TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

September 28, 2023
Project No. T-8565

Mr. Tyler Litzenberger
Vector Development Company
11411 Northeast 124th Street, Suite190
Kirkland, Washington 98034

Subject: Geotechnical Engineering Evaluation
Freeman Logistics
48th Street East and 78th Avenue East
Pierce County, Washington

References: Geotechnical Report, Freeman Logistics, Freeman Road East, and 19th Avenue Northwest, Pierce County, Washington, Project No. T-8565, prepared by Terra Associates, Inc., dated August 11, 2021, Revised July 11, 2022

Dear Mr. Litzenberger:

As requested, we have completed soil explorations along a potential storm sewer line that would connect the northern Freeman Logistics parcel located at Freeman Road East and 19th Avenue Northwest to existing infrastructure located northwest of the site. Our explorations were conducted northwest of the site along a portion of 48th Street East and along the entirety of 78th Avenue East. The purpose of our evaluation is to provide recommendations for excavations, site preparation and grading, utility installation, and pavement design for the project.

Surface/Subsurface

In general, surface conditions along 48th Street East consisted of approximately one to two inches of hot mix asphalt (HMA). The surface conditions along 78th Avenue East consisted of exposed soils and scattered areas of broken asphalt.

Site soils generally consisted of approximately six inches to two and one-half feet of fill material composed of loose to very dense sand with silt and gravel, silty sand with gravel, and silty gravel with sand overlying alluvial deposits consisting of very loose to medium dense sand with varying silt content and very soft to very stiff silt of varying sand content to the termination of the test borings. The exception to this general condition was observed in Test Boring B-301 where the sand with silt material observed underlying the pavement section did not appear to be fill material.

The *Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington* by J.E. Schuster, A.A. Cabibbo, J.F. Schilter, and I.J. Hubert (2015) maps the site as Alluvium (Qa). This mapped description is consistent with the native soils observed onsite.

The preceding discussion is intended to be a general review of the soil conditions encountered. For more detailed descriptions, please refer to the Test Boring Logs attached to this evaluation. The approximate location of the test borings is also shown on Figure 1.

Groundwater

We observed groundwater seepage in every test boring during our explorations. Depth to groundwater ranged from approximately four and one-half feet to nine and one-half feet below existing grades with the observed groundwater levels generally being shallower in the northern test boring locations. The groundwater observed is part of a regional groundwater table within the alluvial formation. We expect groundwater levels and flow rates will fluctuate seasonally and will typically reach their highest levels during, and shortly following, the wet winter months (November through May). Based on the time of year of our explorations, the groundwater likely represents the seasonal low levels.

Excavations

All excavations at the site associated with confined spaces, such as those for utility construction, must be completed in accordance with local, state, or federal requirements. Based on current Washington Industrial Safety and Health Act (WISHA) regulations, the very loose to medium dense granular soils, the very soft to very stiff fine-grained soils, and the fill soils would be classified as Type C soils.

Accordingly, temporary excavations in Type C soils should have their slopes laid back at an inclination of 1.5:1 (Horizontal:Vertical) or flatter, from the toe to the crest of the slope. If there is insufficient space to complete the excavations in this manner, or if excavations greater than 20 feet in depth are planned, temporary shoring to support the excavations may be required. Properly designed and installed shoring trench boxes can be used to support utility trench excavations where required.

Based on our study, groundwater should be anticipated within excavations extending below depths of about four to ten feet below native surface grades. Excavations extending below this depth may encounter groundwater with volumes and flow rates sufficient to require some level of dewatering. Shallow excavations that do not extend more than two to three feet below the groundwater table can likely be dewatered by conventional sump-pumping procedures, along with a system of collection trenches. Deeper excavations will require dewatering by well points or isolated deep-pump wells. The utility subcontractor should be prepared to implement excavation dewatering by well point or deep-pump wells, as needed. This will be an especially critical consideration for any deep excavations such for lift stations and sanitary sewer tie-ins.

This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

Site Preparation and Grading

All exposed bearing surfaces should be observed by a representative of Terra Associates, Inc. to verify soil conditions are as expected and suitable for support of new pavement sections. Our representative may request a proofroll using heavy rubber-tired equipment to determine if any isolated soft or yielding areas are present. If excessively yielding areas are observed and they cannot be stabilized in place by compaction, the affected soil should be excavated and removed to firm bearing and grade restored with new structural fill. If the depth of excavation to remove unstable soils is excessive, the use of geotextile fabrics, such as Mirafi 500X or an equivalent fabric can be used in conjunction with clean granular structural fill. Our experience has shown, in general, that a minimum of 18 inches of a clean, granular structural fill placed and compacted over the geotextile fabric should establish a stable bearing surface.

The majority of the soils encountered at the site contain a sufficient amount of soil fines that will make them very difficult to compact as structural fill when too wet or too dry. The ability to use soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If wet soils are encountered, the contractor will need to dry the soils by aeration during dry weather conditions. Alternatively, the use of an additive, such as Portland cement, cement kiln dust (CKD), or lime to stabilize the soil moisture can be considered. If the soil is amended, additional Best Management Practices (BMPs) addressing the potential for elevated pH levels will need to be included in the Storm Water Pollution Prevention Program (SWPPP) prepared with the Temporary Erosion and Sedimentation Control (TESC) plan.

If utility installation activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet-weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

* Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-1557 (Modified Proctor). If native silt soils are used as trench backfill, we recommend fill be placed in uniform loose layers not exceeding six inches in thickness. The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard.

Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA), or local jurisdictional specifications. At a minimum, trench backfill should be placed and compacted as structural fill as described in the preceding section of this evaluation. As noted, the soils are moisture sensitive and close moisture control will be required to facilitate proper compaction. If utility construction takes place during the wet winter months, it will likely be necessary to import suitable wet-weather fill for utility trench backfilling.

The utility contractor should also be prepared for encountering unstable soft/loose alluvial soils below the pipe invert elevations. If not removed from below the pipe and replaced with crushed rock or additional bedding material, pipe deflections may occur as a result of the soil yielding and compressing in response to loading imposed during trench backfilling. The need to overexcavate and stabilize the pipe foundation before backfilling should be evaluated by observation and testing during construction. We recommend utilizing pipe connections that can accommodate the anticipated settlements discussed in the referenced geotechnical report.

Provided that the contractor follows the above recommendations and the compaction testing meets the outlined requirements, it is our opinion that the risk for post construction settlement along the trench line would be minimal.

Pavements

Pavement subgrades should be prepared as described above and must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy rubber-tired construction equipment such as a loaded ten-yard dump truck to verify this condition. The upper surface conditions in the majority of the test borings indicate some level of stabilization would likely be necessary to create a stable subgrade for the pavement.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. We expect traffic along the roadways will consist of cars and light trucks, along with occasional heavy traffic in the form buses and garbage collector rigs. Following the American Association of State Highway and Transportation Officials (AASHTO) procedures, we used a design 18-kip equivalent single axle load (ESAL) of 50,000 based on our experience with similar projects. We have assigned a M_r value of 9,000 psi to the native and existing fill soils supporting the new pavement section.

We used the Washington State Department of Transportation (WSDOT) structural coefficients of 0.50 for HMA and 0.13 for crushed rock base (CRB) in determining the design of the pavement section. Additional design parameters required for the AASHTO procedure and selected for our analysis include the following:

- Reliability – 90 percent
- Standard deviation – 0.45
- Present serviceability index – 3.5
- Terminal serviceability index – 2.0

Based upon the above parameters, the structural number required to support the design ESAL is 1.98. This equates to three inches of HMA over four inches of CRB, or five inches of HMA over stable subgrade.

Long-term pavement performance will depend upon surface drainage. A poorly drained pavement section will be subject to premature failure resulting from surface water infiltrating the subgrade soils and reducing their supporting capability. For optimum performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks as they occur.

We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

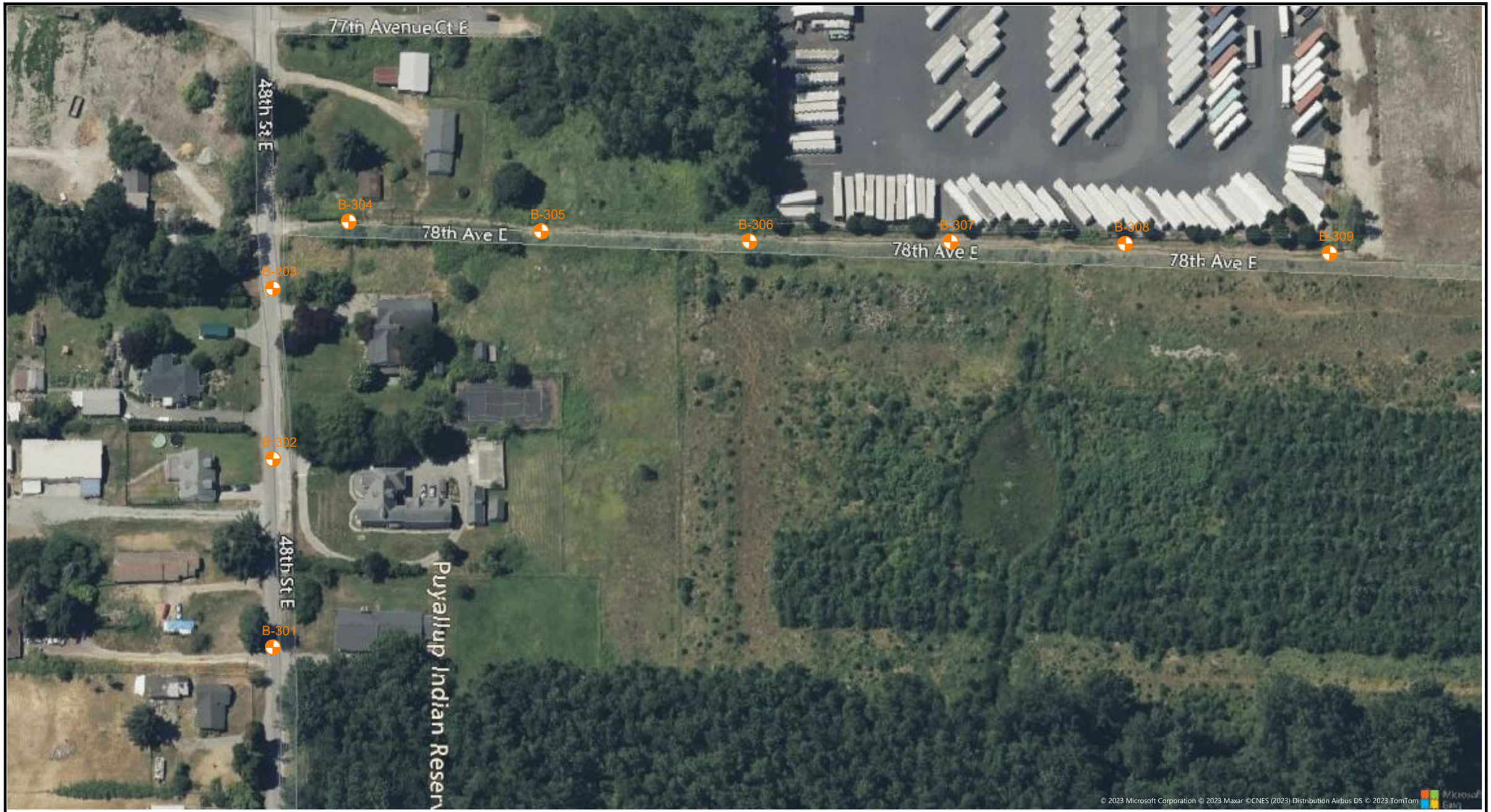
Michael J. Xenos, E.I.T.
Staff Engineer

CAROLYN S. DECKER
STATE OF WASHINGTON
47016
REGISTERED
PROFESSIONAL ENGINEER

9-28-2023

Carolyn S. Decker, P.E.
President

Encl. Figure 1 – Exploration Location Plan
Figures 2 through 10 – Test Boring Logs



NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE: SITE PLAN PROVIDED BY BING MAPS.

LEGEND:

APPROXIMATE BORING LOCATION

0 100 200

APPROXIMATE SCALE IN FEET

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
FREEMAN LOGISTICS
PUYALLUP, WASHINGTON

Proj.No. T-8565	Date:SEPT 2023	Figure 1

LOG OF BORING NO. B-301

Figure No. 2

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 9.5 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 / 30 / 50)	Moisture Content (%)
0		(1-inch HOT MIX ASPHALT)			
		Brown SAND with silt, fine to medium sand, dry, trace silt seams. (SP-SM)	Medium Dense		13.0
		Brown sandy SILT, fine to medium SAND, dry, occasional silt layer. (ML)	Loose	7	28.6
5		Gray SILT, moist, mottled. (ML)	Medium Stiff	5	34.5
		Gray SAND with silt, moist, interbedded silt seams. (SP-SM)	Medium Dense	14	18.6
		Gray SAND, fine to coarse sand, wet, occasional silt seam. (SP)			
10				13	24.5
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 9.5 feet.			

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

LOG OF BORING NO. B-302

Figure No. 3

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 7 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 30 50)	Moisture Content (%)
0		(1-inch HOT MIX ASPHALT)	Loose		27.2
		FILL: Gray SAND with silt and gravel, fine to coarse sand, fine to coarse gravel, dry. (SP-SM)			
		Gray SILT, moist, mottled, interbedded sand with silt layers and silty sand seams. (ML)	Medium Stiff	4	37.4
5			Stiff	13	23.5
		Gray silty SAND, fine to medium sand, wet, interbedded silt seams. (SM)	Loose	7	28.1
10				8	30.2
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 7 feet.			

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

LOG OF BORING NO. B-303

Figure No. 4

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 7 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 / 30 / 50)	Moisture Content (%)
0		(2-inches HOT MIX ASPHALT) FILL: Gray silty GRAVEL with sand, fine to coarse sand, fine to coarse gravel, dry. (GM)	Very Dense		5.1
		Grayish-brown silty SAND, fine to medium sand, moist, occasional silt layer. (SM)	Loose	6	17.7
5		Gray SILT, moist, slightly mottled, occasional small-sized organic fragment, interbedded silty sand seams. (ML)	Medium Stiff	7	34.7
		Gray SILT with sand, fine to medium sand, moist to wet. (ML)		4	29.5
10		Gray SILT, moist to wet, interbedded silty sand layers. (ML)	Stiff	14	29.0
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 7 feet.			

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

LOG OF BORING NO. B-304

Figure No. 5

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 8.5 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 30 50)		Moisture Content (%)
0		FILL: Gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, dry. (SM)	Medium Dense			4.0
		Gray silty SAND, fine sand, moist, mottled. (SM)			11	20.5
5		Gray SILT, moist to wet, mottled, interbedded sand with silt seams and silty sand layers. (ML) *Scattered charcoal fragments observed in sampler*			8	40.6
			Stiff		9	33.6
10					13	29.2
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 8.5 feet.				

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

LOG OF BORING NO. B-305

Figure No. 6

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 5.5 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 30 50)		Moisture Content (%)
0		FILL: Gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, dry. (SM)	Medium Dense			4.7
		Brown SAND with silt, fine to medium sand, moist, occasional silt layer. (SP-SM)			12	14.8
5		Brown silty SAND, fine to medium sand, moist to wet. (SM)	Very Loose		1	33.4
		Gray SILT, wet, slightly mottled. (ML)	Very Soft			
		Gray sandy SILT, fine to medium sand, wet, interbedded silty sand seams. (ML)	Loose		7	30.7
10		Gray silty SAND, fine to medium sand, wet, occasional silt seam. (SM)	Medium Dense		11	29.5
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 5.5 feet.				

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

LOG OF BORING NO. B-306

Figure No. 7

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 5.5 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 30 50)		Moisture Content (%)
0		FILL: Gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, dry to moist. (SM)	Medium Dense			6.7
		Gray silty SAND, fine to medium sand, dry to moist, slightly mottled, occasional silt layer. (SM)	Loose		8	17.3
			Very Loose		2	29.5
5		Gray SILT, moist to wet, slightly mottled, occasional sand with silt layer. (ML)	Very Soft			
			Medium Stiff		6	38.2
10					9	27.4
		Black SAND, fine to medium sand, wet. (SP)	Loose			
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 5.5 feet.				

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

LOG OF BORING NO. B-307

Figure No. 8

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 5 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 / 30 / 50)	Moisture Content (%)
0		FILL: Gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, dry. (SM)	Medium Dense		6.5
		Gray sandy SILT, fine to medium sand, dry to moist, mottled. (ML)		10	19.4
5 ▼		Gray SILT, moist to wet, slightly mottled, occasional rootlet, interbedded sand layers. (ML)	Medium Stiff	5	36.6
			Very Stiff	16	33.0
10		Black SAND, fine to coarse sand, wet, trace small-sized organic fragments, occasional silty sand layer. (SP)	Medium Dense	13	25.4
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 5 feet.			

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

LOG OF BORING NO. B-308

Figure No. 9

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 4.5 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 30 50)		Moisture Content (%)
0		FILL: Gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, dry to moist, trace rootlets. (SM)	Medium Dense			3.9
		Gray silty SAND, fine to medium sand, moist, mottled. (SM)	Loose		8	16.7
5		Gray SILT with sand, fine to medium sand, moist to wet, interbedded sand with silt layers. (ML)	Medium Stiff		4	31.9
		Gray sandy SILT, fine to medium sand, moist to wet, interbedded silty sand seams. (ML)	Loose		9	30.2
10		Black SAND, fine to coarse sand, wet, interbedded silty sand and sandy silt layers. (SP)	Medium Dense		11	26.8
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 4.5 feet.				

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

LOG OF BORING NO. B-309

Figure No. 10

Project: Freeman Logistics - 48th St E **Project No:** T-8565 **Date Drilled:** September 6, 2023

Client: Vector Development Company **Driller:** BoreTec **Logged By:** MJX

Location: Fife, Washington **Depth to Groundwater:** 4.5 feet **Approx. Elev:** NA

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot (10 30 50)		Moisture Content (%)
0		FILL: Gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, dry to moist, occasional rootlet, occasional small-sized organic fragment. (SM)	Medium Dense			5.7
		Gray sandy SILT, fine sand, moist to wet, mottled, interbedded silty sand seams. (ML)	Loose	•	4	29.6
5				•	5	34.9
		Gray SILT with sand, fine to medium sand, moist to wet, slightly mottled, trace sand seams, occasional silty sand layer. (ML)	Stiff	•	10	32.2
10				•	8	27.8
		Test Boring terminated at approximately 10 feet. Groundwater seepage observed at approximately 4.5 feet.				

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences