


Design Report

Thorne Road Container Yard

Port of Tacoma
Tacoma, Washington

Prepared for
Moffatt & Nichol

February 25, 2022
19398-00

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A division of Haley & Aldrich

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Prepared by
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Contents

Design Report

Thorne Road Container Yard

Port of Tacoma, Tacoma, Washington

INTRODUCTION

This report presents our geotechnical engineering design study for the Thorne Road Container Yard in Tacoma, Washington.

This report contains the following sections:

- Introduction;
- Purpose, Scope, and Use of This Report;
- Project Understanding;
- Subsurface Conditions;
- Design Recommendations; and
- Construction Recommendations.

Tables are presented in the text and figures follow the text to illustrate the project area, exploration locations, and geotechnical design recommendations. Appendix A presents field exploration logs for the current study and previous studies by Hart Crowser. Appendix B presents the laboratory test methods and results. Appendix C presents historical exploration logs by others.

PURPOSE, SCOPE, AND USE OF THIS REPORT

Purpose

The purpose of our work is to provide Moffatt & Nichol and its design and construction consultants with subsurface information, along with our interpretation and geotechnical engineering recommendations to support the design of the Thorne Road Container Yard Project.

Scope

Our scope of work for this project included:

- Collect and evaluate existing information provided by the Port of Tacoma;
- Conduct site explorations including test pits, hand augers, and Cone Penetration Tests (CPTs);
- Provide a summary of subsurface conditions and the influence of those conditions on project development;
- Provide recommendations for:
    - Grading, including recommendations for overexcavation of unsuitable pavement and upper fill soils,

- Design of shallow foundations,
- Design of underground utilities,
- Foundations for portable buildings, light poles, luminaires, etc.
- Estimated resilient modulus for pavement design,
- Structural fill placement and suitability of existing site soils for use as structural fill,
- General dewatering recommendations.

■ Producing a geotechnical engineering design report.

Use of this 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

Our understanding of the project is based on our review of the draft Basis of Design (Moffat & Nichol 2018). The purpose of this project is to provide off-dock terminal support primarily consisting of empty container and reefer storage. The project location includes three adjacent Port-owned properties (1451 Thorne Road, 1721 Thorne Road, and 1702 Port of Tacoma Road) in Tacoma, Washington. The project location is shown on Figure 1 – Vicinity Map. The project layout and explorations are shown on Figure 2 – Site and Exploration Plan.

We understand the average existing site elevation is approximately 17 feet mean lower low water (MLLW) and that preliminary estimates of finish grade elevations (including pavement section) are approximately 20 feet MLLW.

SUBSURFACE CONDITIONS

Soil Conditions

Current and historical borings indicate the following soil units in descending order from the ground surface:

Soil Unit 1 – Sandy Gravel, with Occasionally Concrete, Asphalt and Roots (Fill)

Explorations indicate near surface soils as fill consisting of clean to slightly silty, sandy gravel to variable depths below existing ground surface, with occasional roots, recycle concrete, and asphalt. Soil Unit 1 was not identified in all explorations and was generally noted to be less than about 1.5 feet where observed at boring locations.

Soil Unit 2 – Loose to Medium Dense Silty Sand (Dredge Fill)

Below Unit 1 (where present) or from the ground surface, the explorations indicated loose to medium dense, moist to wet, silty sand with occasional gravel. This unit is dredge fill material that appears to have been filled over the years. The bottom of Unit 2 generally sits at about 2 feet below ground surface (bgs) towards the Thorne Road side of the site and dips gently down to about 8 feet bgs on the Port of Tacoma Road side.

Soil Unit 3 – Silt and Organic Soil (Delta Plain Deposits)

Below Unit 2, explorations encountered wet silt, occasional sand, underlain silt with organics or peat. Unit 3 appears to extend down to about 14 feet bgs.

Soil Unit 4 – Loose to Medium Dense Sand and Silt (Delta Plain Deposits)

Below Unit 3, CPT probes encountered wet, sand, occasional silt, underlain silt with organics or peat. Unit 4 was the deepest soil unit encountered in our explorations.

Groundwater Conditions

Our understanding of groundwater conditions at the site is based on observations during our explorations, and conditions described in existing historical borings around the site (Appendix A and C).

Observations indicate that groundwater encounters within Soil Unit 2 under unconfined conditions. The depth to water in this layer ranged from 2 to 6 feet bgs in most of the test pit locations. Surface ground water was observed in the three hand-auger boring locations in the wetlands.

DESIGN RECOMMENDATIONS

Fill-Induced Settlement

We used the computer software CPeT-IT to estimate the settlement of approximately 2 to 3 feet of grade fill material on top of the current ground surface based on data from CONETEC's four CPTs. We analyzed the settlement for two scenarios: primary settlement and secondary (creep) settlement.

Based on this analysis, we estimated the total settlement from the various CPT results to be generally between 0.5 to 1.0 inch. Additionally, the estimated settlements generally occur in the depth of 7 to 17 feet bgs and happen mostly as a result of primary consolidation settlement. We estimate that the primary consolidation settlement will take place within three to four weeks of fill.

Pavement Design Recommendations

These recommendations assume a minimum of 2 feet of structural fill or equivalent placed over existing fill subgrade.

- Well-compacted fill soils (to a minimum depth of 2 feet below final subgrade elevation) will provide a subgrade-resilient modulus of 9,000 to 10,000 pounds per square inch (psi).

- We assume that "well-compacted fills" are compacted to 95 percent of the maximum dry density in the top 2 feet and to 90 percent maximum dry density below that (see Washington State Department of Transportation [WSDOT] Standard Spec 2-03-.3(14)C Method B).

- Based on the soils present at the site, we estimate that a resilient modulus value of approximately 8,000 psi will be achievable for existing soils with in-place compaction where the groundwater is at least 2 feet below the compacted surface. At the time of exploration (January 2020), the groundwater in test pits was generally observed to be about 2.5 to 3 feet bgs, except in the wetland areas.

- Where less than 2 feet of fill is required, we estimate that the composite subgrade resilient modulus of well-compacted fill and existing soils compacted in-place as described above will provide a subgrade modulus of approximately 9,000 psi.

We understand Moffatt & Nichol is proposing a pavement section that consists of 3 inches of asphaltic concrete surface course, over 7 inches of asphaltic concrete base course, over 12 inches of crushed rock base course. 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 rock base course. We understand the performance of the pavement in these areas has been acceptable to the owner and their tenants. Subsurface conditions at Thorne Road Container Yard are generally consistent with subsurface conditions at other areas of the Port where this pavement section has been used.

Asphalt

Asphalt pavement design may assume a subgrade resilient modulus of 9,000 psi.

Concrete

Design for concrete pavement may use a modulus of subgrade reaction of 150 psi, assuming the concrete will be placed on at least 2 feet of compacted structural fill subgrade. Where less than 2 feet of compacted structural fill subgrade is placed, use a modulus of subgrade reaction of 120 psi.

Shallow Foundation Soil Capacities

These recommendations are applicable to lightly loaded structures bearing on shallow spread footings.

- Shallow footings should bear directly on a minimum 2-foot-thick layer of well-compacted structural fill material. This 2-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 foundations 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 pounds per cubic foot (pcf) (105 pcf below the water table) and an allowable base sliding coefficient of friction of 0.25. 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 50 pcf (25 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.

- Where overexcavation and replacement with structural fill is needed, the base of the overexcavation must extend laterally beyond the outside edge of footings to the same distance as the depth of overexcavation.

Pole and Sign Foundations

Design recommendations for short mast and high mast poles are provided below. We generally consider short mast poles to be less than 90 feet in height and high mast poles to be greater than 90 feet in height. However, the required foundations will be dependent on the design loading. Therefore, we recommend using the “short mast” recommendations for foundations up to 10 feet deep and the “high mast” recommendations for foundations deeper than 10 feet.

Short Mast Poles

Design of short mast poles (with foundations limited to 10 feet in depth) 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 Poles

Based on our experience and on standard practice for similar projects, we recommend using deep foundations, typically 4-foot-diamter drilled shafts, to support high mast poles. 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

Soil Unit	Soil Type	Effective Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	P-Y Modulus or E50
New Fill and Unit 1	API Sand	120	34	N/A	default
Unit 2 (above groundwater)	API Sand	115	30	N/A	default
Unit 2 (below groundwater)	API Sand	53	30	N/A	default
Unit 3 (below groundwater)	Soft Clay	48	N/A	400	default
Unit 4 (below groundwater)	API Sand	53	30	N/A	default

Notes:

For liquefied conditions, a P-multiplier of 0.1 should be applied in the LPILE analysis for soils below groundwater.

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 underground structures extending less than 10 feet bgs:

- Lateral active earth pressure of 50 pcf above the groundwater table (gwt) and 25 pcf below the gwt.

- Lateral at-rest earth pressure of 70 pcf above the gwt and 35 pcf below the gwt.
- Lateral allowable passive earth pressure of 215 pcf above the gwt and 105 pcf below the gwt.
- Lateral allowable base sliding coefficient of 0.25.
- Lateral seismic earth pressure increment of 9H 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 the planned excavation (including potential overexcavation).

For planning purposes, assume the groundwater table is located at an elevation of 15 feet MLLW.

CONSTRUCTION RECOMMENDATIONS

SITE PREPARATION

Clearing Vegetation

In the wetland areas, the groundwater was observed to be within inches of the ground surface. The root zone in the wetlands was generally about 6 inches deep. We recommend leaving the wetland soils and the root zone as undisturbed as possible (i.e., cutting trees and shrubs and mowing grasses, but leaving roots in place). The vegetation and roots can act as a stabilizing layer. However, vegetation can also interfere with compaction of fill placed above. Therefore, we recommend that fill thicknesses above the wetland areas be around 2 feet or greater. And the material used to fill the wetland areas should be a well-graded aggregate with less than 5 percent fines (material passing a U.S. No. 200 mesh sieve) by weight based on the minus 3/4-inch fraction. The material should contain a minimum of 40 percent gravel (material coarser than a U.S. No. 4 sieve). Specifications should be prepared in such a manner as to allow the decision about stripping depth to be determined in the field during construction whereby we can observe the conditions and make the appropriate decisions.

Subgrade Preparation

Cut areas and areas of less than 12 inches of fill should receive in-place vibratory compaction with a vibratory roller. The effectiveness of in-place vibratory compaction is highly dependent on moisture content. If construction occurs during wet weather conditions, the assumed improvements from compaction and the ability to place well-compacted fill may be compromised. Other subgrade treatment/fill placement options (such as cement stabilization) may be needed for wet weather construction.

Following site stripping and compaction, the suitability of the subgrade should be evaluated by proof rolling with a fully loaded dump truck or similar heavy rubber-tired construction equipment to identify any remaining soft, loose, or unsuitable areas. The proof roll should be conducted prior to placing fill. The proof rolling should be observed by a representative of Hart Crowser who should evaluate the suitability of the subgrade and identify areas of yielding that are indicative of soft or loose soil.

It should be noted that much of the expected subgrade is moisture sensitive and may be wet of the optimum moisture for compaction. In these cases, it will be necessary to moisture condition the subgrade during dry weather periods using an agricultural disc or other methods to lower the moisture content to within two percent of optimum moisture.

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 U.S. 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.

- Quarry spalls and/or railroad ballast over a geotextile separation fabric may be used as structural fill to backfill areas of overexcavation. Material should be placed in lifts not exceeding 12 inches and tamped into place with a large excavator bucket, or similar. Material placement should be monitored by a Hart Crowser representative.

- 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 U.S. 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 U.S. No. 200 mesh 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; and
- 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 shallow foundation subgrade conditions;
- Consult with the construction team as needed; and
- Respond to other geotechnical engineering considerations that may arise during construction.

REFERENCES

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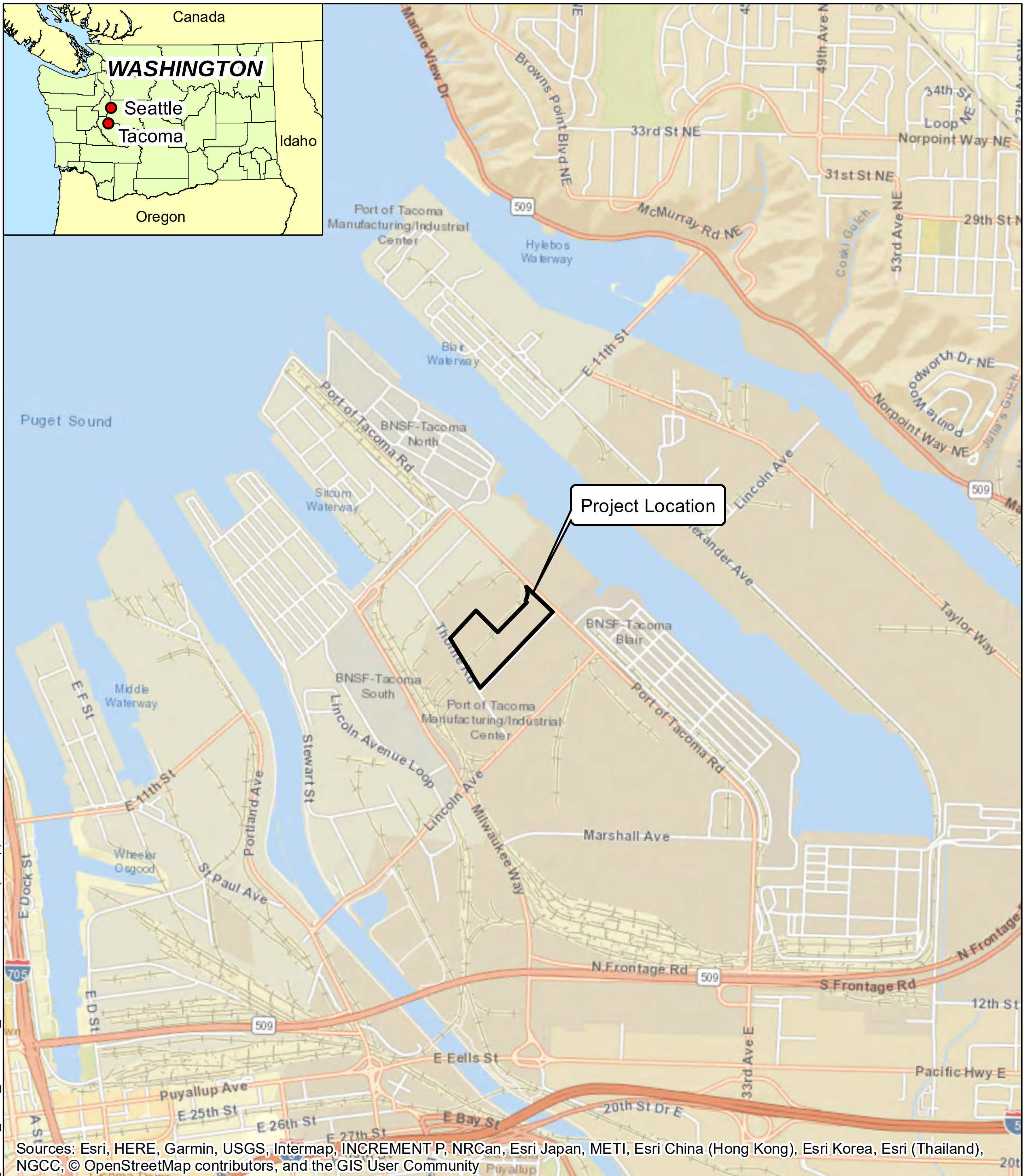

0 1,000 2,000 4,000
Feet

Note: Feature locations are approximate.

N

Thorne Road Container Yard
Tacoma, Washington

Vicinity Map

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Figure
1

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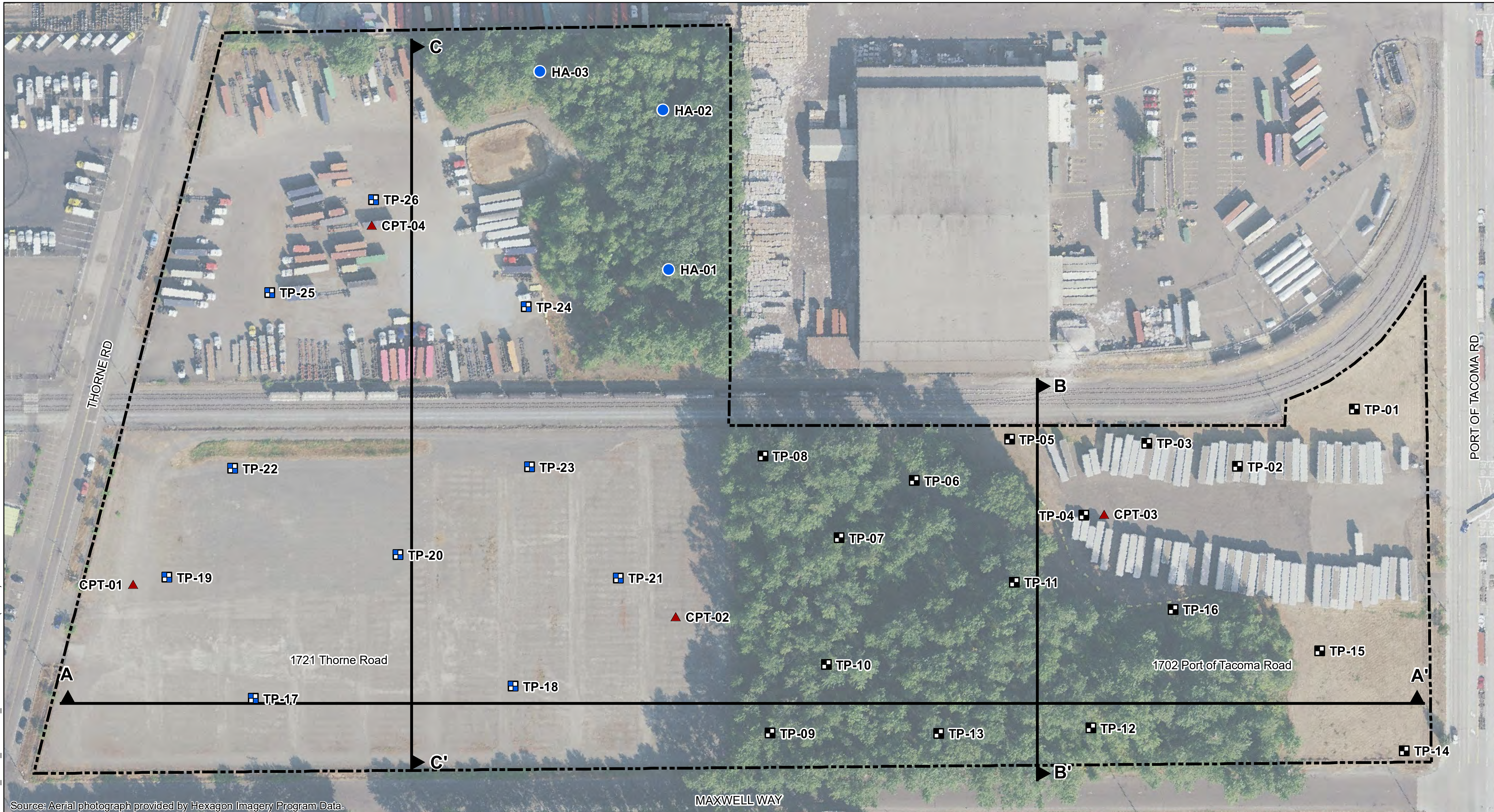

Legend

- Test Pit (Hart Crowser 2020)
- Hand Auger (Hart Crowser 2020)
- Cone Penetration Test (Hart Crowser 2020)
- Test Pit (GeoEngineers 2005)
- Cross Section
- Property Boundary

0 60 120 240 Feet

N

Note: Feature locations are approximate.

Thorne Road Container Yard
Tacoma, Washington

Site and Exploration Plan

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Figure
2

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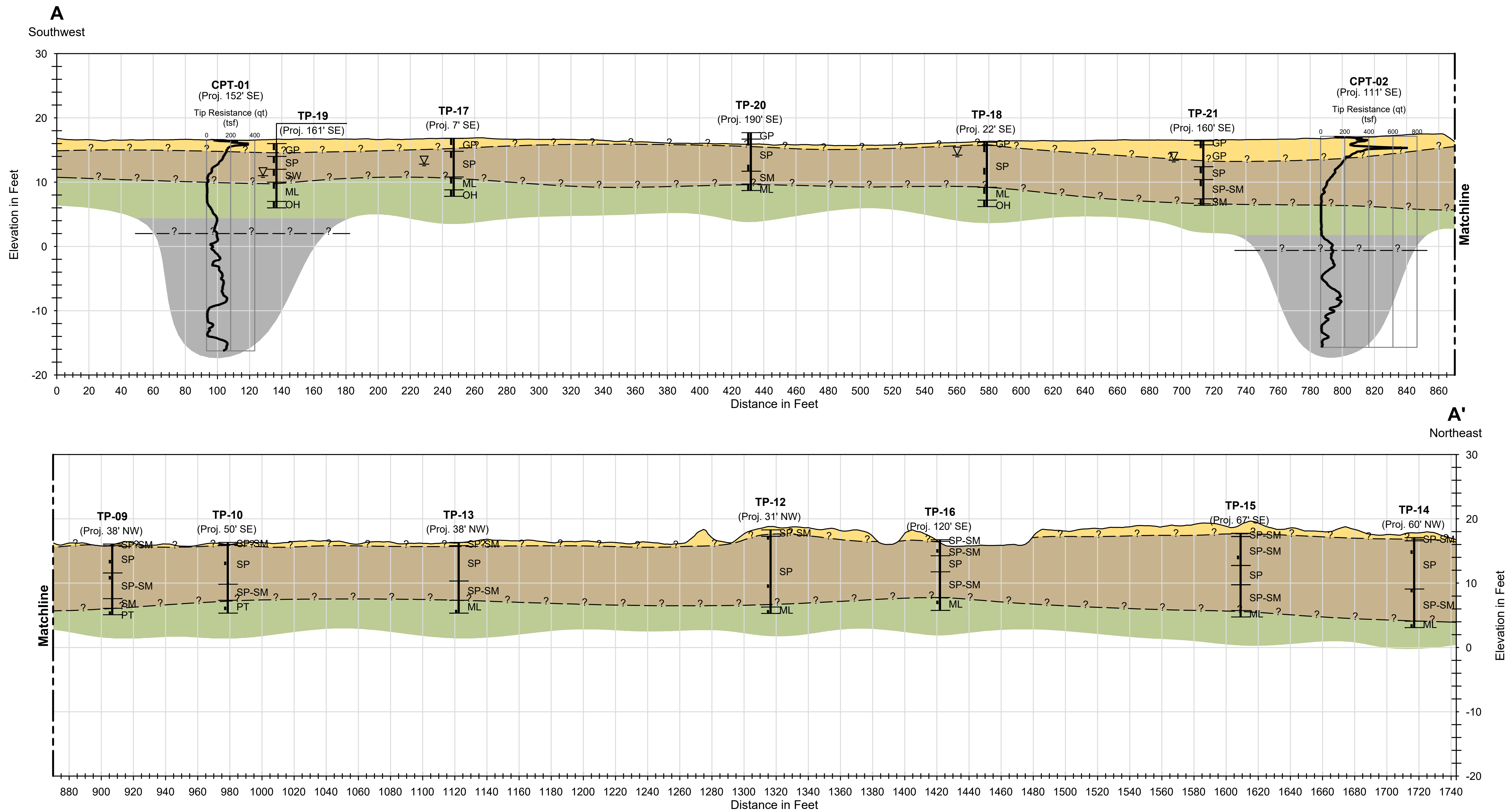

Legend

Exploration Name — **TP-01**
Offset — (Proj. 64' S)
Exploration Location
SP — USCS Soil Classification
Groundwater Elevation
Sample Location

Fill (Soil Unit 1)

Dredge Fill (Soil Unit 2)

Silty Delta Plain Deposits (Soil Unit 3)

Sandy Delta Plain Deposits (Soil Unit 4)

Horizontal Scale in Feet
0 60 120
0 15 30
Vertical Scale in Feet
Vertical Exaggeration x 4

Thorne Road Container Yard
Tacoma, Washington

Generalized Subsurface Cross Section A-A'

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Figure
3

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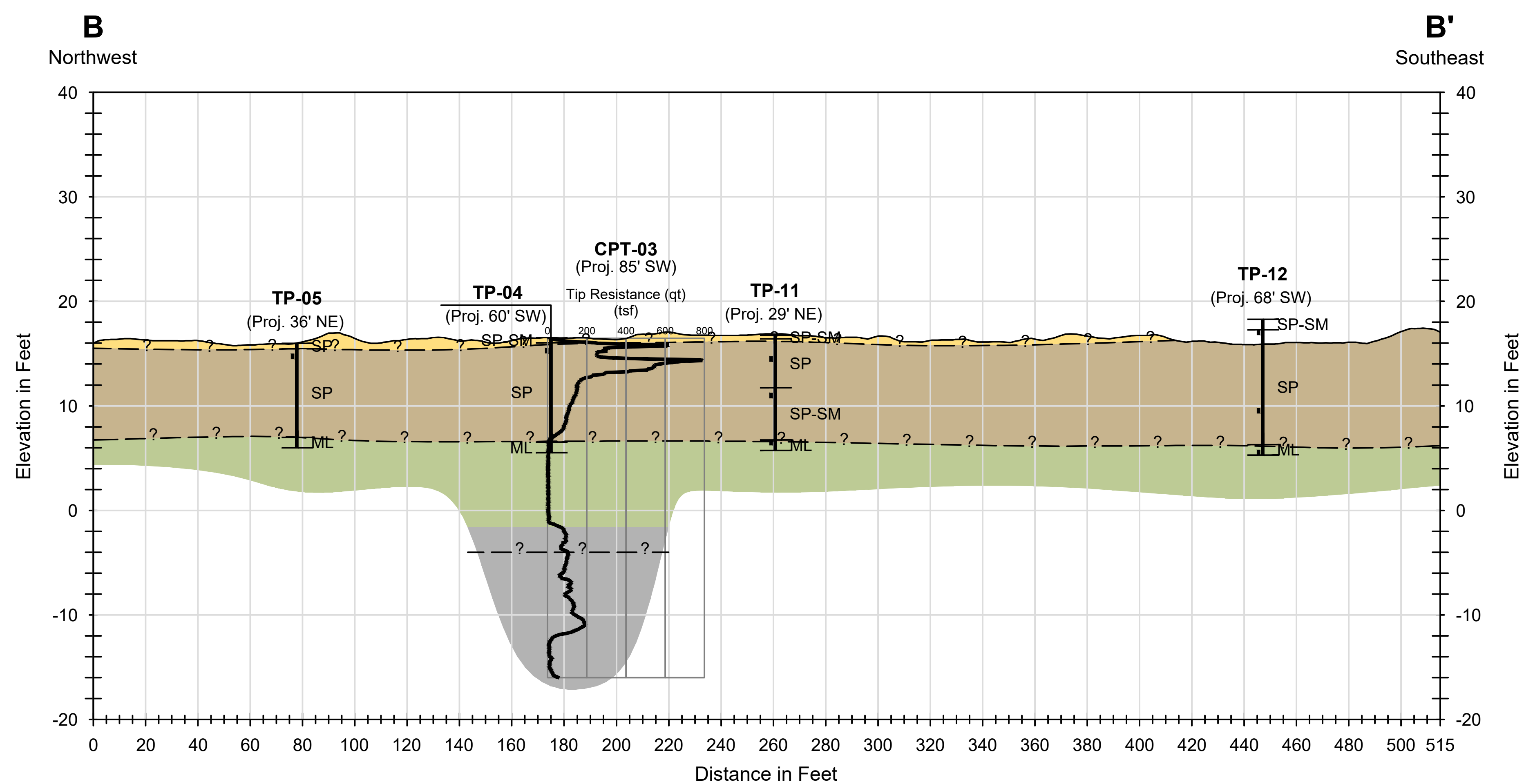

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Exploration Name — **TP-01**
Offset — (Proj. 64' S)
Exploration Location
SP — USCS Soil Classification
Groundwater Elevation
Sample Location

- Fill (Soil Unit 1)
- Dredge Fill (Soil Unit 2)
- Silty Delta Plain Deposits (Soil Unit 3)
- Sandy Delta Plain Deposits (Soil Unit 4)

Horizontal Scale in Feet
0 60 120
0 15 30
Vertical Scale in Feet
Vertical Exaggeration x 4

Thorne Road Container Yard
Tacoma, Washington

Generalized Subsurface Cross Section B-B'

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Figure
4

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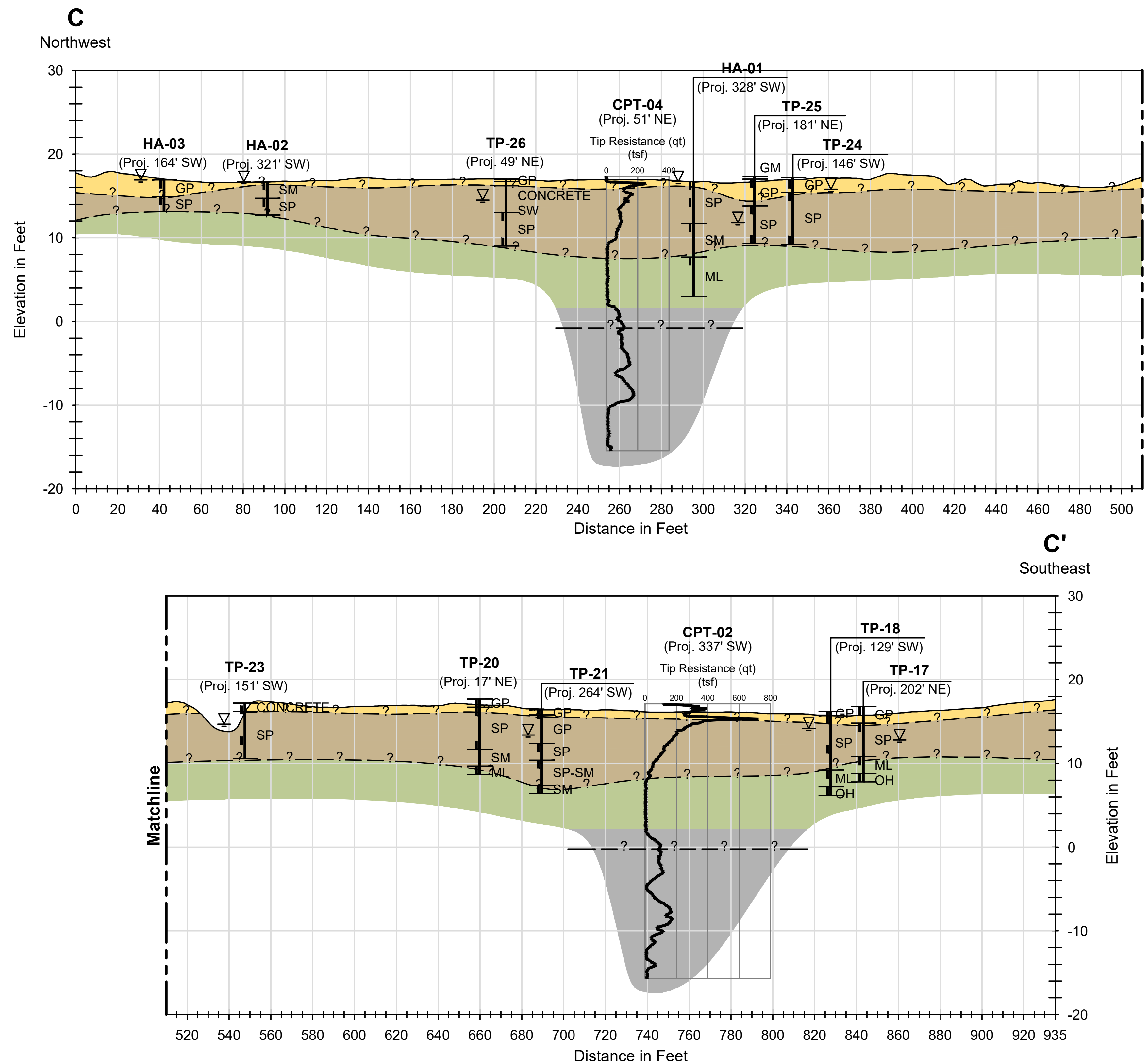

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Exploration Name — TP-01
Offset — (Proj. 64' S)
Exploration Location
SP — USCS Soil Classification
Groundwater Elevation
Sample Location

- Fill (Soil Unit 1)
- Dredge Fill (Soil Unit 2)
- Silty Delta Plain Deposits (Soil Unit 3)
- Sandy Delta Plain Deposits (Soil Unit 4)

Horizontal Scale in Feet
0 60 120

0 15 30
Vertical Scale in Feet
Vertical Exaggeration x 4

Thorne Road Container Yard
Tacoma, Washington

Generalized Subsurface Cross Section C-C'

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Figure
5

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APPENDIX A
HC Borings

Date Started: 1/16/20	Date Completed: 1/17/20	Contractor/Crew: Hart Crowser	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: NA	
Location: Lat: 47.263243 Long: -122.404170 (WGS 84)		Total Depth: 13.7 feet	Depth to Seepage: 0 feet
Ground Surface Elevation: 16.7 feet (MLLW)			
Comments: 1451 Thorne Rd., Tacoma WA			

Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number Tests	Graphic Log	Material Description	Water Level	Depth (feet)
	0		12	S-1		POORLY GRADED SAND (SP), (loose), wet, dark gray, fine to medium sand.	ATD	0
						Scattered roots up to 1 foot.		
15			12	S-2				
	5		12	S-3		SILTY SAND (SM), (loose), wet, dark gray, fine sand.		5
10								
			12	S-4		SILT (ML), trace fine sand, (very soft), wet, gray.		
	10							10
5								
						Bottom of Borehole at 13.7 feet.		
	15							15
0								

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HARTCROWSER	Project: Thorne Road Container Yard Location: Tacoma, WA Project No.: 19398-00	Hand-Auger Log **HA-01**	Figure **A-2** Sheet **1 of 1**

Date Started: 1/16/20	Date Completed: 1/16/20	Contractor/Crew: Hart Crowser	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: NA	
Location: Lat: 47.263610 Long: -122.404789 (WGS 84)		Total Depth: 4 feet	Depth to Seepage: 0 feet
Ground Surface Elevation: 16.7 feet (MLLW)			
Comments: 1451 Thorne Rd., Tacoma WA			

Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number / Tests	Graphic Log	Material Description	Water Level	Depth (feet)
	0		12	S-1		SILTY SAND (SM), (loose), wet, gray-brown, scattered small roots.	ATD	0
15			12	S-2		POORLY GRADED SAND (SP), (loose), wet, dark gray.		
						Needs to be a cased hole for advancing.		
						Bottom of Borehole at 4.0 feet.		
	5							5
10								
	10							10
5								
	15							15
0								

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HARTCROWSER

Project: Thorne Road Container Yard
Location: Tacoma, WA
Project No.: 19398-00

Hand-Auger Log
HA-02

Date Started: 1/16/20	Date Completed: 1/16/20	Contractor/Crew: Hart Crowser	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: NA	
Location: Lat: 47.263388 Long: -122.405366 (WGS 84)		Total Depth: 3.8 feet	Depth to Seepage: 0 feet
Ground Surface Elevation: 16.9 feet (MLLW)			
Comments: 1451 Thorne Rd., Tacoma WA			

Elevation (feet)	Depth (feet)	Sample Data: Type	Sample Data: Length (inches)	Sample Data: Number / Tests	Graphic Log	Material Description	Water Level	Depth (feet)
	0		12	S-1		POORLY GRADED GRAVEL WITH SAND (GP), (loose), wet, gray-brown, subangular to subrounded gravel, fine to medium sand, small roots.	ATD	0
15			12	S-2		POORLY GRADED SAND WITH GRAVEL (SP), (loose), wet, gray-brown, subrounded gravel, fine to medium sand.		
						Needs to be a cased hole for advancing.		
						Bottom of Borehole at 3.8 feet.		
	5							5
10								
	10							10
5								
	15							15
0								

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 1/15/20	Date Completed: 1/15/20	Contractor/Crew: Holt Services, Inc.	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: Mini excavator	
Location: Lat: 47.261155 Long: -122.404018 (WGS 84)		Total Depth: 9 feet	Depth to Seepage: 4 feet
Ground Surface Elevation: 16.9 feet (MLLW)			
Comments: 1721 Thorne Rd., Tacoma WA			

Depth (feet)	Sample Data: Length (inches)	Sample Data: Number / Tests	Material Description	Water Level
0	12	S-1	POORLY GRADED GRAVEL WITH SAND (GP), (dense), moist, gray-brown, subangular to subrounded gravel, fine to medium sand.	
2	12	S-2	POORLY GRADED SAND (SP), (dense), moist, black, fine to medium sand.	
4			Caving from 4 feet.	ATD ∇
6	12	S-3	SILT (ML), moist, gray, some organics.	
8	12	S-4	ORGANIC SILT (OH), wet, black, many roots.	
9			Bottom of Test Pit at 9.0 feet.	

Elevation (feet): 15, 10, 5, 0 — Depth (feet): 0, 5, 10, 15

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 1/15/20	Date Completed: 1/15/20	Contractor/Crew: Holt Services, Inc.	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: Mini excavator	
Location: Lat: 47.261848 Long: -122.403151 (WGS 84)		Total Depth: 10 feet	Depth to Seepage: 2 feet
Ground Surface Elevation: 16.2 feet (MLLW)			
Comments: 1721 Thorne Rd., Tacoma WA			

Depth (feet)	Length (inches)	Number / Tests	Material Description	Water Level	PL / WC / LL
0	6	S-1	POORLY GRADED GRAVEL WITH SAND (GP), (dense), moist, gray-brown, subangular gravel, medium to fine sand.		
	12	S-2	POORLY GRADED SAND (SP), (medium dense), moist, dark gray, fine to medium sand. Caving from 2 to 6.5 feet.	ATD (2 ft)	
	12	S-3			
	12	S-4 / AL, WC	SILT (ML), trace fine sand, (medium stiff), moist, gray.		PL ~30, LL ~30, WC ~38
	12	S-5	ORGANIC SILT (OH), (soft), moist, dark gray.		
10			Bottom of Test Pit at 10.0 feet.		

Elevation (feet): 15, 10, 5, 0 · Depth (feet): 0, 5, 10, 15 · Water content scale: 10, 20, 30, 40

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 1/15/20	Date Completed: 1/15/20	Contractor/Crew: Holt Services, Inc.	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: Mini excavator	
Location: Lat: 47.261223 Long: -122.404776 (WGS 84)		Total Depth: 10 feet	Depth to Seepage: 5 feet
Ground Surface Elevation: 16 feet (MLLW)			
Comments: 1721 Thorne Rd., Tacoma WA			

Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number Tests	Graphic Log	Material Description	Water Level	Depth (feet)
	0		12	S-1		POORLY GRADED GRAVEL WITH SAND (GP), few cobbles, (dense), moist, brown, subrounded gravel, medium sand. Caving from 1.5 to 5 feet.		0
15								
			12	S-2		POORLY GRADED SAND (SP), (medium dense), moist, dark gray, fine to medium sand.		
			12	S-3		WELL-GRADED SAND (SW), (medium dense), moist, dark gray, fine sand.		
	5						ATD	5
10			12	S-4		SILT (ML), (soft), moist to wet, gray, some organics.		
			12	S-5		ORGANIC SILT (OH), (soft), light brown, many roots.		
	10					Bottom of Test Pit at 10.0 feet.		10
5								
	15							15
0								

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 1/15/20	Date Completed: 1/15/20	Contractor/Crew: Holt Services, Inc.	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: Mini excavator	
Location: Lat: 47.261869 Long: -122.404049 (WGS 84)		Total Depth: 9 feet	Depth to Seepage: Not Encountered
Ground Surface Elevation: 17.7 feet (MLLW)			
Comments: 1721 Thorne Rd., Tacoma WA			

Depth (feet)	Sample Length (inches)	Sample Number / Tests	Material Description
0	12	S-1	POORLY GRADED GRAVEL (GP), few medium sand, few cobbles, (dense), moist, gray, subangular gravel.
1	12	S-2	POORLY GRADED SAND (SP), trace gravel, (medium dense), moist, dark gray, fine to medium sand. Caving from 2 feet.
5	12	S-3	
6			SILTY SAND (SM), (medium dense), wet, gray, fine sand.
8	12	S-4	SANDY SILT (ML), (medium stiff), wet, gray, some organics (laminated).
9			Bottom of Test Pit at 9.0 feet.

Elevation (feet) scale: 15, 10, 5, 0. Depth (feet) scale: 0, 5, 10, 15.

General Notes:

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HARTCROWSER

Project: Thorne Road Container Yard
Location: Tacoma, WA
Project No.: 19398-00

Test Pit Log
TP-20

Figure **A-8**
Sheet **1 of 1**

Date Started: 1/14/20 | Date Completed: 1/14/20 | Contractor/Crew: Holt Services, Inc.
Logged by: B. McDonald | Checked by: M. Liu | Rig Model/Type: Mini excavator
Location: Lat: 47.262377 Long: -122.403187 (WGS 84) | Total Depth: 10 feet | Depth to Seepage: 3 feet
Ground Surface Elevation: 16.4 feet (MLLW)
Comments: 1721 Thorne Rd., Tacoma WA

Elevation (feet)	Depth (feet)	Type	Length (inches)	Number / Tests	Graphic Log	Material Description	Water Level	WC ● / ✖ Fines Content (%) (10, 20, 30, 40)	Depth (feet)
	0		6	S-1		POORLY GRADED GRAVEL WITH SAND (GP), (dense), moist, gray-brown, subangular to subrounded gravel, fine to medium sand.			0
15			6	S-2		POORLY GRADED GRAVEL (GP), some silt and medium sand, few cobbles, (dense), moist, gray, subrounded gravel.	ATD ▽ (3 ft)		
			12	S-3 GS, WC		POORLY GRADED SAND (SP), (medium dense), moist to wet, dark gray, fine to medium sand.		✖ 3; ● ~25	
	5								5
10			12	S-4		POORLY GRADED SAND WITH SILT (SP-SM), wet, dark gray, fine to medium sand.			
			12	S-5		SILTY SAND (SM), (medium dense), wet, dark gray, fine sand.			
	10					Bottom of Test Pit at 10.0 feet.			10
5									
	15								15
0									

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 1/14/20 | Date Completed: 1/14/20 | Contractor/Crew: Holt Services, Inc.
Logged by: B. McDonald | Checked by: M. Liu | Rig Model/Type: Mini excavator
Location: Lat: 47.261653 Long: -122.404955 (WGS 84) | Total Depth: 9 feet | Depth to Seepage: 3 feet
Ground Surface Elevation: 15.1 feet (MLLW)
Comments: 1721 Thorne Rd., Tacoma WA

Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number / Tests	Graphic Log	Material Description	Water Level	PL / WC / LL (10 20 30 40)
15	0		0	S-1		Recycled asphalt, sandy gravel, dense, moist, dark gray.		
			0	S-2		Recycled concrete, sandy gravel, dense, moist, light gray.		
			12	S-3		SILTY SAND WITH GRAVEL (SM), (dense), moist, dark gray, subrounded gravel, fine to medium sand.		
			12	S-4		POORLY GRADED SAND (SP), (dense), moist to wet, dark gray, fine to medium sand.	ATD ∇	
10	5							
			12	S-5 AL, WC		SILT (ML), few fine sand, (medium dense), moist, gray.		H ●
			12	S-6		ORGANIC SILT (OH), (soft), moist, dark gray.		

Bottom of Test Pit at 9.0 feet.

Elevation (feet)	Depth (feet)
5	10
0	15

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 1/14/20	Date Completed: 1/14/20	Contractor/Crew: Holt Services, Inc.	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: Mini excavator	
Location: Lat: 47.262415 Long: -122.403916 (WGS 84)		Total Depth: 6.6 feet	Depth to Seepage: 2.5 feet
Ground Surface Elevation: 17.2 feet (MLLW)			
Comments: 1721 Thorne Rd., Tacoma WA			

Elevation (feet)	Depth (feet)	Sample Data: Type	Sample Data: Length (inches)	Sample Data: Number / Tests	Graphic Log	Material Description	Water Level	Depth (feet)
	0		0	S-1		Recycled concrete, dense, moist, light brown.		0
			12	S-2				
						POORLY GRADED SAND (SP), (medium dense), moist, dark gray, fine to medium sand.		
15							ATD	
						Substantial caving from 2.5 feet.		
						Becomes moist to wet.		
			12	S-3				
	5							5
10						Bottom of Test Pit at 6.6 feet.		
	10							10
5								
	15							15
0								

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HARTCROWSER

Project: Thorne Road Container Yard
Location: Tacoma, WA
Project No.: 19398-00

Test Pit Log
TP-23

Figure **A-11**
Sheet **1 of 1**

Date Started: 1/14/20 | Date Completed: 1/14/20 | Contractor/Crew: Holt Services, Inc.
Logged by: B. McDonald | Checked by: M. Liu | Rig Model/Type: Mini excavator
Location: Lat: 47.262790 Long: -122.404530 (WGS 84) | Total Depth: 8 feet | Depth to Seepage: 1.4 feet
Ground Surface Elevation: 17.2 feet (MLLW)
Comments: 1451 Thorne Rd., Tacoma WA

Depth (feet)	Length (inches)	Sample Number / Tests	Material Description	Water Level
0	0	S-1	POORLY GRADED GRAVEL WITH SAND (GP), (dense), moist, gray to dark gray, subangular gravel, fine to medium sand.	
	12	S-2	Becomes medium sand, gray-brown.	ATD (1.4 ft)
	12	S-3	POORLY GRADED SAND (SP), trace silt, (loose to medium dense), moist to wet, dark gray, fine to medium sand, occasional small root. Substantial caving below 2 feet.	
	12	S-4		

Bottom of Test Pit at 8.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HC TEST PIT - \\SEAFS\DATA\GINT\HC_LIBRARY.GLB - 4/17/20 10:59 - L:\NOTEBOOKS\1939800_THORNE_ROAD_CONTAINER_YARD\FIELD DATA\PERM_GINT FILES\1939800-BL.GPJ - lornearnold

HARTCROWSER
Project: Thorne Road Container Yard
Location: Tacoma, WA
Project No.: 19398-00

Test Pit Log
TP-24

Figure **A-12**
Sheet **1 of 1**

Date Started: 1/14/20	Date Completed: 1/14/20	Contractor/Crew: Holt Services, Inc.	
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: Mini excavator	
Location: Lat: 47.262168 Long: -122.405485 (WGS 84)		Total Depth: 8 feet	Depth to Seepage: 5.5 feet
Ground Surface Elevation: 17.3 feet (MLLW)			
Comments: 1451 Thorne Rd., Tacoma WA			

Elevation (feet)	Depth (feet)	Length (inches)	Number / Tests	Material Description	Water Level	WC / Fines Content (%)
	0	0	S-1	SILTY GRAVEL WITH SAND (GM), (dense), moist, dark gray, fine to coarse gravel, medium sand.		
		12	S-2	POORLY GRADED GRAVEL WITH SAND (GP), (dense), moist, gray-brown, subrounded gravel, fine to medium sand.		
15						
		12	S-3	POORLY GRADED SAND (SP), (medium dense), moist, dark gray, fine to medium sand.		
	5			Substantial caving from 5 feet.	ATD ∇	
				Occasional silty fine sand.		
10		12	S-4 GS, WC	Becomes trace silt, wet to moist.		Fines 1; WC ~18

Bottom of Test Pit at 8.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 1/14/20	Date Completed: 1/14/20	Contractor/Crew: Holt Services, Inc.			
Logged by: B. McDonald	Checked by: M. Liu	Rig Model/Type: Mini excavator			
Location: Lat: 47.262657 Long: -122.405470 (WGS 84)		Total Depth: 8 feet	Depth to Seepage: 2.5 feet		
Ground Surface Elevation: 17 feet (MLLW)					
Comments: 1451 Thorne Rd., Tacoma WA					

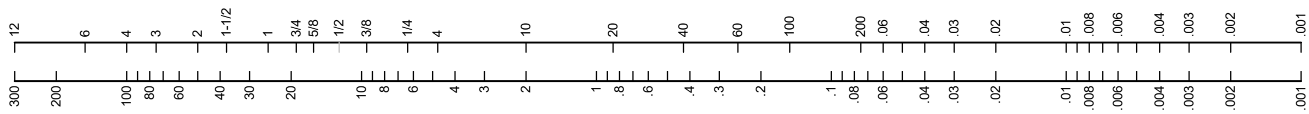
Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number / Tests	Material Description	Water Level
	0		0	S-1	Substantial caving from 2.5 feet.	
			0	S-2	Recycled concrete, poorly graded gravel with sand, dense, light gray.	
15			0	S-3	WELL-GRADED SAND (SW), trace gravel, (loose), moist to wet, brown, fine to medium sand.	ATD
					Import fill from 2.8 to 3 feet.	
			12	S-4	POORLY GRADED SAND (SP), (medium dense), wet to moist, dark gray, fine to medium sand.	
10	5		12	S-5	Becomes wet.	
	8				Bottom of Test Pit at 8.0 feet.	

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

APPENDIX B
Lab Test Results

Soil Grain Size

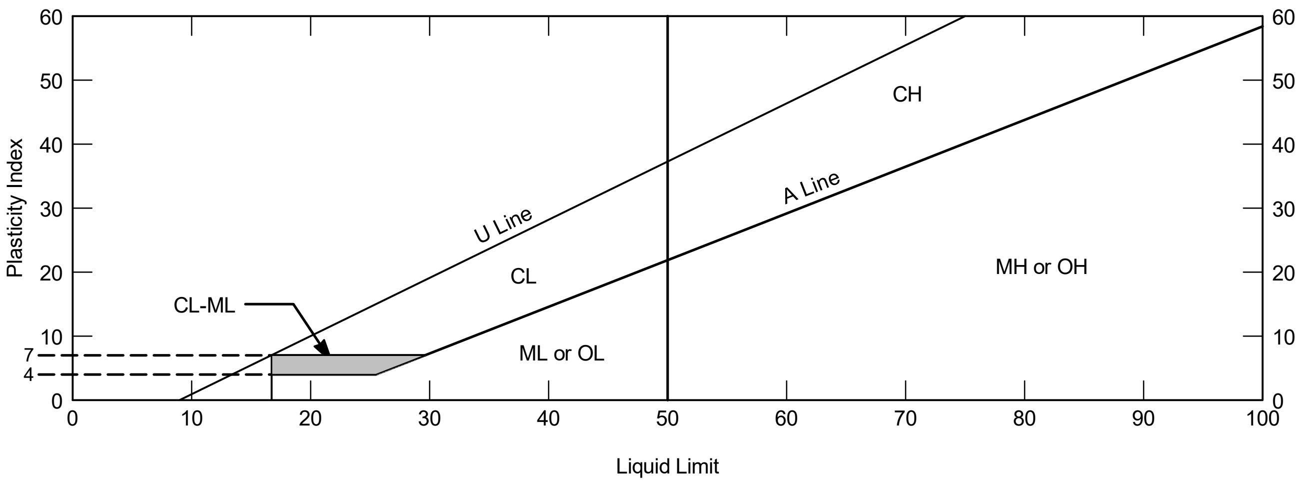
Size of Opening in Inches	Number of Mesh per Inch (US Standard)	Grain Size in Millimeters



COBBLES	GRAVEL	SAND	SILT and CLAY
Coarse-Grained Soils			Fine-Grained Soils

Fine-Grained Soils

Fine-Grained Soils > 50% smaller than No. 200 Sieve						
Soils with Liquid Limit < 50%			Soils with Liquid Limit > 50%			
SILT	CLAY	ORGANIC	SILT	CLAY	ORGANIC	PEAT
ML	**CL**	**OL**	**MH**	**CH**	**OH**	**PT**



Coarse-Grained Soils

Coarse-Grained Soils > 50% Larger than No. 200 Sieve									
GRAVEL > 50% Coarse Fraction Larger than No. 4 Sieve					SAND > 50% Coarse Fraction Smaller than No. 4 Sieve				
GRAVEL with 5% Fines	GW		GP		SAND with 5% Fines	SW		SP	
GRAVEL with >12% Fines	GM		GC		SAND with > 12% Fines	SM		SC	
GRAVEL with 5% < Fines <12%	GW-GM	GW-GC	GP-GM	GP-GC	SAND with 5% < Fines <12%	SW-SM	SW-SC	SP-SM	SP-SC

For clean sands and gravels:

$1 \le \frac{(D_{30})^2}{D_{10} \times D_{60}} \le 3$ & $\frac{D_{60}}{D_{10}}$ where > 4 for GW, > 6 for SW otherwise GP or SP

$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ $C_u = \frac{D_{60}}{D_{10}}$

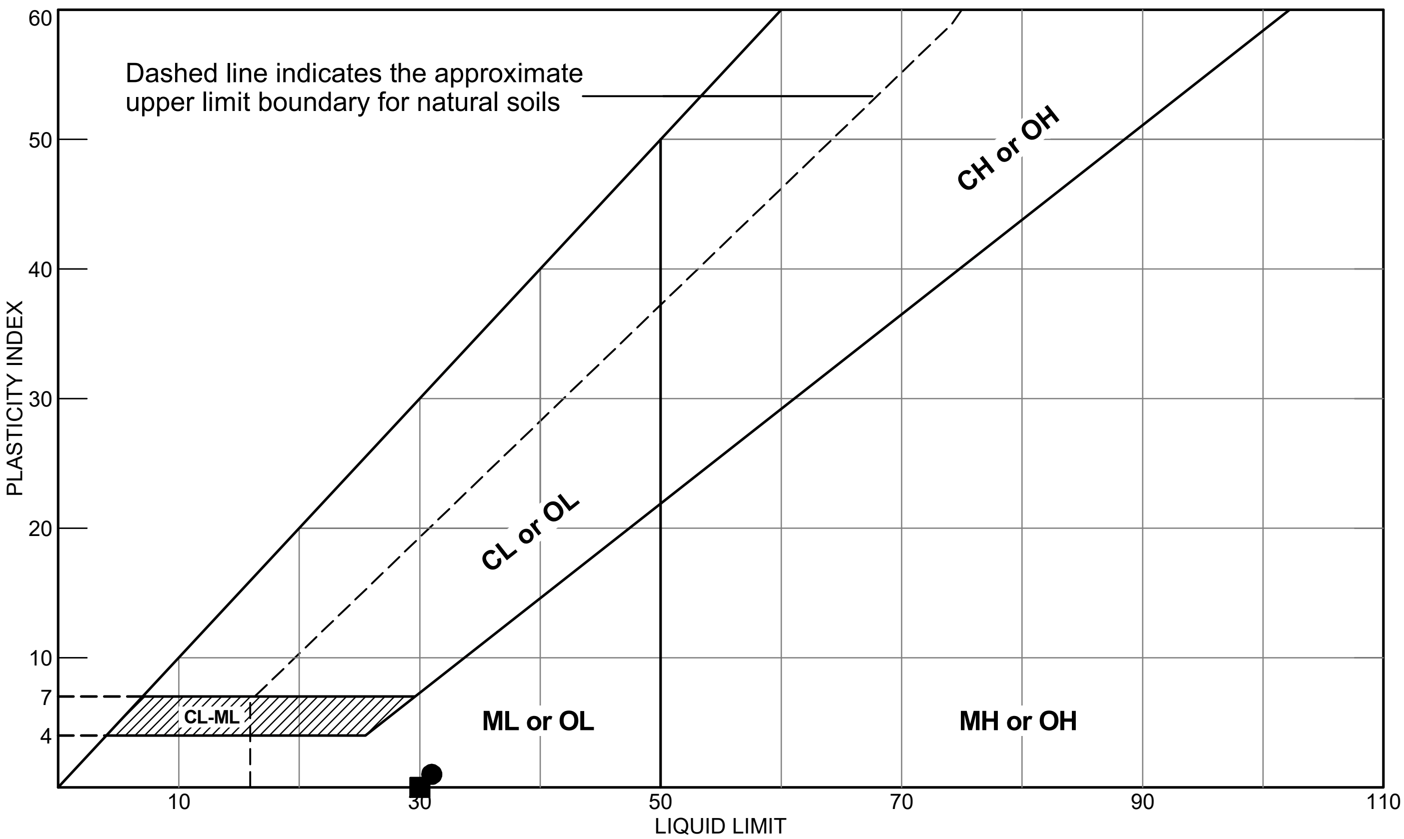
D_{10}, D_{30}, D_{60} are particle diameters for which 10, 30, and 60 percent, respectively, of the soil mass are finer.

For sands and gravels with fines:

GM and SM Atterberg limits below A line with PI < 4

GC and SC Atterberg limits above A line with PI > 7

HARTCROWSER	Project: Thorne Road Container Yard Location: Tacoma, WA Project No.: 19398-00	**Unified Soil Classification (USC) System**	Figure **B-1** Sheet **1 of 1**



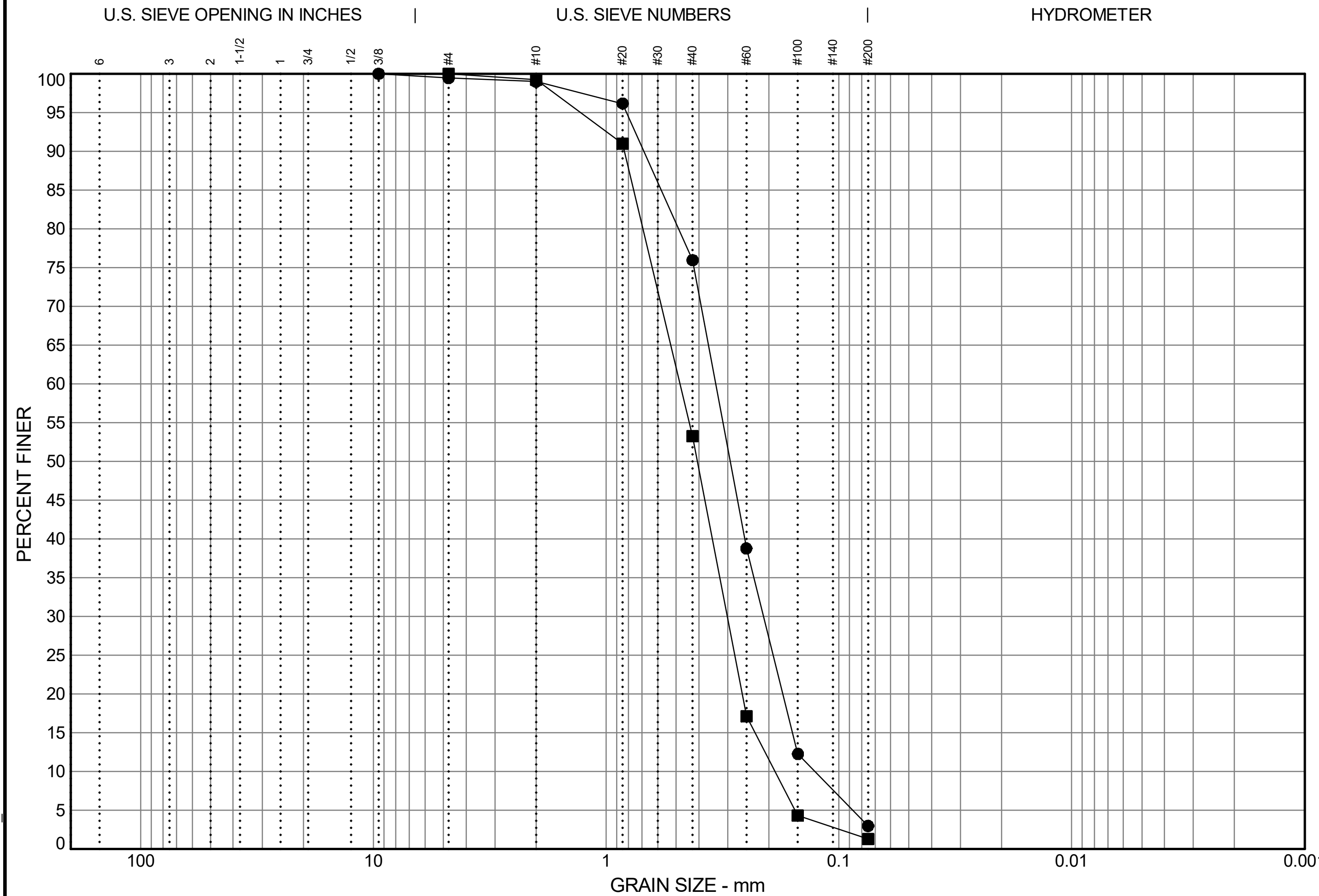
Location and Description	LL	PL	PI	-#200	MC%	USCS
● **Source:** TP-18 **Sample No.:** S-4 **Depth:** 7.0 to 8.0 SILT	31	30	1	NT	38	ML
■ **Source:** TP-22 **Sample No.:** S-5 **Depth:** 6.0 to 7.0 SILT	30	31	NP	NT	35	ML

Remarks:

●

■ Non Plastic

HARTCROWSER	Project: Thorne Road Container Yard Location: Tacoma, WA Project No.: 19398-00	**Liquid Limit, Plastic Limit, and Plasticity Index**	Figure **B-2** Sheet **1 of 1**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Location and Description	% Cobbles	% Gravel	% Sand	% Silt / % Clay	MC%	USCS
● **Source:** TP-21 **Sample No.:** S-3 **Depth:** 4.0 to 5.0 POORLY GRADED SAND	0.0	0.6	96.5	3.0	25	SP
■ **Source:** TP-25 **Sample No.:** S-4 **Depth:** 7.0 to 8.0 POORLY GRADED SAND	0.0	0.0	98.7	1.3	18	SP

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.579	0.338	0.293	0.211	0.158	0.127	1.04	2.67
■			0.761	0.481	0.405	0.302	0.230	0.188	1.01	2.56

Remarks:

●

■

HARTCROWSER

Project: Thorne Road Container Yard
Location: Tacoma, WA
Project No.: 19398-00

Particle-Size Analysis

Figure **B-3**
Sheet **1 of 1**

APPENDIX C
Historical Subsurface Data

APPENDIX C

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.

Date Excavated: 07/07/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (loose, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose, moist) (fill)	NS	0.0	
		X	1					NS	0.0	SA; MC=4%
								NS	0.0	
								NS	0.0	
								NS	0.0	
5	5									
0	10									
						ML	Gray silt (soft, moist)			
		X	2					NS	0.2	
-5	15									

Test pit completed at 12 feet on 07/07/05
No groundwater seepage observed
Severe caving observed below 6 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 01

GeoEngineers

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-2
Sheet 1 of 1

Date Excavated: 07/07/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (loose, moist) (fill)			
						SP	Brown fine to medium sand trace roots (loose, moist) (fill)	NS	0.0	
							Grades to no roots	NS	7.2	
		X	1							
		▽								
							Grades to moist to wet	NS	6.5	
5	5									
								NS	0.0	
								NS	0.0	
								NS	0.7	
0	10					ML	Gray silt (soft, moist to wet)			
-5	15									

Test pit completed at 11 feet on 07/07/05
Slow groundwater seepage observed at 4 feet
Severe caving observed below 3 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 02

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-3
Sheet 1 of 1

Date Excavated: 07/07/05 | Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe | Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SM	Brown silty fine to medium sand with roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose, moist) (fill)	NS		
		X	1					NS	1.4	
							Grades to no roots	NS		
								NS		
								NS	1.4	
5	5									
								NS	4.3	
							Grades to moist to wet			
								NS	0.0	
0	10					ML	Gray silt (soft, moist)			
		X	2					NS	0.7	
-5	15									

Test pit completed at 12 feet on 07/07/05
No groundwater seepage observed
Severe caving observed below 4 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 03

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-4
Sheet 1 of 1

Date Excavated: 07/07/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Reddish-brown fine to coarse sand with gravel and silt (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose to medium dense, moist) (fill)	NS	0.0	
								NS	0.0	
							Grades to no roots			
		X	1							
								NS	0.0	
5	5									
							Grades to moist to wet			
0	10					ML	Gray silt (soft, moist to wet)			
								NS	0.0	
-5	15									

Test pit completed at 11 feet on 07/07/05
No groundwater seepage observed
Moderate caving observed below 4 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 04

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-5
Sheet 1 of 1

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Date Excavated: 07/07/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP	Brown fine to medium sand, trace roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose, moist) (fill)	NS	0.0	
		X	1					NS		MC=5%
							Grades to no roots	NS	0.0	
								NS		
								NS	0.0	
5	5									
						ML	Gray silt (soft, moist)	NS	0.0	
0	10									
-5	15									

Test pit completed at 10 feet on 07/07/05
No groundwater seepage observed
Moderate caving observed below 5 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 05

GeoEngineers

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-6
Sheet 1 of 1

Date Excavated: 07/07/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt, roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose to medium dense, moist) (fill)	NS	0.0	
		X	1							
								NS	0.0	
								NS	0.0	
5	5									
						ML	Gray silt, trace sand (soft, moist to wet) (fill?)			
		X	2					NS	4.3	
0	10									
						ML	Gray silt, trace organics (medium stiff, moist)			
		X	3							
-5	15									

Test pit completed at 14 feet on 07/07/05
No groundwater seepage observed
Moderate caving observed below 4 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 06

GeoEngineers

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-7
Sheet 1 of 1

Date Excavated: 07/07/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose to medium dense, moist) (fill)	NS	0.0	
		X	1				Grades to no roots	NS	0.6	
								NS		
5	5					SM	Gray silty fine to medium sand (medium dense, moist) (fill?)	NS		
								NS	0.0	
						ML	Gray silt with organics (medium stiff, moist)			
		X	2							
0	10							NS	0.0	
-5	15									

Test pit completed at 10.5 feet on 07/07/05
No groundwater seepage observed
Moderate caving observed below 3 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 07

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-8
Sheet 1 of 1

Date Excavated: 07/07/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand (loose, moist) (fill)	NS	0.0	
		X	1							MC=11%
								NS	0.0	
								NS	0.0	
5	5									
						SM	Gray silty fine sand (medium dense, moist to wet) (fill?)	NS	0.0	
		X	2							SA; MC=38%
						ML	Gray silt with organics (medium stiff, moist)	NS	0.0	
0	10									
-5	15									

Test pit completed at 11 feet on 07/07/05
No groundwater seepage observed
Severe caving observed below 4 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 08

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Date Excavated: 07/07/05

Equipment: Case 580 Rubber Tired Backhoe

Logged by: GRL

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose, moist) (fill)	NS	0.0	
		X	1				Grades to no roots	NS	0.0	
						SP-SM	Gray fine to medium sand with silt (medium dense, moist to wet) (fill?)	NS	0.0	
5	5	X	2							
								NS	0.0	
						SM	Gray silty fine to medium sand (medium dense, moist to wet) (fill)			
								NS	0.0	
0	10					PT	Dark brown peat (soft, wet)			
		X	3					NS	0.0	
-5	15									

Test pit completed at 11 feet on 07/07/05
No groundwater seepage observed
Moderate caving observed below 5 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 09

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-10
Sheet 1 of 1

Date Excavated: 07/07/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose, moist) (fill)	NS	0.0	
								NS	0.0	
		☒	1							SA; MC=9%
								NS		
									0.0	
5	5									
								NS		
						SP-SM	Gray fine to medium sand with silt (medium dense, moist) (fill?)			
								NS	0.0	
						PT	Dark brown peat (soft, wet)			
								NS	0.0	
0	10	☒	2							MC=137%
-5	15									

Test pit completed at 11 feet on 07/07/05
No groundwater seepage observed
Moderate caving observed below 3 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 10

GeoEngineers

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-11
Sheet 1 of 1

Date Excavated: 07/08/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots, occasional gravel (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose to medium dense, moist) (fill)	NS	0.0	
		X	1					NS	0.0	
5	5					SP-SM	Gray fine to medium sand with silt (medium dense, moist) (fill?)			
		X	2					NS	0.0	SA
								NS	0.0	
0	10	X	3			ML	Gray silt with organics (medium stiff, moist)			
-5	15									

Test pit completed at 11 feet on 07/08/05
No groundwater seepage observed
Moderate to severe caving observed below 3 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 11

GeoEngineers

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-12

Date Excavated: 07/08/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to coarse sand with silt, trace roots, occasional gravel (loose to medium dense, moist) (fill)	NS	0.0	
		X	1			SP	Brown fine to medium sand, occasional gravel, trace roots (loose to medium dense, moist) (fill)			
								NS	0.0	
							Grades to no roots			
								NS	0.0	
5	5									
							Grades to gray			
		X	2					NS	0.0	SA; MC=15%
0	10									
								NS	11.1	
						ML	Gray silt (soft, moist)			
		X	3							MC=50%
							Test pit completed at 13 feet on 07/08/05 No groundwater seepage observed Moderate caving observed below 3 feet			
-5	15									

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 12

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-13
Sheet 1 of 1

Date Excavated: 07/08/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose to medium dense, moist) (fill)	NS	0.0	
								NS	0.0	
								NS	0.0	
5	5									
						SP-SM	Gray fine to medium sand with silt (medium dense, moist) (fill?)	NS	0.0	
						ML	Gray silt (soft, moist)	NS	0.0	
0	10									
		X	1							
-5	15									

Test pit completed at 11 feet on 07/08/05
No groundwater seepage observed
Moderate caving observed below 4 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 13

GeoEngineers

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-14
Sheet 1 of 1

Date Excavated: 07/08/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (medium dense, moist) (fill)			
						SP	Brown fine to medium sand, trace roots (loose, moist) (fill)	NS	0.0	
								NS	0.0	
		X	1					NS	0.0	
							Grades to no roots			
								NS	0.0	
5	5									
		X	2			SP-SM	Gray fine to medium sand with silt (medium dense, moist to wet) (fill?)			
0	10									
						ML	Gray silt (soft, moist)			
		X	3							
-5	15									

Test pit completed at 14 feet on 07/08/05
Slow groundwater seepage observed below 8 feet
Moderate caving observed between 5 to 10 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 14

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Figure A-15
Sheet 1 of 1

Date Excavated: 07/08/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt, roots and occasional gravel (medium dense, moist) (fill)			
						SP-SM	Brown fine to medium sand with silt, trace roots and occasional gravel (medium dense, moist) (fill)	NS	0.0	
							Grades to trace concrete pieces (1' x 6" x 5")	NS	0.0	
		X	1				Grades to no concrete	NS	0.0	SA; MC=4%
5	5					SP	Brown fine to medium sand (medium dense, moist) (fill)	NS	0.0	
						SP-SM	Gray fine to medium sand with silt (medium dense, moist) (fill?)	NS	0.0	
0	10									
						ML	Gray silt (soft, moist)			
-5	15									

Test pit completed at 13 feet on 07/08/05
No groundwater seepage observed
Moderate caving observed below 5 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 15

GeoEngineers

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00

Date Excavated: 07/08/05

Logged by: GRL

Equipment: Case 580 Rubber Tired Backhoe

Surface Elevation (ft): 10

Elevation feet	Depth feet	Sample	Sample Number	Analytical Testing	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Sheen	Headspace Vapor PID (ppm)	OTHER TESTS AND NOTES
10	0					SP-SM	Brown fine to medium sand with silt and roots (medium dense, moist) (fill)			
						SP-SM	Brown fine to medium sand with silt, trace roots (medium dense, moist) (fill)	NS	0.0	
								NS	0.0	
		X	1							
						SP	Brown fine to medium sand (medium dense, moist) (fill)	LS	1.8	
								NS	0.0	
5	5					SP-SM	Gray fine to medium sand with silt (medium dense, moist) (fill?)			
						ML	Gray silt with organics (soft to medium stiff, moist)			
0	10	X	2							

Test pit completed at 11 feet on 07/08/05
No groundwater seepage observed
Moderate to severe caving observed below 3 feet

-5 15

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 16

GEOENGINEERS

Project: Parcel "O" - Phase B
Project Location: Tacoma, Washington
Project Number: 0454-097-00