AAA Cooper Terminal

Geotechnical Engineering Report

Spokane, Spokane County, WA 99217

August 6, 2025 | Terracon Project No. 81255013

Prepared for:

Knight-Swift Transportation
Holdings Inc.
1751 Kinsey Road
Dothan, Alabama, 36303

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August 6, 2025

Knight-Swift Transportation Holdings Inc.
1751 Kinsey Road
Dothan, Alabama, 36303

Attn: John Roberson – Director of Design and Construction
P: (334) 319-0672
E: John.Roberson@aaacooper.com

Re: Geotechnical Engineering Report
AAA Cooper Terminal
4011 N Ralph Street
Spokane, WA
Terracon Project No. 81255013

Dear Mr. Roberson:

We have completed the scope of services for the above referenced project in general accordance with Terracon Proposal No. P81255013 dated January 24, 2025. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork, the design and construction of foundations and floor slabs, and roller compacted concrete (RCC) pavements for the proposed project.

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

Kenneth H. Morrow, E.I.T.
Senior Staff Engineer

Zachary L. Koehn, P.E.
Geotechnical Department Manager

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Attachments

Introduction

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed tractor trailer truck terminal facility to be located at 4011 N Ralph Street in Spokane, WA. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface and groundwater conditions
- Seismic site class and hazards
- Summary of corrosivity and resistivity results
- Site preparation and earthwork
- Foundation design and construction
- Floor slab design and construction
- Lateral earth pressure
- Stormwater management discussion
- Pavement design and construction

The preliminary geotechnical engineering scope of services for this project included the advancement of seven (7) soil borings to depths ranging from approximately 11½ to 26½ feet below existing site grades (bgs), laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and as separate graphs in the **Exploration and Laboratory Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. Our final understanding of the project conditions is as follows:

Item	Description
Information Provided	■ Email request for proposal prepared by Knight-Swift dated January 15, 2025 ■ Conceptual site layout prepared by Knight-Swift undated

Item	Description
Project Description	The project is anticipated to include the construction of a slab-on-grade, single-story, metal or timber building. The building is expected to be lightly loaded and have a plan area of approximately 27,000 square feet. Loading docks are planned on the east, west, and north sides of the building. Semi-truck and trailer parking is planned on the east, west, and north sides of the site and passenger vehicle parking is planned on the south side of the site. Pavements are planned to consist of roller compacted concrete (RCC) for truck traffic areas and passenger vehicle parking areas. We request to review any additional site information such as a grading plan or an updated site plan when available to either confirm our recommendations or provide supplemental recommendations.
Building Construction	We anticipate that the building will be constructed using steel or timber framing and shallow foundations with slab-on-grade floors.
Finished Floor Elevation	Finished floor elevation for the building has not been provided to us. We anticipate the finished floor elevation for the building will be about 4 feet above surrounding finished grades.
Maximum Loads	Anticipated structural loads were not provided. In the absence of information provided by the design team, we will use the following loads in estimating settlement based on our experience with similar projects. ▪ Columns: 100 kips ▪ Walls: 3 kips per linear foot (klf) ▪ Slabs: 250 pounds per square foot (psf)
Grading/Slopes	A grading plan with building location was not available. Based on the topography of the site, up to 4 feet of cut/fill may be required to level the site prior to building and pavement construction.
Free-Standing Retaining Walls	Loading dock walls are anticipated to be constructed as part of the site development. We assume these dock walls will have a maximum height of 4 feet or less.

Item	Description
Pavements	We understand the following traffic loading to be used for the roller compacted pavement design at this site: ▪ Loaded semi-tractor trailer trucks 200 AADT ▪ Unloaded semi-tractor trailer trucks 200 AADT ▪ Design Life of 25 years ▪ 0 percent growth rate ▪ Average trucks/day in design lane over design life: 400 ▪ Total trucks in design lane over design life: 3,652,500 ▪ Equivalent single axle loads (ESALs): 7,540,000 If traffic loading will differ than the above, please notify Terracon at the time of authorization.
Building Code	The following design codes are assumed: ▪ International Building code – Version 2021 (2021 IBC)

Terracon should be notified if any of the above information is inconsistent with the planned construction as modifications to our recommendations may be necessary.

Site Conditions

The following description is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at 4011 N Ralph Street in Spokane, WA. Lot Size: ~ 8.4 acres Latitude (approximate): 47.6948° N Longitude (approximate): 117.3615° W See **Site Location**
Existing Improvements	The site is currently undeveloped. A shop building is located on the parcel southeast of the site.
Current Ground Cover	Earthen, moderately-heavily vegetated, cobbles and boulders scattered across the surface of the site.
Existing Topography	The site has a slight decrease in elevation from north to south with elevations ranging from 2,036 to 2,040 based on **Google Earth Pro.**

Geotechnical Characterization

Subsurface Conditions

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs and the GeoModel can be found in the **Exploration Results** section of this report.

Soil Layer	Layer Name	USCS	General Description
---	**Topsoil**	SM	Sod, silty SAND with fine roots, fine to medium grained, brown, moist, organic rich soils to approximately 6 inches below ground surface. Cobbles and boulders were observed at the surface of the site.
1	**Glacial Flood Deposits**	SP-SM/SM	Loose to very dense, poorly graded SAND with variable silt and gravel, silty SAND with variable gravel, dark brown to grayish brown, moist, fine to coarse graine. Some densities conveyed in the boring logs may be overstated due to the presence of cobbles and boulders.

Groundwater Conditions

The boreholes were observed while drilling for the presence and level of groundwater. Groundwater was not observed during the exploration, nor for the short duration that the borings remained open after augers were extracted.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Seismic Site Class and Hazards

Ground Motion

The 2021 IBC allows the Multi-Period Response Spectrum (MPRS) of ASCE 7-22 for determination of design ground motion values. The MPRS values were obtained from the ASCE 7-22 online tool (**https://asce7hazardtool.online/**) and are presented in the below table.

Description	Value [1]
ASCE 7-22 Site Classification	D
Site Latitude	47.6948° North
Site Longitude	117.3615° West
S_S – Short Period Spectral Acceleration	0.32 g
S_1 – 1-Second Period Spectral Acceleration	0.093 g
S_{MS} – Short Period Spectral Acceleration Adjusted for Site Class	0.47 g
S_{M1} – 1-Second Spectral Acceleration Adjusted for Site Class	0.25 g
S_{DS} – Design Short Period Spectral Acceleration	0.31 g
S_{D1} – Design 1-Second Spectral Acceleration	0.17 g
PGA_M - ASCE 7, PGA Adjusted for Site Class	0.19 g

1. The IBC requires a site profile extending to a depth of 100 feet for seismic site classification. Borings were extended to a maximum depth of 26½ feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area.

Surface-Fault Rupture

The hazard of damage from onsite fault rupture appears to be low based on review of the USGS Earthquake Hazards Program Quaternary Faults and Folds Database available online (**https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf**) accessed on February 21, 2025. The closest mapped fault is the Bull Lake fault zone, which lies approximately 65 miles to the northeast, and has a slip rate of less than 0.2 mm/yr.

Liquefaction

Liquefaction is the phenomenon where saturated soils develop high pore water pressures during seismic shaking and lose their strength characteristics. This phenomenon generally occurs in areas of high seismicity, where groundwater is shallow and loose granular soils or relatively non-plastic fine-grained soils are present. Based on the site geology and subsurface groundwater conditions, the hazard of liquefaction of the site soils is low for this site during a design level earthquake. The likelihood of lateral spreading is low while the likelihood of flow sliding is negligible largely due to the absence of a free-face slope.

Summary of Corrosivity and Resistivity Results

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Tests	Test Methods[1]	Test Results		
		B-01	B-02	B-03
Sample Location (Boring No./depth below grade)	--	B-01/0–2½ feet	B-02/0–2½ feet	B-03/0–2½ feet
pH	ASTM D4972	8.34	8.65	8.70
Soluble Sulfate (percent)	ASTM C1580	0.01	0.01	0.01
Sulfides (percent)	ASTM D4658	<0.01	<0.01	<0.01
Chlorides (percent)	ASTM D512	0.01	0.01	0.01
Red-Ox[2] (mV)	ASTM G200	+729	+727	+728
Total Salts (percent)	AWWA 2520 B	0.04	0.06	0.04
Saturated Minimum Resistivity (Ω-cm)	ASTM G-57	3551	3149	2613

1. ASTM = American Society for Testing and Materials, AWWA = American Water Works Association.
2. Reduction-Oxidation potential (positive values indicate an oxidizing environment).

Results of soluble sulfate testing can be classified in accordance with ACI 318 – Building Code Requirements for Structural Concrete, Chapter 19. Numerous sources are available to characterize corrosion potential to buried metals using the parameters above. ANSI/AWWA is commonly used for ductile iron, while threshold values for evaluating the effect on steel can be specific to the buried feature (e.g., piling, culverts, welded wire reinforcement, etc.) or agency for which the work is performed. Imported fill materials may have significantly different properties than the site materials noted above and should be evaluated if expected to be in contact with metals used for construction. Consultation with a NACE certified corrosion professional is recommended for buried metals on the site.

Geotechnical Overview

The near-surface materials could become unstable with typical earthwork and construction traffic, especially after precipitation events. Effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, and increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

Large, coarse granular particles (i.e. cobbles and boulders) were observed on the surface at the site and were encountered during our site explorations. We suspect that the surface cobbles were placed on site during the construction of the adjacent highway construction to the west of the site. Cobbles and boulders within subgrades of concrete presents a risk of concentrated stresses on the foundations, floor slabs, and pavements that could cause cracking. The contractor should be prepared to encounter cobbles and boulders during construction. Particle sizes greater than 3 inches should be removed prior to reuse of onsite soils. See the **Site Preparation** section for additional recommendations on over-excavation of cobbles and boulders.

Geotechnical engineering recommendations for shallow foundations systems and slab-on-grade support of the building are outlined in the **Shallow Foundations** and the **Floor Slabs** sections.

Our recommendation of pavement section thickness design has been developed based on our understanding of the intended use, assumed traffic, and subgrade preparation recommended herein. We understand that the owner is considering roller compacted concrete (RCC) design for parking/driveway areas. Specific design parameters, design methodologies, and recommendations are presented in the **Pavements** section.

Specific conclusions and recommendations regarding these geotechnical considerations, as well as other geotechnical aspects of design and construction of foundation systems and other earthwork related phases of the project are outlined in the following sections. The recommendations contained in this report are based upon the results of field and laboratory testing, engineering analyses, and our current understanding of the proposed project. ASTM and Washington State Department of Transportation (WSDOT) specification codes cited herein respectively refer to the current manual published by the American

Society for Testing & Materials and the current edition of the *Standard Specifications for Road, Bridge, and Municipal Construction, (M41-10)*.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing of the surface vegetation, excavations, and engineered fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas. Prior to placing fill, existing vegetation, topsoil, root mats, and other deleterious materials should be removed completely from the construction areas.

Following stripping of the topsoil and prior to placement of fill, the subgrades should be proofrolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck to help identify cobbles and boulders, and unsuitable subgrade soils. The proofrolling should be performed under the observation of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the contractor. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

Cobbles and boulders were observed within the near-surface soils. Cobbles and boulders within subgrades of concrete features present a risk of concentrated stress on the foundations, slabs, and pavements. The following is recommended to reduce the risk of cracking:

- Over-excavate foundations at least 2 feet and restore grades with compacted structural fill as recommended herein.
- Excavate or scarify slab and pavement areas a minimum depth of 12 inches and remove all cobbles and boulders before recompacting.

Due to the presence of variable fines content in the near-surface soils, earthwork operations must consider the impact of weather and construction traffic. Subsurface soils at this site are considered moisture sensitive. Excessively wet or dry material should either be removed or replaced with structural fill as recommended herein.

The moisture content and stability of subgrade soils should be maintained until slab, pavement, and foundation construction. Concrete should be placed soon after excavating to reduce bearing soil disturbance. If allowed to collect, water can soften bearing subgrade and make disturbance by foot or construction traffic more likely.

Fill Material Types

Excavated native sand soils from Soil Layer 1 can be reused as both structural and common fill provided cobble and boulder-sized particles are removed and materials are free of organic material and debris. Due to the variable fines content within the on-site soils, these soils may become moisture sensitive and may not be practical for reuse as structural fill if the moisture content deviates more than a few percent from optimum. Particles sizes larger than 3 inches are recommended to be removed prior to reuse. Fill placement should not be performed on frozen subgrades and frozen materials should not be used. Frozen subgrades should be removed or thawed prior to fill placement.

Fill required to achieve design grade should be classified as structural fill and common fill. Structural fill is material used below, or within 10 feet of structures and appurtenances, and pavements. Common fill is material used to achieve grade outside of these areas.

Earthen materials used for structural and common fill should meet the following material property requirements:

Fill Type	Recommended Materials	Acceptable Location for Placement
Structural Fill	9-03.9(3) *Crushed Surfacing Base Course* [1] 9-03.12(1)A *Gravel Backfill for Foundations Class A* [1] 9-03.14(1) *Gravel Borrow* [1] On-site Soils with some handling (i.e. Soil Layer 1) [2, 3]	Beneath and adjacent to structural slabs, foundations, building appurtenances, and pavement subgrades
Common Fill	Section 9-03.14(3) *Common Borrow* [1] On-site Soils with some handling (i.e. Soil Layer 1) [2, 3]	Grade filling, utility trench backfill outside the building foundation and appurtenances

Fill Type	Recommended Materials	Acceptable Location for Placement
Free-Draining Granular Fill	Structural Fill [4] 9-03.12(2) *Gravel Backfill for Walls* [1] 9-03.12(4) *Gravel Backfill for Drains* [1]	Backfilling in wet weather, drainage layers for walls, sump drains, footing drains [5]

1. WSDOT Standard Specifications
2. Structural and common fill should consist of approved materials free of organic matter and debris. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
3. May contain local areas of higher fines content that could make this material moisture sensitive. Particles with a nominal diameter greater than about 3 in. should be removed.
4. Material provided must be specified to be less than 5-percent passing the #200 sieve for the portion of material passing the #4 sieve.
5. Minimum particle size must be greater than drainpipe perforations.

Other earthen materials may be suitable for use in addition to the options presented in the table above. All materials should be approved by the Geotechnical Engineer prior to use.

Fill Placement and Compaction Requirements

Structural and common fill should meet the following compaction requirements.

Item	Structural Fill	Common Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as structural fill
Minimum Compaction Requirements[1,2]	95% of maximum dry density	92% of maximum dry density
Water Content Range[1]	Typically, within 2% of optimum	As required to achieve min. compaction requirements

1. Maximum density and optimum water content as determined by the Modified Proctor test (ASTM D 1557).
2. Terracon should observe exposed subgrades to help identify areas where deficient subgrades exist.

Utility Trench Backfill

All trenches should be wide enough to allow for compaction around the haunches of the pipe. If water is encountered in the excavations, it should be removed prior to fill placement. As noted in the **Geotechnical Overview** section, the presence of cobbles and boulders may present challenges with respect to trench stability. Nested cobbles and boulders in trench side walls may become loosened during trench that could influence trench stability. The utility contractor should be prepared to contend with the likely presence of cobbles and boulders in utility trench alignments.

Placement and compaction of recommended materials for utility trench backfill should be in accordance with the recommendations presented herein. In our opinion, the initial lift thickness should not exceed 1-foot unless recommended by the manufacturer to protect utilities from damage by compacting equipment. Light, hand-operated compaction equipment in conjunction with thinner lift thicknesses may be used on backfill placed above utilities if damage resulting from heavier compaction equipment is of concern.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Effective drainage will be essential during construction to limit the extent of soil disturbance during the wet season.

Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. Gutters and downspouts should be routed into tightline pipes that discharge either directly into a municipal storm drain or to an alternative drainage facility. Splash-blocks should also be considered below hose bibs and water spigots.

Site grades should be established such that surface water is directed away from foundation and pavement subgrades to prevent an increase in the water content of the soils. Adequate positive drainage diverting water from structures, open cuts, and slopes should be established to prevent erosion, ground loss, and instability. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping, final grades should be verified to document effective drainage has been achieved. Where paving or flatwork abuts the structure a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to continuing construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer. Observation should include documentation of adequate removal of surficial materials (vegetation, and topsoil), as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content. In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Wet Weather Earthwork

The near-surface soils have variable fines content based on our visual observations and lab testing and are considered moisture sensitive. The soils will exhibit moderate erosion potential and may be transported by running water. Silt fences and other best-management practices will be necessary to control erosion and sediment transport during construction.

The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the fines content (the soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. Optimum moisture content is the moisture content at which the maximum dry density for the material is achieved in the laboratory by the ASTM D1557 test procedure.

If inclement weather or in situ soil moisture content prevents the use of on-site material as structural fill, we recommend use of materials specified in **Fill Material Types** for free-draining granular fill.

Shallow Foundations

Cobbles and boulders within and near the foundation subgrades present a risk of foundation cracking that could influence the long-term performance of the development. To reduce this risk, we recommend foundation subgrades are over-excavated 2 feet and replaced with compacted structural fill.

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2, 3] Foundations bearing on at least 2 feet of compacted structural fill	3,000 psf for Spread Footing 3,000 psf for Wall Footing
Minimum Foundation Dimensions	24 inches for Spread Footing 18 inches for Wall Footing
Ultimate Passive Resistance [4] **(Equivalent fluid pressures)**	400 pcf

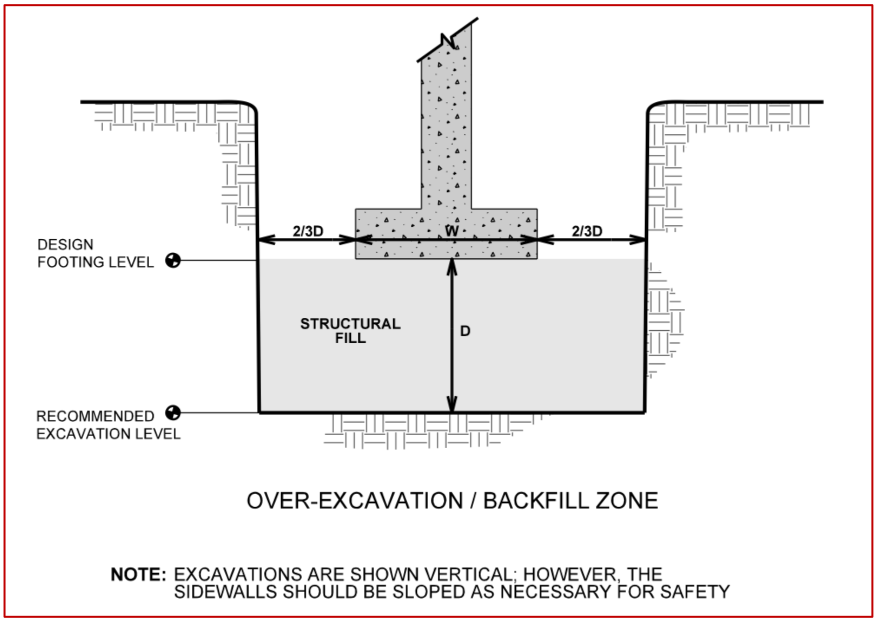
Item	Description
Allowable Sliding Resistance [5]	0.35
Minimum Embedment below Finished Grade [6]	24 inches
Estimated Total Settlement from Structural Loads [2]	<1 inch
Estimated Differential Settlement [2, 7]	About 2/3 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. Values assume that exterior grades are relatively level adjacent to the structure.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in **Earthwork**.
4. Passive resistance in the upper 2 feet of the soil profile should be neglected. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. For frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils. For perimeter footing and footings beneath unheated areas. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are as measured over a span of 50 feet. We should review the settlement estimates after the foundation plan has been prepared by the structural engineer

Foundation Construction Considerations

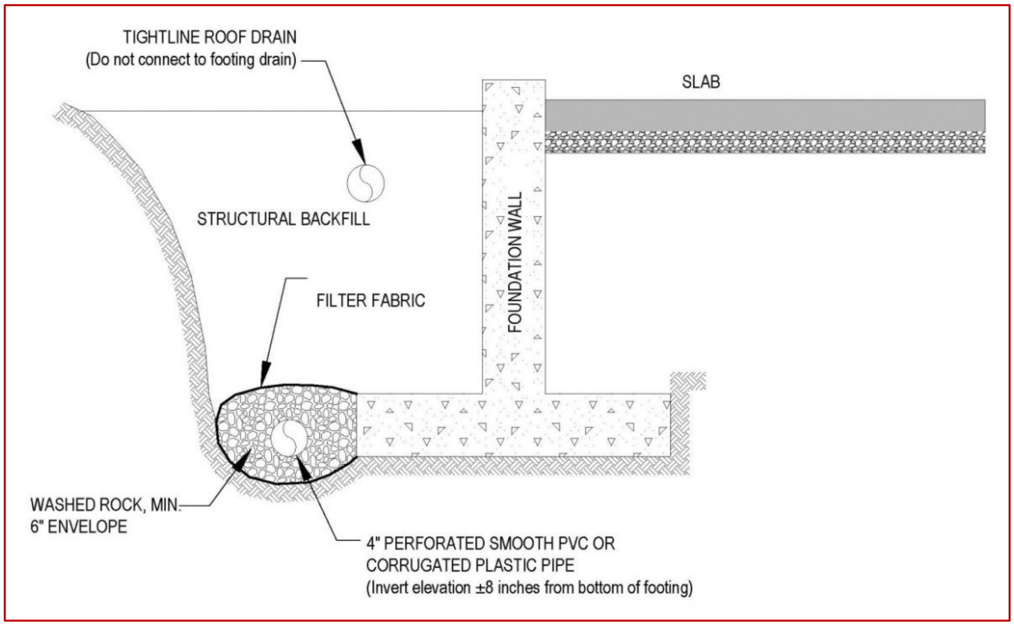
As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with structural fill placed, as recommended in the **Earthwork** section.



Foundation Drains

We recommend the building be encircled with a perimeter foundation drain to collect exterior seepage water. This drain should consist of a 4-inch diameter perforated pipe within an envelope of washed rock, extending at least 6 inches on all sides of the pipe. The washed rock should conform to WSDOT Section 9-03.12(4), Gravel Backfill for Drains or 9-03.12(5), Gravel Backfill for Drywells. The washed rock envelope should be wrapped with filter fabric meeting the material requirements for Low Survivability Nonwoven with maximum AOS of No. 40 Geotextile for Underground Drainage found in WSDOT Section 9-33.2(1) (such as Mirafi 140N, or equal) to reduce the migration of fines from the surrounding soil. Ideally, the drain invert would be installed no more than 8 inches above or below the base of the perimeter footings. The perimeter foundation drain should not be connected to roof downspout drains and should be constructed to discharge into the site storm water system or other appropriate outlet. These recommendations are summarized in the figure below.



Floor Slabs

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. We assume the floor slabs will be supported on at least 12 inches of compacted structural fill. Specific attention should be given to have positive drainage away from the structure along with positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	12 inches of compacted structural fill underlying at least 6 inches of free-draining of either of the following[2, 3]: ▪ 9-03.9(3) Crushed Surfacing Base Course ▪ 9-03.12(1)A *Gravel Backfill for Foundations Class A* (compacted to at least 95% of ASTM D 1557)
Estimated Modulus of Subgrade Reaction [4]	Estimated modulus of subgrade reaction generally exhibit the following: ▪ 220 pounds per square inch per inch (psi/in) for point loads ▪ 130 psi/in for distributed loads up to 4-foot wide

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. WSDOT Standard Specification.
3. Free-draining granular material should have less than 5% fines (material passing the No. 200 sieve).

Item	Description
4.	Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, when the project includes humidity-controlled areas, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut contraction joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a waterproof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

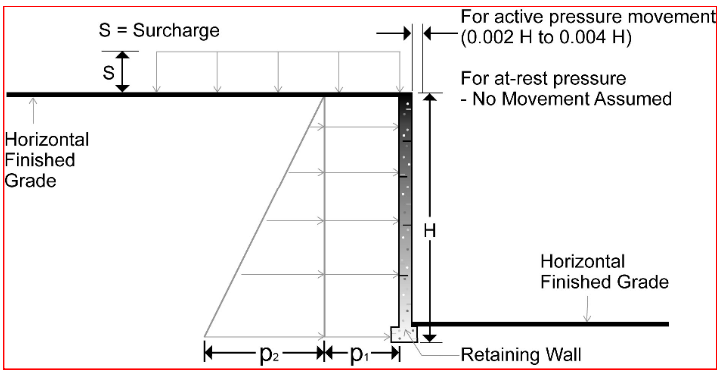
The Geotechnical Engineer should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

Lateral Earth Pressures

We understand that loading docks are anticipated to be constructed as part of the site development. Recommendations provided herein assumes that the maximum height of loading dock walls will be on the order of 4 feet or less.

Design Parameters – Backfilled Walls

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3,4,5] p_1 (psf)	Equivalent Fluid Pressures (psf) [2,4,5]
Active (Ka)	0.31	(0.31)S	(40)H
At-Rest (Ko)	0.47	(0.47)S	(60)H
Passive (Kp)	3.25	---	(400)H
Seismic[6]	---	(4)H – Active (7)H – At-Rest	---

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance. Cohesive soils should not be used as backfill behind the wall.
2. Uniform, horizontal backfill, compacted to at least 92 percent of the ASTM D1557 maximum dry density.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included in these values
6. Values are in addition to static earth pressures

Backfill placed against structures should consist of granular soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

Preliminary Stormwater Management Discussion

Currently, the stormwater management testing requirements are unknown. For planning purposes, we evaluated infiltration potential based on grain size analysis. These should be used for preliminary sizing of the infiltration facility only. In situ testing via pilot infiltration testing (PIT) may be required by local jurisdictions to confirm the values herein.

Using the grain size methodology developed by Massmann (2003) for saturated hydraulic conductivity, a design infiltration rate of 5 inches per hour is estimated. Reduction factors of 1.0, 0.4, and 0.9 were applied for site variability, test method, and siltation/bio-buildup, respectively.

The civil engineer should consort with the city to determine infiltration testing requirements for the site. Following determination of the infiltration testing requirements, the initial size and location of the stormwater management system, please contact Terracon for additional needs.

Pavements

General Pavement Comments

The pavement design for this project was completed using the ACPA online tool (**https://www.pavementdesigner.org**) and design results are provided herein. The online tool follows guidelines from 1993 Guideline for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO-1993), the 2008 Design and Construction of Concrete Parking Lots by the American Concrete Institute (ACI-330R-08), and the Guide for the Design and Construction of Concrete Site Paving for Industrial and Trucking Facilities (ACI-330.2R-17).

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

The following subsections detail the subgrade, traffic and material design parameters for pavement design for this project as well as our recommended pavement thickness design.

Subgrade Design Parameters

Laboratory testing suggests a California Bearing Ratio (CBR) of 154 for a composite bulk sample of near-surface soils within the proposed parking and driveway areas. CBR testing is performed in a controlled laboratory environment and does not consider the variability of field conditions. For design purposes, we have assumed a CBR of at least 20 at a relative compaction of 95 percent (ASTM D1557).

Laboratory test results and our assumed design CBR values were correlated to subgrade resilient modulus. The results of the correlations are presented in the following table:

Preliminary Design Subgrade Values

Sample Location	Laboratory CBR	Design CBR	Correlated Resilient Modulus (psi)
Composite B-04/ B-05/B-06/B-07	154	20	17,380

1. Based on the following correlation published by the National Cooperative Highway Research Program (NCHRP) Publications 1-37A, 2004: M_r(psi) = 2555 x $CBR^{0.64}$

Traffic Design Parameters

The following traffic design parameters were assumed during project planning and were used for our preliminary pavement design. If traffic volumes differ significantly for the project, please notify Terracon to revise our recommendations.

Design Criteria	Value
Pavement Design Life	25 years
Design Average One-way AADT	■ Loaded semi-tractor trailer trucks 200 AADT ■ Unloaded semi-tractor trailer trucks 200 AADT
Estimated Growth Factor Percentage	0 percent
Approximate Truck Percentage	100 percent
Directional Distribution	100 percent
Average Truck/Day in Design Lane over the Design Life	400

Design Criteria	Value
Total Trucks in Design Lane over the Design Life	3,652,500
Equivalent Single Axle Loads (ESALs)	7,540,000

Pavement Design Considerations

We understand the RCC is anticipated to be constructed with frequent joint spacing of 12 feet or less. RCC pavements typically shrink less than conventional concrete due to the low water to cement ratio used in the design and construction of RCC pavements. Considering the low shrinkage potential and the frequent joint spacing, we expect expansion at the contraction joints to be minimal. We also expect the aggregate interlock of the contraction joints to contribute significantly more to the join load transfer than for conventional concrete.

Pavement Section Thicknesses

Based on the guidance in the above referenced documents, the following pavement design parameters were utilized in the preliminary thickness design of the RCC pavement for this project:

Preliminary Pavement Thickness Design Parameters

Input Parameter	Value
Reliability	85%
Serviceability	2.0
Standard Deviation	0.35
Modulus of Rupture (psi)	650
Effective Modulus of Subgrade Reaction (pci) beneath RCC	200

As a minimum, we suggest the following preliminary pavement sections be considered for this project:

Preliminary Roller Compacted Concrete Pavement Design Layer Thicknesses

Layer	Specifications	Thickness (in)[1]
Roller Compacted Concrete	Minimum flexural strength of 650 psi at 28 days	9
Crushed Aggregate Base [2]	9-03.9(3) Crushed Surfacing Base Course	6
Compacted Native/Structural Fill Subgrade [3]	See recommendations in **Earthwork**	12

1. The individual and total material thickness values presented herein represent minimum thickness values, not averages.
2. WSDOT Standard Specification.
3. Compacted to at least 95% of the material's maximum dry density by Modified Proctor (ASTM D1557).

Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. Preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations 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. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services 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. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Explorations	Type of Exploration	Approximate Exploration Depth (feet)	Location
3	Soil Boring	26½	Building Area
4	Soil Boring	11½	Parking/Drive Aisles

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were obtained by interpolation from Google Earth Pro. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Soil Boring Procedures: We advanced the borings with a truck-mounted rotary drill rig using continuous flight hollow stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with bentonite chip after their completion in accordance with Washington Department of Ecology requirements related to completion of borings.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. Groundwater was not observed at these times in the boreholes.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D1140 Standard Test Methods for Determining the Amount of Material Finer than 75-μm (No. 200) Sieve in Soils by Washing
- ASTM D2974 Standard Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils
- Corrosivity testing including pH (ASTM D4972), water soluble sulfates (ASTM C1580), sulfides (ASTM D4658), chlorides ASTM D512), Red-ox (ASTM G200), total salts (AWWA 2520 B), and saturated minimum resistivity (ASTM G-57).
- ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM D1883 Standard Test Method for California Bearing Ratio of Laboratory-Compacted Soils

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Site Location and Exploration Plans

Contents:

Site Location

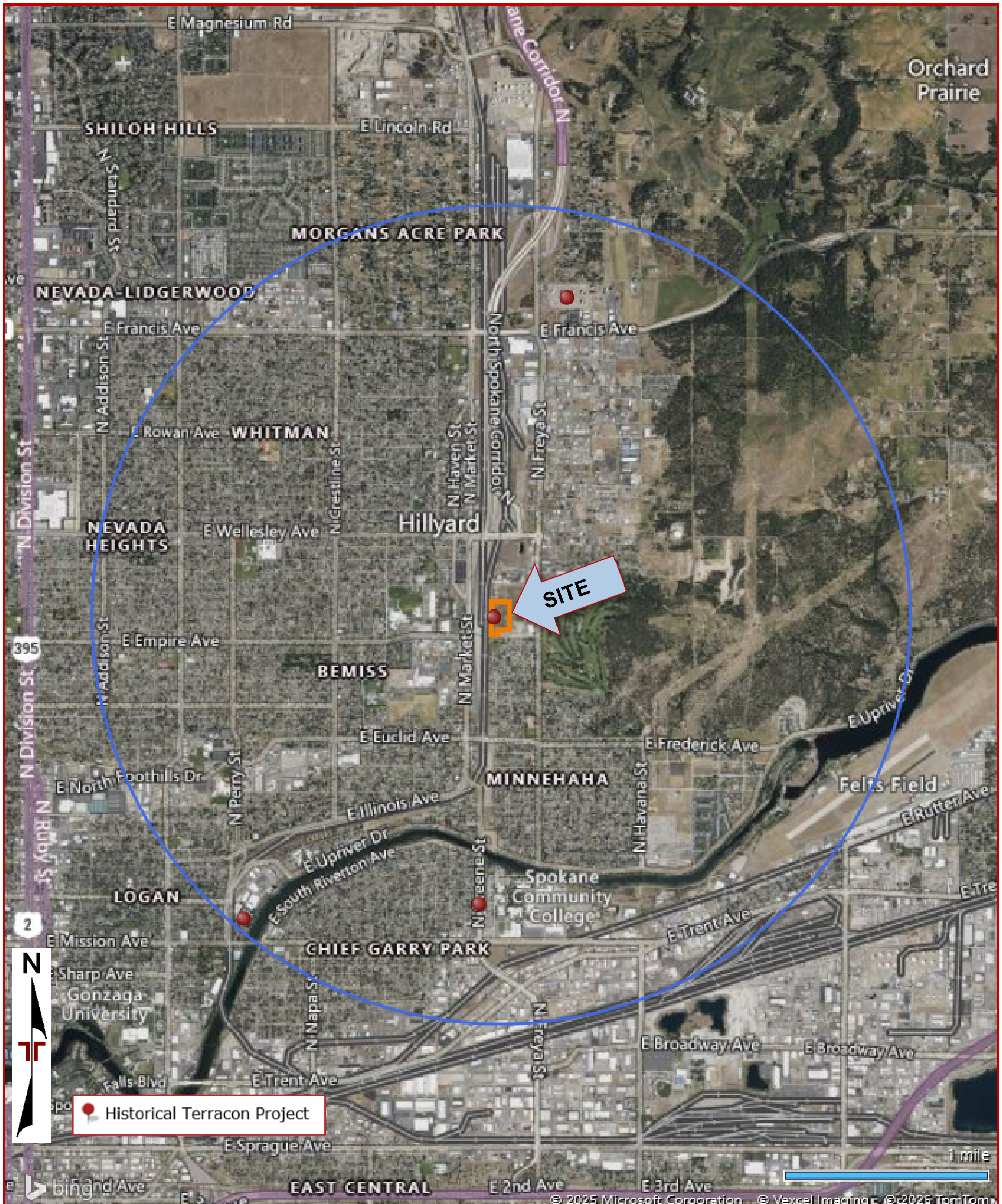


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

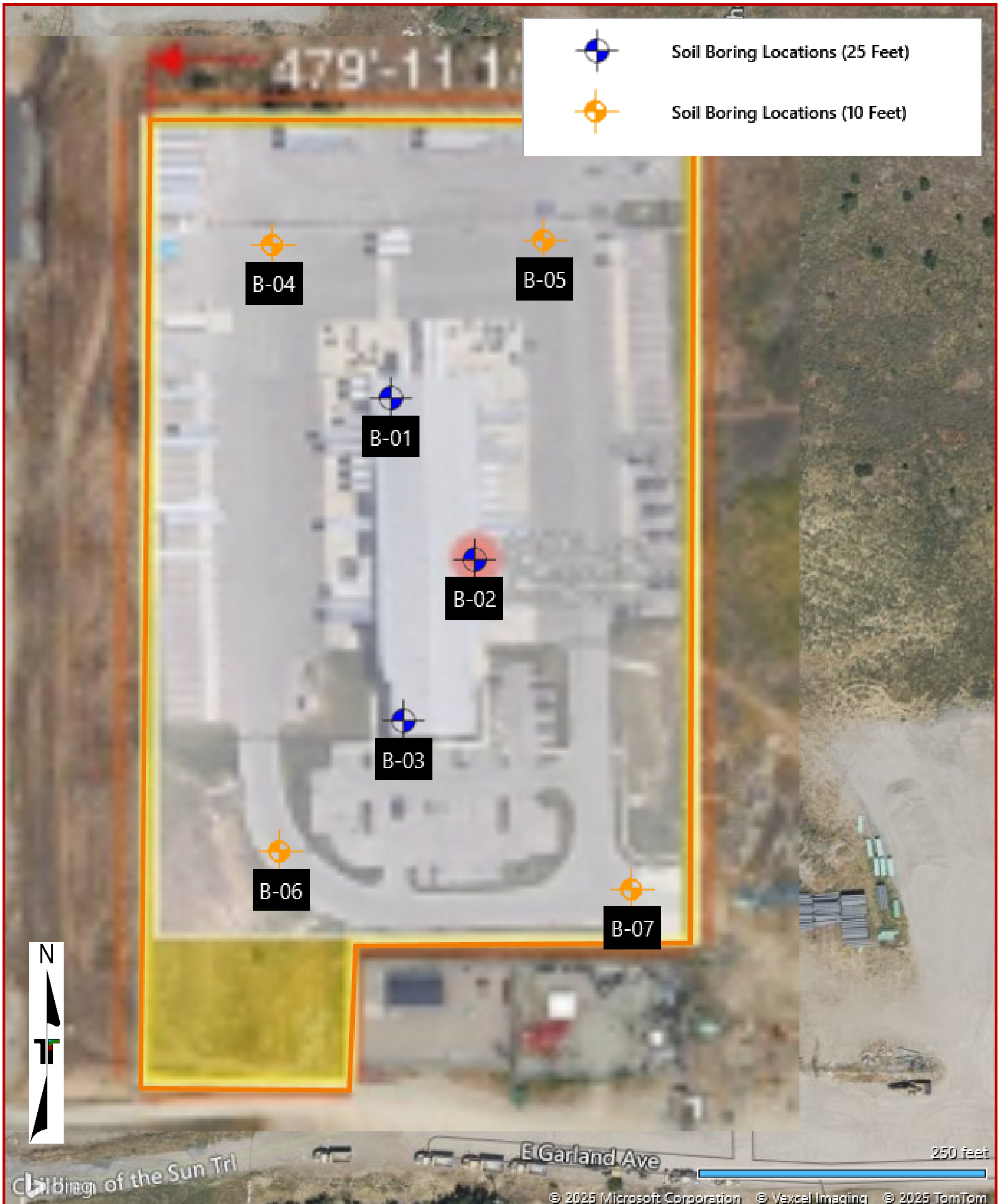


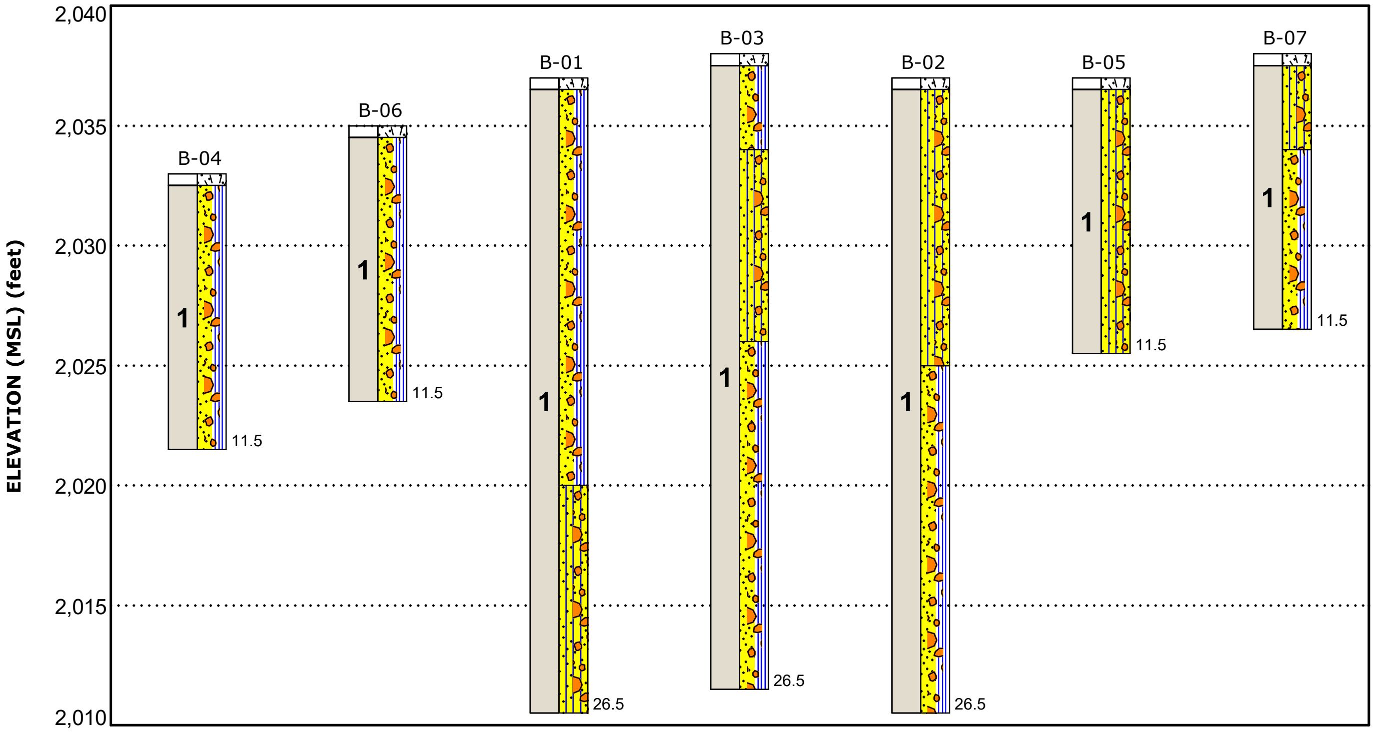
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

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

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Glacial Flood Deposits**	Loose to very dense, poorly graded SAND with variable silt and sand, silty SAND with variable gravel, dark brown to grayish brown, moist, fine to coarse grained

Legend

- Topsoil
- Silty Sand with Gravel
- Poorly-graded Sand with Silt and Gravel

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

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

Boring Log No. B-01

Location: See Exploration Plan

Latitude: 47.6952° Longitude: -117.3617°

Approximate Elevation: 2037 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)
	0.5	**SILTY SAND (SM)**, with fine roots, fine to medium grained, non plastic, brown, moist, medium dense	2036.5
1	17.0	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with cobbles, fine to coarse grained, brown to grayish brown, moist, loose to medium dense ~ 13 feet: increasing silt content with depth ~ 17 feet: larger gravel in auger cuttings	2020
1	26.5	**SILTY SAND WITH GRAVEL (SM)**, with cobbles, fine to coarse grained, grayish brown, moist, dense	2010.5

Boring Terminated at 26.5 Feet

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Water Content (%)	Percent Fines
2.5–4		X	6	5-4-3 N=7	S-1		
5–6.5		X	7	5-6-7 N=13	S-2	4.2	9.5
7.5–9		X	4	7-6-8 N=14	S-3		
10–11.5		X	4	9-8-8 N=16	S-4		
15		X	4	50/5"	S-5		
20		X	0	50/2"	S-6		
25–26.5		X	4	18-20-15 N=35	S-7		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not observed

Drill Rig
GD550

Hammer Type
Automatic (ETR = 95.7%)

Driller
GeoWest

Notes
Surface Conditions: Moderate vegetation, cobbles at suface, with snow cover
S-5: rock fragments observed in sampler, cobble obstruction, blowcounts may be overstated
S-6: rock fragments observed in sampler, cobble obstruction, blowcounts may be overstated

Advancement Method
Hollow Stem Auger 4.25 inch I.D., 8 inch O.D.

Abandonment Method
Boring backfilled with bentonite upon completion.

Logged by
WG

Boring Started
02-11-2025

Boring Completed
02-11-2025

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

Boring Log No. B-02

Location: See Exploration Plan

Latitude: 47.6948° Longitude: -117.3614°

Approximate Elevation: 2037 (Ft.)

Model Layer: 1

Depth (Ft.)	Material Description	Elevation (Ft.)
0.5	**SILTY SAND (SM)**, with fine roots, fine to medium grained, non plastic, brown, moist, medium dense	2036.5
12.0	**SILTY SAND WITH GRAVEL (SM)**, with cobbles, fine to coarse grained, nonplastic, brown to grayish brown, moist, medium dense to dense	2025
26.5	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with cobbles, fine to coarse grained, grayish brown, moist, medium dense to dense	2010.5

Boring Terminated at 26.5 Feet

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Water Content (%)	Percent Fines
2.5–4		X	6	7-9-6 N=15	S-1	5.1	14.3
5–6.5		X	2	4-5-5 N=10	S-2		
7.5–9		X	8	6-10-11 N=21	S-3		
10–11.5		X	8	9-14-16 N=30	S-4		
15–16.5		X	4	7-10-13 N=23	S-5		
20		X	0	50/4"	S-6		
25–26.5		X	7	42-15-22 N=37	S-7		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not observed

Drill Rig
GD550

Hammer Type
Automatic (ETR = 95.7%)

Driller
GeoWest

Notes
Surface Conditions: Moderate vegetation, cobbles at suface, with snow cover
S-6: rock fragments observed in sampler, cobble obstruction, blowcounts may be overstated

Advancement Method
Hollow Stem Auger 4.25 inch I.D., 8 inch O.D.

Abandonment Method
Boring backfilled with bentonite upon completion.

Logged by
WG

Boring Started
02-11-2025

Boring Completed
02-11-2025

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

Boring Log No. B-03

Location: See Exploration Plan

Latitude: 47.6945° Longitude: -117.3616°

Approximate Elevation: 2038 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)
1	0.5	**SILTY SAND (SM)**, with fine roots, fine to medium grained, non plastic, brown, moist, medium dense	2037.5
1	4.0	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, fine to coarse grained, brown, moist, dense	2034
1	12.0	**SILTY SAND WITH GRAVEL (SM)**, trace wood debris, fine to medium grained, nonplastic, dark brown, moist, loose to dense ~7.5 feet: Organic Content = 2.1%	2026
1	26.5	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with cobbles, fine to coarse grained, grayish brown, moist, medium dense to dense	2011.5

Boring Terminated at 26.5 Feet

Sample ID	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Percent Fines
S-1	X	6	7-11-24 N=35		
S-2	X	8	10-21-14 N=35	6.5	21.0
S-3	X	7	2-3-3 N=6	9.9	23.9
S-4	X	5	3-4-5 N=9		
S-5	X	3	15-25-27 N=52		
S-6	X	9	33-19-19 N=38		
S-7	X	8	9-11-10 N=21		

Water Level Observations: none recorded

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not observed

Drill Rig
GD550

Hammer Type
Automatic (ETR = 95.7%)

Driller
GeoWest

Notes
Surface Conditions: Moderate vegetation, cobbles at suface, with snow cover
S-5: rock fragments observed in sampler, cobble obstruction, blowcounts may be overstated

Advancement Method
Hollow Stem Auger 4.25 inch I.D., 8 inch O.D.

Abandonment Method
Boring backfilled with bentonite upon completion.

Logged by
WG

Boring Started
02-11-2025

Boring Completed
02-11-2025

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

Boring Log No. B-04

Location: See Exploration Plan

Latitude: 47.6956° Longitude: -117.3621°

Model Layer	Depth (Ft.)	Description	Approximate Elevation: 2033 (Ft.)
	0.5	**SILTY SAND (SM)**, with fine roots, fine to medium grained, non plastic, brown, moist, medium dense	2032.5
1	11.5	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with cobbles, fine to coarse grained, brown to grayish brown, moist, loose to medium dense	2021.5

Boring Terminated at 11.5 Feet

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Water Content (%)	Percent Fines
2.5–4		X	8	3-3-6 N=9	S-1		
5–6.5		X	8	3-5-7 N=12	S-2		
7.5–9		X	4	6-6-7 N=13	S-3		
10–11.5		X	2	3-6-5 N=11	S-4		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not observed

Drill Rig
GD550

Hammer Type
Automatic (ETR = 95.7%)

Driller
GeoWest

Notes
Surface Conditions: Moderate vegetation, cobbles at suface, with snow cover

Advancement Method
Hollow Stem Auger 4.25 inch I.D., 8 inch O.D.

Abandonment Method
Boring backfilled with bentonite upon completion.

Logged by
WG

Boring Started
02-11-2025

Boring Completed
02-11-2025

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

Boring Log No. B-05

Location: See Exploration Plan

Latitude: 47.6956° Longitude: -117.3611°

Approximate Elevation: 2037 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)
	0.5	**SILTY SAND (SM)**, with fine roots, fine to medium grained, non plastic, brown, moist, medium dense	2036.5
1	11.5	**SILTY SAND WITH GRAVEL (SM)**, with cobbles, fine to coarse grained, nonplastic, dark brown, moist, loose to medium dense	2025.5

Boring Terminated at 11.5 Feet

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Water Content (%)	Percent Fines
2.5–4		X	6	2-2-2 N=4	S-1		
5–6.5		X	8	7-6-6 N=12	S-2	5.6	13.7
7.5–9		X	12	4-6-10 N=16	S-3		
10–11.5		X	8	2-3-2 N=5	S-4		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not observed

Drill Rig
GD550

Hammer Type
Automatic (ETR = 95.7%)

Driller
GeoWest

Notes
Surface Conditions: Moderate vegetation, cobbles at suface, with snow cover

Advancement Method
Hollow Stem Auger 4.25 inch I.D., 8 inch O.D.

Abandonment Method
Boring backfilled with bentonite upon completion.

Logged by
WG

Boring Started
02-11-2025

Boring Completed
02-11-2025

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

Boring Log No. B-06

Location: See Exploration Plan

Latitude: 47.6941° Longitude: -117.3621°

Approximate Elevation: 2035 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Water Content (%)	Percent Fines
	0.5	**SILTY SAND (SM)**, with fine roots, fine to medium grained, non plastic, brown, moist, medium dense	2034.5								
1	11.5	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with cobbles, fine to coarse grained, brown to grayish brown, moist, medium dense to very dense	2023.5			X	1	6-4-6 N=10	S-1		
				5		X	4	4-6-11 N=17	S-2	3.8	11.0
						X	6	14-22-36 N=58	S-3		
				10		X	11	12-23-30 N=53	S-4		

Boring Terminated at 11.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not observed

Drill Rig
GD550

Hammer Type
Automatic (ETR = 95.7%)

Driller
GeoWest

Notes
Surface Conditions: Moderate vegetation, cobbles at suface, with snow cover
S-3: possible cobble obstruction, blowcounts may be overstated
S-4: possible cobble obstruction, blowcounts may be overstated

Advancement Method
Hollow Stem Auger 4.25 inch I.D., 8 inch O.D.

Abandonment Method
Boring backfilled with bentonite upon completion.

Logged by
WG

Boring Started
02-11-2025

Boring Completed
02-11-2025

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

Boring Log No. B-07

Location: See Exploration Plan

Latitude: 47.6941° Longitude: -117.3608°

Model Layer	Depth (Ft.)	Material Description	Approximate Elevation: 2038 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Water Content (%)	Percent Fines
	0.5	**SILTY SAND (SM)**, with fine roots, fine to medium grained, non plastic, brown, moist, medium dense	2037.5								
1	4.0	**SILTY SAND WITH GRAVEL (SM)**, fine to coarse grained, nonplastic, dark brown, moist, medium dense	2034			X	4	5-11-9 N=20	S-1		
1	11.5	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with cobbles, fine to coarse grained, brown to grayish brown, moist, medium dense	2026.5	5		X	7	6-5-5 N=10	S-2		
						X	8	7-11-11 N=22	S-3		
				10		X	5	7-6-7 N=13	S-4		

Boring Terminated at 11.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not observed

Drill Rig
GD550

Hammer Type
Automatic (ETR = 95.7%)

Driller
GeoWest

Notes
Surface Conditions: Moderate vegetation, cobbles at suface, with snow cover

Advancement Method
Hollow Stem Auger 4.25 inch I.D., 8 inch O.D.

Abandonment Method
Boring backfilled with bentonite upon completion.

Logged by
WG

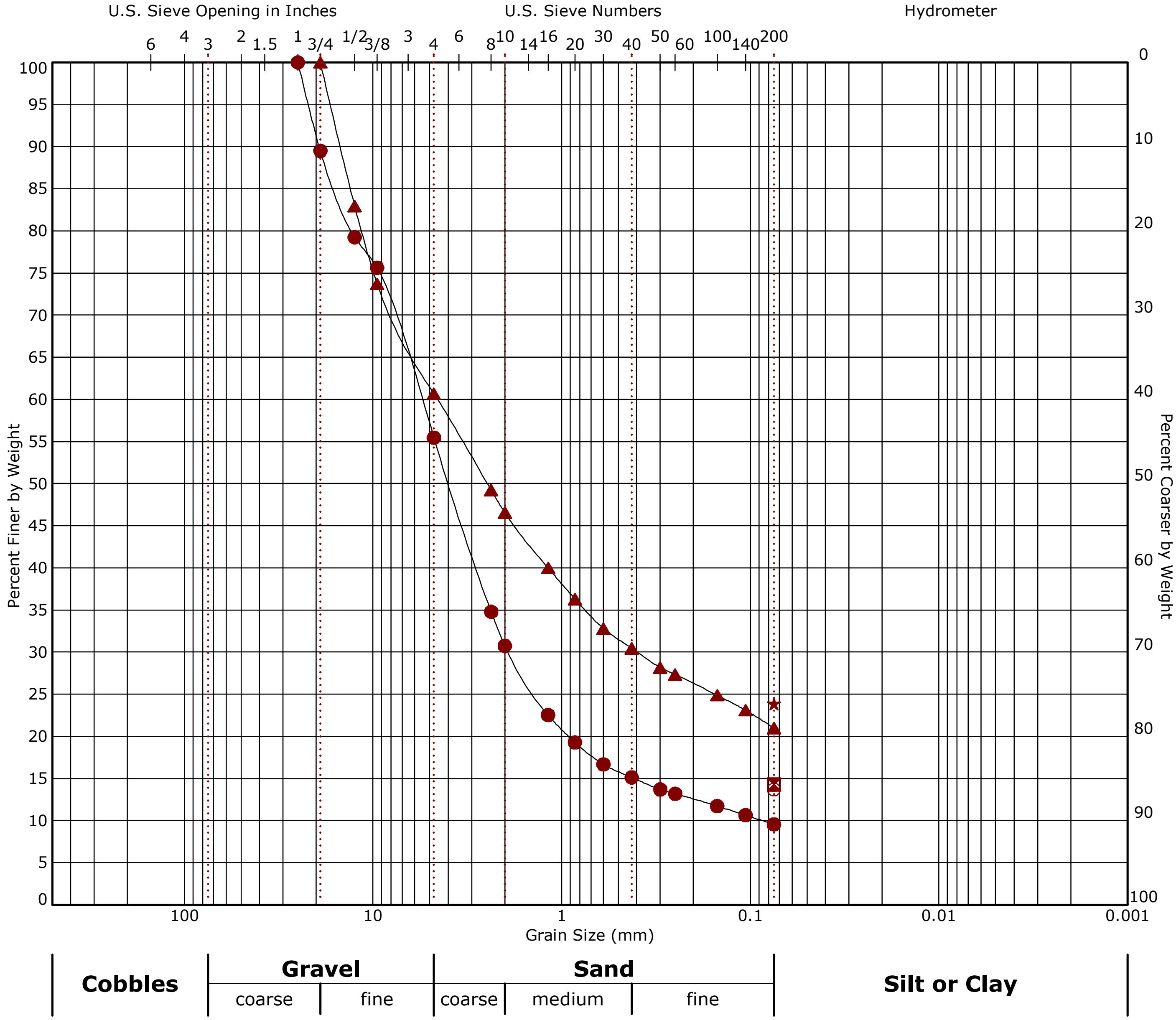
Boring Started
02-11-2025

Boring Completed
02-11-2025

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

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



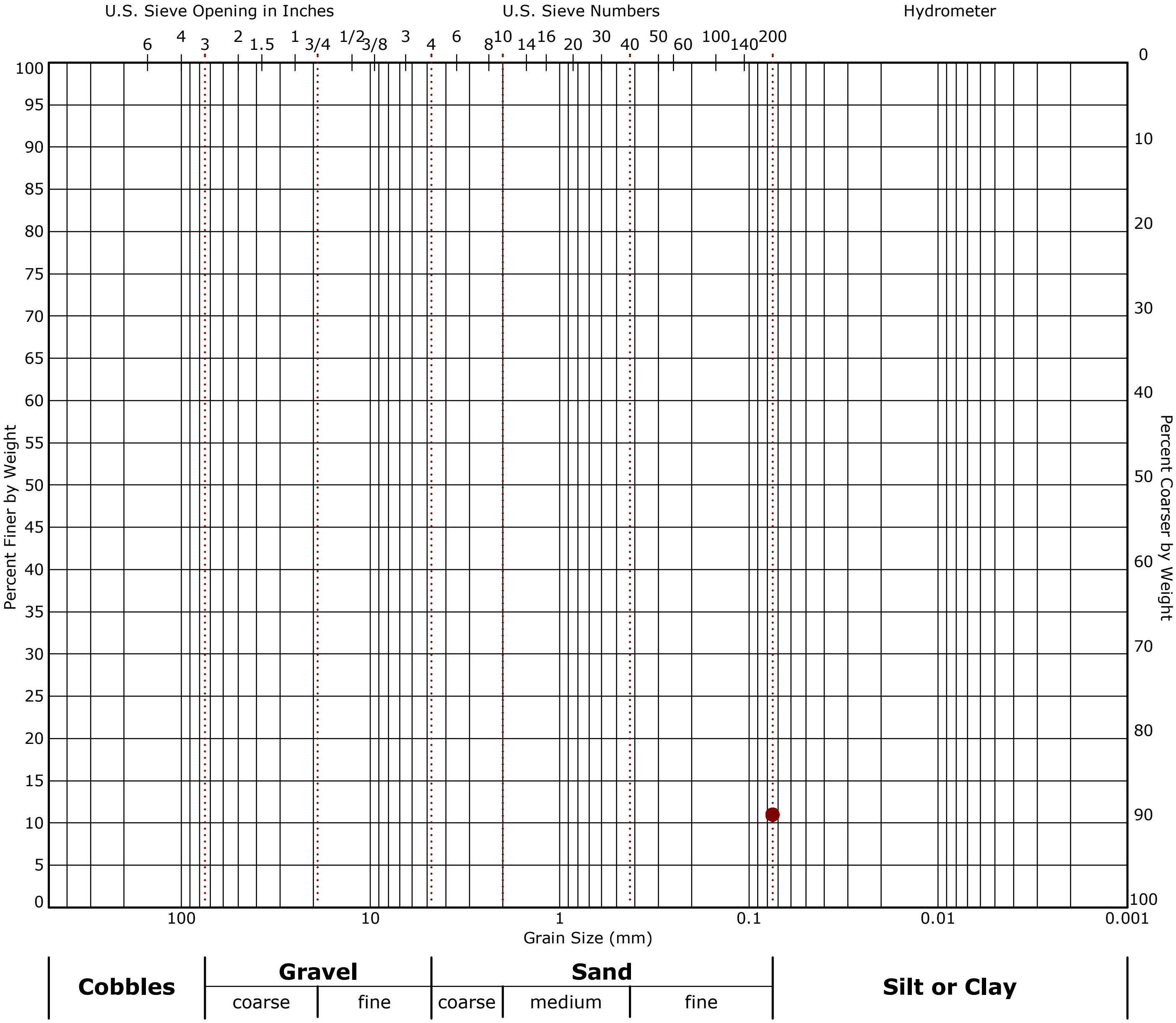
	Boring ID	Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	B-01	5 - 6.5	poorly graded SAND with silt and gravel	SP-SM				7.57	64.27
⊠	B-02	2.5 - 4	silty SAND with gravel	SM					
▲	B-03	5 - 6.5	silty SAND with gravel	SM					
★	B-03	7.5 - 9	silty SAND with gravel	SM					
⊙	B-05	5 - 6.5	silty SAND with gravel	SM					

	Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-01	5 - 6.5	25	5.553	1.906	0.086	0.0	44.5	45.9	9.5		
⊠	B-02	2.5 - 4	0.075							14.3		
▲	B-03	5 - 6.5	19	4.554	0.396		0.0	39.3	39.7	21.0		
★	B-03	7.5 - 9	0.075							23.9		
⊙	B-05	5 - 6.5	0.075							13.7		

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

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Boring ID	Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
● B-06	5 - 6.5	poorly graded SAND with silt and gravel	SP-SM					

Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● B-06	5 - 6.5	0.075							11.0		

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Terracon

Client
Knight-Swift Transportation Holdings Inc.

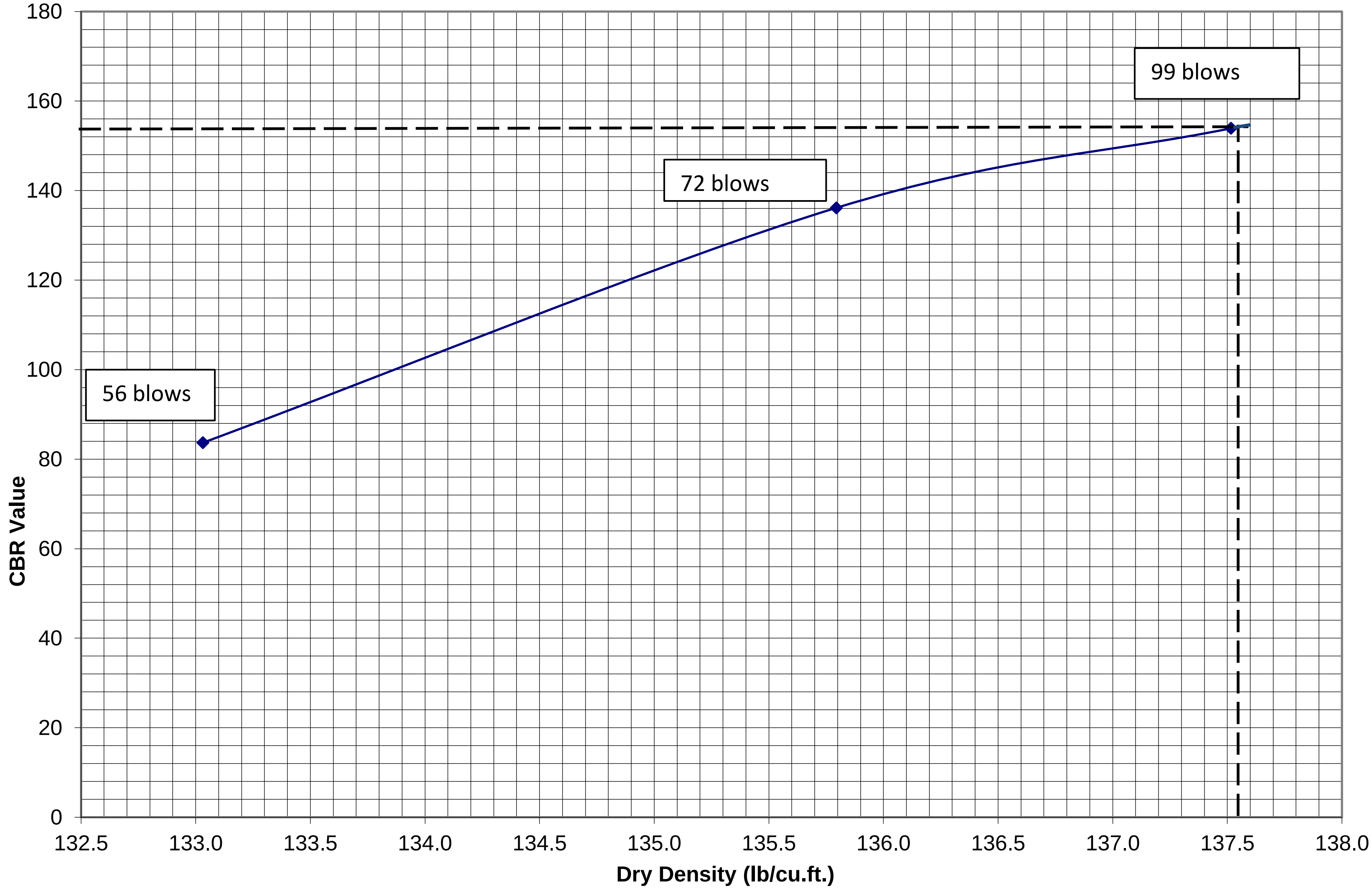
Project
AAA Cooper Terminal - Spokane WA

Sample Submitted By: Terracon (81) **Date Received:** 2/20/2025 **Lab No.: 25-0075**

Results of Corrosion Analysis

Sample Number	--	--	--
Sample Location	B-01	B-02	B-03
Sample Depth (ft.)	2.5	2.5	2.5
pH Analysis, ASTM D4972	8.34	8.65	8.70
Water Soluble Sulfate (SO4), ASTM C 1580 (Percent %)	0.01	0.01	0.01
Sulfides, ASTM D4658, (Percent %)	<0.01	<0.01	<0.01
Chlorides, ASTM D512, (Percent %)	0.01	0.01	0.01
Red-Ox, ASTM G200, (mV)	+729	+727	+728
Total Salts, AWWA 2520 B, (Percent %)	0.04	0.06	0.04
Saturated Minimum Resistivity, ASTM G-57, (ohm-cm)	3551	3149	2613

Analyzed By N. Campo
Nathan Campo
Laboratory Coordinator



Client:	Knight-Swift Transportation Holdings Inc	Maximum Dry Density:	144.8 lbs/ft³
Project:	AAA Cooper Terminal - Spokane WA	Optimum Moisture Content:	4.9%
Project #:	81255013.00	Surcharge Weight:	`10 lbs
Lab: #	647	CBR at 0.1" penetration (95%):	154
Sample Description:	Dark brown gravel with silt, sand, and organics	CBR at 0.2" penetration (95%):	219
Depth of Penetration:	0.5"	Average Swell:	0.4%

Supporting Information

Contents:

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

General Notes

Sampling	Water Level		Field Tests	
Standard Penetration Test		Water Initially Encountered	N	Standard Penetration Test Resistance (Blows/Ft.)
		Water Level After a Specified Period of Time	(HP)	Hand Penetrometer
		Water Level After a Specified Period of Time	(T)	Torvane
		Cave In Encountered	(DCP)	Dynamic Cone Penetrometer
			UC	Unconfined Compressive Strength
			(PID)	Photo-Ionization Detector
			(OVA)	Organic Vapor Analyzer

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.

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. 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		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

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≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [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≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [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 above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					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:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					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] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[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.