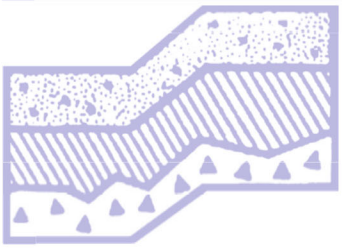
DRAFT

GEOTECHNICAL REPORT

Sherwood Industrial
13700 Southwest Tonquin Road
Sherwood, Oregon

Project No. T-8912



Terra Associates, Inc.

Prepared for:

Panattoni Development Company
Tacoma, Washington

July 20, 2023

TERRA ASSOCIATES, Inc.

Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

July 20, 2023
Project No. T-8912

DRAFT

Ms. Brenda Fodge
Panattoni Development Company
1821 Dock Street, Suite 100
Tacoma, Washington 98402

Subject: Geotechnical Report
Sherwood Industrial
13700 Southwest Tonquin Road
Sherwood, Oregon

Dear Ms. Fodge:

As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Basalt bedrock underlies the entire site at relatively shallow depths. Where encountered, soils overlying the bedrock consist mainly of fill composed predominantly of silty sand with gravel to silty gravel with sand containing numerous angular basalt cobbles and scattered basalt boulders. Native soils encountered in several of the test pits included slightly clayey to clayey silt, fine sandy silt, and silty fine sand. We did not observe groundwater seepage in any of the test pits.

In our opinion, the building can be supported on conventional spread footings bearing on properly prepared native materials, on structural fill that is placed and compacted on a competent subgrade, or on existing medium dense to dense fill that is composed primarily of mineral soil and/or rock fragments. Pavement and floor slabs can be similarly supported. Excavations at the site extending more than a few feet below existing grade will likely require the use of hard rock excavation methods.

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

Sincerely yours,
TERRA ASSOCIATES, INC.

John C. Sadler, R.G.
Senior Engineering Geologist

DRAFT

Carolyn S. Decker, P.E.
President

12220 113th Avenue NE, Ste. 130, Kirkland, Washington 98034
Phone (425) 821-7777

TABLE OF CONTENTS

Page No.

Figures

Appendices

Geotechnical Report
Sherwood Industrial
13700 Southwest Tonquin Road
Sherwood, Oregon

1.0 PROJECT DESCRIPTION

The proposed project consists of developing the property with an approximately 407,150 square-foot industrial building along with associated infrastructure improvements. A schematic site plan by Twinsteps Architecture, dated May 8, 2023, shows the building located in the southern portion of the site with dock high loading located on the south side of the building. A stormwater detention pond and a semi-trailer parking area are located northwest of the building.

Site development and building plans are currently not available. We expect the building will be constructed using precast concrete tilt-up perimeter wall panels with interior columns supporting the roof structure. The floor slab will be constructed at grade. Structural loading is expected to be light to moderate, with isolated columns carrying loads of 80 to 150 kips and bearing walls carrying 6 to 8 kips per foot. Maximum product loading on the floors is not expected to exceed 350 pounds per square foot (psf).

The recommendations in the following sections of this report are based on our understanding of the design features outlined above. We should review design drawings as they become available to verify that our recommendations have been properly interpreted and to supplement them, if required.

2.0 SCOPE OF WORK

Our work was completed in accordance with our authorized proposal, dated June 13, 2023. Accordingly, on June 29, 2023, we explored subsurface conditions at the site by excavating 26 test pits to maximum depths ranging from about 1 to 10.5 feet below existing ground surface using a track-mounted excavator. Using the results of our field study and laboratory testing, we performed analyses to develop geotechnical engineering recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions.
- Seismic considerations.
- Site preparation and grading.
- Excavations.
- Foundations.
- Slab-on-grade floors.
- Lateral earth pressures for retaining wall design.
- Infiltration feasibility.
- Stormwater detention pond.

- Drainage.
- Utilities.
- Pavements.

It should be noted that recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment are beyond Terra Associates' purview. A building envelope specialist or contractor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The site is an approximately 28-acre assemblage of two vacant tax parcels located east of and adjacent to Southwest Tonquin Road, and approximately 300 to 1,700 feet south of the intersection with Southwest Oregon Street in Sherwood, Oregon. The approximate site location is shown on Figure 1.

The two site parcels are individually referred to in this report as the West Parcel and the East Parcel. The parcel locations and existing site topography are shown on Figure 2. Generalized parcel descriptions are presented below.

West Parcel

The West Parcel is a vacant, 8.16-acre, triangular-shaped property. The western and northern parcel margins are bordered by Southwest Tonquin Road and a private road/driveway, respectively. The northern approximately 600 feet of the eastern property margin is bordered by a new development that is currently being cleared and graded. The southern approximately 600 feet of the eastern parcel margin adjoins the East Parcel of the subject site.

Topography generally slopes down to the west-southwest to Southwest Tonquin Road with a topographic relief of about 60 feet. Existing surface gradients are relatively flat in the upper eastern portion of the parcel. Elevation contours obtained for the site using the Washington County GIS Intermap website (https://wcgis1.co.washington.or.us/Html5Viewer/index.html?viewer=Intermap) shows slope gradients in the northern portion of the West Parcel typically ranging between about 7 and 40 percent. Slope gradients in the southern portion of the West Parcel are generally steeper, with inclinations typically ranging between about 25 and 50 percent. Localized slope areas as steep as 100 percent are located adjacent to a road cut for an access road that traverses down the slope form the East Parcel to Southwest Tonquin Road, and the cut for a former haul road between the East Parcel and the central portion of the West Parcel. We did not observe any obvious on-site indications of instability, significant active erosion, groundwater seepage, or persistently wet surface conditions.

Site vegetation generally consists of grasses, brush, with scattered deciduous and coniferous trees near the western and northeastern site margins. We observed an area in the east-central portion of the West Parcel where hand-held GPS positioning indicates that active grading associated with a new fill embankment for the east-adjacent site development work extends more than 100 feet into the subject property.

East Parcel

The East Parcel is a rectangular, 20-acre property that is adjacent to the southeastern margin of the West Parcel. Areas of the site are currently being used by a construction company for stockpiling and dumping mineral soil and aggregates, material processing, and heavy equipment parking. Surface indications of past rock quarrying are visible in the central portion of the site, including a large rectangular excavation that is bordered by a vertical rock ledge. We observed surface indications of fill placement throughout much of the western and central areas of the parcel, including a relatively steep fill embankment near the western parcel margin and windrowed mineral soil fill within the rectangular rock excavation area. At the time of our fieldwork, imported vegetation debris was being stockpiled in the east-central portion of the parcel. We did not observe any other areas where significant amounts of vegetation had been dumped.

Existing topography is relatively flat to undulating with a gentle overall slope down to the west. Topographic relief between the eastern and western parcel margins is generally about 40 feet, but increases to about 70 feet at the southwest parcel corner. Surface gradients near the southwestern parcel corner slope down to the southwest at about 26 percent. Localized slope areas adjacent to the road cuts described above are generally between about 50 and 100 percent. We did not observe any obvious on-site indications of instability, significant active erosion, groundwater seepage, or persistently wet surface conditions. The vast majority of the parcel has been cleared of vegetation. The slope areas in the western portion of the parcel are generally vegetated with grasses, brush, and scattered younger deciduous trees.

3.2 Subsurface Exploration

Columbia River Basalt bedrock was encountered in all the test pits except Test Pits TP-17 and TP-18, which were terminated due to excavator refusal in materials interpreted to be fill at depths of about 7.5 feet and 10.5 feet, respectively. The competent basalt is generally brown to gray, moderately weak to moderately strong (R2 to R3), highly fractured with closely- to moderately-spaced fractures, and slightly to moderately weathered. Completely- to highly-weathered basalt consisting of medium dense to dense silty sand with gravel to silty gravel with sand, scattered to numerous angular to subangular basalt cobbles, and scattered angular to subangular basalt boulders was encountered in eight of the test pits between the ground surface and a maximum depth of about six and one-half feet.

We observed native soils consisting of medium stiff to stiff, slightly clayey to clayey silt; medium dense, dark brown organic silty sand; and medium dense, silty fine sand, overlying the basalt in Test Pits TP-5, TP-11, and TP-23, respectively. Test Pit TP-16 was terminated in medium dense to dense, fine sandy silt at a depth of about 10 feet. The fine sandy silt and silty fine sand observed in Test Pits TP-16 and TP-23 are interpreted to be fine grained Missoula flood deposits. The slightly clayey to clayey silt observed in Test Pit TP-5 and organic silty sand observed in Test Pit TP-11 are interpreted to be a localized lacustrine deposit and a former topsoil horizon.

Fill soils consisting predominantly of medium dense to dense, silty sand with gravel with scattered angular basalt cobbles and occasional trace amounts of debris and organics were observed in 13 of the test pits. Fill thicknesses ranged between about one foot at Test Pits TP-2, TP-5, and TP-15 to at least 10.5 feet in Test Pit TP-18. Test Pits TP-17 and TP-18 were terminated in materials interpreted to be fill or possible fill due to excavator refusal or reach limitations.

The *Lidar-Based Surficial Geologic Map and Database of the Greater Portland Area, Clackamas, Columbia, Marion, Multnomah, Washington, and Yamhill Counties, Oregon, and Clark County, Washington* by Lina Ma, Ian P. Madin, Serin Duplantis, and Kendra J. Williams (2012) shows surficial geology at the subject site mapped as fine-grained Missoula flood deposits (Mff) in the area of the West Parcel and Columbia River Basalt bedrock (Br) in the area of the East Parcel. Based on our site explorations, basalt bedrock consistent with the Br geologic map unit underlies the vast majority of the site. The fine-grained soils observed Test Pits TP-16 and TP-23 are generally consistent with the Mff geologic map unit.

Detailed descriptions of the subsurface conditions observed in the test pits are presented on the Test Pit Logs in Appendix A. The approximate test pit locations are shown on Figure 3.

3.3 Groundwater

We observed indications of localized perched groundwater in Test Pit TP-9, where the basalt fracture faces were generally iron-oxide stained and wet, but exhibited no sustained seepage. Although not observed at other site locations, we expect that shallow perched groundwater develops at the site at times, with the most prevalent development occurring during the normally wet winter and spring months.

3.4 Seismic Site Class

Based on the conditions observed in the subsurface explorations and our knowledge of the area geology, per Chapter 16 of the current International Building Code (IBC), site class "C" should be used in structural design.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Based on our study, in our opinion, there are no geotechnical considerations that would preclude development of the site, as currently planned. The primary geotechnical consideration is the presence of relatively hard basalt bedrock that underlies the entire site at relatively shallow depths. We expect that site excavations extending more than a few feet into the basalt would require the use of hard-rock excavation methods.

In our opinion, the building can be supported on conventional spread footings bearing on competent native soils and bedrock, on structural fill that is placed and compacted on a competent subgrade, or on existing medium dense to dense fill that is composed primarily of mineral soil and/or rock fragments. Pavement and floor slabs can be similarly supported. Fill materials that are in a loose condition and/or contain excessive organic material or debris will not be suitable and should be removed and replaced with structural fill.

The building will be subject to differential settlement where foundation support and pavement subgrades transition from rock to native soil or fill. In our opinion, overexcavating the rock at least 12 inches and restoring grade with granular structural fill to create a uniform subgrade condition beneath the building foundations and pavement section would significantly reduce the potential for differential building settlement and pavement distress.

Most of the native soils and existing fill soils encountered at the site contain a significant amount of soil fines that will make compaction as structural fill difficult when too wet. The ability to use the native soil from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during the wet winter months, the owner should be prepared to import clean granular material for use as structural fill and backfill. The use of excavated rock and some of the existing fill materials as structural fill will require efforts by the contractor to maintain a maximum rock fragment size of three inches in diameter or less.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections. These recommendations should be incorporated into the final design drawings and construction specifications.

4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious material should be stripped and removed from the site. Organic surface soils are generally absent or sparsely distributed across the site. Based on conditions observed in the test pits, we expect that stripping depths would generally be less than four to six inches. Soil containing organic material will not be suitable for use as structural fill but may be used for limited depths in nonstructural areas.

Once stripping operations are complete, cut and fill operations can be initiated to establish desired site grades. As noted above, site excavations extending more than a few feet below existing grade will likely encounter relatively-hard basalt bedrock that will require the use of hard rock excavation methods.

Prior to placing fill, all exposed bearing surfaces should be observed by a representative of Terra Associates, Inc. to verify conditions are as expected and suitable for support of new fill or building elements. In areas underlain by soil, our representative may request a proofroll using heavy rubber-tired equipment to determine if any isolated soft and yielding areas are present. If excessively yielding areas are observed, and they cannot be stabilized in place by compaction, the affected soils 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 that, in general, a minimum of 18 inches of a clean, granular structural fill place and compacted over the geotextile fabric should establish a stable bearing surface.

Our study indicates that most of the site soils and existing fill materials contain a sufficient percentage of fines (silt and clay size particles) that may make them difficult to compact as structural fill if they are too wet or too dry. Accordingly, the ability to use these materials as structural fill will depend on their moisture content and the prevailing weather conditions when site grading activities take place. Soils that are too wet to properly compact could be dried by aeration during dry weather conditions or mixed with an additive such as cement or lime to stabilize the soil and facilitate compaction. If an additive is used, additional Best Management Practices (BMPs) for its use will need to be incorporated into the Temporary Erosion and Sedimentation Control plan (TESC) for the project. Soils that are dry of optimum should be moisture conditioned by controlled addition of water and blending prior to material placement. The use of excavated rock and some of the existing fill materials as structural fill will require efforts by the contractor to maintain a maximum rock fragment size of three inches in diameter or less.

If grading 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 ¾-inch fraction.

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

Structural fill should be placed in uniform loose layers not exceeding 6 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-698 (Standard Proctor). 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. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

4.3 Excavations

All excavations at the site associated with confined spaces, such as utility trenches, must be completed in accordance with local, state, and federal requirements. Based on regulations outlined in the Occupational Safety and Health Administration (OSHA), the fine-grained native silt soils would be classified as Type B soil. Existing fill soils would be classified as Type C soil.

Accordingly, for temporary excavations of more than 4 feet and less than 20 feet in depth, the side slopes in Type B soil can be sloped at an inclination of 1:1 (Horizontal:Vertical) or flatter. Type C soils should be sloped at an inclination of 1.5:1 or flatter. If there is insufficient room to complete the excavations in this manner, the use of temporary shoring may need to be considered to support the excavation. A properly designed and installed shoring trench box can be used to support utility trench excavation sidewalls. Excavations made in the moderately weak to moderately strong (R2 to R3) basalt bedrock that requires hard rock excavation methods can be made vertical.

Based on the conditions observed in the test pits, we do not expect that site excavations will encounter significant groundwater seepage during the normally dry summer and fall months. If groundwater is encountered, conventional sump pumping procedures, along with a system of collection trenches if necessary, should be capable of maintaining a relatively dry excavation for construction purposes.

The above 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.

4.4 Foundations

The industrial building may be supported on conventional spread footing foundations bearing on foundation subgrade prepared as recommended in Section 4.2 of this report. Perimeter foundations exposed to the weather should bear at a minimum depth of one and one-half feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab.

We recommend designing foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used in design. Based on the structural loading as anticipated and this bearing stress applied, estimated immediate maximum foundation settlements of about one-inch and differential settlement of one half-inch should be expected.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the sides of the footings can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 350 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because it can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be backfilled with structural fill, as described in Section 4.2 of this report. The values recommended include a safety factor of 1.5.

4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on a subgrade as recommended in Section 4.2. Immediately below the floor slab, we recommend placing a four-inch thick capillary break layer composed of clean, coarse sand or fine gravel that has less than five percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and to aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will not be effective in assisting uniform curing of the slab and can actually serve as a water supply for moisture bleeding through the slab, potentially affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained. We recommend floor designers and contractors refer to the current American Concrete Institute (ACI) Manual of Concrete Practice for further information regarding vapor barrier installation below slab-on-grade floors.

4.6 Lateral Earth Pressures for Retaining Walls

The magnitude of earth pressures developing on below-grade walls will depend upon the quality and compaction of the wall backfill. We recommend placing and compacting wall backfill as structural fill, as described in Section 4.2 of this report. To prevent overstressing the walls during backfilling, heavy construction machinery should not be operated within five feet of the back of the wall. Wall backfill in this zone should be compacted with hand-operated equipment. To prevent hydrostatic pressure development, wall drainage must also be installed. A typical wall drainage detail is shown on Figure 4.

With wall backfill placed and compacted as recommended, and drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pounds per cubic foot (pcf). For restrained walls, an additional uniform load of 100 psf should be added to the 35 pcf. To account for typical traffic surcharge loading, the walls can be designed for an additional imaginary height of two feet (two-foot soil surcharge). For evaluation of wall performance under seismic loading, a uniform pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall should be applied in addition to the static lateral earth pressure. These values assume a horizontal backfill condition and that no other surcharge loading, sloping embankments, or adjacent buildings will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 4.4 of this report.

4.7 Infiltration Feasibility

Based on our study, it is our opinion that subsurface conditions at the site would not support infiltration of site stormwater or the use of low impact development (LID) techniques.

4.8 Stormwater Detention Pond

The schematic site plan shows a stormwater detention pond occupying most of the central portion of the West Parcel. Proposed pond elevations and grading plans are currently not available; however, with existing slope gradients in the area ranging between about 15 and 25 percent, we expect pond construction would require both rock cuts and construction of a structural fill berm on the downgradient perimeter.

Berm locations should be stripped of any organic surface soils prior to the placement of fill. The fill soil used for berm construction should be moisture conditioned to within 2 percent of its optimum moisture, placed in loose lifts of 12 inches or less, and mechanically compacted to at least 95 percent of the maximum dry density determined by ASTM Test Designation D-1557 (Modified Proctor). Material used to construct pond berms should consist of predominately granular soils with a maximum size of 3 inches and a minimum of 20 percent soil fines (material passing the No. 200 sieve). Terra Associates, Inc. should examine and test all onsite or imported materials proposed for use as berm fill prior to their use.

Because of exposure to fluctuating stored water levels, soils exposed on the interior pond slopes may be subject to some risk of periodic shallow instability or sloughing. Establishing interior slopes at a 3:1 gradient will significantly reduce or eliminate this potential. Exterior berm slopes and interior slopes above the maximum water surface should be graded to a finished inclination no steeper than 2:1. Finished slope faces should be thoroughly compacted and vegetated to guard against erosion.

Lining the pond with either a compacted soil liner or a flexible membrane liner (FML) would adequately mitigate the potential for water loss into the underlying fractured basalt bedrock. The liner can consist of soils meeting the gradation recommended above for pond containment berms. A compacted soil liner should have a minimum thickness of two feet. If a FML is used, we recommend that it have a minimum thickness of 40 mils. Plastic, HDPE, or a composite liners can be considered. The liner should be installed on a properly prepared subgrade in accordance with the liner manufacturer's specifications. If the pond slopes are required to be vegetated, it will be necessary to specify a liner that will exhibit sufficient friction to ensure topsoil will not slide off the liner when the pond is in service. Alternatively, a geo-cell confinement system could be installed over the liner and infilled with topsoil.

As penetrations through the liner would not be allowed, the geo-cell system would need to be anchored at the top of the pond in a keyway and supported by tendons that extend through the geo-cell webbing. Geo-Web cellular confinement or similar systems could be considered for this purpose.

4.9 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the building at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building area. We recommend providing a positive drainage gradient away from the building perimeter. If this gradient cannot be provided, surface water should be collected adjacent to the structures and disposed to appropriate storm facilities.

Surface water must not be allowed to flow uncontrolled over the crest of the site slopes and embankments. Surface water should be directed away from the slope crests to a point of collection and controlled discharge. If site grades do not allow for directing surface water away from the slopes, then water should be collected and tightlined down the slope face in a controlled manner.

Subsurface

With positive drainage away from the building provided and with paved surfaces extending to the building perimeter, in our opinion, customary installation of the perimeter foundation drains would not be required. Foundation drains should be installed where positive drainage is not provided or where soft landscaping will occur at the building perimeter. The drains can consist of 4-inch diameter perforated PVC pipe that is enveloped in washed ½- to ¾-inch gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The foundation drains and roof downspouts should be tight-lined separately to an approved point of controlled discharge. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once each year.

4.10 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or local jurisdictional requirements. At a minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report.

As noted, we anticipate that most site excavations extending more than a few feet below existing site grades would encountered moderately weak to moderately strong (R2 to R3) basalt bedrock that will likely require hard rock excavation methods. Utility trenches that terminate in intact rock or cobble- to boulder-size rock fragments should be over excavated to allow for the placement of a leveling course of at least four inches of structural fill or pipe bedding material. Native soils and existing fill materials observed at the site would generally be suitable for use as trench backfill material provided they can be adequately moisture conditioned to facilitate proper compaction and do not contain rock fragments greater than three inches in diameter. Imported material used for utility trench backfilling should meet the gradation recommended for wet weather fill in Section 4.2.

4.11 Pavements

Pavement subgrade should be prepared as described in the Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy rubber-tired construction equipment such as a load ten-yard dump truck to verify this condition. As noted, pavement subgrades consisting of moderately weak to moderately strong (R2 to R3) basalt bedrock should be overexcavated to allow placement of at least 12 inches granular structural fill to create a uniform subgrade condition.

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 at the facility will consist of cars and light trucks, along with heavy traffic in the form of tractor-trailer rigs. For design considerations, we have assumed traffic in parking and in car/light truck access pavement areas can be represented by an 18-kip Equivalent Single Axle Loading (ESAL) of 50,000 over a 20-year design life. For heavy traffic pavement areas, we have assumed an ESAL of 500,000 would be representative of the expected loading. These ESALs represent traffic loading equivalent to 3 and 29, loaded (80,000 pound gross vehicle weight) tractor-trailer rigs, respectively, traversing the pavement per day over a 20-year design life.

With a stable subgrade prepared as recommended, we recommend the following pavement sections:

Light Traffic and Parking:

- Two inches of hot mix asphalt (HMA) over six inches of crushed rock base (CRB)
- Four inches of full depth HMA

Heavy Traffic:

- Three inches of HMA over eight inches of CRB
- Six inches of full depth HMA

For exterior Portland cement concrete (PCC) pavement, we recommend the following:

- 6 inches of PCC over two inches of crushed surfacing top course
    - 28-day compressive strength – 4,000 psi
    - Control joints spaced at a maximum of 15 feet

The paving materials used should conform to the Oregon Department of Transportation (ODOT) specifications for ½-inch class HMA, PCC, and CRB.

Long-term pavement performance will depend on 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.

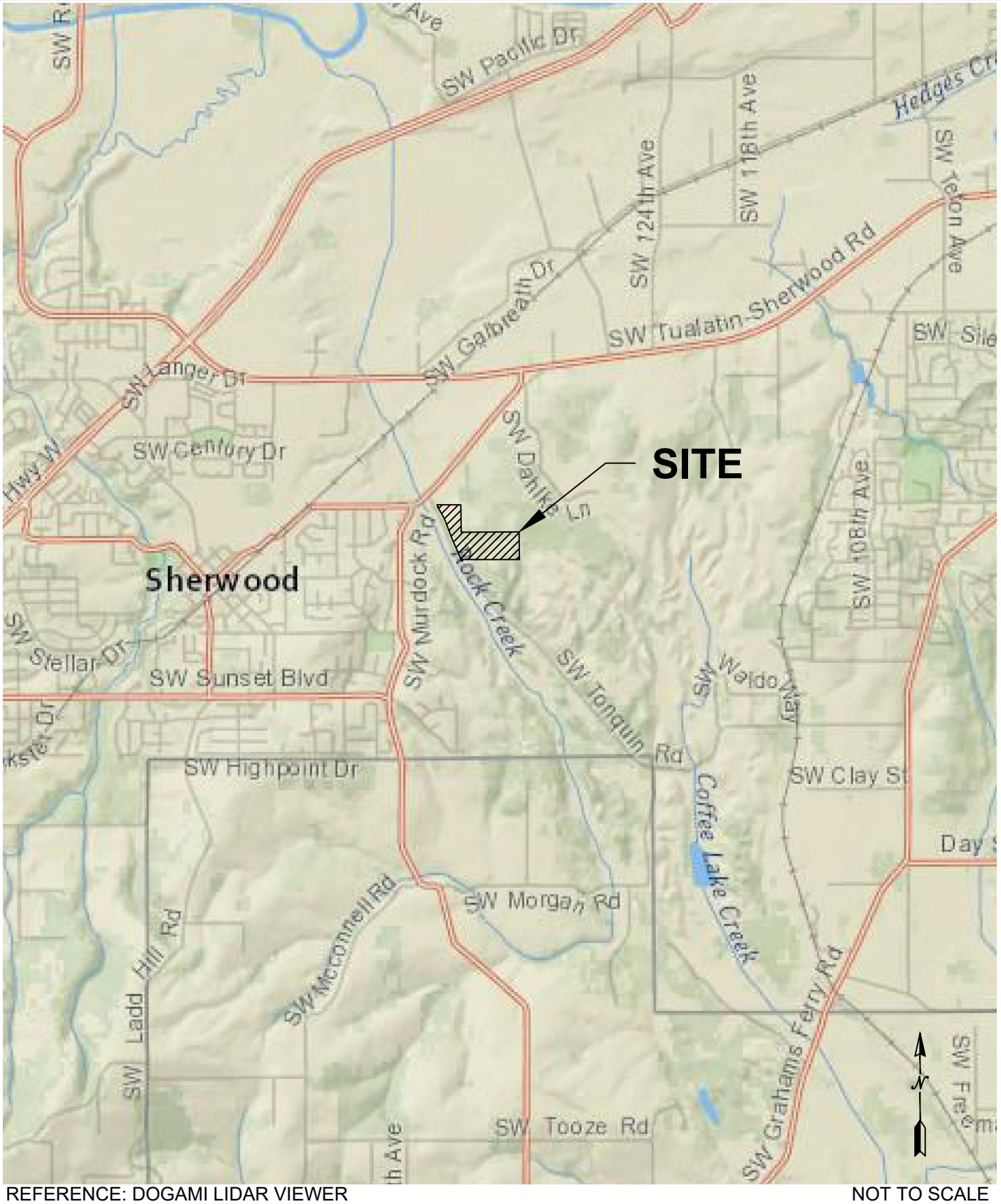
5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final design drawings and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Sherwood Industrial project in Sherwood, Oregon. This report is for the exclusive use of Panattoni Development Company and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the onsite subsurface explorations. Variations in subsurface conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.

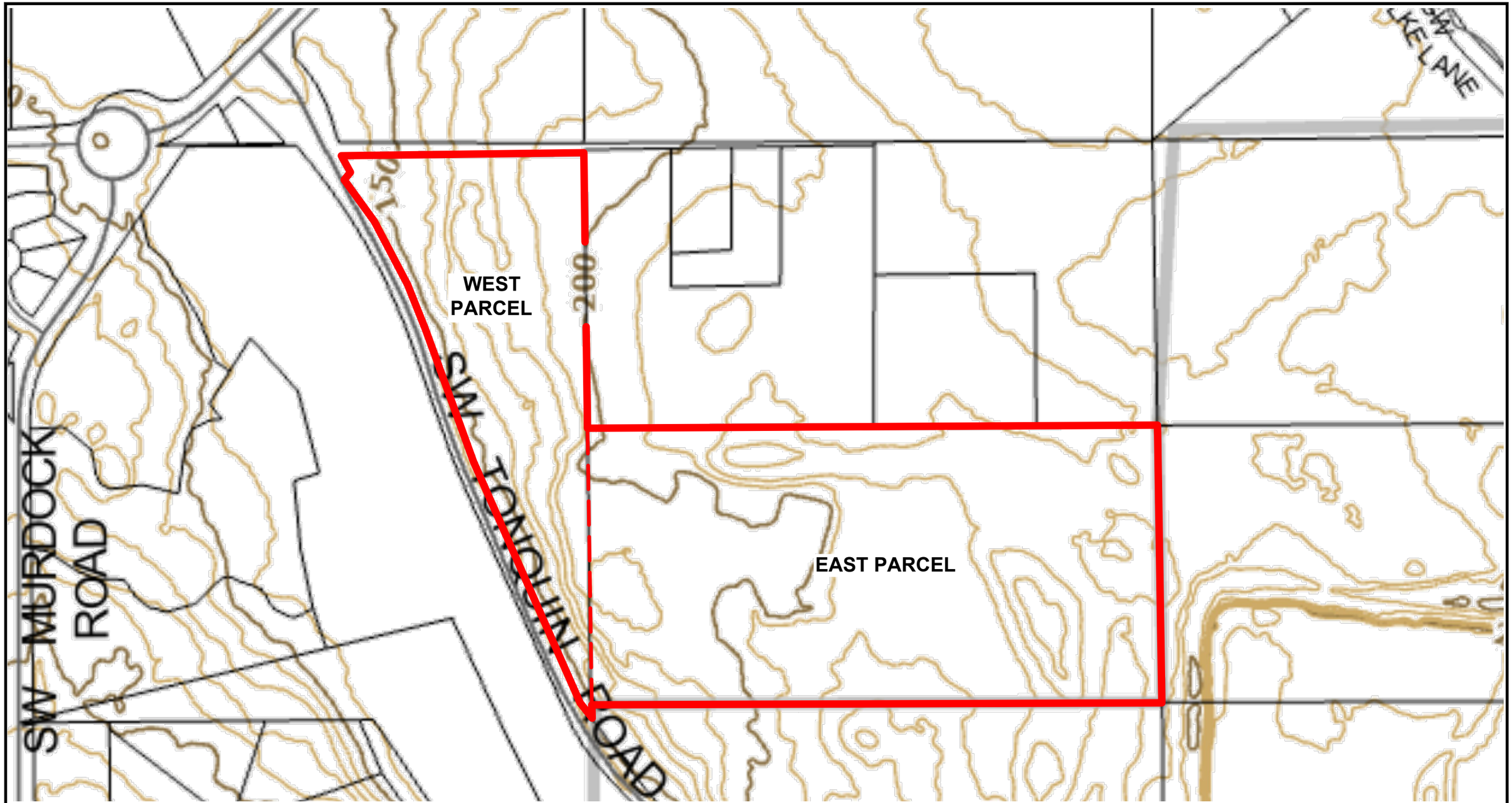


REFERENCE: DOGAMI LIDAR VIEWER NOT TO SCALE

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

VICINITY MAP
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure 1



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:

WASHINGTON COUNTY INTERMAP

LEGEND:

APPROXIMATE TEST PIT LOCATION

0 200 400

APPROXIMATE SCALE IN FEET

CONTOUR INTERVAL = 10 FEET

N

Terra Associates, Inc.

Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

PARCEL LOCATION MAP
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure 2

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:

GOOGLE EARTH

LEGEND:

APPROXIMATE TEST PIT LOCATION

0 200 400

APPROXIMATE SCALE IN FEET

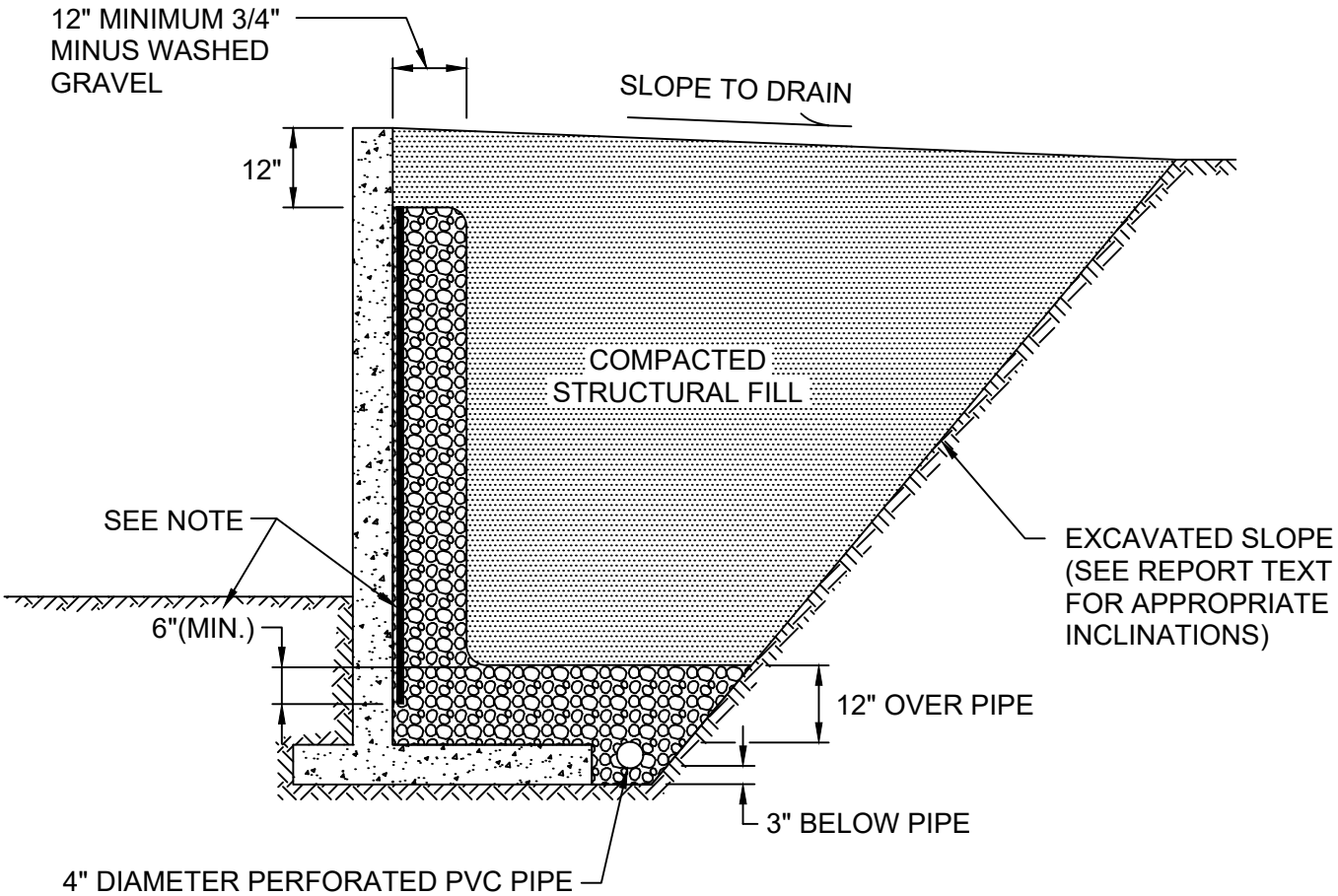
N

Terra Associates, Inc.

Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure 3



NOT TO SCALE

NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

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

TYPICAL WALL DRAINAGE DETAIL
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure 4

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Sherwood Industrial
Sherwood, Oregon

We explored subsurface conditions at the site in 26 test pits excavated to depths ranging between about 1 foot and 10.5 feet using a track-mounted excavator. Test pit locations were determined in the field using hand-held GPS locating and by sighting relative to existing surface features. The approximate location of the test pits is shown on Figure 3. The Test Pit Logs are attached as Figures A-3 through A-28.

An engineering geologist from our office conducted the field exploration, classified the observed soils and rock, maintained a log of each test pit, obtained representative soil samples, and performed a visual reconnaissance of the site and surrounding areas. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1. A generalized rock description key is attached as Figure A-2.

Representative soil samples obtained from the test borings were placed in closed containers and taken to our laboratory for further examination and testing. Laboratory testing included determining the moisture content of all soil samples, grain size distributions on six soil samples, and Atterberg Limit determinations of one soil sample. The soil moisture contents and Atterberg Limits are reported on the Test Pit Logs. The result of the grain size analyses are shown on Figures A-29 and A-30.

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS: More than 50% material larger than No. 200 sieve size	**GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, sands with gravel, little or no fines.
			SP	Poorly-graded sands, sands with gravel, little or no fines.
		Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS: More than 50% material smaller than No. 200 sieve size	**SILTS AND CLAYS** Liquid Limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity. (Lean clay)
			OL	Organic silts and organic clays of low plasticity.
	SILTS AND CLAYS Liquid Limit is greater than 50%		MH	Inorganic silts, elastic.
			CH	Inorganic clays of high plasticity. (Fat clay)
			OH	Organic clays of high plasticity.
HIGHLY ORGANIC SOILS			PT	Peat.

DEFINITION OF TERMS AND SYMBOLS

COHESIONLESS

Density	Standard Penetration Resistance in Blows/Foot
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	>50

COHESIVE

Consistancy	Standard Penetration Resistance in Blows/Foot
Very Soft	0-2
Soft	2-4
Medium Stiff	4-8
Stiff	8-16
Very Stiff	16-32
Hard	>32

I	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
‖	2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
▼	WATER LEVEL (Date)
Tr	TORVANE READINGS, tsf
Pp	PENETROMETER READING, tsf
DD	DRY DENSITY, pounds per cubic foot
LL	LIQUID LIMIT, percent
PI	PLASTIC INDEX
N	STANDARD PENETRATION, blows per foot

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

UNIFIED SOIL CLASSIFICATION SYSTEM
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

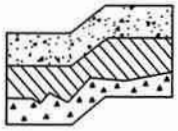
Proj. No.T-8912	Date JULY 2023	Figure A-1

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

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

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

DISCONTINUITIES			
Spacing		Condition	
Very Widely	> 10 ft	Excellent	Very rough surfaces, no separation, hard discontinuity wall
Widely	3 ft to 10 ft	Good	Slightly rough surfaces, separation less than 0.05 in, hard discontinuity wall.
Moderately	1 ft to 3 ft	Fair	Slightly rough surfaces, separation greater than 0.05 in, soft discontinuity wall.
Closely	2 in to 12 in	Poor	Slickensided surfaces, or soft gouge less than 0.2 in thick, or open discontinuities 0.05 to 0.2 in.
Very Closely	< 2 in	Very Poor	Soft gouge greater than 0.2 in thick, or open discontinuities greater than 0.2 in.



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

ROCK DESCRIPTION KEY
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure A-2

LOG OF TEST PIT NO. 1

FIGURE A-3

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–1		Fill: Gray-brown GRAVEL with sand, fine to coarse angular basalt gravel, fine sand, dry to moist, numerous angular basalt cobbles. (GP)	Dense	
2–3		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
4		Test pit terminated at 3.5 feet due to excavator refusal. No groundwater seepage.		
5–8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 2

FIGURE A-4

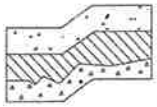
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Gray-brown GRAVEL with sand, fine to coarse angular basalt gravel, fine sand, dry to moist, numerous angular basalt cobbles. (GP)	Dense	
1		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
2				
3		Test pit terminated at 3 feet due to excavator refusal. No groundwater seepage.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 3

FIGURE A-5

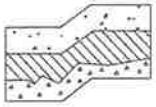
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown silty GRAVEL with sand, fine to coarse angular gravel, fine sand, moist. (GM)	Medium Dense	
1				
2		Fill: Dark gray silty SAND with gravel to silty GRAVEL with sand, fine to coarse sand, fine to coarse gravel, moist, scattered cobbles and organics. (SM/GM)	Medium Dense to Dense	
3				
4	1			15.2
5		BASALT: moderately weak to moderately strong (R2 to R3), gray to brown; angular gravel- to cobble-size blocks, completely weathered to soil between blocks, slightly to moderately weathered (Columbia River Basalt).		
6				
7		Test pit terminated at 6.5 feet due to excavator refusal. No groundwater seepge.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 4

FIGURE A-6

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Gray-brown GRAVEL with silt and sand, fine to coarse angular basalt gravel, fine sand, moist, numerous angular basalt cobbles. (GP-GM) (Mechanically-ripped basalt)	Loose	
3		BASALT: strong (R4), gray to brown; angular gravel-size blocks, slightly weathered (Columbia River Basalt).		
4		Test pit terminated at about 3.5 feet due to excavator refusal. No groundwater seepge.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 5

FIGURE A-7

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Hog Fuel.	Loose	
1		Gray slightly clayey to clayey SILT, moist, trace of organics. (ML) (LL=42, PI=14)	Medium Stiff to Stiff	
2				
3	1			27.9
4		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
5		Test pit terminated at about 4.5 feet due to excavator refusal. No groundwater seepge.		
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 6

FIGURE A-8

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular cobble- to boulder-size blocks, slightly to moderately weathered (Columbia River Basalt).		
6		Test pit terminated at 6 feet due to excavator refusal. No groundwater seepge.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 7

FIGURE A-9

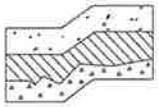
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–1		Fill: Brown silty GRAVEL with sand, fine to coarse angular basalt gravel, fine sand, dry. (GM)	Loose	
1–2		Dark brown silty SAND with gravel, fine sand, fine to coarse angular basalt gravel, moist. (SM) (Completely weathered basalt)	Medium Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, slightly to moderately weathered (Columbia River Basalt).		
3		Test pit terminated at 2.5 feet due to excavator refusal. No groundwater seepge.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 8

FIGURE A-10

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Dark gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist, trace of wood fragments. (SM)	Medium Dense	
3	1	Gray-brown to brown silty SAND with gravel to silty GRAVEL with sand, fine sand, fine to coarse angular basalt gravel, moist, scattered angular basalt cobbles. (SM/GM) (Completely weathered basalt)	Dense	19.4
5		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, slightly to moderately weathered (Columbia River Basalt).		
		Test pit terminated at about 4.75 feet due to excavator refusal. No groundwater seepge.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 9

FIGURE A-11

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray to brown, angular gravel- to boulder-size blocks, stained, wet, fracture faces, slightly to moderately weathered (Columbia River Basalt).		
4		Test pit terminated at 4 feet due to excavator refusal. No groundwater seepage. Wet, stained fracture faces.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 10

FIGURE A-12

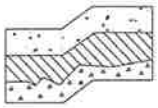
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray-brown, angular gravel- to boulder-size blocks, slightly to moderately weathered (Columbia River Basalt).		
1		Test pit terminated at 1 foot due to excavator refusal. No groundwater seepge.		
2				
3				
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 11

FIGURE A-13

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown to gray silty SAND with gravel and gray SILT, fine sand, fine to coarse gravel, moist, trace of wire debris and organics. (SM)		
1				
2	1		Medium Dense	20.5
3				
4	2			19.2
5		Dark brown organic silty SAND, fine grained, moist. (OL/SM) (Topsoil horizon)		
6		Gray-brown silty SAND with gravel to silty GRAVEL with sand, fine to coarse sand, fine to coarse angular basalt gravel, moist. (SM/GM) (Completely to highly weathered basalt)	Dense	
7		Test pit terminated at 6.5 feet due to excavator refusal. No groundwater seepge.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 12

FIGURE A-14

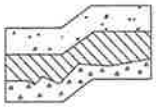
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: strong (R4), gray, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
1		Test pit terminated at 1 foot due to excavator refusal. No groundwater seepge.		
2				
3				
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 13

FIGURE A-15

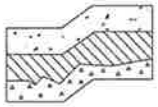
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0	1	Fill: Brown sandy SILT with gravel, fine sand, fine to coarse gravel, moist, trace of debris and organics, 2-foot diameter boulder. (ML)	Medium Dense	17.8
7		Dark brown silty SAND with gravel, fine to medium sand, fine to coarse angular bassalt gravel, moist. (SM) (Possible fill)	Medium Dense to Dense	
8		Test pit terminated at 7.5 feet due to excavator refusal. No groundwater seepge.		
9				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 14

FIGURE A-16

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–1		Fill: Brown sandy SILT with gravel, fine sand, fine to coarse gravel, moist, trace of debris and organics. (ML)	Medium Dense	
1–3		Brown silty SAND with gravel, fine sand, fine to coarse angular basalt gravel, moist, numerous angular basalt cobbles, scattered angular basalt boulders. (SM) (Completely to highly weathered basalt)	Medium Dense to Dense	
3–8		Test pit terminated at 3.5 feet due to excavator refusal. No groundwater seepge.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 15

FIGURE A-17

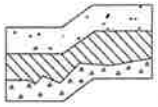
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Dark gray to brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, 2-inch thick asphalt pavement between 4 and 6 inches. (ML)	Medium Dense to Dense	
1		BASALT: moderately weak to moderately strong (R2 to R3), orange-brown, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
2				
3		Test pit terminated at 3 feet due to excavator refusal. No groundwater seepge.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 16

FIGURE A-18

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0	1	Fill: Brown silty SAND with gravel to silty GRAVEL with sand, fine sand, fine to coarse angular basalt gravel, moist, scattered angular basalt cobbles, scattered debris (wires, aluminum conduit, plastic, wood). (SM/GM)	Medium Dense	12.9
6	2	Red-brown sandy SILT, fine grained, trace of fine gravel, moist. (ML)	Medium Dense to Dense	31.1
10		Test pit terminated at 10 feet. No groundwater seepage.		
12				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 17

FIGURE A-19

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0	1	Fill: Dark brown silty SAND, fine to coarse angular sand, scattered fine angular gravel, moist. (SM) (Processed material)	Medium Dense	7.1
4		Gray angular basalt cobbles and boulders, moist. (Possible fill)	Dense	
8		Test pit terminated at 7.5 feet due to excavator refusal. No groundwater seepage.		
12				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 18

FIGURE A-20

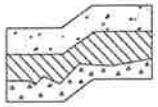
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Dark brown silty SAND, fine to coarse angular sand, scattered fine angular gravel, moist. (SM) (Processed material)	Medium Dense	
3		Fill: Dark gray-brown sandy SILT with gravel to silty SAND with gravel, fine to medium sand, fine to coarse angular to subrounded gravel, moist, scattered wood fragments, 6"x6" timber at 7 feet, faint organic odor. (ML/SM)	Dense to Very Dense	
11		Test pit terminated at 10.5 feet. No groundwater seepage.		
12				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 19

FIGURE A-21

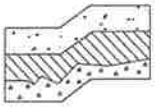
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Brown silty GRAVEL with sand, fine to coarse angular basalt gravel, fine to medium sand, moist. (GM) (Highly to completely weathered basalt)	Medium Dense to Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, moderately weathered (Columbia River Basalt).		
3		Test pit terminated at 3 feet due to excavator refusal. No groundwater seepage.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 20

FIGURE A-22

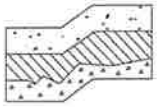
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		4 inches Sod and Topsoil.		
1		Red-brown silty GRAVEL with sand, fine to coarse angular basalt gravel, fine to coarse sand, dry to moist, numerous angular basalt cobbles. (GM) (Highly weathered basalt)	Medium Dense to Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular cobble- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
3				
4		Test pit terminated at 4 feet due to excavator refusal. No groundwater seepage.		
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 21

FIGURE A-23

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		2 inches Sod and Topsoil.		
1		Red-brown to gray silty GRAVEL with sand, fine to coarse angular basalt gravel, fine to coarse sand, dry to moist, numerous angular basalt cobbles, scattered angular basalt boulders. (GM) (Highly weathered basalt)	Medium Dense to Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular cobble- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
3		Test pit terminated at 3 feet due to excavator refusal. No groundwater seepage.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 22

FIGURE A-24

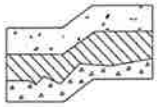
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		2 inches Sod and Topsoil.		
1		Red-brown to gray silty GRAVEL with sand, fine to coarse angular basalt gravel, fine to coarse sand, dry to moist, numerous angular basalt cobbles, scattered angular basalt boulders. (GM) (Highly weathered basalt)	Medium Dense to Dense	
2				
3		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular cobble- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
4		Test pit terminated at 4 feet due to excavator refusal. No groundwater seepage.		
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 23

FIGURE A-25

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Red-brown silty SAND, fine grained, trace of fine to coarse subrounded to subangular gravel, dry. (SM)	Medium Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), red-brown to gray-brown, angular gravel- to cobble-size blocks, highly weathered (Columbia River Basalt).		
5		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
6		Test pit terminated at 5.5 feet due to excavator refusal. No groundwater seepage.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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

LOG OF TEST PIT NO. 24

FIGURE A-26

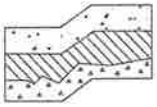
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray-brown, angular gravel- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
1		Test pit terminated at 1 foot due to excavator refusal. No groundwater seepage.		
2				
3				
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 25

FIGURE A-27

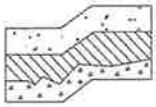
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Sparse brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray-brown, angular gravel- to cobble-size blocks, highly weathered (Columbia River Basalt).		
4		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
7		Test pit terminated at 7 feet due to excavator refusal. No groundwater seepage.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

LOG OF TEST PIT NO. 26

FIGURE A-28

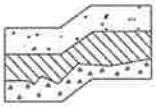
PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray-brown, angular gravel- to cobble-size blocks, highly weathered (Columbia River Basalt).		
4		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
7		Test pit terminated at 7 feet due to excavator refusal. No groundwater seepage.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	20.5	22.1	8.8	13.7	10.5	24.4	
□	0.0	7.5	35.6	11.1	12.1	9.1	24.6	
△	0.0	2.0	28.2	13.0	13.0	10.9	32.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			23.5340	5.7678	2.3759	0.2217				
□			14.3510	5.6474	2.9545	0.2224				
△			10.3281	2.5703	0.9046					

	Material Description	USCS	AASHTO
○	silty GRAVEL with sand	GM	
□	silty GRAVEL with sand	GM	
△	silty SAND with gravel	SM	

Project No. T-8912 **Client:** Panattoni Development Co.

Project: Sherwood Industrial

○ **Location:** TP-3 **Depth:** 4'

□ **Location:** TP-8 **Depth:** 3'

△ **Location:** TP-11 **Depth:** 2'

Terra Associates, Inc.

Kirkland, WA

Remarks:

○ Tested July 13, 2023

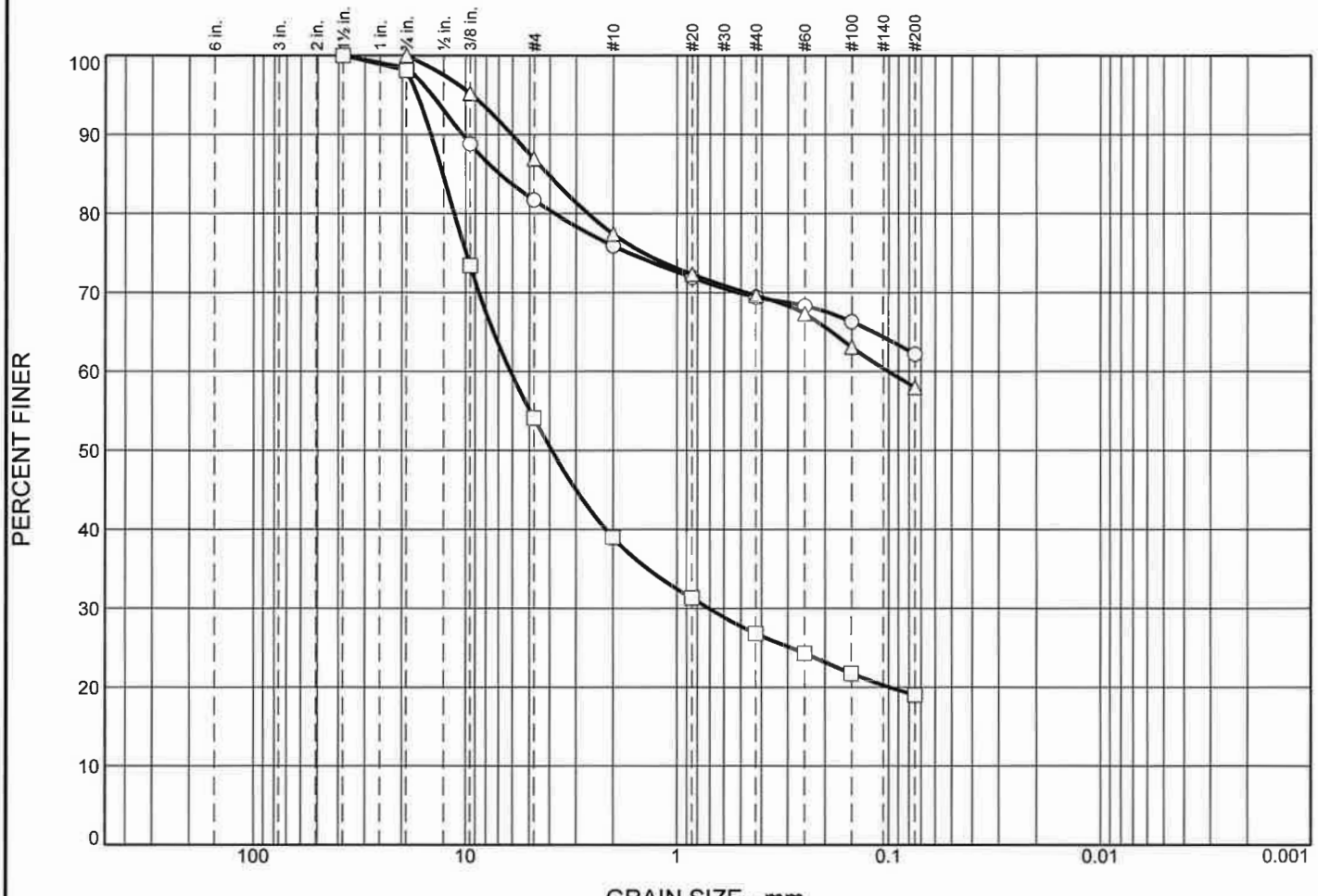
□ Tested July 13, 2023

△ Tested July 13, 2023

Figure A-29

Tested By: KJ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	1.6	16.7	5.8	6.5	7.2	62.2	
□	0.0	1.9	44.0	15.1	12.2	7.8	19.0	
△	0.0	0.0	13.1	9.5	7.8	11.6	58.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			6.9082							
□			12.7716	6.1247	3.9022	0.7072				
△			4.0826	0.1002						

Material Description	USCS	AASHTO
○ sandy SILT with gravel	ML	
□ silty GRAVEL with sand	GM	
△ sandy SILT	ML	

Project No. T-8912 **Client:** Panattoni Development Co.

Project: Sherwood Industrial

○ **Location:** TP-13 **Depth:** 1.5'

□ **Location:** TP-16 **Depth:** 3'

△ **Location:** TP-16 **Depth:** 7'

Remarks:

○ Tested July 13, 2023

□ Tested July 13, 2023

△ Tested July 13, 2023

Terra Associates, Inc.

Kirkland, WA

Figure A-30

Tested By: KJ