</tr>
</tbody>
</table>

#### Remarks:

- 

#### Project:

Port of Tacoma Pier 4 Reconfiguration

#### Client:

- 

#### Location:

- 

---

**Figure B-16**

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**HARTCROWSER**
**Remarks:**
- Description and Classification based on Atterberg Limit test results only.
- Description and Classification based on Atterberg Limit test results only.

**Project:** Port of Tacoma Pier 4 Reconfiguration

**Client:**

**Location:**

---

### Location + Description

<table>
<thead>
<tr>
<th>Location + Description</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>USCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Source: HC12-B1  Sample No.: S-23  Depth: 116  SILT</td>
<td>32</td>
<td>25</td>
<td>7</td>
<td>ML</td>
</tr>
<tr>
<td>■ Source: HC12-B4  Sample No.: S-19  Depth: 98  SILT</td>
<td>29</td>
<td>26</td>
<td>3</td>
<td>ML</td>
</tr>
<tr>
<td>▲ Source: HC12-B5  Sample No.: S-30  Depth: 170  SILT</td>
<td>33</td>
<td>27</td>
<td>6</td>
<td>ML</td>
</tr>
<tr>
<td>● Source: HC12-B5  Sample No.: S-38  Depth: 245  SILT</td>
<td>39</td>
<td>26</td>
<td>13</td>
<td>ML</td>
</tr>
<tr>
<td>▼ Source: HC12-B6  Sample No.: S-24  Depth: 119.5  SILT</td>
<td>31</td>
<td>27</td>
<td>4</td>
<td>ML</td>
</tr>
</tbody>
</table>

---

Dashed line indicates the approximate upper limit boundary for natural soils.
### Liquid and Plastic Limits Test Report

Dashed line indicates the approximate upper limit boundary for natural soils.

#### Location + Description

<table>
<thead>
<tr>
<th>Source: HC12-B6</th>
<th>Sample No.: S-41</th>
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</thead>
<tbody>
<tr>
<td>SILT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location + Description</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>-200</th>
<th>USCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILT</td>
<td>38</td>
<td>26</td>
<td>12</td>
<td>ML</td>
<td></td>
</tr>
</tbody>
</table>

#### Remarks:
- 

#### Project:
- Port of Tacoma Pier 4 Reconfiguration

#### Client:
- 

#### Location:
- 

---

**Figure B-18**

---