Draft Preliminary Geotechnical Engineering Report

25th Avenue NE Flood Reduction
Shoreline, Washington

September 6, 2016
Terracon Project No. 81165045

Prepared for:
Louis Berger, Inc.
Seattle, Washington

Prepared by:
Terracon Consultants, Inc.
Mountlake Terrace, Washington

September 6, 2016

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Attn: Mr. Mike Giseburt, P.E.
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Re: Draft Preliminary Geotechnical Engineering Report
25th Avenue NE Flood Reduction
Shoreline, Washington
Terracon Project Number: 81165045

Dear Mr. Giseburt:

Terracon Consultants, Inc. (Terracon) has completed the Phase I preliminary geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number P81165045 dated March 2, 2016 and a Services Task Order between Louis Berger, Inc. (Louis Berger) and Terracon dated May 16, 2016. This report presents the findings of the subsurface and hydrologic exploration and provides preliminary geotechnical recommendations concerning the alternatives under consideration for proposed stormwater improvements. Once the approach and configuration of the proposed stormwater improvements is selected, it is intended that Terracon develop a geotechnical design report to address specific design and construction considerations related to the selected alternative.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Tori Hesedahl, E.I.T.
Geotechnical Engineer

Dennis R. Stettler, P.E.
Senior Consultant

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EXECUTIVE SUMMARY

Terracon has performed preliminary geotechnical engineering services to support the evaluation and selection of preferred alternatives for the 25th Avenue NE Flood Reduction project in Shoreline, Washington. As part of these services we conducted geotechnical explorations which consisted of four borings to a maximum depth below existing site grade (bgs) of about 31 ½ feet. We also searched for existing subsurface information in publicly available resources and our own records.

Based on the information obtained from our subsurface exploration and research of existing information, construction of the proposed project alternatives appears to be geotechnically feasible. The following geotechnical considerations were identified:

- Underlying soil conditions typically consist of transitional beds of medium dense to very dense Sand and Gravel with varying fines (silt and clay) content. Soil interpreted to be alluvium consisting of very loose silty Sand extends to a depth of up to about 13 feet below ground surface in most of the borings. Fill overlies the alluvium or transitional beds and typically consists of very loose to medium dense silty Sand with gravel. The fill disclosed in the four borings advanced for this project extended to a depth of about 3.5 to 5 feet below the ground surface, but could be variable along the alignment based on past grading activities and the location of utility trench backfill.

- Oil and diesel range hydrocarbons were detected between 3 and 3 ¼ feet in boring B-4 and in some of the explorations completed on the adjacent Shoreline North Maintenance Facility site as a part of a separate City of Shoreline project. While the sample tested from boring B-4 was below Washington State Model Toxics Control Act (MTCA) cleanup levels, excavation could uncover areas with higher concentrations.

- Groundwater was observed within 2 feet below ground surface (bgs) in most of our explorations with depth to groundwater being near 7 feet bgs at higher ground elevations near NE 195th Street . Shallow groundwater will likely present constructability issues related to trenching for culvert installation and for daylight stream sections.

- Groundwater samples from two of the monitoring wells installed as a part of this project were analyzed for total petroleum hydrocarbons, volatile organic compounds, and metals. All of the test results were below the method reporting limits except for arsenic which was detected at a level slightly above the MTCA cleanup level. The arsenic finding was consistent with test results often indicative of background levels of arsenic in the Puget Sound area.

- A number of buried utilities run along the existing culvert on the east side of 25th Avenue NE. In the consideration of alternatives the design team appears to have largely avoided conflict

with these utilities by either running the alignment down the west side of 25th Avenue NE, or into the school district property on the east side of 25th Avenue NE.

- Replacing the culvert crossing at NE 195th Street will be complicated by a 66-inch water transmission pipe that runs along the south side of NE 195th Street. The pipeline will likely need to be temporarily underpinned and supported across the culvert excavation by a pile-supported frame.

- Stream channel regrading is proposed to accommodate the new stream gradient which is necessitated, in part, by clearance below the existing 66-inch water main. Proposed lowering of the stream channel would result in subvertical to vertical banks of up to about 4 feet of exposed height (1 foot existing sediment buildup plus up to 3 feet deepening) at the toe of steep slopes (such as north of NE 195th Street and at the toe of a distressed gabion basket retaining wall south of NE 195th Street. New stream channel walls will likely be required and need to be designed to support surcharge from the slope and roadway above, and for scour.

- Open channel stream bank slopes should be sloped no steeper than 2H:1V and will require protection from erosion.

- Potentially liquefieable soils were identified in borings B-4 and H-1-16.

- Close monitoring of the construction operations discussed herein will be critical in achieving the project design. We therefore recommend that the Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for preliminary design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

DRAFT PRELIMINARY GEOTECHNICAL ENGINEERING REPORT
25th Avenue NE Flood Reduction
Shoreline, Washington

Terracon Project No. 81165045
September 6, 2016

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) is pleased to present the results of our preliminary geotechnical engineering services for the proposed stormwater conveyance improvements. The project alignment runs along 25th Avenue NE between Brugger's Bog Park in Shoreline, then crosses beneath NE 195th Street and follows along the south side of Ballinger Way for a few hundred feet within the city of Lake Forest Park. Logs of the site explorations along with a site location map and exploration plan are included in Appendix A of this report.

The purpose of these services is to provide subsurface information and preliminary geotechnical engineering recommendations to support evaluation and selection of project alternatives. Geotechnical conditions were considered relative to:

- subsurface soil conditions
- earthwork
- existing retaining walls
- groundwater conditions
- existing slopes
- support of stormwater conveyance pipeline

This information and preliminary recommendations are intended to support preliminary design and alternative selection for the project. Once the project alignment, preliminary grading concepts, and channel/culvert configuration are finalized, this preliminary report should be revised and updated to address the specific details of the planned stormwater conveyance improvements.

2.0 PROJECT INFORMATION

2.1 Project Description

Significant flooding is a recurrent issue along Ballinger Creek from approximately the City of Shoreline corporate limits at NE 195th Street, north to the crossing with 25th Avenue NE, and into Brugger's Bog Park, including portions of the proposed Shoreline North Maintenance Facility (SNMF). This problem was previously studied and the basin plan concluded that the approximate 550-foot-long pipe system crossing 25th Avenue NE and extending south has inadequate capacity. In addition, it concluded that the 74-foot-long culvert crossing of NE 195th Street, located

just downstream of the 25th Avenue NE pipe system, is also undersized, and contributes to the upstream flooding.

The objective of this project is to perform preliminary design, permitting and final design for the replacements of both the 25th Avenue NE pipe system and the NE 195th Street culvert in order to improve the level of flood protection in this area. The schedule for the project is important because the City is in the process of redeveloping the SNMF and the two projects need to be coordinated.

Four alternative designs for the stretch between Brugger's Bog Park and NE 195th Street are proposed for further study in meeting summary minutes from the August 2, 2016 meeting between design team members from Herrera, Louis Berger, and the City of Shoreline.

- **Option A - Maximum Feasibility –** Daylight the stream within the right-of-way on the west side of 25th Avenue NE along the SNMF frontage, then
  - Culvert across 25th at an angle, daylight between south side of 195th Place NE and driveway to 2518 NE 195th Street, new culvert under driveway, or
  - One long culvert under 25th Avenue NE with outlet at existing location south of driveway to 2518 NE 195th Street
- **Option B - Maximum Habitat/Fish Passage Benefit –** Daylight creek on east side of 25th Avenue NE on Aldercrest Annex property and within 25th Avenue NE ROW south of 195th Place, use fish passable culverts at all roadway/driveway crossings
- **Option C - Lowest Cost –** Closed conduit under west side of 25th Avenue NE, cross near existing open channel south of driveway to 2518 NE 195th Street
- **Option D - High Flow Bypass Replacement –** Replace existing high flow bypass and move outlet to downstream side of NE 195th Street culvert.

Alternative designs to carry the stream under NE 195th Street were also identified in the meeting minutes.

- Fish Passable Culvert
  - Standard dimension box culvert. or
  - Minimum thickness/clearance culvert
- Maintain existing culvert for normal flow and rely on High Flow Bypass Replacement option above to carry storm event flows under NE 195th Street.

Should any of the above information be inconsistent with the proposed project, please let us know so we may make any necessary modifications to this report.

2.2 Site Location and Description

The project is located in the cities of Shoreline and Lake Forest Park, Washington. The alignment under consideration begins as an open channel in Brugger's Bog Park. At the southeast corner of the park the stream enters a pair of parallel culverts which continue south along either side of 25th Avenue NE. The outfall of the culverts is on the east side of 25th Avenue NE, approximately opposite the southeast corner of the Shoreline North Maintenance Facility. An open channel continues south from the outfall along the east side of 25th Avenue NE, crosses under NE 195th Street through a culvert, then continues along the north side of Ballinger Way. The project ends several hundred feet downstream.

Item	Description
Location	25th Avenue NE in the City of Shoreline, Washington, from Brugger's Bog Park to NE 195th Street and along Ballinger Way in Lake Forest Park, Washington
Existing conveyance	Parallel buried culverts on either side of 25th Avenue NE from the southeast corner of Brugger's Bog Park to the south end of the future Shoreline North Maintenance Facility, open channel from there to NE 195th Street, culvert under NE 195th Street, and open channel along Ballinger Way
Current ground cover	Variable along alignment – includes gravel surfacing, roadway pavements, trees and brush
Existing topography	Relatively flat along the northern portion of 25th Avenue NE; as 25th Avenue NE approaches Ballinger Way it slopes up to match grade with Ballinger Way forming an approximately 1H:1V sloped bank down to the open channel; along Ballinger Way the south stream bank is formed by a distressed gabion basket wall with exposed height of about 8 feet and 2.5H:1V backslope above.

3.0 SUBSURFACE CONDITIONS

3.1 Geology

The Geologic map of the Edmonds East and part of the Edmonds West quadrangles, Washington (Minard, J.P. 1983) shows the surficial geology for the site is mapped as Qtb – Transitional Beds. This unit is Fraser-age to Pre-Fraser. These glacial and non-glacial deposits are highly variable in composition but consist mostly of gray clay, silt, and fine sand. Gravels, cobbles, and boulders may also be present.

3.2 Typical Profile

Based on the results of borings B-1, B-2, and B-3, subsurface conditions along the project alignment from the southeast corner of Brugger's Bog Park to about 195th Place NE can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	3.5 to 5	Possible Fill consisting of silty SAND with gravel	Very Loose to Medium Dense
2[1]	Greater than 21.5	Transitional beds consisting of interbedded SAND and GRAVEL with varying fines content	Medium Dense to Very Dense

1. Each of the borings B-1, B-2, and B-3 were terminated at its planned depth of approximately 20 feet within this stratum.

Based on the results of boring B-4 and Washington State Department of Transportation (WSDOT) boring H-1-16, subsurface conditions along the project alignment south from about 195th Place NE can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	3.3 to 4.5	Roadway Fill consisting of silty SAND in B-4 and well graded GRAVEL in H-1-16	Medium Dense to Dense
2[2]	13	Alluvium consisting of silty SAND with gravel and organics	Very Loose
3[1]	Greater than 59.5	Transitional Beds consisting of interbedded SAND and GRAVEL with varying fines content and sandy SILT	Medium Dense to Very Dense

1. Borings B-4 and H-1-16 were terminated at their planned depth of approximately 30 and 60 feet, respectively, within this stratum.
2. This stratum was not observed in boring B-4.

In boring B-4 we noted olfactory detection of hydrocarbons from soil between 3 and 3 ¼ feet bgs. Subsequent lab testing results detected oil and diesel range hydrocarbons at a concentration below Model Toxics Control Act clean up levels. Some soil samples from explorations on the adjacent Shoreline North Maintenance Facility also noted hydrocarbon odors or detection in laboratory test results.

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report.

3.3 Groundwater

Groundwater was observed in each of our explorations. Standpipe piezometer type wells were installed in borings B-1 through B-3. The well in boring B-1 was not sounded on 7/25/2016 during our site visit to perform slug testing. The table below summarizes groundwater observations. Groundwater levels can be expected to vary seasonally and from year to year depending on precipitation, site utilization, and other on- and off-site factors.

Boring	While Drilling (feet)		7/11/2016 (feet)		7/25/2016 (feet)	
	Depth	Elevation	Depth	Elevation	Depth	Elevation
B-1	7.5	210	1.6	216	---	---
B-2	5	210	1.8	213	2.0	213
B-3	5	208	2.8	210	2.9	210
B-4	7.5	210	---	---	---	---
WSDOT H-1-16	7	208.6	---	---	---	---

Slug tests were performed in wells installed in borings B-2 and B-3. Hydraulic conductivity estimates calculated from the slug test monitoring data ranged from about 11 to 26 feet per day. Average hydraulic conductivity is estimated to be 19 and 13 feet per day in wells installed in borings B-2 and B-3, respectively. A description of our slug test and analysis procedures along with our results are included in Appendix D.

Terracon collected groundwater samples from wells installed in borings B-2 and B-3 on July 27, 2016 and submitted them for analytical testing. All total petroleum hydrocarbon (TPH) and volatile organic compounds (VOC) results were below the laboratory method reporting limits (MRLs). Arsenic was detected in the samples, but no other metals. The groundwater sample collected from boring B-2 has a reported arsenic concentration of 5.3 micrograms per liter (µg/L, or parts per billion [ppb]), which is just above the Washington State Model Toxics Control Act (MTCA) Method A cleanup level of 5 µg/L, which is protective of groundwater as a potable drinking water source. This low arsenic detection in the groundwater sample is likely due to background levels of arsenic in the glacially-derived sediment, and does not appear to be an indication of the presence of a release of contaminants to the environment, based on the lack of other contaminants detected in the sample.

4.0 PRELIMINARY RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the results of the subsurface exploration, laboratory testing, and our analyses, it is our opinion that the proposed stormwater conveyance improvement alternatives are geotechnically feasible. Geotechnical considerations for this project include:

- undocumented fill – environmental impacts
- groundwater and dewatering
- existing utilities
- steep slopes and existing retaining walls
- liquefaction

4.1.1 Undocumented Fill

Oil and diesel range hydrocarbons were detected in a sample from boring B-4. While the sample tested was below MTCA cleanup levels, excavation could uncover areas with higher concentrations.

4.1.2 Groundwater

Shallow groundwater will likely present constructability issues related to trenching for culvert installation and for daylight sections. Intensive dewatering effort will likely be required depending on depth and location of cut.

4.1.3 Existing Utilities

A number of buried utilities run along the existing culvert on the east side of 25th Avenue NE. The design team appears to have largely avoided conflict with these utilities in their consideration of alternatives by either running the alignment down the west side of 25th Avenue NE, or into the school district property on the east side of 25th Avenue NE.

Seattle Public Utilities owns a 66-inch water transmission pipe that runs along NE 195th Street. Construction of a culvert crossing of NE 195th Street will be complicated by the location of this pipe. Box culvert replacements will have to be designed such that the stream bed is lowered by 2 to 3 feet. The pipeline will likely need to be temporarily supported across the culvert excavation during construction.

4.1.4 Steep Slope North of NE 195th Street

The west bank of the existing open channel slopes up 10 to 12 feet from the creek to 25th Avenue NE at about a 1H:1V slope. Some boulders in the stream bed appear to have tumbled down from the slope above. Proposed channel regrading and lowering would cut subvertical to vertical banks of up to about 4 feet of exposed height (1 foot of existing sediment accumulation plus 3 feet

deepening) at the toe of this slope. Given the existing constrained stream channel and available right-of-way, a new stream channel wall on the west side of the stream channel will be required and need to be designed to support surcharge from the slope and roadway above. Scour will be another major design consideration that compounds the concerns with the cut at the toe of the surcharged slope.

4.1.5 Existing Retaining Wall South of NE 195th Street

WSDOT owns a gabion basket retaining wall that forms the NE 195th Street culvert outfall headwall and the south bank of the stream channel downstream of NE 195th Street. This wall extends from the corner of NE 195th Street and Ballinger Way and continues along Ballinger Way past the south end of the project alignment. Exposed height appears to be about 8 feet with a 2.5H:1V backslope above based on a review of topographic contours and observations in the field.

The headwall for the existing culvert has completely failed and is planned for replacement by WSDOT in the next few months. The wall is in fair to poor condition along Ballinger Way. The gabion wire baskets at the base of the wall in the zone of water inundation have corroded completely through and the formerly contained spalls have spilled out. The walls appears to be leaning out from the slope in some areas due to the loss of support and the walls could be subject to failure. Proposed regrading of the stream channel would cut subvertical to vertical banks of up to about 4 feet of exposed height (1 foot existing sediment accumulation plus up to 3 feet deepening) at the toe of this wall which could cause the wall to completely fail without mitigation.

Coordinating wall replacement or rehabilitation efforts with culvert replacement and stream channel regrading has the potential advantage of addressing existing wall stability and deepened stream channel issues in one system. However, since WSDOT owns the gabion basket wall, coordination and cost sharing issues in a timely manner could be problematic.

To deepen the channel while leaving the existing gabion basket wall in place would require permanent shoring to prevent undermining the gabion wall.

4.1.6 Liquefaction

The term liquefaction refers to a phenomenon by which saturated soils develop high pore water pressures during seismic shaking and, as a result, lose their strength characteristics. This phenomenon generally occurs in areas of high seismicity, where groundwater is relatively shallow and where loose granular soils (mainly sands) or non-plastic fine-grained soils (mainly silts) are present. Ground water was encountered within about 1.5 to 7.5 feet of the ground surface in our exploratory borings. Considering depth to groundwater and varying composition and density of soil encountered in our boring, our opinion is that risk of occurrence of liquefaction is moderate.

4.2 Earthwork

Based on the subsurface conditions encountered in our exploration, we expect that all of the on-site soils within the limits of construction can be removed with conventional excavation equipment. Cobbles and boulders were not observed in our exploration but are often found in transitional beds. The contractor should be prepared to deal with cobbles and boulders. Recommendations for site preparation, structural fill, and permanent slopes are presented below.

4.2.1 Site Preparation

Prior to equipment arriving onsite, clearing and grading limits should be established and marked. Silt fences should be constructed along the downslope side of all areas planned for clearing and grading. Preparation for site grading and construction should begin with procedures intended to control surface water runoff. Diversion of the existing stream will be necessary for excavation and construction in the existing channel. The sandy site soils are moderately susceptible to erosion by flowing water.

Stripping efforts should include removal of vegetation, organic materials, and any deleterious debris from the project alignment. It appears that up to about 0.5 feet of stripping will be necessary in areas with light vegetation. Greater depths of stripping and grubbing may be necessary in areas with thick vegetation and tree roots. These materials are not suitable for reuse as structural fill. Site disturbance beyond the work area should be limited to reduce the potential for erosion and off-site sediment transport.

Areas that are stripped or excavated to the design subgrade elevation, or that are to receive structural fill, should be systematically probed to evaluate the subgrade. Any soft, loose, or otherwise unsuitable areas identified during probing should be recompacted if practical or removed and replaced with structural fill. We recommend that probing of the subgrade be observed by a representative of our firm to assess the adequacy of the subgrade conditions and identify areas needing remedial work.

4.2.2 Reuse of Site Soils

Onsite granular soils are suitable for reuse as structural fill or trench backfill on the basis of gradation. However, the fines content of near-surface onsite granular soil make this material highly moisture sensitive. The high groundwater level and in situ moisture content may make this material unsuitable for reuse as structural fill without drying back. This material is unsuitable for use during periods of wet weather.

Fine-grained soil was observed in boring B-4 and H-1-16. This material is not suitable for reuse as structural fill or trench backfill but may be reused in landscaped areas.

4.3 Dewatering

We anticipate that, with careful construction sequencing, shallow excavations less than approximately 2 feet below water table may be dewatered with sumps and pumps. Examples of sequencing construction to manage groundwater include, but are not limited to, starting at the low end of excavation and opening only limited areas so that seepage remains within the removal capacity of the equipment on hand. These considerations may apply to portions of the alignment where the stream may be daylighted.

For deeper excavations a more intensive dewatering effort will be required. While dewatering design is the responsibility of the contractor, we expect that a system of vacuum well points for dewatering less than 15 feet below top of the extraction well, or pumping extraction wells for deeper pumping depths, will be suitable for dewatering trenches to install pipe culvert or box culverts. The trench should be dewatered prior to and during construction to a depth of at least 2 feet below the trench bottom. Disposal of water pumped from the trench should be in accordance with City, County, and State requirements.

Terracon estimates that flow rates may be expected to be in the range of about 250 gallons per minute to about 60 gallons per minute. Dewatering flow rate estimates are based on a number of assumptions and idealizations, including dewatered length limited to 100 feet at a time and depth to about 10 feet. Hydrogeological conditions are greatly simplified from existing conditions for the purpose of estimation. The flow rate estimates are average values over time. Instantaneous flow rates may be significantly higher, particularly at start of pumping a new section. Actual flow rates observed at a particular time and location during construction could vary significantly from the estimates provided due to:

- spatial variability in hydraulic conductivity,
- groundwater elevations at the time of dewatering (including seasonal variability),
- the depth of drawdown required at a particular location,
- the stage of dewatering (higher rates to initially drawdown the groundwater; lower rates to maintain a steady state condition once drawdown has occurred),
- the length of trench dewatered at one time,
- dewatering system design,
- construction sequencing, and/or other factors.

It should also be noted that a factor of safety or other specific conservative assumptions were not included in the model input parameters. Therefore, use of the flow rate estimates from the model should be used carefully and with full consideration of how actual conditions could vary from the model assumptions.

At commencement of dewatering any given section, flow rates are expected to be highest and would decrease as the dewatering system draws the water table down. Dewatering rates would tend toward the lower end of the estimated range for shallower excavations for stream daylighting.

4.4 Box Culverts

Box culverts are proposed in several configurations as part of Options A, B, and C. Foundations should bear on either relatively undisturbed medium dense to very dense sand and gravel of the transitional beds, or structural fill extending down to the transitional beds. Based on the preliminary profile provided by Louis Berger, it appears that thalweg will be within about 2 to 5 feet with the contact with the transitional beds. Given that minimum embedment of foundations of 2 feet and that foundations may be deeper for scour considerations we anticipate minimal overexcavation would be required for box culvert foundations.

Headwalls of box culverts should extend below scour depth. For preliminary design we recommend assuming that headwalls should extend at least 2 feet below the culvert footing depth.

4.5 Pipe Culverts

Based on the preliminary profile provided by Louis Berger, it appears that thalweg will be within about 2 to 5 feet of the contact with the transitional beds. The medium dense to very dense sand and gravel transitional bed soils or medium dense granular alluvial soils will provide adequate support to the 72-inch diameter corrugated metal pipe (CMP) culvert proposed in Options C and D. Localized soft areas at the bottom of the trench excavation may need to be overexcavated and replaced with structural fill. The CMP should be bedded in a well-graded granular material with particles no larger than 1 ½-inches in diameter and fines content less than 10 percent.

4.6 Support of Tolt Pipeline

We expect that the pipeline will not be able to span the 15 to 20 foot wide excavation required to install a 10 foot wide culvert. Smaller pipelines are sometimes supported from above by spanning the excavation with structural steel placed on grade and tying the pipeline to the steel. The size of this pipe may require bracing the pipeline on a pile-supported frame. Based on the information from WSDOT boring H-1-16, driving piles with impact or vibratory hammers or drilling soldier piles appears feasible.

The design team expects minimum clearance between the pipe invert and the top of the culvert. Standard culvert designs typically require 2 or more feet of soil cover to distribute heavy loads from above. Depending on culvert design and configuration, pipeline bracing may need to be permanent to keep load off of the culvert.

4.7 Open Channel Slopes

Open channel cut slopes should be no steeper than 2H:1V and would require surface protection from erosion. Cut slopes covered by a geotextile and rock facing sized to prevent erosion and

scour could be used to protect the cut slopes. Synthetic slope protection systems are also available such as cellular confinement (or geocells) with the cells filled with granular material and seeded with grasses to provide a greener alternate slope protection concept.

4.8 Channel Wall Alternatives

Permanent stream channel walls and temporary shoring for stream regrading will need to be designed to support surcharge from the slopes and potentially the roadway above. Scour will be another major design consideration that compounds the concerns with the cut at the toe of the surcharged slope since it means effectively designing for a higher retained height at toe of slope. These considerations limit feasible wall system alternatives where surcharges exist along 25th Avenue NE and Ballinger Way .

4.8.1 Soldier Pile and Lagging

A soldier pile wall with lagging would be capable of supporting the surcharges. Equipment access could be a challenge to constructing this system at this location. Driving piles with a vibratory hammer appears to be feasible based on the soils observed in boring B-4 and H-1-16. Given space constraints for equipment and the desirability of not generating spoils, driven piles offer an advantage over drilled soldier piles. However, ground vibrations from installation by driven methods could be of concern for nearby residential structures. Permanent soldier piles would require corrosion protection (hot dip galvanizing is typical) or sacrificial thickness if left exposed to the elements. Lagging should be installed to at least 2 feet below the anticipated scour depth.

Lagging/facing options include:

- Pressure-treated wood lagging is often used for permanent walls without other facing for its ease of installation and relative price. However, this alternative may not be the most appropriate considering the alternate wetting and drying conditions at the stream channel and potential environmental concerns for use of pressure-treated products in an aquatic environment.
- Concrete lagging might be a lower maintenance alternative to pressure-treated wood. The exposed side can be formed and dyed to give an attractive appearance. Installation can be difficult, however. Concrete lagging is typically precast and sizing in the field is not possible. Pile installation tolerances may need to be tightened or a wider flange on the piles may be needed to ensure adequate bearing area of the lagging on the pile flanges. Of the facing options presented this could be the most expensive to construct.
- Temporary wood (untreated) lagging with a permanent concrete facing has some of the advantages of both pressure treated wood and concrete lagging. The facing can be precast concrete panels or shotcrete sculpted and dyed to give a more natural appearance. With adequate shotcrete cover over the piles, corrosion protection or sacrificial thickness may not be required. Initial installation of lagging is still relatively simple but requires the additional step of adding permanent facing.

Placing shotcrete in the stream channel may pose permitting and/or constructability challenges.

4.8.2 Gravity

A gravity wall constructed with ecology blocks or cast-in-place concrete is another alternative capable of supporting the surcharges. Ecology blocks are available with many facing patterns and can be dyed for asthetics. We anticipate that this wall system will have to extend about 4 feet below the proposed channel bottom to account for scour depth and to maintain minimum embedment depth. This means that a cut of 6 to 8 feet at the toe of slope will be required. Our opinion is that stand-up times in the wet silty sand soil observed in boring B-4 would be too short to allow an open cut of even a modest length for construction. We expect that some form of temporary shoring such as sheet piles or soldier pile and lagging would be required to construct a gravity wall.

4.8.3 Sheet Piles

Driving sheets with impact or a vibratory hammer appears to be feasible though driving could be difficult through the silty gravel observed between elevation 196.5 and 192 feet in boring B-4. Sheet piles could be used for temporary shoring or for a permanent wall though the aesthetics may not be as pleasing as other alternatives. As with exposed soldier piles for permanent applications, corrosion protection or sacrificial steel should be provided for the portion of the piles above seasonal low groundwater.

4.8.4 Rockery

We understand that a rockery has been considered initially by the design team. Rockeries are suitable for protection of cut slopes of limited height in otherwise stable ground and are not considered to be effective as engineered retaining structres. In our opinion, rockeries are not suitable for retaining slopes with the soil conditions present at borings B-4 and H-1-16. Armoring the east bank of the stream channel where the backslope is relatively level and of limited height with a rockery (or slope armored with rock) appears feasible geotechnically. It is our opinion that a rockery is not appropriate along the relatively high and steep west bank along 25th Avenue NE north of NE 195th Street or the south bank along Ballinger Way where the existing height and steepness of slope or the presence of a failing gabion wall requires a more positive form of slope retention.

4.9 Recommendations for Final Design

After the preferred alternative is selected, Terracon will refine and expand upon the preliminary recommendations presented in this report and make them specific to the preferred alternative. These refinements may include, depending on the alternative selected:

- Slope stability modeling of the proposed final stream configuration at 25th Avenue NE and Ballinger Way

- One additional boring downstream of NE 195th Street
- Specific material and compaction requirements for support and backfill of buried structures
- Shoring and/or retaining wall recommendations specific to the selected system
- Underpinning and protection of the SPU water pipe
- Plan review for consistency with our geotechnical recommendations.

5.0 GENERAL COMMENTS

This report has been prepared to provide preliminary geotechnical engineering to support evaluation of project alternatives. Once an alternative is selected and the project moves toward final design, it is intended that Terracon replace this preliminary report with a design phase geotechnical engineering report that addresses the specific geotechnical design and construction elements associated with the selected project alternative.

At the conclustion of design, Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

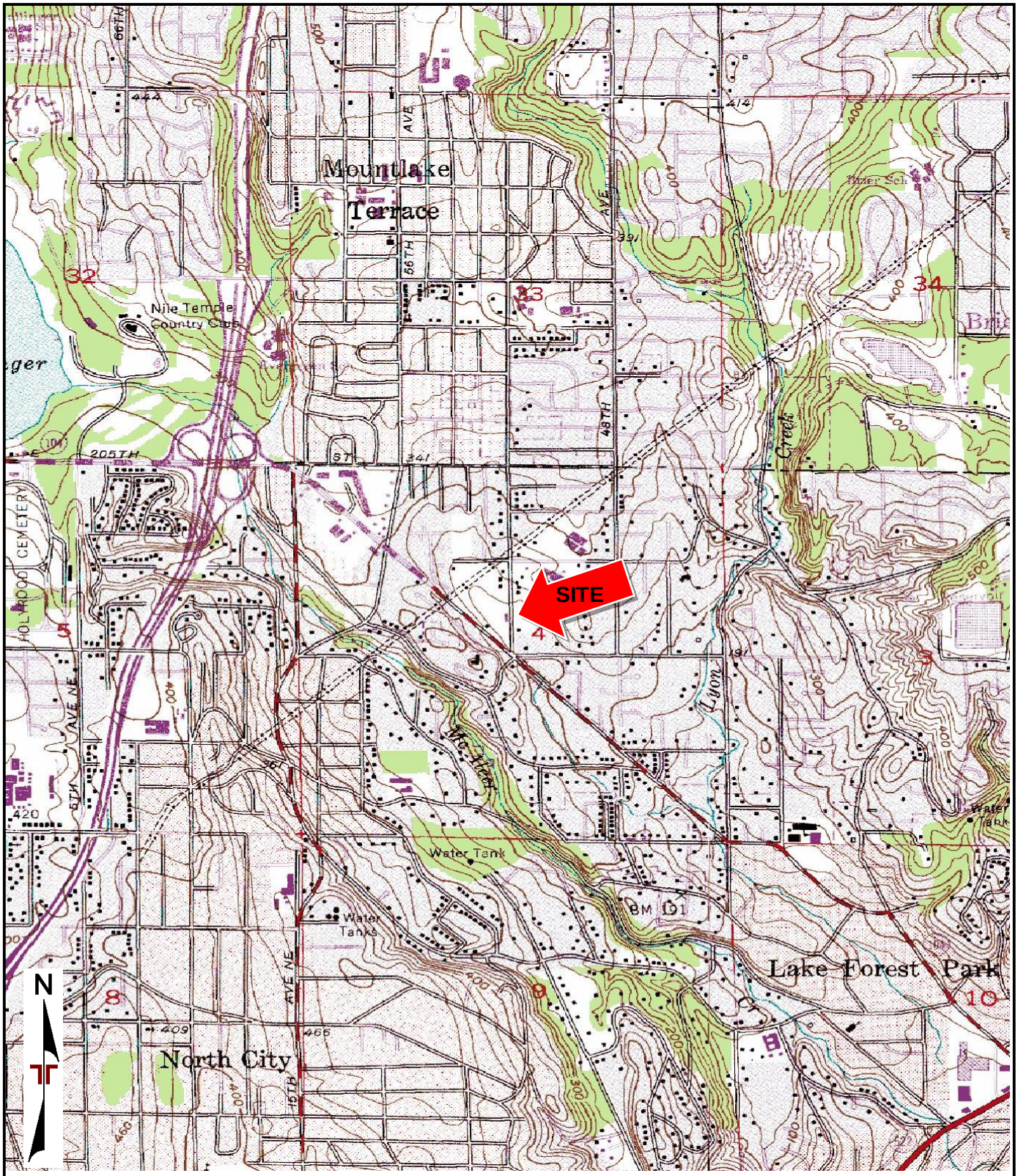
The preliminary analyses and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions other than the limited soil and groundwater testing as discussed in this report. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of Louis Berger for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered

valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

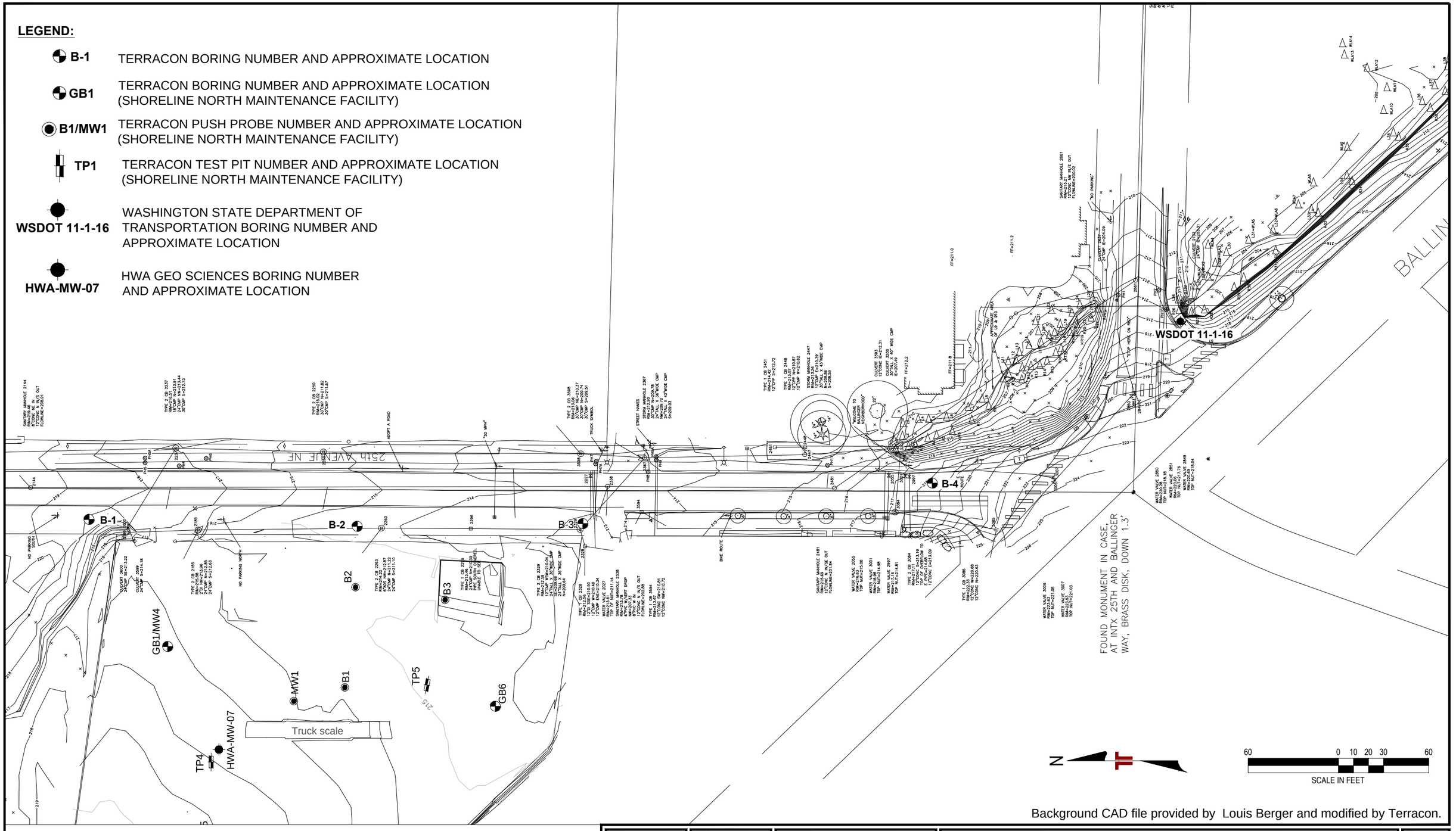


TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: EDMONDS EAST, WA (1/1/1981) and SEATTLE NORTH, WA (1/1/1983).

Project Manager: TLH	Project No. 81165045	Terracon 21905 64th Ave W Ste 100 Mountlake Terrace, WA 98043-2251	SITE LOCATION 25th Ave NE Flood Reduction Project 25th Ave NE Shoreline, King County, Washington	Exhibit A-1
Drawn by: AMP	Scale: 1"=2,000'			
Checked by: TLH	File Name: Exhibit 1			
Approved by: TLH	Date: July 2016			

LEGEND:

B-1	TERRACON BORING NUMBER AND APPROXIMATE LOCATION
GB1	TERRACON BORING NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)
B1/MW1	TERRACON PUSH PROBE NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)
TP1	TERRACON TEST PIT NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)
WSDOT 11-1-16	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION BORING NUMBER AND APPROXIMATE LOCATION
HWA-MW-07	HWA GEO SCIENCES BORING NUMBER AND APPROXIMATE LOCATION



Background CAD file provided by Louis Berger and modified by Terracon.

Project Mngr:	TLH
Drawn By:	AMP
Checked By:	TLH
Approved By:	DRS
Project No.	81165045
Scale:	AS SHOWN
File No.	Exhibit A-2
Date:	July 2016

Terracon
Consulting Engineers and Scientists
21905 64th Avenue W, Ste 100 Mountlake Terrace, WA 98043
PH. (425) 771-3304 FAX. (425) 771-3549

SITE AND EXPLORATION PLAN

25th Ave NE Flood Reduction Project
25th Ave NE
Shoreline, King County, Washington

EXHIBIT

A-2

Field Exploration Description

The proposed boring locations were laid out in the field by a Terracon representative using a scaled site plan provided by Louis Berger, Inc. and a tape measure. Ground surface elevations indicated on the boring logs were interpolated from the topographic contours on the site plan. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a truck-mounted rotary drill rig using hollow-stem augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using the split-barrel sampling procedures.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in situ relative density of cohesionless soils and consistency of cohesive soils.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with bentonite chips prior to the drill crew leaving the site.

Standpipe piezometers were installed in borings B-1, B-2, and B-3. Each of these wells was screened from approximately 10 feet below ground surface (bgs) to 20 feet bgs with 2-inch nominal diameter by 0.020-inch slotted PVC pipe. The filter pack consisted of #10-20 Colorado Sand.

A field log of each boring was prepared by a Terracon geotechnical engineer. These logs included visual classifications of the materials encountered during drilling as well as the engineer's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

BORING LOG NO. B-1

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger
Seattle, Washington

SITE:
Shoreline, Washington

LOCATION: See Exhibit A-2

Latitude: 47.772063° Longitude: -122.302964°

Approximate Surface Elev: 219 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION
0.5	218.5+/-	**SOD**
		SILTY SAND (SM), olive gray, moist
2.0	217+/-	
		SILTY SAND (SM), with gravel, brown, very loose, moist, with rootlets
5.0	214+/-	
		POORLY GRADED SAND WITH SILT (SP-SM), gravelly, gray, medium dense, wet
		trace gravel
		gravelly, very dense
		with gravel, dense
		very dense
20.0	199+/-	
20.8	198+/-	**SILTY SAND**, very dense, wet
		Boring Terminated at 20.83 Feet

DEPTH (Ft.)	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
5	2	2-1-1 N=2	S-1	0.2		
	11	6-9-15 N=24	S-2	0.3	15	8
	12	8-9-15 N=24	S-3	0.4		
10	12	12-49-35 N=84	S-4	0.4		
	6	7-14-16 N=30	S-5	0.6		
15	15	16-21-30 N=51	S-6	0.5		
20	14	39-50/4" N=50/4"	S-7	0.4		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:
Well Tag BJW 176

WATER LEVEL OBSERVATIONS

While drilling

1.6' bgs on 7/11/2016

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/5/2016 | Boring Completed: 7/5/2016

Drill Rig: D-120 truck | Driller: Holocene

Project No.: 81165045 | Exhibit: A-4

BORING LOG NO. B-2

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger
Seattle, Washington

SITE:
Shoreline, Washington

LOCATION: See Exhibit A-2

Latitude: 47.771543° Longitude: -122.302944°

Approximate Surface Elev: 215 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	LITHOLOGY
0.5	214.5+/-	**FILL - , CRUSHED ROCK SURFACING**
		SILTY SAND (SM), with gravel, olive gray, medium dense, moist
4.0	211+/-	
		SILTY SAND (SM), olive gray, medium dense, wet
7.5	207.5+/-	
		SILTY GRAVEL (GM), sandy, gray, very dense, wet
12.5	202.5+/-	
		SILTY SAND (SM), gravelly, gray, dense, wet
		medium dense
		very dense
21.5	193.5+/-	
		Boring Terminated at 21.5 Feet

INSTALLATION DETAILS

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
	▽	X	7	6-10-11 N=21	S-1	1.0		
5	▽	X	10	6-10-15 N=25	S-2	0.5		
		X	9	27-30-29 N=59	S-3	0.6	8	14
10		X	12	17-30-27 N=57	S-4	1.2		
		X	12	14-21-27 N=48	S-5	0.5		
15		X	10	14-12-12 N=24	S-6	1.0		
20		X	12	21-30-33 N=63	S-7	0.7		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:
Well Tag BJW 175

WATER LEVEL OBSERVATIONS

▽ *While drilling*
▽ *1.8' bgs on 7/11/2016*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/5/2016 | Boring Completed: 7/5/2016
Drill Rig: DR009 | Driller: Holocene
Project No.: 81165045 | Exhibit: A-5

BORING LOG NO. B-3

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger
Seattle, Washington

SITE:
Shoreline, Washington

LOCATION: See Exhibit A-2

Latitude: 47.77112° Longitude: -122.302913°

Approximate Surface Elev: 213 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION
0.5	212.5+/-	**FILL - , CRUSHED ROCK SURFACING**
		SILTY SAND (SM), trace gravel, olive gray, medium dense, moist
3.5	209.5+/-	
		WELL GRADED GRAVEL WITH SILT (GW-GM), sandy, gray, medium dense, wet
		gravelly, wood fragments
7.5	205.5+/-	
		SILTY SAND (SM), gravelly, gray, very dense, wet
		dense
12.5	200.5+/-	
		SILTY GRAVEL (GM), sandy, gray, very dense, wet
20.0	193+/-	
		SILTY SAND (SM), with gravel, gray, very dense, wet
21.5	191.5+/-	
		Boring Terminated at 21.5 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
	▽							
			6	5-8-6 N=14	S-1	0.3		
	▽							
5			6	5-7-7 N=14	S-2	0.3	14	7
			14	26-36-23 N=59	S-3	0.3	12	19
10			13	8-17-22 N=39	S-4	0.2		
			6	22-50 N= N=50/6"	S-5	0.2		
15			6	28-50 N= N=50/3"	S-6	0.4		
20			12	23-29-31 N=60	S-7	0.4		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:
Well Tag BJW 174

WATER LEVEL OBSERVATIONS

▽ *While drilling*
▽ *2.8' bgs on 7/11/2016*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/5/2016 | Boring Completed: 7/5/2016
Drill Rig: DR009 | Driller: Holocene
Project No.: 81165045 | Exhibit: A-6

BORING LOG NO. B-4

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger
Seattle, Washington

SITE:
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.770511° Longitude: -122.302816°

Approximate Surface Elev: 222 (Ft.) +/-

DEPTH		ELEVATION (Ft.)
0.5	**FILL - ASPHALT CONCRETE**, 6"	221.5+/-
1.0	**FILL - AGGREGATE BASE COURSE**, 6"	221+/-
	FILL - SILTY SAND (SM), with gravel, olive gray, loose to medium dense, moist	
2.5		219.5+/-
3.0	**FILL - LEAN CLAY (CL)**, sandy, gray, very soft to soft, moist	219+/-
3.3	**FILL - SILTY SAND (SM)**, gravelly, black, dense, oily feel, hydrocarbon odor	219+/-
	LEAN CLAY (CL), sandy, gray, stiff, moist	
	No recovery	
8.3		214+/-
	POORLY GRADED SAND (SP-SM), with silt, red brown, loose, moist	
10.0		212+/-
	SILTY SAND (SM), gray, very loose, wet	
	medium dense	

DEPTH (Ft.)	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
	10	2-1-29 N=30	S-1	11.3		
5	0	4-5-5 N=10	S-2	0.3		
	9	3-2-2 N=4	S-3	0.8		
10	5	1-1-1 N=2	S-4	0.2		
	5	6-9-13 N=22	S-5			
15	9	8-6-5 N=11	S-6			
20	12	11-18-25 N=43	S-7			
25						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/6/2016 | Boring Completed: 7/6/2016

Drill Rig: DR009 | Driller: Holocene

Project No.: 81165045 | Exhibit: A-7

BORING LOG NO. B-4

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger
Seattle, Washington

SITE:
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.770511° Longitude: -122.302816°

Approximate Surface Elev: 222 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
	25.5	196.5+/-									
	SILTY GRAVEL (GM), with sand, gray, very dense, wet, broken gravels				X	13	13-32-30 N=62	S-8			
	30.0	192+/-	30								
	SILTY SAND (SM), gray, medium dense, wet, driller added water at 30' bgs, driller notes heave at 30'				X	8	5-5-6 N=11	S-9			
	31.5	190.5+/-									
	Boring Terminated at 31.5 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/6/2016 | Boring Completed: 7/6/2016

Drill Rig: DR009 | Driller: Holocene

Project No.: 81165045 | Exhibit: A-7

WELL LOG NO. GB1/MW-4

PROJECT: Shoreline North Maintenance Facility

CLIENT: TCF Architecture
Tacoma, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.771851° Longitude: -122.303263°

Approximate Surface Elev: 217.5 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2 **ASPHALT 1-2"**	217.5+/-									
1.0 **SILTY SAND (SM)**, with gravel, dark brown, moist	216.5+/-									
SAND (SP-SM), with silt, trace gravel, dark gray, medium dense, wet			▽							
					6	5-11-10 N=21	S-1	16		11
grades to dense		5			12	11-16-16 N=32	S-2			
7.0	210.5+/-									
SAND (SP-SM), with silt and gravel, dark gray, dense, wet					12	16-19-20 N=39	S-3			
9.5	208+/-									
GRAVEL (GP), with sand, trace silt, very dense, wet		10			6	20-50/6" N=50/6"	S-4			
					12	19-25-21 N=46	S-5			
		15			6	50/6" N=50/6"	S-6			
20.5	197+/-									
21.5 **SANDY SILT (ML)**, with gravel, gray, hard, wet	196+/-	20			12	30-50/6" N=50/6"	S-7			
Boring Terminated at 21.5 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
8" Hollow Stem Auger

Abandonment Method:
2" Monitoring Well

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Well Started: 1/20/2016 | Well Completed: 1/20/2016

Drill Rig: B-59 | Driller: Holt Services, Inc.

Project No.: 81155070 | Exhibit: A-8

BORING LOG NO. GB6

PROJECT: Shoreline North Maintenance Facility

CLIENT: TCF Architecture
Tacoma, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.771262° Longitude: -122.303336°

Approximate Surface Elev: 217 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2 **ASPHALT 1-2"**	217+/-									
1.0 **SILTY SAND (SM)**, with gravel, dark brown, moist	216+/-									
SILTY SAND (SM), with gravel, gray, loose, moist			▽		9	4-2-4 N=6	S-1	15		21
grades to wet										
4.5	212.5+/-									
SILTY SAND (SM), with gravel, gray, dense, wet		5			9	15-16-20 N=36	S-2			
grades to very dense					9	17-22-44 N=66	S-3			
9.5	207.5+/-									
GRAVELLY SAND (SP), trace silt, gray, very dense, wet		10			18	8-17-24 N=41	S-4			
					18	13-47-50 N=97	S-5			
14.0	203+/-									
Boring Terminated at 14 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
8" Hollow Stem Auger

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 1/21/2016 Boring Completed: 1/21/2016

Drill Rig: B-59 Driller: Holt Services, Inc.

Project No.: 81155070 Exhibit: A-9

TEST PIT LOG NO. TP4

PROJECT: Shoreline North Maintenance Facility

CLIENT: TCF Architecture
Tacoma, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.771831° Longitude: -122.303584°

Approximate Surface Elev: 218 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2 **FILL - ASPHALT CONCRETE**, 2 1/2"	218+/-									
0.5 **FILL - AGGREGATE BASE COURSE**, black, medium dense to dense, 3 1/2" oily feel, strong hydrocarbon odor	217.5+/-						S-1			
FILL - SILTY SAND (SM), trace gravel, gray to red brown, very loose to loose, moist, trace organics and woody fragments tree roots										
3.0	215+/-						S-2	243	NP	
PEAT (PT), brown, very soft to soft										
5.5 groundwater seepage observed pit wall at 5'	212.5+/-	5	▽				S-3			
POORLY GRADED GRAVEL WITH SILT (GP-GM), sandy, gray, medium dense to dense, wet, minor caving below 5.5'										
6.5 **SILTY SAND (SM)**, olive gray, medium dense to dense, wet	211.5+/-						S-4			
8.0	210+/-									
Test Pit Terminated at 8 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Backhoe with 36" bucket

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While digging*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Test Pit Started: 6/27/2016
Test Pit Completed: 6/27/2016
Excavator: Cat 420F IT backhoe
Operator: City of Shoreline
Project No.: 81155070
Exhibit: A-10

TEST PIT LOG NO. TP5

PROJECT: Shoreline North Maintenance Facility

CLIENT: TCF Architecture
Tacoma, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.771698° Longitude: -122.303424°

Approximate Surface Elev: 215 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE NUMBER	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	215+/-					
FILL - ASPHALT CONCRETE, 3"						
0.5	214.5+/-					
FILL - AGGREGATE BASE COURSE, black, medium dense to dense, 3" oily feel, strong hydrocarbon odor			S-1			
FILL - SILTY SAND (SM), with gravel, trace cobbles, gray to red brown, very loose to loose, moist, trace organics and woody fragments			S-2			
3.5	211.5+/-					
4.0 tree roots	211+/-		S-3	80	NP	
PEAT (PT), brown, very soft to soft						
5.0	210+/-	5	S-4			
POORLY GRADED GRAVEL WITH SILT (GP-GM), sandy, fine gravel, gray, medium dense to dense, wet, trace woody fragments, groundwater seepage from 4'						
6.0	209+/-					
SILTY SAND (SM), olive gray, medium dense to dense, wet						
POORLY GRADED GRAVEL WITH SILT (GP-GM), sandy, coarse gravel, gray, medium dense to dense, wet,			S-5			
8.5	206.5+/-					
Test Pit Terminated at 8.5 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Backhoe with 36" bucket

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While digging*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Test Pit Started: 6/27/2016
Test Pit Completed: 6/27/2016
Excavator: Cat 420F IT backhoe
Operator: City of Shoreline
Project No.: 81155070
Exhibit: A-11

WELL LOG NO. B1

PROJECT: Shoreline North Maintenance Facility - LSI

CLIENT: TCF Architecture
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)
0.2	**ASPHALT 1-2"**	
0.5	**SILTY SAND (SM)**, with gravel, brown/dark brown	
	SAND (SP), gray, moist, hydrocarbon odor	
	grades to saturated	
4.0		
4.5	**SILT (ML)**, with organics, dark brown, moist	
5.0	**SAND (SP)**, with gravel, gray, wet	
	SILT (ML), with organics, dark brown, moist	
6.5		
	GRAVELLY SAND (SP), gray, wet	
8.0		
8.5	**CLAYEY SILT (CL-ML)**, tan, moist	
	GRAVELLY SAND (SP), gray, wet	
13.0		
	SANDY SILT (SM), tan, wet	
14.0		
	Boring Refusal at 14 Feet	

INSTALLATION DETAILS

Well Completion: 3/4" Slotted PVC pipe packed in sand

DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SPT N-VALUE	SAMPLE NUMBER
			<1		
	▽	■	48.7		B1-3'
5			3.8		
			<1		
10					
			<1		

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Appendices for description of field procedures.

Notes:
- Temporary well removed after groundwater sample collection.

WATER LEVEL OBSERVATIONS

▽ *While Drilling*

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Well Started: 1/11/2016 | Well Completed: 1/11/2016

Drill Rig: AMS Power Probe | Driller: Holt Services, Inc.

Project No.: 81157201 | Exhibit: A-12

WELL LOG NO. B2

PROJECT: Shoreline North Maintenance Facility - LSI

CLIENT: TCF Architecture
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)
0.2	**ASPHALT 1-2"**	
	SILTY SAND (SM), with gravel, brown/dark brown, moist	
	grades to gray	
5.5	**SILTY SAND (SM)**, with organics, gray, wet	
7.0		
7.5	**SILT (ML)**, gray, moist	
	GRAVELLY SAND (SP), gray, wet	
13.0	**GRAVEL (GP)**, with sand, gray, wet	
15.0	***Boring Terminated at 15 Feet***	

INSTALLATION DETAILS

Well Completion:

3/4" Slotted PVC pipe packed in sand

DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SPT N-VALUE	SAMPLE NUMBER
5			<1		
			<1		
			<1		
	▽	■	<1		B2-7.5'
10			<1		
15					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Appendices for description of field procedures.

Notes:
- Temporary well removed after groundwater sample collection.

WATER LEVEL OBSERVATIONS

▽ *While Drilling*

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Well Started: 1/11/2016 | Well Completed: 1/11/2016

Drill Rig: AMS Power Probe | Driller: Holt Services, Inc.

Project No.: 81157201 | Exhibit: A-13

WELL LOG NO. B3

PROJECT: Shoreline North Maintenance Facility - LSI

CLIENT: TCF Architecture
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)
0.3	**3-4" Concrete**	
	GRAVEL (GP), with sand, gray, wet	
5.0		
	GRAVEL (GP), gray, wet	
6.0		
	SAND (SP), with gravel, gray-brown, wet	
8.0		
	SAND (SP), black	
10.0		
	GRAVELLY SAND (GP), gray, wet	
	grades to brown	
15.0		
	Boring Terminated at 15 Feet	

INSTALLATION DETAILS

Well Completion:

3/4" Slotted PVC pipe packed in sand

DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SPT N-VALUE	SAMPLE NUMBER
	▽				
		■	<1		B3-1'
			<1		
5		■	<1		B3-2'
			<1		
10			<1		
15					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Appendices for description of field procedures.

Notes:
- Temporary well removed after groundwater sample collection.

WATER LEVEL OBSERVATIONS

▽ *While Drilling*

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Well Started: 1/11/2016 | Well Completed: 1/11/2016

Drill Rig: AMS Power Probe | Driller: Holt Services, Inc.

Project No.: 81157201 | Exhibit: A-14

BORING LOG NO. MW1

PROJECT: Shoreline North Maintenance Facility - LSI

CLIENT: TCF Architecture
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SPT N-VALUE	SAMPLE NUMBER
0.2	**ASPHALT 1-2"**							
	SAND (SP), brown-gray, moist					<1		
4.0	grades to wet			▽	■	<1		MW1-3.5
4.5	**SILT (ML)**, with organics, dark brown, moist							
	SAND (SP), gray, wet		5			<1		
7.0	grades to brown							
	SILT (ML), light brown with orange mottling, wet							
8.0	**SILTY SAND (SM)**, with gravel, gray, wet					<1		
			10					
11.0	***Refusal at 11 Feet***							

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Appendices for description of field procedures.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While Drilling*

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Boring Started: 1/11/2016 | Boring Completed: 1/11/2016

Drill Rig: AMS Power Probe | Driller: Holt Services, Inc.

Project No.: 81157201 | Exhibit: A-15

APPENDIX B
LABORATORY TESTING

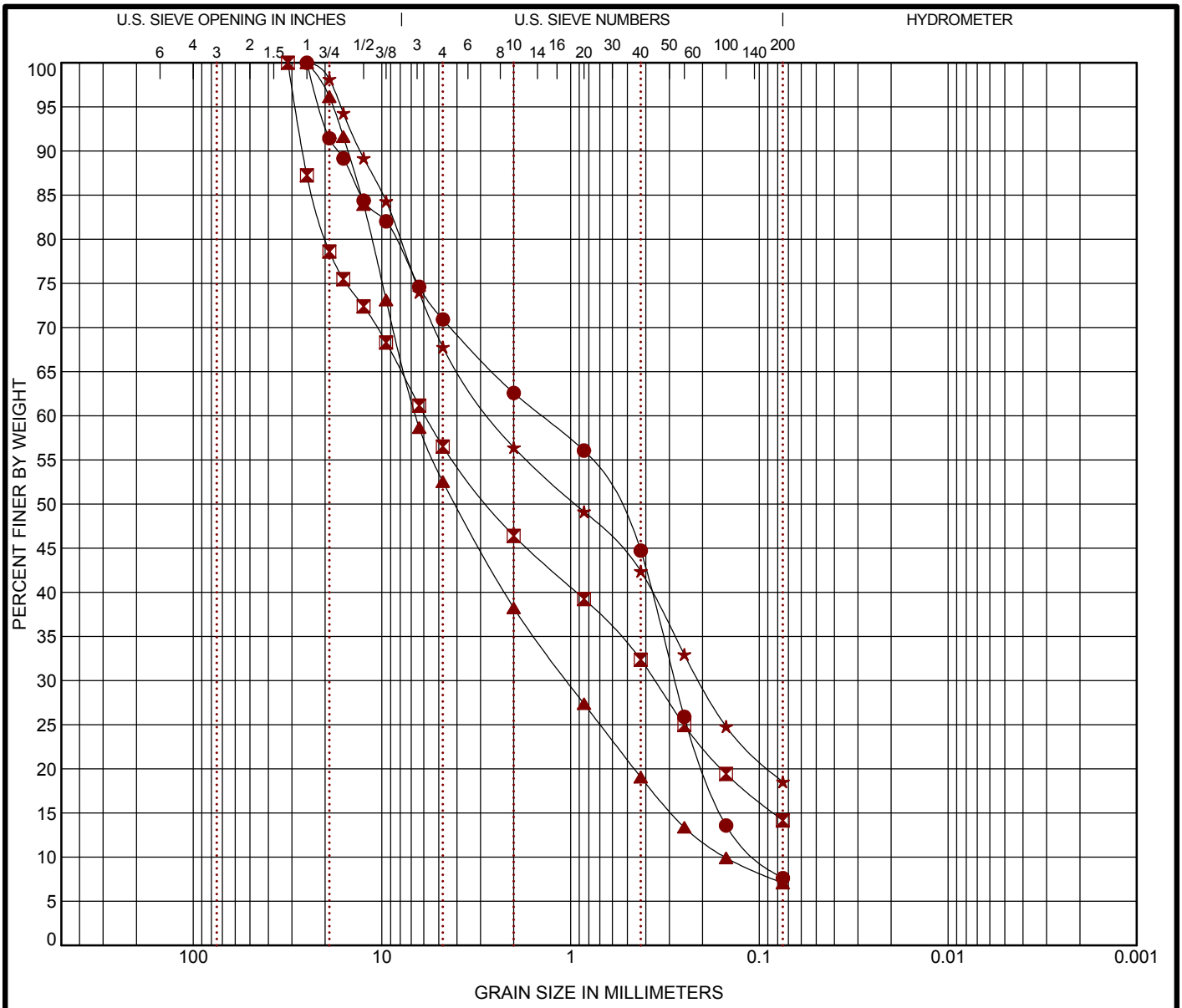
Laboratory Testing Description

Soil samples were tested in the laboratory to measure their natural water content. The test results are provided on the boring logs included in Appendix A.

Descriptive classifications of the soils indicated on the boring logs are in accordance with the enclosed General Notes and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is attached to this report. All classification was by visual manual procedures. Selected samples were further classified using the results of grain size distribution testing. Grain size distribution plots are included in this appendix. Fines content results are also provided on the boring logs.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	B-1	5 - 6.5	POORLY GRADED SAND WITH SILT AND GRAVEL SP-SM				0.56	14.41
⊠	B-2	7.5 - 9	SILTY GRAVEL WITH SAND GM					
▲	B-3	5 - 6.5	WELL GRADED GRAVEL WITH SILT AND SAND GW-GM				1.09	43.38
★	B-3	7.5 - 9	SILTY SAND WITH GRAVEL SM					

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Fines
●	B-1	5 - 6.5	25	1.425	0.281	0.099	29.1	63.3	7.6
⊠	B-2	7.5 - 9	31.5	5.907	0.359		43.5	42.4	14.1
▲	B-3	5 - 6.5	25	6.591	1.046	0.152	47.5	45.5	7.1
★	B-3	7.5 - 9	25	2.63	0.208		32.2	49.2	18.5

PROJECT: 25th Avenue NE Flood Reduction

SITE: Shoreline, Washington

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

PROJECT NUMBER: 81165045

CLIENT: Louis Berger
Seattle, Washington

EXHIBIT: B-2

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 81165045.GPJ 35159097 - ATTERBERG ISSUE.GPJ 9/2/16

August 2, 2016

Mr. Mike Noll
Terracon
21905 - 64th Ave W, Suite 100
Mountlake Terrace, WA 98043

Dear Mr. Noll,

On July 27th, 2 samples were received by our laboratory and assigned our laboratory project number EV16070152. The project was identified as your 81165045. The sample identification and requested analyses are outlined on the attached chain of custody record.

No abnormalities or nonconformances were observed during the analyses of the project samples.

Please do not hesitate to call me if you have any questions or if I can be of further assistance.

Sincerely,

ALS Laboratory Group

Rick Bagan
Laboratory Director

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	8/2/2016
		ALS JOB#:	EV16070152
		ALS SAMPLE#:	EV16070152-01
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 12:51:00 PM
CLIENT SAMPLE ID	B-2-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	50	1	UG/L	07/29/2016	PAB
TPH-Diesel Range	NWTPH-DX	U	130	1	UG/L	07/28/2016	EBS
TPH-Oil Range	NWTPH-DX	U	250	1	UG/L	07/28/2016	EBS
Dichlorodifluoromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Vinyl Chloride	EPA-8260	U	0.20	1	UG/L	07/29/2016	DLC
Bromomethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Carbon Tetrachloride	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trichlorofluoromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Carbon Disulfide	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Acetone	EPA-8260	U	25	1	UG/L	07/29/2016	DLC
1,1-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Methylene Chloride	EPA-8260	U	5.0	1	UG/L	07/29/2016	DLC
Acrylonitrile	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Methyl T-Butyl Ether	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1-Dichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Butanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2,2-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromochloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloroform	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,1-Trichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Dibromomethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromodichloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
4-Methyl-2-Pentanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Toluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,2-Trichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Hexanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
1,3-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-01
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 12:51:00 PM
CLIENT SAMPLE ID	B-2-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Tetrachloroethylene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Dibromochloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dibromoethane	EPA-8260	U	0.010	1	UG/L	07/29/2016	DLC
Chlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Ethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
m,p-Xylene	EPA-8260	U	4.0	1	UG/L	07/29/2016	DLC
Styrene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
o-Xylene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromoform	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Isopropylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,3-Trichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
N-Propyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Chlorotoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
4-Chlorotoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
T-Butyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
S-Butyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
P-Isopropyltoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,3-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,4-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
N-Butylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Hexachlorobutadiene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Naphthalene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Mercury	EPA-245.1	U	0.20	1	UG/L	07/28/2016	RAL
Arsenic	EPA-200.8	**5.3**	1.0	1	UG/L	07/28/2016	RAL
Cadmium	EPA-200.8	U	1.0	1	UG/L	07/28/2016	RAL
Chromium	EPA-200.8	U	2.0	1	UG/L	07/28/2016	RAL
Lead	EPA-200.8	U	1.0	1	UG/L	07/28/2016	RAL

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-01
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 12:51:00 PM
CLIENT SAMPLE ID	B-2-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**83.5**	07/29/2016	PAB
C25	NWTPH-DX	**92.1**	07/28/2016	EBS
1,2-Dichloroethane-d4	EPA-8260	**97.5**	07/29/2016	DLC
Toluene-d8	EPA-8260	**101**	07/29/2016	DLC
4-Bromofluorobenzene	EPA-8260	**88.9**	07/29/2016	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-02
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 1:33:00 PM
CLIENT SAMPLE ID	B-3-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	50	1	UG/L	07/29/2016	PAB
TPH-Diesel Range	NWTPH-DX	U	130	1	UG/L	07/28/2016	EBS
TPH-Oil Range	NWTPH-DX	U	250	1	UG/L	07/28/2016	EBS
Dichlorodifluoromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Vinyl Chloride	EPA-8260	U	0.20	1	UG/L	07/29/2016	DLC
Bromomethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Carbon Tetrachloride	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trichlorofluoromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Carbon Disulfide	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Acetone	EPA-8260	U	25	1	UG/L	07/29/2016	DLC
1,1-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Methylene Chloride	EPA-8260	U	5.0	1	UG/L	07/29/2016	DLC
Acrylonitrile	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Methyl T-Butyl Ether	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1-Dichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Butanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2,2-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromochloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloroform	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,1-Trichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Dibromomethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromodichloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
4-Methyl-2-Pentanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Toluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,2-Trichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Hexanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
1,3-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Tetrachloroethylene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-02
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 1:33:00 PM
CLIENT SAMPLE ID	B-3-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dibromoethane	EPA-8260	U	0.010	1	UG/L	07/29/2016	DLC
Chlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Ethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
m,p-Xylene	EPA-8260	U	4.0	1	UG/L	07/29/2016	DLC
Styrene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
o-Xylene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromoform	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Isopropylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,3-Trichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
N-Propyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Chlorotoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
4-Chlorotoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
T-Butyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
S-Butyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
P-Isopropyltoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,3-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,4-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
N-Butylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Hexachlorobutadiene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Naphthalene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Mercury	EPA-245.1	U	0.20	1	UG/L	07/28/2016	RAL
Arsenic	EPA-200.8	**1.7**	1.0	1	UG/L	07/28/2016	RAL
Cadmium	EPA-200.8	U	1.0	1	UG/L	07/28/2016	RAL
Chromium	EPA-200.8	U	2.0	1	UG/L	07/28/2016	RAL
Lead	EPA-200.8	U	1.0	1	UG/L	07/28/2016	RAL

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**83.5**	07/29/2016	PAB

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
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Exhibit C-3

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-02
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 1:33:00 PM
CLIENT SAMPLE ID	B-3-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
C25	NWTPH-DX	**100**	07/28/2016	EBS
1,2-Dichloroethane-d4	EPA-8260	**99.4**	07/29/2016	DLC
Toluene-d8	EPA-8260	**97.2**	07/29/2016	DLC
4-Bromofluorobenzene	EPA-8260	**94.0**	07/29/2016	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

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ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT: Terracon
21905 - 64th Ave W, Suite 100
Mountlake Terrace, WA 98043
CLIENT CONTACT: Mike Noll
CLIENT PROJECT: 81165045

DATE: 8/2/2016
ALS SDG#: EV16070152
WDOE ACCREDITATION: C601

LABORATORY BLANK RESULTS

MBG-072616W - Batch 106613 - Water by NWTPH-GX

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	UG/L	50	07/26/2016	PAB

U - Analyte analyzed for but not detected at level above reporting limit.

MB-072216W - Batch 106552 - Water by NWTPH-DX

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
TPH-Diesel Range	NWTPH-DX	U	UG/L	130	07/22/2016	EBS
TPH-Oil Range	NWTPH-DX	U	UG/L	250	07/22/2016	EBS

U - Analyte analyzed for but not detected at level above reporting limit.

MB-072816W2 - Batch 106694 - Water by EPA-8260

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
Dichlorodifluoromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Chloromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Vinyl Chloride	EPA-8260	U	UG/L	0.20	07/28/2016	DLC
Bromomethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Chloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Carbon Tetrachloride	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Trichlorofluoromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Carbon Disulfide	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Acetone	EPA-8260	U	UG/L	25	07/28/2016	DLC
1,1-Dichloroethene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Methylene Chloride	EPA-8260	U	UG/L	5.0	07/28/2016	DLC
Acrylonitrile	EPA-8260	U	UG/L	10	07/28/2016	DLC
Methyl T-Butyl Ether	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1-Dichloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
2-Butanone	EPA-8260	U	UG/L	10	07/28/2016	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
2,2-Dichloropropane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Bromochloromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Chloroform	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1,1-Trichloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1-Dichloropropene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2-Dichloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Benzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Trichloroethene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC

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ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT: Terracon
21905 - 64th Ave W, Suite 100
Mountlake Terrace, WA 98043

DATE: 8/2/2016
ALS SDG#: EV16070152
WDOE ACCREDITATION: C601

CLIENT CONTACT: Mike Noll
CLIENT PROJECT: 81165045

LABORATORY BLANK RESULTS

MB-072816W2 - Batch 106694 - Water by EPA-8260

1,2-Dichloropropane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Dibromomethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Bromodichloromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
4-Methyl-2-Pentanone	EPA-8260	U	UG/L	10	07/28/2016	DLC
Toluene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1,2-Trichloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
2-Hexanone	EPA-8260	U	UG/L	10	07/28/2016	DLC
1,3-Dichloropropane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Tetrachloroethylene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Dibromochloromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2-Dibromoethane	EPA-8260	U	UG/L	0.010	07/28/2016	DLC
Chlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Ethylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
m,p-Xylene	EPA-8260	U	UG/L	4.0	07/28/2016	DLC
Styrene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
o-Xylene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Bromoform	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Isopropylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2,3-Trichloropropane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Bromobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
N-Propyl Benzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
2-Chlorotoluene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
4-Chlorotoluene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
T-Butyl Benzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
S-Butyl Benzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
P-Isopropyltoluene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,3-Dichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,4-Dichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
N-Butylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2-Dichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	UG/L	10	07/28/2016	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Hexachlorobutadiene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Naphthalene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC

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ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	8/2/2016
		ALS SDG#:	EV16070152
		WDOE ACCREDITATION:	C601
CLIENT CONTACT:	Mike Noll		
CLIENT PROJECT:	81165045		

LABORATORY BLANK RESULTS

MB-072816W2 - Batch 106694 - Water by EPA-8260

U - Analyte analyzed for but not detected at level above reporting limit.

MBLK-279076 - Batch R279076 - Water by EPA-245.1

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
Mercury	EPA-245.1	U	UG/L	0.20	07/28/2016	RAL

U - Analyte analyzed for but not detected at level above reporting limit.

MB-072816W - Batch 106635 - Water by EPA-200.8

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
Arsenic	EPA-200.8	U	UG/L	1.0	07/28/2016	RAL
Cadmium	EPA-200.8	U	UG/L	1.0	07/28/2016	RAL
Chromium	EPA-200.8	U	UG/L	2.0	07/28/2016	RAL
Lead	EPA-200.8	U	UG/L	1.0	07/28/2016	RAL

U - Analyte analyzed for but not detected at level above reporting limit.

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT: Terracon
21905 - 64th Ave W, Suite 100
Mountlake Terrace, WA 98043
CLIENT CONTACT: Mike Noll
CLIENT PROJECT: 81165045

DATE: 8/2/2016
ALS SDG#: EV16070152
WDOE ACCREDITATION: C601

LABORATORY CONTROL SAMPLE RESULTS

ALS Test Batch ID: 106613 - Water by NWTPH-GX

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range - BS	NWTPH-GX	**87.6**			66.5	122.7	07/26/2016	PAB
TPH-Volatile Range - BSD	NWTPH-GX	**89.8**	**2**		66.5	122.7	07/26/2016	PAB

ALS Test Batch ID: 106552 - Water by NWTPH-DX

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
TPH-Diesel Range - BS	NWTPH-DX	**87.4**			67	125.2	07/25/2016	EBS
TPH-Diesel Range - BSD	NWTPH-DX	**92.5**	**6**		67	125.2	07/25/2016	EBS

ALS Test Batch ID: 106694 - Water by EPA-8260

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
1,1-Dichloroethene - BS	EPA-8260	**107**			72.5	136	07/28/2016	DLC
1,1-Dichloroethene - BSD	EPA-8260	**118**	**10**		72.5	136	07/28/2016	DLC
Benzene - BS	EPA-8260	**102**			74.7	143	07/28/2016	DLC
Benzene - BSD	EPA-8260	**118**	**15**		74.7	143	07/28/2016	DLC
Trichloroethene - BS	EPA-8260	**103**			74.4	141	07/28/2016	DLC
Trichloroethene - BSD	EPA-8260	**119**	**14**		74.4	141	07/28/2016	DLC
Toluene - BS	EPA-8260	**90.1**			71.7	139	07/28/2016	DLC
Toluene - BSD	EPA-8260	**102**	**13**		71.7	139	07/28/2016	DLC
Chlorobenzene - BS	EPA-8260	**93.6**			73	131	07/28/2016	DLC
Chlorobenzene - BSD	EPA-8260	**108**	**14**		73	131	07/28/2016	DLC

ALS Test Batch ID: R279076 - Water by EPA-245.1

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
Mercury - BS	EPA-245.1	**100**			80.6	118	07/28/2016	RAL
Mercury - BSD	EPA-245.1	**106**	**6**		80.6	118	07/28/2016	RAL

ALS Test Batch ID: 106635 - Water by EPA-200.8

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
Arsenic - BS	EPA-200.8	**93.5**			89.1	110	07/28/2016	RAL
Arsenic - BSD	EPA-200.8	**94.5**	**1**		89.1	110	07/28/2016	RAL
Cadmium - BS	EPA-200.8	**95.9**			89.4	109	07/28/2016	RAL
Cadmium - BSD	EPA-200.8	**98.4**	**3**		89.4	109	07/28/2016	RAL
Chromium - BS	EPA-200.8	**95.8**			86.2	107	07/28/2016	RAL
Chromium - BSD	EPA-200.8	**97.4**	**2**		86.2	107	07/28/2016	RAL
Lead - BS	EPA-200.8	**96.9**			87.5	107	07/28/2016	RAL

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Exhibit C-3

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	8/2/2016
		ALS SDG#:	EV16070152
		WDOE ACCREDITATION:	C601
CLIENT CONTACT:	Mike Noll		
CLIENT PROJECT:	81165045		

LABORATORY CONTROL SAMPLE RESULTS

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
Lead - BSD	EPA-200.8	**97.8**	**1**		87.5	107	07/28/2016	RAL

APPROVED BY

Laboratory Director

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental
8620 Holly Drive, Suite 100
Everett, WA 98208
Phone (425) 356-2600
Fax (425) 356-2626
http://www.alsglobal.com

Chain Of Custody/ Laboratory Analysis Request

ALS Job# (Laboratory Use Only): EV1607015 2

Date 7/27/16 Page 1 Of 1

PROJECT ID: ~~811550 45~~ 81165045
REPORT TO COMPANY: Terracon
PROJECT MANAGER: Mike Noll
ADDRESS: 21905 64th Ave W Ste 100
Mountlake Terrace, WA 98043
PHONE: 425-771-3304 FAX:
P.O. #: E-MAIL: mdnoll@terracon.com
INVOICE TO COMPANY:
ATTENTION: Same
ADDRESS:

SAMPLE I.D.	DATE	TIME	TYPE	LAB#
1. B-2-W	7/27/16	12:51	GW	1
2. B-3-W	7/27/16	13:33	GW	2
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

ANALYSIS REQUESTED

NWTPH-HCID	NWTPH-DX	NWTPH-GX	BTEX by EPA 8021 ☐ BTEX by EPA 8260 ☐	MTBE by EPA 8021 ☐ MTBE by EPA 8260 ☐	Halogenated Volatiles by EPA 8260	Volatile Organic Compounds by EPA 8260	EDB / EDC by EPA 8260 SIM (water)	EDB / EDC by EPA 8260 (soil)	Semivolatile Organic Compounds by EPA 8270	Polycyclic Aromatic Hydrocarbons (PAH) by EPA 8270 SIM	PCB by EPA 8082 ☐ Pesticides by EPA 8081 ☐	Metals-MTCA-5 ☒ RCRA-8 ☐ Pri Pol ☐ TAL ☐	Metals Other (Specify)	TCLP-Metals ☐ VOA ☐ Semi-Vol ☐ Pest ☐ Herbs ☐
	X	X				X						X		
	X	X				X						X		

OTHER (Specify): Total metals SKL

NUMBER OF CONTAINERS	RECEIVED IN GOOD CONDITION?
7	
7	

SPECIAL INSTRUCTIONS

SIGNATURES (Name, Company, Date, Time):
1. Relinquished By: Terracon 7/27/16 2:50pm
Received By: ALS 7/27/16 250
2. Relinquished By:
Received By:

TURNAROUND REQUESTED in Business Days*
Organic, Metals & Inorganic Analysis: 10 Standard | 5 | 3 | 2 | 1 | SAME DAY
Fuels & Hydrocarbon Analysis: 5 Standard | 3 | 1 | SAME DAY
OTHER: Specify: Per personnel account

Exhibit C-3

*Turnaround request less than standard may incur Rush Charges

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Standard Penetration Test

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

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Exhibit: C-1

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

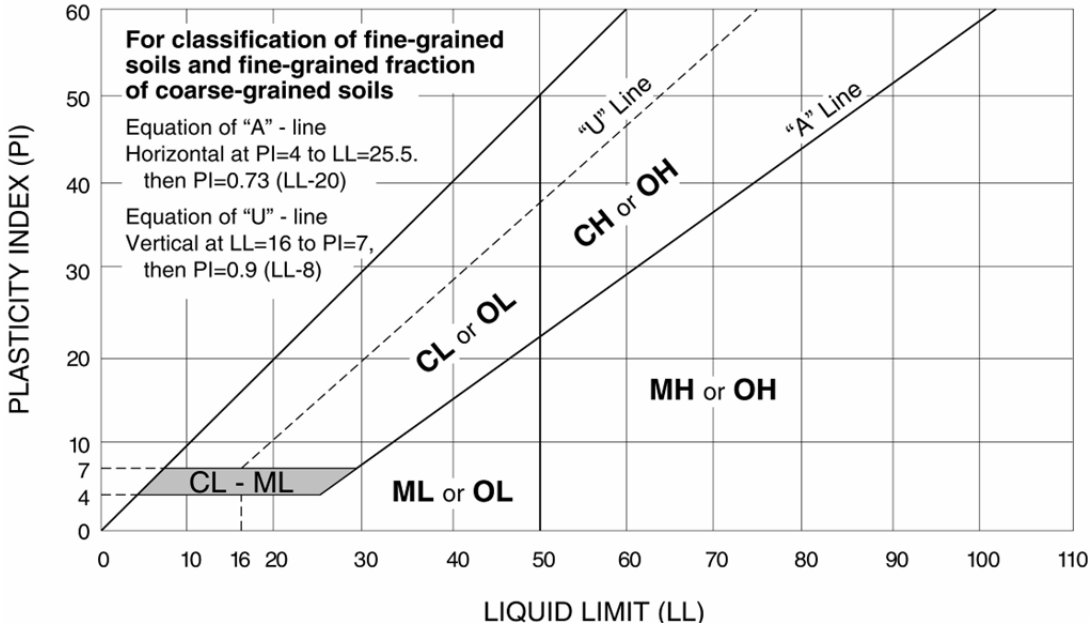
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Exhibit C-2

APPENDIX D
SLUG TESTING

Slug Test Description

Terracon performed field slug tests in two monitoring wells (B-2 and B-3) in order to calculate the estimated hydraulic conductivity of the aquifer. Each slug test was performed in general accordance with applicable guidelines (USGS, 2010). Before slug testing commenced, an Instrumentation Northwest P2X transducer was suspended approximately 1 foot from the bottom of the well. A 5-foot long slug fabricated from 1-inch nominal diameter schedule 40 PVC pipe was then quickly submerged in the well until reaching near-steady state conditions (i.e. slug-in or falling-head test). Upon reaching near-steady state conditions, the slug was quickly elevated above the water column and removed from the well (i.e. slug-out or rising-head test). The water level recovery was recorded using the pressure transducer and was monitored until sufficient recovery had been observed (approximately 95%). Typically, three slug-out tests were performed at each well. Slug test data was downloaded from the pressure transducers and saved to a handheld Model Demand field computer.

Raw data was extracted from the transducers using Aqua4Plus software. Prior to conducting analysis, slug test data was processed to yield displacement (feet) and elapsed time (second) for each test. This was calculated from the difference of the pre-test water level from the maximum (or minimum) water elevation and by verifying the accuracy of the timestamp prior to commencing the tests.

Aquifer parameters and well construction details were obtained based on information from the boring well development logs. Among the required input parameters is an estimate of the depth to the next confining unit. According to regional geologic information and boring log HWA-MW-7 advanced at the adjacent Shoreline North Maintenance Facility for the Brightwater Outfall, the confining was estimated to be approximately 237 feet below ground surface (bgs) throughout the project area.

Hydraulic conductivity was subsequently estimated using Aqtesolv Pro software and the Bouwer and Rice solution (Bouwer, H. and R.C. Rice, 1976). This method is widely used and suitable for wells screened in unconfined aquifers that partially or fully penetrate the aquifer. It can also be used if the well screen is only partially submerged.

A summary of hydraulic conductivity (K) values obtained from the slug tests is presented on Table D-1 and the Aqtesolv Slug Test Summary Sheets are provided in this appendix.

References:

United States Geological Survey (USGS), 2010, *GWPD 17—Conducting an Instantaneous Change in Head (Slug) Test with a Mechanical Slug and Submersible Pressure Transducer*.

Bouwer, Herman, and Rice, R.C., 1976, *A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells*: Water Resources Research, v. 12, no. 3, p. 423–428.

Hydraulic Conductivity Summary

									Aqtesolv Input								Aqtesolv Output	
Well ID	Date Slug Test Completed	Type (Falling Head or Rising Head)	DTB (ft bgs)	Static DTW (ft bgs)	Well Casing Diameter (inches)	Borehole Diameter (inches)	Depth to Bottom Confining Layer (ft bgs)	Lithology in screened interval	Initial Displacement H_0(ft)	Static Water Column Height H (ft)	Sat Thickness Aquifer b (ft)	Depth to top of well screen d (ft)	Length of Screen (ft)	Casing Radius r(c) (ft)	Downhole Equip. Radius (ft)	Well Radius (including filter pack) (ft)	K (ft/d)	Arith. Mean K (ft/d)
B2	7/25/2016	FH	19.5	1.97	2	8	237	Silty Gravel / Silty Sand	1.50	17.53	235.03	7.53	10	0.083	0.010	0.333	17.91	18.69
	7/25/2016	RH							1.47								18.22	
	7/25/2016	FH							1.09								10.75	
	7/25/2016	RH							1.44								26.37	
	7/25/2016	FH							1.39								12.73	
	7/25/2016	RH							1.47								26.15	
B3	7/25/2016	FH	18.75	2.85	2	8	237	Silty Gravel / Silty Sand	1.38	15.90	234.15	5.90	10	0.083	0.010	0.333	12.58	12.94
	7/25/2016	RH							1.63								13.76	
	7/25/2016	FH							1.99								12.87	
	7/25/2016	RH							1.64								12.03	
	7/25/2016	FH							1.72								11.54	
	7/25/2016	RH							1.59								14.83	

Notes:

DTB - Depth to bottom

DTW - Depth to water

K - hydraulic conductivity

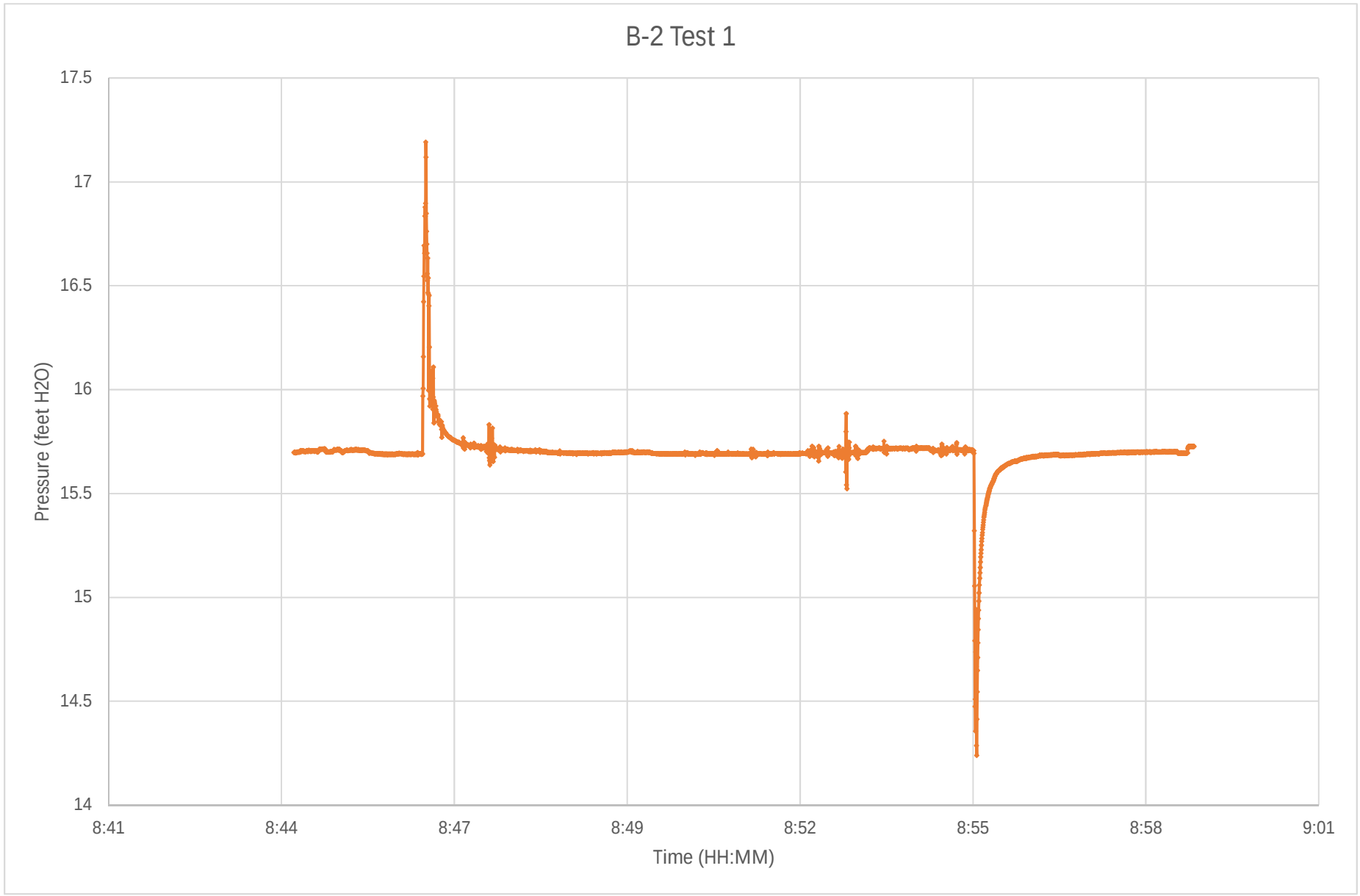
Isotropic conditions were assumed in all directions (Kv/Kh = 1).

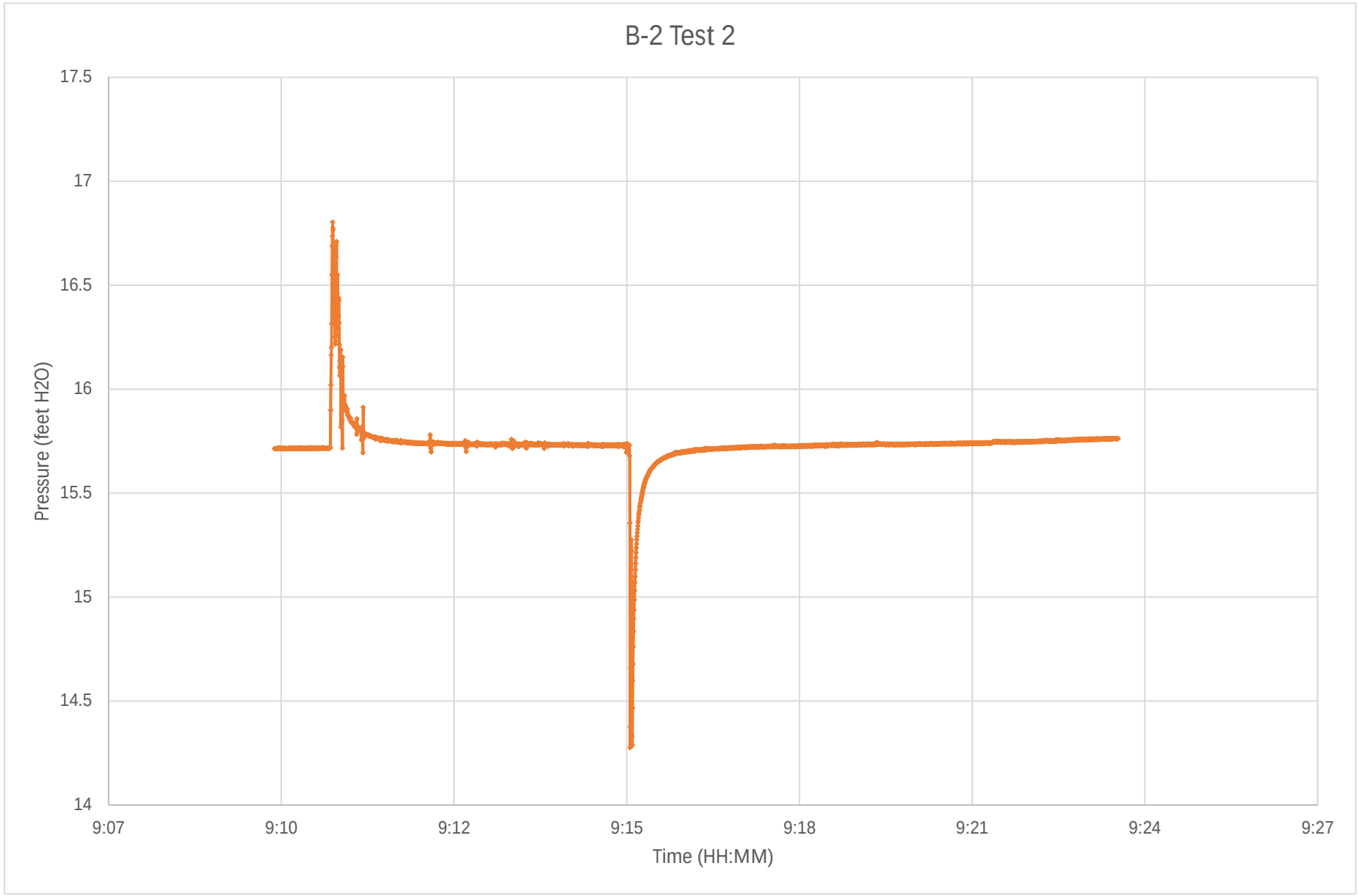
No well/borehole skin was assumed. Wells were assumed properly developed.

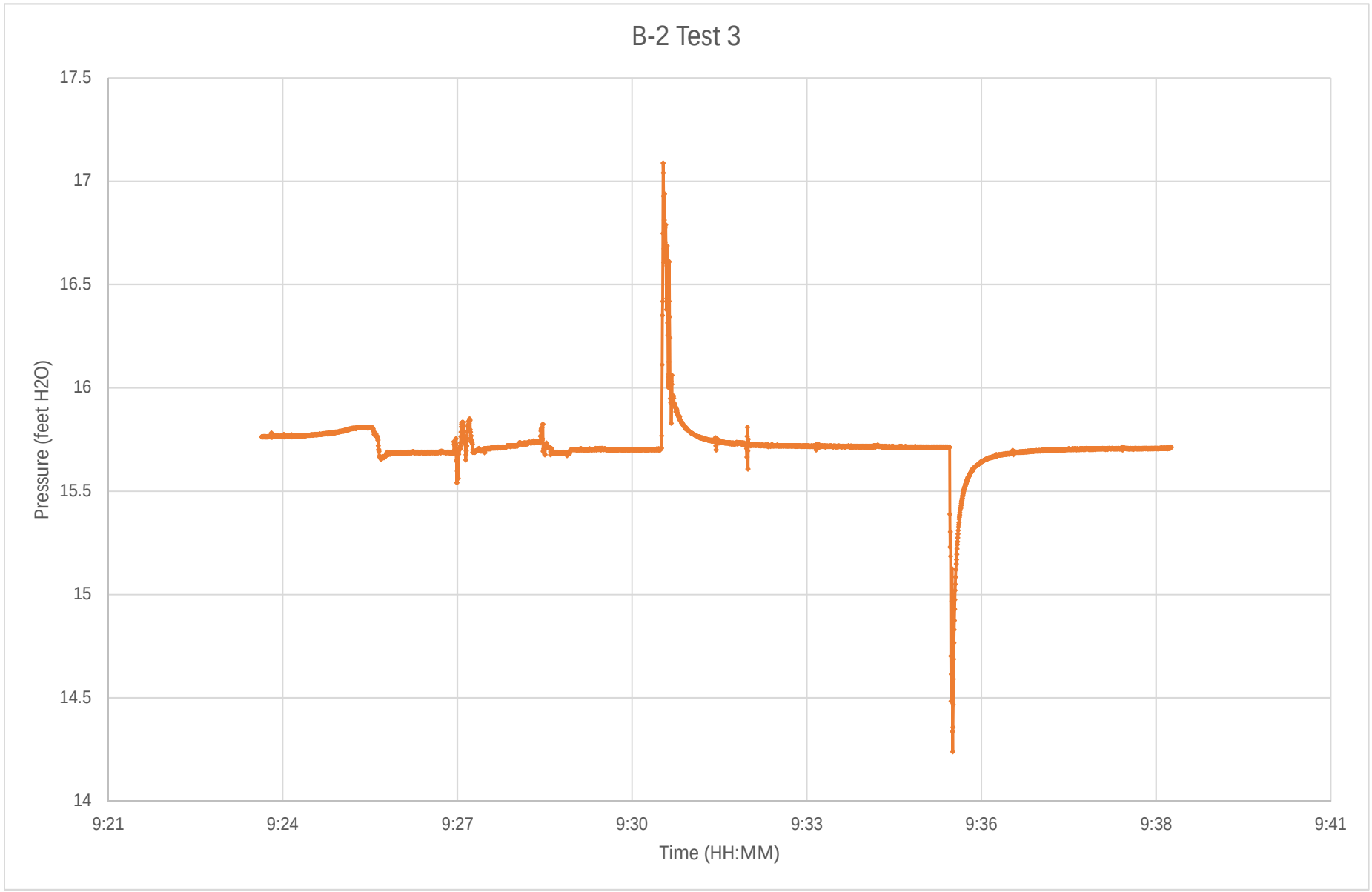
All three wells have fully submerged well screens (no correction necessary).

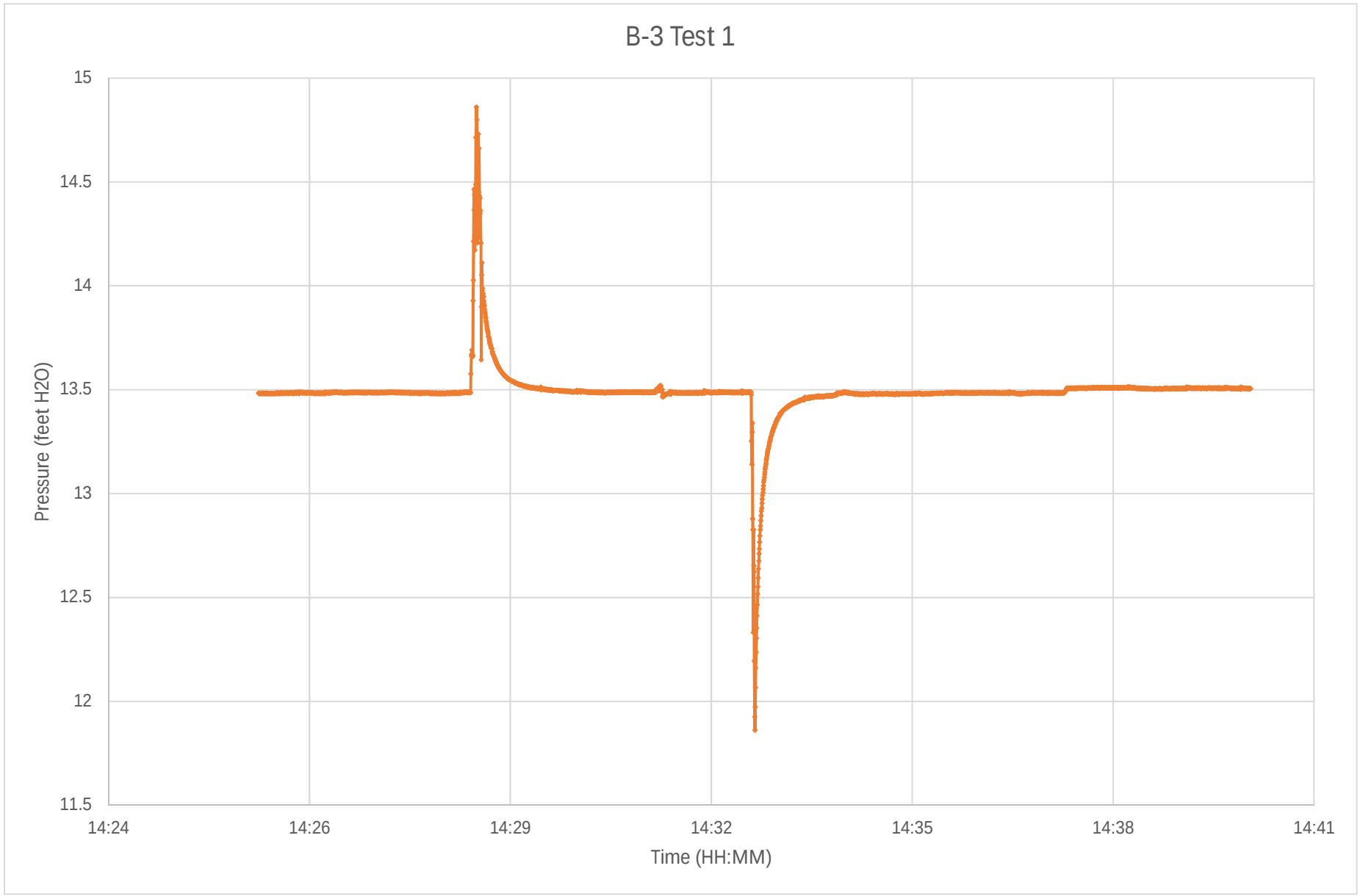
Depth to bottom confining unit based on boring log for MW-4 (fat clay at 237 ft). At MW-3, clay is at 202 ft, at MW-5 at 196 ft.

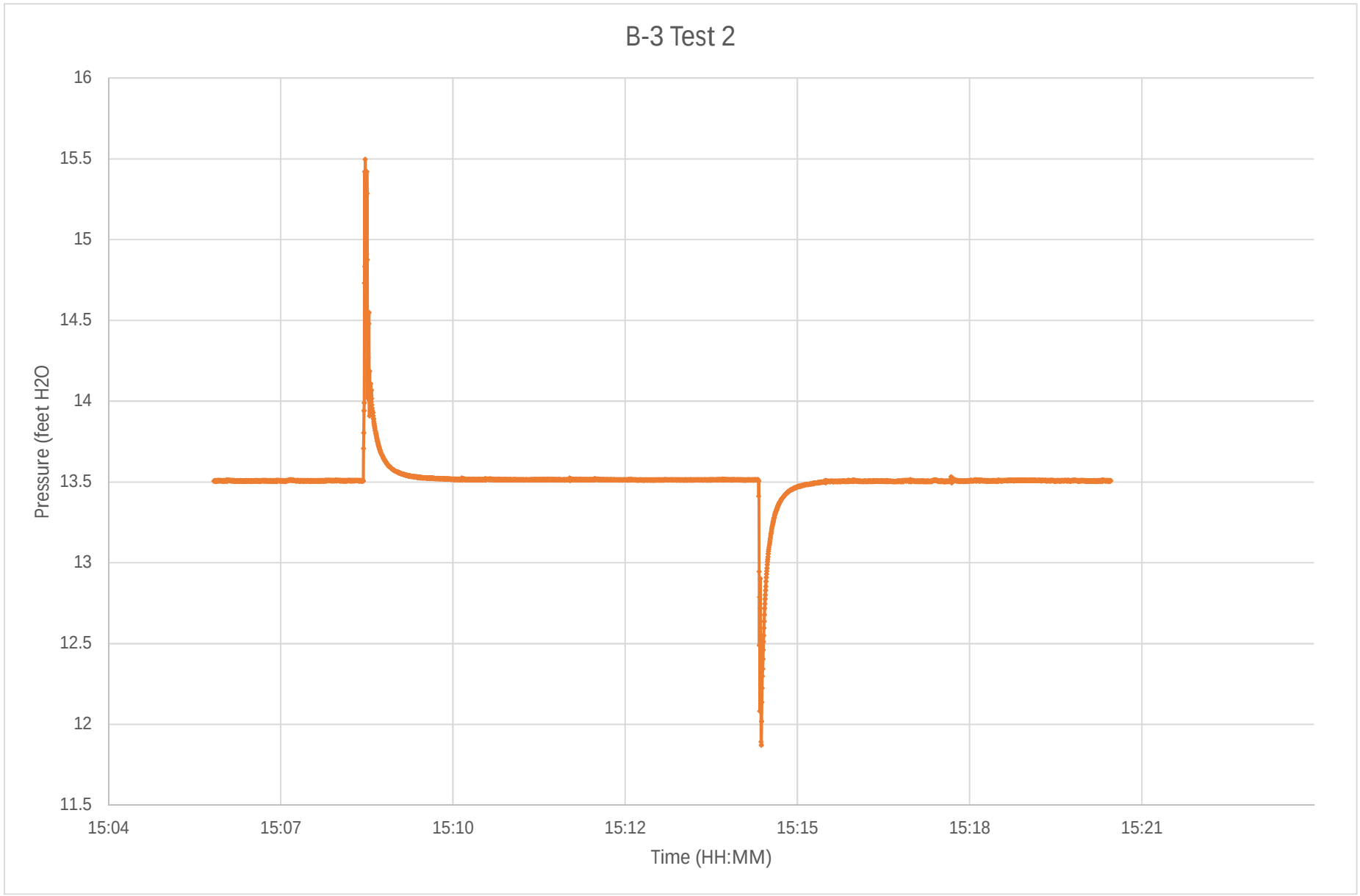
Maximum calculated displacement assuming a 5 foot long 1-inch nominal diameter Schedule 40 PVC (1.315-inch OD) slug and a 2-inch ID PVC well casing is 2.16 feet.

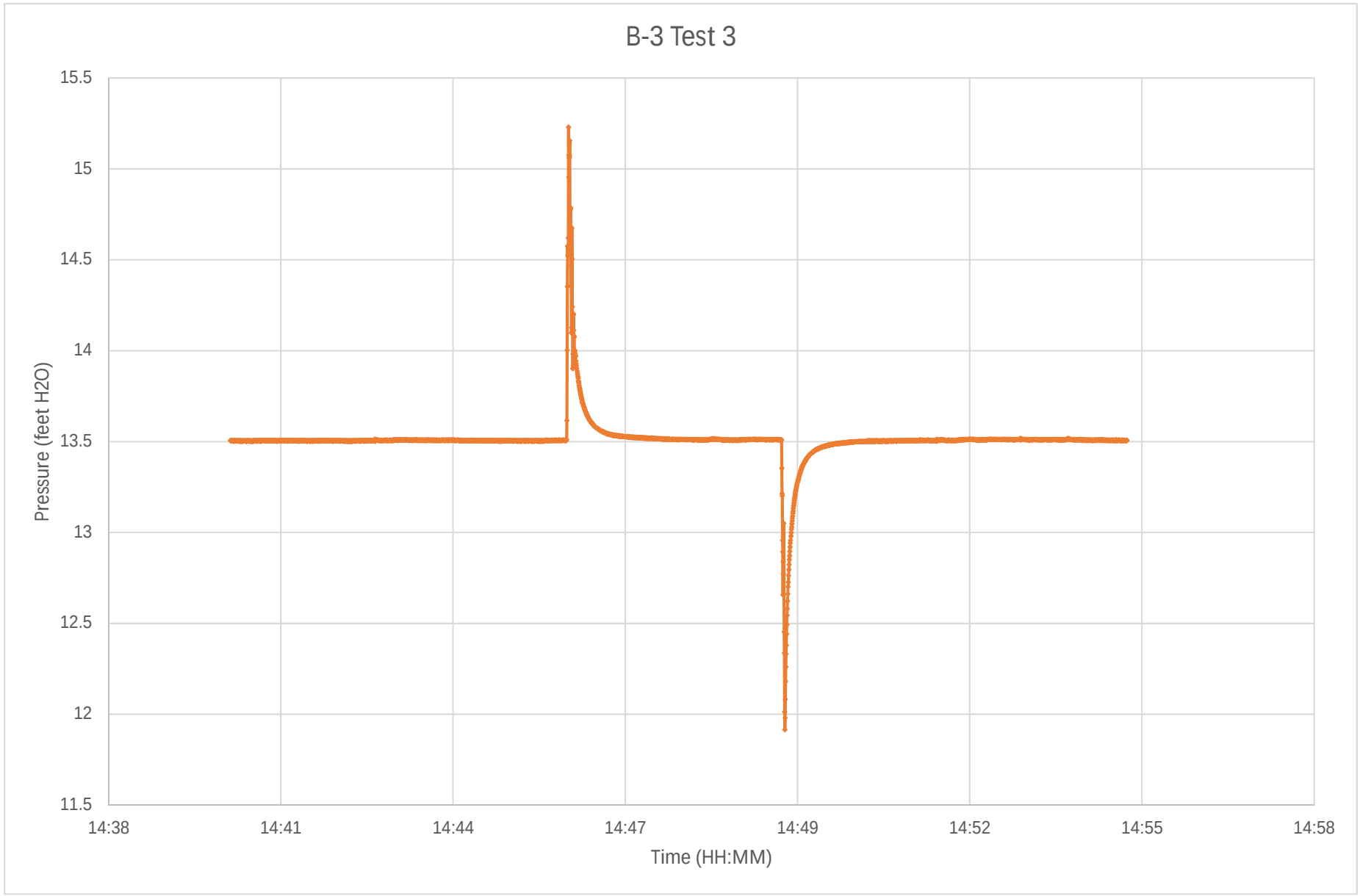

B-2 Test 1
17.5
17
16.5
16
15.5
15
14.5
14
Pressure (feet H2O)
8:41
8:44
8:47
8:49
8:52
8:55
8:58
9:01
Time (HH:MM)


B-2 Test 2
17.5
17
16.5
16
15.5
15
14.5
14
Pressure (feet H2O)
9:07
9:10
9:12
9:15
9:18
9:21
9:24
9:27
Time (HH:MM)


B-2 Test 3
17.5
17
16.5
16
15.5
15
14.5
14
Pressure (feet H2O)
9:21
9:24
9:27
9:30
9:33
9:36
9:38
9:41
Time (HH:MM)


B-3 Test 1
15
14.5
14
13.5
13
12.5
12
11.5
Pressure (feet H2O)
14:24
14:26
14:29
14:32
14:35
14:38
14:41
Time (HH:MM)


B-3 Test 2
16
15.5
15
14.5
14
13.5
13
12.5
12
11.5
Pressure (feet H2O
15:04
15:07
15:10
15:12
15:15
15:18
15:21
Time (HH:MM)


B-3 Test 3
15.5
15
14.5
14
13.5
13
12.5
12
11.5
Pressure (feet H2O)
14:38
14:41
14:44
14:47
14:49
14:52
14:55
14:58
Time (HH:MM)

APPENDIX E
BORINGS BY OTHERS

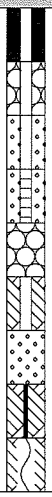
Washington State
Department of Transportation

Boring and Test Pit Legend

Sampler Symbols

Standard Penetration Test
Non-Standard Sized Penetration Test
Shelby Tube
Piston Sample
Washington Undisturbed
Vane Shear Test
Core
Becker Hammer
Bag Sample

Well Symbols



Cement Surface Seal
Piezometer Pipe in Granular Bentonite Seal
Piezometer Pipe in Sand
Well Screen in Sand
Granular Bentonite Seal
Inclinometer Casing or PVC Pipe in Cement Bentonite Grout
Sand
Vibe Wire in Grout
Miscellaneous, noted on boring log

Laboratory Testing Codes

AL	Atterberg Limits
CD	Consolidated Drained Triaxial
CN	Consolidation Test
CSS	Cyclic Simple Shear
CU	Consolidated Undrained Triaxial
DG	Degradation
DN	Density
DS	Direct Shear Test
DSS	Direct Simple Shear
GS	Grain Size Distribution
HT	Hydrometer Test
LA	LA Abrasion
LOI	Loss on Ignition
MC	Moisture Content
PT	Point Load Compressive Test
RM	Resilient Modulus
RS	Ring Shear Test
SG	Specific Gravity
SL	Slake Test
UC	Unconfined Compression Test
UU	Unconsolidated Undrained Triaxial

Soil Density Modifiers

Gravel, Sand & Non-plastic Silt		Elastic Silts and Clay	
SPT Blows/ft	Density	SPT Blows/ft	Consistency
0-4	Very Loose	0-1	Very Soft
5-10	Loose	2-4	Soft
11-24	Medium Dense	5-8	Medium Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
(REF)	Refusal	31-60	Hard
		>60	Very Hard

Angularity of Gravel & Cobbles

Angular	Coarse particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Coarse grained particles are similar to angular but have rounded edges.
Subrounded	Coarse grained particles have nearly plane sides but have well rounded corners and edges.
Rounded	Coarse grained particles have smoothly curved sides and no edges.

Soil Moisture Modifiers

Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

Soil Structure

Stratified	Alternating layers of varying material or color at least 6mm thick; note thickness and inclination.
Laminated	Alternating layers of varying material or color less than 6mm thick; note thickness and inclination.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown.
Disrupted	Soil structure is broken and mixed. Infers that material has moved substantially - landslide debris.
Homogeneous	Same color and appearance throughout.

HCl Reaction

No HCl Reaction	No visible reaction.
Weak HCl Reaction	Some reaction with bubbles forming slowly.
Strong HCl Reaction	Violent reaction with bubbles forming immediately.

Degree of Vesicularity of Pyroclastic Rocks

Slightly Vesicular	5 to 10 percent of total
Moderately Vesicular	10 to 25 percent of total
Highly Vesicular	25 to 50 percent of total
Scoriaceous	Greater than 50 percent of total

Washington State
Department of Transportation

Boring and Test Pit Legend

Grain Size

Fine Grained	< 0.04 in	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	0.04 to 0.2 in	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	> 0.2 in	Most crystal boundaries/grains are distinguishable with the naked eye.

Weathered State

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as core stones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as discontinuous framework or as core stone.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Relative Rock Strength

Grade	Description	Field Identification	Uniaxial Compressive Strength approx
R1	Very Weak	Specimen crumbles under sharp blow from point of geological hammer, and can be cut with a pocket knife.	0.15 to 3.6 ksi
R2	Moderately Weak	Shallow cuts or scrapes can be made in a specimen with a pocket knife. Geological hammer point indents deeply with firm blow.	3.6 to 7.3 ksi
R3	Moderately Strong	Specimen cannot be scraped or cut with a pocket knife, shallow indentation can be made under firm blows from a hammer.	7.3 to 15 ksi
R4	Strong	Specimen breaks with one firm blow from the hammer end of a geological hammer.	15 to 29 ksi
R5	Very Strong	Specimen requires many blows of a geological hammer to break intact sample.	Greater than 29 ksi

Discontinuities

Spacing	
Very Widely	Greater than 10 ft
Widely	3 ft to 10 ft
Moderately	1 ft to 3 ft
Closely	2 inches to 12 inches
Very Closely	Less than 2 inches

RQD (%)

$$\frac{100(\text{length of core in pieces} > 100\text{mm})}{\text{Length of core run}}$$

Condition	
Excellent	Very rough surfaces, no separation, hard discontinuity wall
Good	Slightly rough surfaces, separation less than 0.05 in, hard discontinuity wall.
Fair	Slightly rough surfaces, separation greater than 0.05 in, soft discontinuity wall.
Poor	Slickensided surfaces, or soft gouge less than 0.2 in thick, or open discontinuities 0.05 to 0.2 in.
Very Poor	Soft gouge greater than 0.2 in thick, or open discontinuities greater than 0.2 in.

Fracture Frequency (FF) is the average number of fractures per 1 ft of core. This does not include mechanical breaks caused by drilling or handling.

Datum:
NAD 83/91 HARN = North American Datum of 1983/1991 High Accuracy Reference Network
NAVD88 = North American Vertical Datum of 1988
SPN (ft) = State Plane North (ft)
SPS (ft) = State Plane South (ft)

Exhibit E-1

Washington State Department of Transportation

LOG OF TEST BORING

Start Card SE-57728 / AE-36443

Job No. DMA-177 SR 104 Elevation 215.4 ft

HOLE No. H-1-16

Sheet 1 of 3

Project SR104 Gabion Rock Wall Emergency Repair

Driller Fetterly, Jamie Lic# 2507

Component

Inspector Harvey, Thomas #2599

Start March 14, 2016 Completion March 14, 2016 Well ID#

Equipment CME 55 (9C7-1)

Station A-Line 10+38.86 Offset 4.1 feet right Hole Dia (inches) 4

Historical SPT Efficiency 87.3%

Northing 284337.206 Easting 1279195.088 Collected by

Method Mud Rotary

Lat 47.7700478 Long -122.3023422 Datum NAD 83/91 HARN, NAVD88, SPN (ft)

Drill Fluid Bentonite

SPT Efficiency
Field SPT (N)
Moisture Content
RQD
20 40 60 80

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	215.0							
		8 9 11 (20)		D-1		Well graded GRAVEL, sub-rounded, medium dense, gray, wet, homogeneous. HCl not tested. Recovered: 0.2 ft Retained: 0.2 ft		
						ESU 1		
5						ESU 2	03-14-2016	
	210.0	2 1 2 (3)		D-2		No Recovery. HCl not tested.		
		1 0 1 (1)		D-3		Silty SAND with gravel with organic, sub-rounded, very loose, brown, wet, homogeneous, laminated. HCl not tested. Recovered: 0.4 ft Retained: 0.4 ft		
10	205.0	1 1 2 (3)		D-4		Silty SAND with gravel with organic, sub-rounded, very loose, dark brown, wet, homogeneous. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft		
						ESU 2		
		6 12 11 (23)		D-5		ESU 3 SILT with sand withwell grade sand /gravel/organic, medium dense, gray, wet, stratified. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
15	200.0							
		9 15 16 (31)		D-6		Poorly graded SAND trace gravel, dense, gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
		7 14 21 (35)		D-7		Silty SAND trace silt, dense, gray, wet, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
20								

ENTERPRISE BORING LOG DMA-177 104 GABION WALL FAILURE.GPJ ENTERPRISE DATA TEMPLATE.GDT 4/5/16

Exhibit E-2

Washington State Department of Transportation

LOG OF TEST BORING

Job No. DMA-177 SR 104 Elevation 215.4 ft HOLE No. H-1-16

Sheet 2 of 3

Project SR104 Gabion Rock Wall Emergency Repair Driller Fetterly, Jamie

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	195									
				15 16 18 (34)		D-8		SILT with sand, dense, gray, moist, stratified, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
25	190									
				11 12 12 (24)		D-9		SILT with sand, medium dense, gray, wet, stratified, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
30	185									
				7 9 12 (21)		D-10		Sandy SILT trace gravel, medium dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
35	180									
				6 11 13 (24)		D-11		Sandy SILT, medium dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
40	175									
				7 12 15 (27)		D-12		Sandy SILT with gravel, sub-rounded, dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
45										

ENTERPRISE BORING LOG DMA-177 104 GABION WALL FAILURE.GPJ ENTERPRISE DATA TEMPLATE.GDT 4/5/16

Exhibit E-2

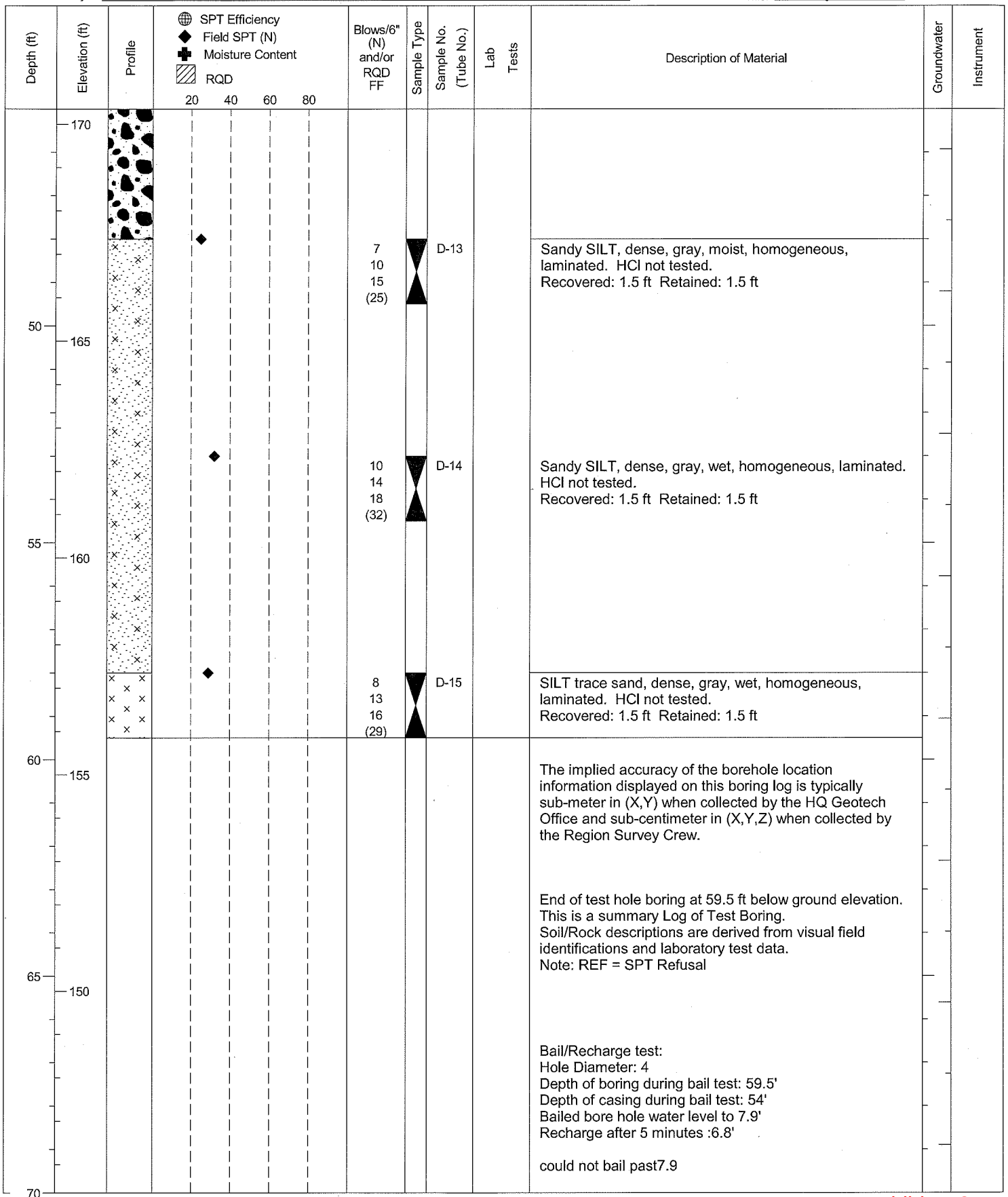
Washington State
Department of Transportation

LOG OF TEST BORING

Job No. DMA-177 SR 104 Elevation 215.4 ft HOLE No. H-1-16

Sheet 3 of 3

Project SR104 Gabion Rock Wall Emergency Repair Driller Fetterly, Jamie



ENTERPRISE BORING LOG DMA-177 104 GABION WALL FAILURE.GPJ ENTERPRISE DATA TEMPLATE.GDT 4/5/16

Exhibit E-2

Project: CSI Brightwater Project Location: King and Snohomish Counties Contract Number: E83004E	**Log of Boring MW- 7** Sheet 1 of 5

Date(s) Drilled	12/10/01 - 12/12/01	Geotechnical Consultant	HWA GeoSciences Inc.	Logged By	BKH	Checked By	MLR/SEG
Drilling Method/ Rig Type	Becker Hammer/ Truck	Drilling Contractor	Layne Christensen Company	Total Depth of Borehole	266.5 feet		
Drill Bit Size/Type	Dual Wall Reverse Circ.	Hammer Weight/Drop (lbs/in.)	300#, 30"	Ground Surface Elevation/Datum	213 feet / NAVD88		
Location	Bruger Bog K.C. Public Works Facility	Coordinates	N. 47.77175 W. 122.30361	Elevation Source	Plan		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Blows / 6 in. (N)	Recovery, %	Graphic Log	USCS	MATERIAL DESCRIPTION	Piezometer Schematic	Lab Tests	Moisture Content, %	REMARKS AND OTHER TESTS
213	0						SP-SM	*Medium dense*, olive gray, slightly silty, gravelly, fine to coarse SAND, wet.				3/28/2002 0.4 ft 2/8/2002 0.93 ft
								(ALLUVIUM, Qal)				
210	5											VWP-17.9 feet Artesian Head, 3/28/2002
	10		S-1	6 - 8 - 5 (13)	100			Abundant wood pieces present in cuttings.		M	16.5	
200	15						SP	Dense, grayish brown, fine gravelly, fine to coarse SAND, wet.				
	20		S-2	6 - 20 - 39 (59)	100			(GLACIAL FLUVIAL, Qva)		M SA	12.2	
190	25						ML	Hard, gray, slightly fine sandy, SILT, moist.				
	30		S-3	14 - 37 - 35 (72)	100			(GLACIOLACUSTRINE, Qvgl)		M SA	22.4	
180	35											
	40		S-4	4 - 5 - 7 (12)	100			At 39 feet, silt becomes stiff and interbedded thin, fine sand seams are present.		M SA HA	28.3	
170	45											
	50			3 - 7 - 10						M	29.9	

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HWA GeoSciences Inc.

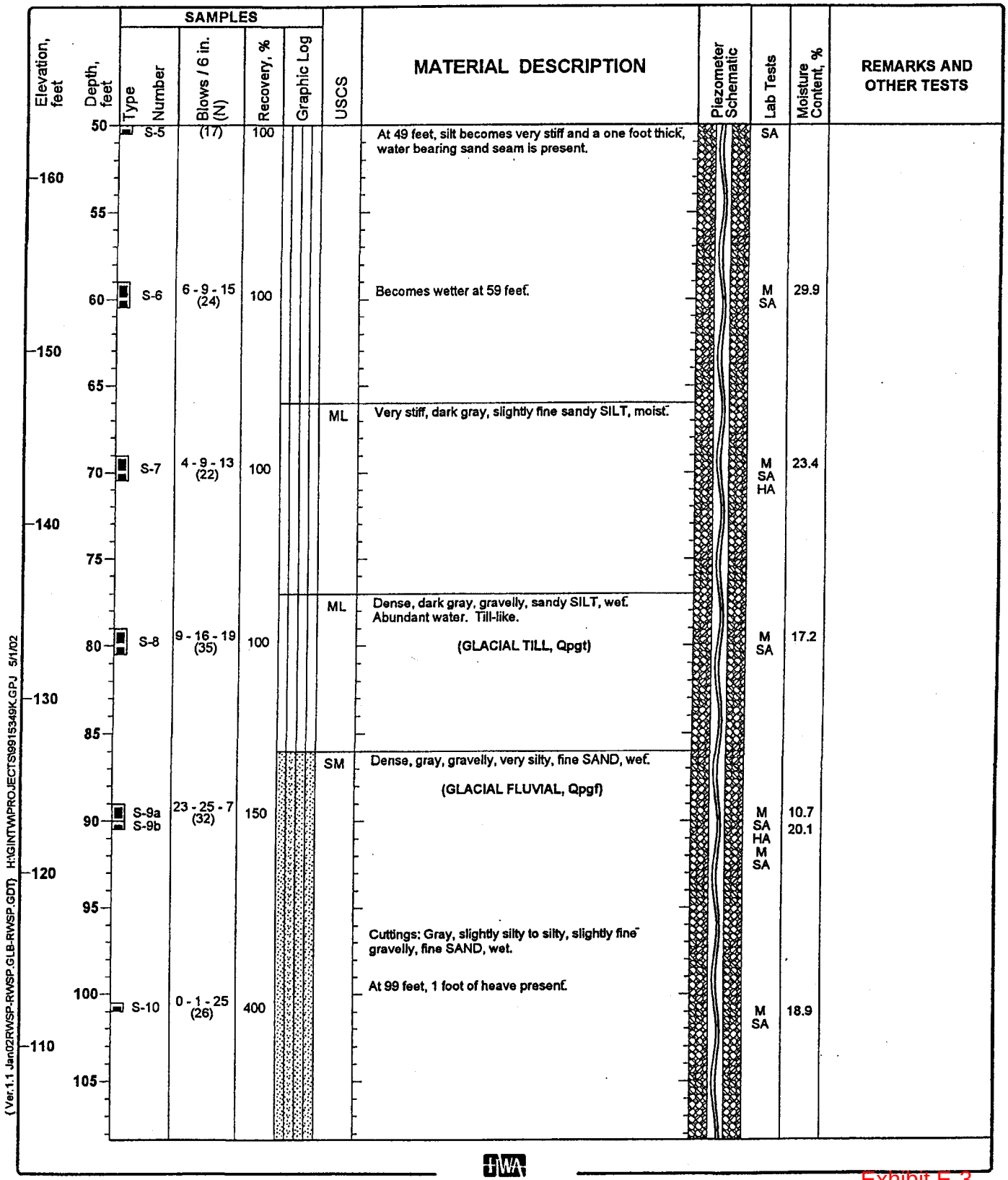
Exhibit E-3

Figure: A-8.1

Project: CSI Brightwater
Project Location: King and Snohomish Counties
Contract Number: E83004E

Log of Boring MW- 7

Sheet 2 of 5



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HWA GEOSCIENCES INC.

Exhibit E-3

Figure: A-8.2

Project: CSI Brightwater
Project Location: King and Snohomish Counties
Contract Number: E83004E

Log of Boring MW- 7

Sheet 3 of 5

Elevation, feet	Depth, feet	SAMPLES Type	Number	Blows / 6 in. (N)	Recovery, %	Graphic Log	USCS	MATERIAL DESCRIPTION	Piezometer Schematic	Lab Tests	Moisture Content, %	REMARKS AND OTHER TESTS
								Fine gravel and coarse sand present in cuttings.				
	110		S-11		0							
100							SP	8 feet of heave present at 110 feet. No sample driven. Cuttings are gray, very gravelly, fine to medium SAND, wet.		M SA	10.8	
	115							No water in cuttings.				
	120							5 feet of heave present at 120 feet.				
90							SC	Medium dense, gray, clayey, gravelly, fine to medium SAND to slightly gravelly, very fine sandy CLAY, moist to wet. Till-like. Trace fine, rounded gravel and trace rounded coarse sand.				
	125		S-12		0					M	21.7	
								(GLACIOMARINE DRIFT, Qpgm)				
	130		S-13	7 - 9 - 12 (21)	100					M SA HA	16.0	
80							CL	Very stiff, gray with whitish banding, slightly fine to medium gravelly, CLAY, moist. Sub-angular gravel.				
	135							(GLACIOLACUSTRINE, Qpgl)				
	140		S-14	5 - 9 - 14 (23)	100					M SA AL HA	21.6	
70												
	145		S-15	7 - 10 - 14 (24)	100			At 145 feet, clay becomes highly plastic.		M SA AL	28.8	
							SM	Very dense, gray, very silty, fine to coarse gravelly, fine to medium SAND, moist. Sub-rounded to sub-angular gravel.				
	150		S-16	110	83					M SA HA	8.9	
60								(GLACIAL TILL, Qpgt)				
	155		S-17	104	83			At 155 feet, sand becomes fine to coarse.		M SA	9.1	
	160		S-18	99	83		GM	Very dense, gray, silty, gravelly SAND to silty, sandy GRAVEL, moist to wet. Sand is fine to coarse and gravel is fine to coarse and subrounded.		M	9.5	
50							ML	Hard, gray, SILT, moist. Laminated. Low plasticity.				
	165		S-19	78	83					M	20.4	

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HWA GEOSCIENCES INC.

Exhibit E-3

Figure: A-8.3

Project: CSI Brightwater
Project Location: King and Snohomish Counties
Contract Number: E83004E

Log of Boring MW- 7

Sheet 4 of 5

Elevation, feet	Depth, feet	SAMPLES Type	Number	Blows / 6 in. (N)	Recovery, %	Graphic Log	USCS	MATERIAL DESCRIPTION	Piezometer Schematic	Lab Tests	Moisture Content, %	REMARKS AND OTHER TESTS
										SA		
	170	S-20		74	83		CL	Hard, dark gray with light gray bandings, slightly sandy, CLAY, moist. (GLACIOLACUSTRINE, Qpgl)		M SA AL HA	15.6	
40	175	S-21		92	83		CL	Hard, gray, CLAY interbedded with very dense, gray, slightly fine gravelly, fine to medium SAND, moist.		M	16.6	
	180	S-22		15 - 23 - 35 (58)	100		CH	Hard, dark gray with light gray banding and mottling, CLAY, moist. High plasticity.		M SA AL HA	16.9	
30	185	S-23		82	83		SC	Very dense, gray, fine to coarse gravelly, very clayey, fine to coarse SAND, moist. Occasional wood fragments and sub-rounded gravel present. (NONGLACIAL FLUVIAL, Qpnf)		M SA HA	11.3	
	190	S-24		78	83		SP-SM	Very dense, gray, slightly silty, gravelly, fine to coarse SAND, moist.		M SA	12.1	
20	195	S-25		19 - 30 - 51 (81)	100		CL	Hard, gray to dark gray with light gray mottling, fine to coarse gravelly, fine to coarse sandy, CLAY, moist. Till-like. (GLACIAOMARINE DRIFT, Qpgm)		M SA AL HA	12.2	
	200	S-26		11 - 18 - 27 (45)	100		CL	Very stiff to hard, gray to dark gray with light gray banding, CLAY, moist. (NONGLACIAL LACUSTRINE, Qpnl) Two 1-2 mm seams of fine sand present at 199 feet.				
10	205	S-27		10 - 18 - 32 (50)	100			At 205 feet, soil becomes slightly fine sandy CLAY with several thin light gray sandy seams.		M SA AL HA	18.8	
	210	S-28		8 - 19 - 40 (59)	100		CL	Hard, gray with light gray flecks, slightly fine to coarse gravelly, slightly fine to medium sandy, CLAY, moist.		M SA AL	14.5	
0	215	S-29		8 - 15 - 23 (38)	100		CL	Hard, gray, slightly fine sandy, CLAY, moist. Trace fine to coarse gravel.		M SA AL	19.3	
	220	S-30		8 - 16 - 19 (35)	100		CH	Hard, dark gray with light gray streaks, slightly fine gravelly, CLAY, moist. Highly plastic.		M SA	20.6	
-10	225							At 225 feet, clay becomes very stiff and contains light gray to white vertically oriented laminations.				

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HWA GEOSCIENCES INC.

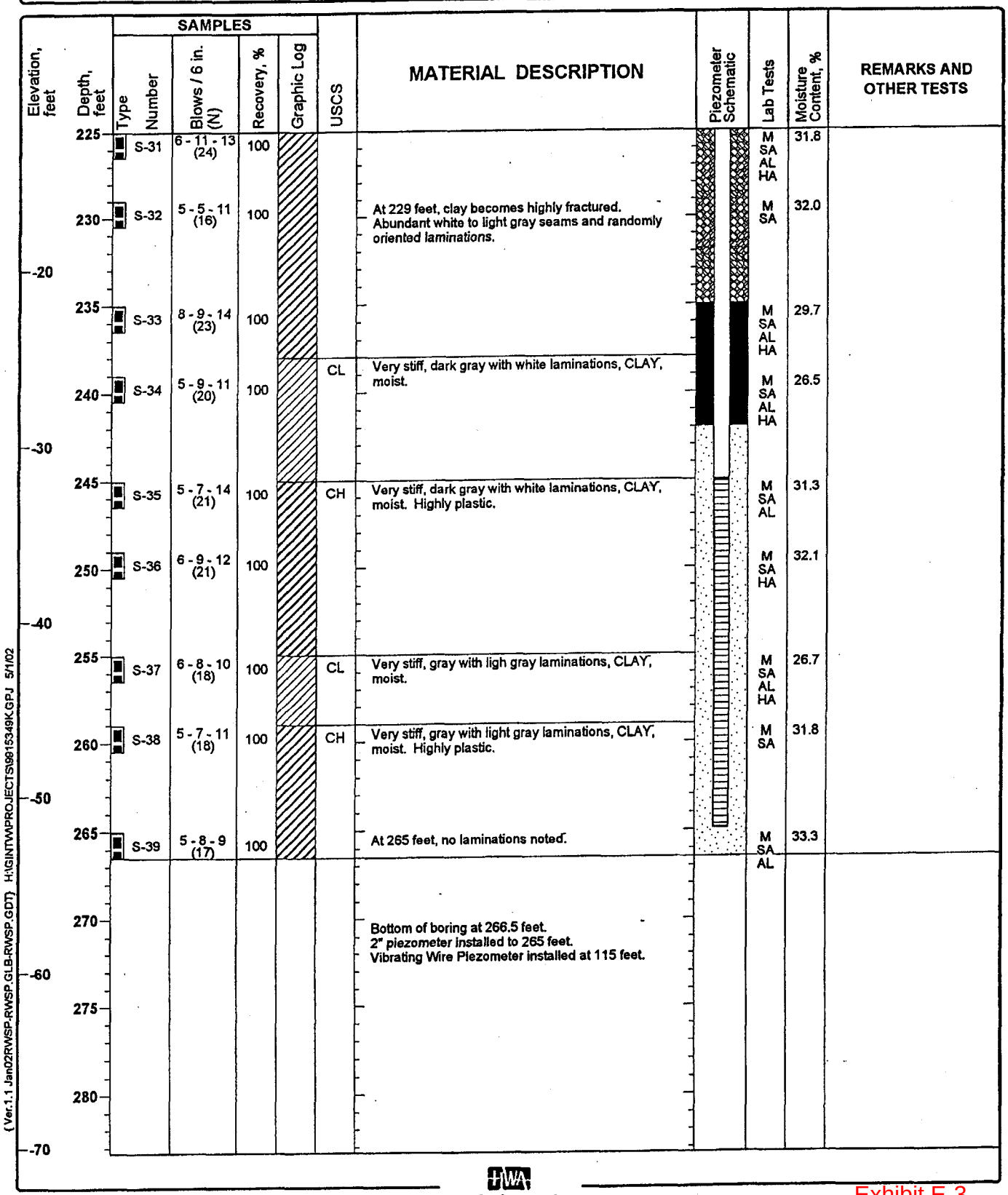
Exhibit E-3

Figure: A-8.4

Project: CSI Brightwater
Project Location: King and Snohomish Counties
Contract Number: E83004E

Log of Boring MW- 7

Sheet 5 of 5



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HWA GEOSCIENCES INC.

Exhibit E-3

Figure: A-8.5