GEOTECHNICAL REPORT

Minor Marysville Property
8512 East Sunnyside School Road
Marysville, Washington

Project No. T-8970

Terra Associates, Inc.

Prepared for:

South Lake Ridge, LLC
c/o Land Pro Group, Inc.
Lake Stevens, Washington

January 25, 2024

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

January 25, 2024
Project No. T-8970

South Lake Ridge, LLC
c/o Mr. Mark Villwock
Land Pro Group, Inc.
10515 – 20th Street Southeast, Suite 202
Redmond, Washington 98052

Subject: Geotechnical Report
Minor Marysville Property
8512 E Sunnyside School Road
Marysville, Washington

Dear Mr. Villwock:

As requested, we 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.

The native soils observed in our subsurface explorations are glacial deposits consisting primarily of medium dense to dense, silty fine-grained sand with variable minor proportions of gravel, and occasional trace amounts of cobbles and one to one- and one-half foot diameter boulders. Till and till-like soils consisting of dense to very dense, moderately cemented, silty sand with gravel was encountered below depths of about three- and one-half to six- and one-half feet in several of the test pits. We observed light seepage of perched groundwater between depths of about two and six- and one-half feet at two test pit locations.

In our opinion, there are no geotechnical conditions that would preclude the planned residential development. Buildings can be supported on conventional spread footings bearing on competent native soils or on structural fill that is placed on a competent native soil subgrade. Floor slabs and pavements can be similarly supported.

Detailed recommendations addressing these issues and other geotechnical design considerations are presented in the attached report. 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.

John C. Sadler, L.E.G., L.H.G.
Senior Engineering Geologist

Carolyn S. Decker, P.E.
President

CAROLYN S. DECKER
STATE OF WASHINGTON
47016
REGISTERED
PROFESSIONAL ENGINEER

1-25-2024

TABLE OF CONTENTS

Page No.

Figures

Appendix

Geotechnical Report
Minor Marysville Property
8512 East Sunnyside School Road
Marysville, Washington

1.0 PROJECT DESCRIPTION

The proposed project is a residential development. Based on the Preliminary Road and Grading plan prepared by Solid Ground Engineering dated December 21, 2023, the site will be developed with 29 single family residential building lot, 2 detention vaults, retaining walls, and associated access and utilities. Grading to achieve building lot and roadway grades will consist of cuts and fills from one to eight feet. Vertical grade transitions will be supported with retaining walls. Site stormwater will be collected and directed to one of two detention vaults located in the northwest corner of the site and the east-central portion of the site.

We expect the buildings will be wood-frame structures with their lower-floor levels framed over a crawl space or constructed at grade. Foundation loads should be relatively light, in the range of 2 to 3 kips per foot for bearing walls and 20 to 40 kips for isolated columns.

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

2.0 SCOPE OF WORK

Our work was completed in accordance with our authorized proposal, dated October 31, 2023. Accordingly on November 9, 2023, we explored subsurface conditions in seven test pits excavated to maximum depths of about seven to eight feet using a track-mounted excavator. Based on the results of our field study, laboratory testing, and analyses, we developed geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions.
- Geologic Hazards per the Marysville Municipal Code.
- Seismic site class per the current International Building Code (IBC).
- Site preparation and grading.
- Excavations.
- Foundations.
- Slab-on-grade floors.
- Lateral earth pressures for retaining wall design.

- Stormwater facilities.
- Infiltration feasibility.
- Drainage.
- Utilities.
- Pavements.

It should be noted, 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, Inc.'s purview. A building envelope specialist or contractor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The project site is a 3.94-acre residential parcel located south of and adjacent East Sunnyside School Road, just northwest of the intersection with 87th avenue NE in Marysville, Washington. The site location is shown on Figure 1.

A single-family residence, detached garage, and barn occupy the central portion of the parcel. Site vegetation consists mainly of grass lawn with scattered landscape trees and shrubs around the buildings. Several mature coniferous trees are scattered across the southeastern portion of the site.

Site topography generally slopes down to the northeast. Elevation contours obtained from the Snohomish County PDS Map Portal website (https://gismaps.snoco.org/Html5Viewer/Index.html?viewer=pdsmapportal) shows site surface gradients typically ranging between about 3 and 6 percent with the exception of a localized slope area in the southeastern portion of the site, which slopes down to the east-northeast at an inclination of about 13 percent.

3.2 Soils

The native soils observed in our subsurface explorations are glacial deposits consisting primarily of medium dense to dense, silty fine-grained sand with variable minor proportions of gravel, and occasional trace amounts of cobbles and one to one- and one-half foot diameter boulders. Exceptions to this were observed at lower site elevations in Test Pits TP-1, and Test Pits TP-5 through TP-7, where some of the silty sand is interbedded with fine- to medium-grained sand layers, and in Test Pit TP-5, where we observed a medium stiff to stiff, slightly clayey, fine sandy silt between depths of five and seven feet. We observed till and till-like soils consisting of dense to very dense, moderately cemented, silty sand with gravel below depths of about three- and one-half to six- and one-half feet in Test Pits TP-2 through TP-4, and Test Pit TP-6.

We observed approximately four to ten inches of sod and topsoil overlying the native soils in the test pits. Approximately one- and one-half to two feet of dark brown silty sand to organic silty sand was observed above the native glacial deposits in Test Pits TP-3 and TP-4 in the southern portion of the site.

The *Geologic Map of the Lake Stevens Quadrangle, Snohomish County, Washington* by J.P. Minard (1985) shows surficial geology at the site mapped as Vashon Till (Qvt). The dense to very dense, cemented, silty sand with gravel deposits observed below depths of three- and one-half to six- and one-half feet in Test Pits TP-2, TP-3, TP-4, and TP-6 is generally consistent with this geologic map unit. The medium dense to dense deposits observed in the test pits are interpreted to be ablation till and recessional outwash deposits.

Detailed descriptions of the conditions observed in our subsurface explorations are presented on the Test Pit Logs in Appendix A. The approximate test pit locations are shown on Figure 2.

3.3 Groundwater

We observed light seepage of perched groundwater at a depth of about two feet in Test Pit TP-3 and from interbedded sand layers between depths of about two and six- and one-half feet in Test Pit TP-6. We also observed mottled soils in five of the seven test pits. Mottling is an indication of fluctuating soil moisture and can be indicative of the development of a perched groundwater table. The development of shallow perched groundwater is typical for sites underlain by relatively impermeable till and till-like soils. Perched groundwater levels and flow rates will fluctuate seasonally, and typically reach their highest levels during the wet winter months (October through May).

3.4 Geologic Hazards

We evaluated site conditions for the presence of geologic hazards as designated in the Marysville Municipal Code (MMC). Chapter 22A.020.080 (G Definitions) of the MMC defines geologic hazard areas (GHAs) as lands or areas characterized by geologic, hydrologic, and topographic conditions that render them susceptible to potentially significant or severe risk of landslides, erosion, or seismic activity.

Erosion Hazard Areas

Chapter 22A.020.060 (E Definitions) of the MMC defines erosion hazard areas as "lands or areas that, based on a combination of slope inclination and the characteristics of the underlying soils, are susceptible to varying degrees of risk of erosion." Erosion hazard areas are classified as low hazard, moderate hazard, and high hazard, based on the following criteria:

1. Low Hazard. Areas sloping less than 15 percent.

2. Moderate Hazard. Areas sloping between 15 and 40 percent and underlain by soils that consist predominantly of silt, clay, bedrock, or glacial till.

3. High Hazard. Areas sloping between 15 and 40 percent that are underlain by soils consisting largely of sand and gravel, and all areas sloping more steeply than 40 percent."

As discussed, maximum surface gradients at the site are flatter than 15 percent. Therefore, per the above criteria, the site has a low erosion hazard. However, the site soils will be susceptible to erosion when exposed during construction. In our opinion, the erosion potential of site soils would be adequately mitigated with proper implementation and maintenance of City of Marysville approved Best Management Practices (BMPs) for erosion prevention and sedimentation control during construction.

Landslide Hazard Areas

Chapter 22A.020.130 (L Definitions) of the MMC defines landslide hazard areas as "areas that, due to a combination of slope inclination and relative soil permeability, are susceptible to varying degrees of risk of land sliding. Landslide hazard areas are classified as Classes I- IV based on the degree of risk as follows:

1. Low Hazard. Areas with slopes of less than 15 percent.

2. Moderate Hazard. Areas with slopes of between 15 and 40 percent and that are underlain by soils that consist largely of sand, gravel, bedrock, or glacial till.

3. High Hazard. Areas with slopes between 15 percent and 40 percent that are underlain by soils consisting largely of silt and clay, and all areas sloping more steeply than 40 percent.

4. Very High Hazard. Areas with slopes over 40 percent and areas of known mappable landslide deposits."

Based on the above criteria, the site is classified as having a low landslide hazard. In our opinion, the site conditions are not susceptible to landsliding.

Seismic Hazard Areas

Chapter 22A.020.200 (S Definitions) of the MMC defines seismic hazard areas as "areas that, due to a combination of soil and groundwater conditions, are subject to severe risk of ground shaking, subsidence, or liquefaction of soils during earthquakes. These areas are typically underlain by soft or loose saturated soils (such as alluvium), have a shallow groundwater table and are typically located on the floors of river valleys. Seismic hazard areas are classified as follows:

1. Low Hazard. Areas underlain by dense soils or bedrock.

2. High Hazard. Areas underlain by soft or loose saturated soils."

Using the above criteria, the site is classified as having a low seismic hazard. Based on the soil and groundwater conditions we observed at the site, it is our opinion that there is little to no risk for site damage resulting from soil liquefaction or subsidence during a severe seismic event. In our opinion, there are no unusual seismic hazards at the site and design in accordance with local building codes for determining seismic forces would adequately mitigate impacts associated with ground shaking.

3.5 Seismic Site Class

Based on the site soil conditions and our knowledge of the area geology, per the 2018 International Building Code (IBC), site class "D" should be used in structural design.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Based on our study, there are no geotechnical conditions that would preclude the planned development. Buildings can be supported on conventional spread footings bearing on competent native soils underlying the surficial organic soils or on structural fill placed on a competent native soil subgrade. Floor slabs and pavements can be similarly supported.

The site soils contain a sufficient amount of fines (silt- and clay-sized particles) such that they will be difficult to compact as structural fill when too wet or too dry. Accordingly, the ability to use the soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions at the time of construction. If grading activities take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections of this report. 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 materials should be stripped and removed from the site. We expect surface stripping depths of about 4 to 24 inches will generally be required to remove the surficial topsoil and organic soils. Stripped vegetation debris should be removed from the site. Organic soils will not be suitable for use as structural fill but may be used for landscaping purposes or in limited thicknesses as general fill in nonstructural areas.

Demolition of existing structures should include removal of foundations and slabs, and abandonment of underground septic systems and other buried utilities. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil.

Once clearing and grubbing operations are complete, cut and fill operations to establish desired building grades can be initiated. A representative of Terra Associates, Inc. should examine all bearing surfaces to verify that the conditions encountered are as anticipated and are suitable for placement of structural fill or direct support of building and pavement elements. Our representative may request proofrolling exposed surfaces with a heavy rubber-tired vehicle to determine if any isolated soft and yielding areas are present. If unstable yielding areas are observed, they should be cut to firm bearing soil and filled to grade with structural fill. If the depth of excavation to remove unstable soils is excessive, use of a geotextile fabric such as Mirafi 500X or equivalent in conjunction with structural fill can be considered in order to limit the depth of removal. In general, our experience has shown that a minimum of 18 inches of clean, granular structural fill over the geotextile fabric should establish a stable bearing surface.

Our study indicates the inorganic native soils contain a sufficient amount of fines (silt- and clay-sized particles) that will make the soils difficult to compact as structural fill when too wet or too dry. Provided these soils are near optimum moisture when excavated and are placed during dry weather conditions, we anticipate they will be suitable for direct use as structural fill. In order to use soils that are wet of optimum as structural fill, drying the soils by aeration during dry weather conditions or using soil amendments such as lime or Portland cement to reduce and stabilize the soil's moisture content will need to be considered. If soil amendment products are used, additional Temporary Erosion and Sedimentation Control (TESC) BMPs will need to be implemented to mitigate potential impacts to stormwater runoff associated with possible elevated pH levels.

If grading activities are planned during the wet winter months, or if they 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 planned to be 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-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 may be reduced to 90 percent.

4.3 Excavations

All excavations at the site associated with confined spaces, such as utility trenches and retaining walls, must be completed in accordance with local, state, or federal requirements. Based on current Washington Industrial Safety and Health Act (WISHA) regulations, the medium dense to dense native soils would typically be classified as Type C soils. Dense to very dense, cemented till-like soils would typically be classified as Type A 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. Side slopes in Type A soils can be laid back at a slope inclination of 0.75:1 or flatter. For temporary excavation slopes less than 8 feet in height in Type A soils, the lower 3.5 feet can be cut to a vertical condition, with a 0.75:1 slope graded above. For temporary excavation slopes greater than 8 feet in height up to a maximum height of 12 feet, the slope above the 3.5-foot vertical portion will need to be laid back at a minimum slope inclination of 1:1. No vertical cut with a backslope immediately above is allowed for excavation depths that exceed 12 feet. In this case, a four-foot vertical cut with an equivalent horizontal bench to the cut slope toe is required.

All exposed temporary slope faces that will remain open for an extended period of time should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation.

Based on our subsurface explorations, seepage of perched groundwater should be anticipated within excavations extending below a depth of about two feet in the south-central and northeastern portions of the site. We expect that the volume of water and rate of flow into the excavation should be relatively minor and would not be expected to impact the stability of the excavations when completed as described above. In general, 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.

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.

4.4 Foundations

The structures may be supported on conventional spread footing foundations bearing on competent native soils or on structural fill that is placed on a competent native soil subgrade. Foundation subgrades should be 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 that bear on competent soils 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. With the anticipated loads and this bearing stress applied, building settlements should be less than one-half inch total and one-fourth inch differential.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressure acting on the sides of the footings may also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent native soil or the excavations are backfilled with structural fill, as described in Section 4.2 of this report. The recommended passive and friction values include a safety factor of 1.5.

4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on a subgrade prepared as recommended in Section 4.2 of this report. 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, then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction and aid in uniform curing of the concrete slab. It should be noted, if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting uniform curing of the slab and can actually serve as a water supply for moisture seeping through the slab and 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.

4.6 Lateral Earth Pressures for Retaining Walls

The magnitude of earth pressure development on lower-level building or cast-in-place concrete retaining walls will partly depend on the quality of the wall backfill. We recommend placing and compacting wall backfill as structural fill. Below improved areas, such as pavements or floor slabs, the backfill should be compacted to a minimum of 95 percent of its maximum dry unit weight as determined by ASTM Test Designation D-698 (Standard Proctor). In unimproved areas, the relative compaction can be reduced to 90 percent. To guard against hydrostatic pressure development, wall drainage must also be installed. A typical recommended wall drainage detail is shown on Figure 3.

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 pcf. For restrained walls, an additional uniform lateral pressure of 100 psf should be added to the 35 pcf. These values assume a horizontal backfill condition and that no other surcharge loading, such as traffic, 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.

4.7 Infiltration Feasibility

Due to the relatively high soil fines content, evidence of shallow perched groundwater, and the underlying presence of dense to very dense, cemented, till and till-like soils, it is our opinion that stormwater management using full infiltration will not be feasible at the site. The results of grain size analyses indicate that the upper approximately 4.5 feet of native soils are categorized as *silt loam* using USDA textural analysis. Even in the absence of perched groundwater, it is our opinion that these soils would not be suitable for limited infiltration using low impact development (LID) natural drainage practices (NDPs).

4.8 Stormwater Facilities

As noted above, site stormwater will be collected and directed to one of two detention vaults located in the northwest corner and east-central portions of the site. Design details for the vaults were unavailable at the time of this report.

We expect that the vault excavation would expose medium dense to dense silty sand and/or interbedded silty sand and sand. Vault foundations supported by these native soils may be designed for an allowable bearing capacity of 4,000 psf provided that the foundation subgrade is at least 8 feet below finished grade adjacent to the vault. For short-term loads, such as seismic, a one-third increase in this allowable capacity can be used. 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.

The magnitude of earth pressures developing on the vault walls will depend in part on the quality and compaction of the wall backfill. We recommend placing and compacting wall backfill as structural fill, as recommended in the Section 4.2 of this report. Lateral earth pressures recommended in Section 4.6 can be used in designing the below-grade vault walls. For evaluating walls under seismic loading, an additional uniform earth pressure equivalent to 8H psf, where H is the height of the below-grade wall in feet, can be used. These values assume a horizontal backfill condition. Where applicable, a uniform horizontal traffic surcharge value of 75 psf should be included in the design of vault walls. If it is not possible to discharge collected water at the footing elevation, we recommend setting the invert elevation of the wall drainpipe equivalent to the outfall invert and connecting the drain to the outfall pipe for discharge. For any portion of the wall that falls below the invert elevation of the wall drain, an earth pressure equivalent to a fluid weighing 85 pcf should be used.

The vault may be subject to uplift pressures if drainage is not provided for the full depth of the structure. The weight of the structure and the weight of the backfill soil above its foundation will provide resistance to uplift. A soil unit weight of 125 pcf can be used for the vault backfill provided the backfill is placed and compacted as structural fill as recommended above.

4.9 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the building areas. We recommend providing a positive drainage gradient away from building perimeters. If a positive gradient cannot be provided, provisions for collection and disposal of surface water adjacent to the structures should be provided.

Subsurface

We recommend installing a continuous drain along the outside lower edge of the perimeter building foundations. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The drains can consist of four-inch diameter perforated PVC pipe enveloped in washed half- to three-quarter-inch gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. The foundation drains and roof downspouts should be tightlined 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 minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report. As noted, soils excavated on-site should generally be suitable for use as backfill material. However, the site soils are typically fine grained and moisture sensitive; therefore, moisture conditioning may be necessary to facilitate proper compaction. If utility construction takes place during the winter, it may be necessary to import suitable wet weather fill for utility trench backfilling.

4.11 Pavements

Pavement subgrades should be prepared as described in Section 4.2. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proof rolled with heavy construction equipment, such as a loaded ten-yard dump truck, to verify this 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. For traffic consisting mainly of light passenger and commercial vehicles with only occasional heavy traffic, and with a stable subgrade prepared as recommended, we recommend the following pavement sections:

- Two inches of hot mix asphalt (HMA) over four inches of crushed rock base (CRB)
- Thee- and one-half inches full depth HMA

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½ inch HMA and crushed surfacing rock.

Long-term pavement performance will depend on surface drainage. A poorly drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement 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 when they occur.

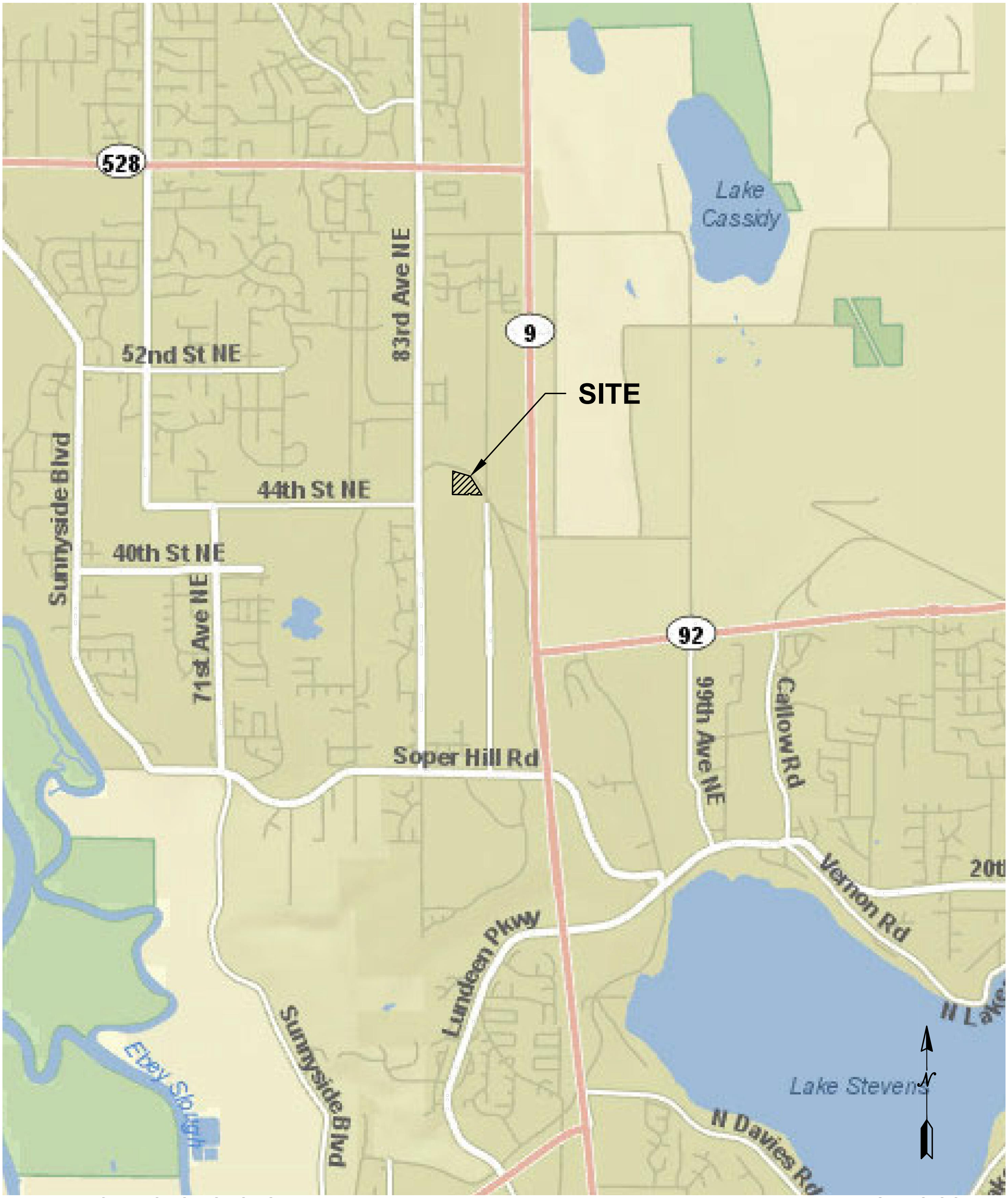
5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final designs and specifications in order to verify earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction in order 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. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Minor Marysville Property project in Marysville, Washington. This report is for the exclusive use of South Lake Ridge, LLC, and their authorized representatives. No other warranty, expressed or implied, is made.

The analyses and recommendations presented in this report are based on data obtained from the subsurface explorations completed onsite. Variations in soil 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: WSDOT GEOPORTAL

NOT TO SCALE

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

VICINITY MAP
MINOR MARYSVILLE PROPERTY
MARYSVILLE, WASHINGTON

Proj. No.T-8970	Date JAN 2024	Figure 1

REFERENCE:

SITE PLAN PROVIDED BY SOLID GROUND ENGINEERING

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.

LEGEND:

APPROXIMATE TEST PIT LOCATION

0 100 200

APPROXIMATE SCALE IN FEET

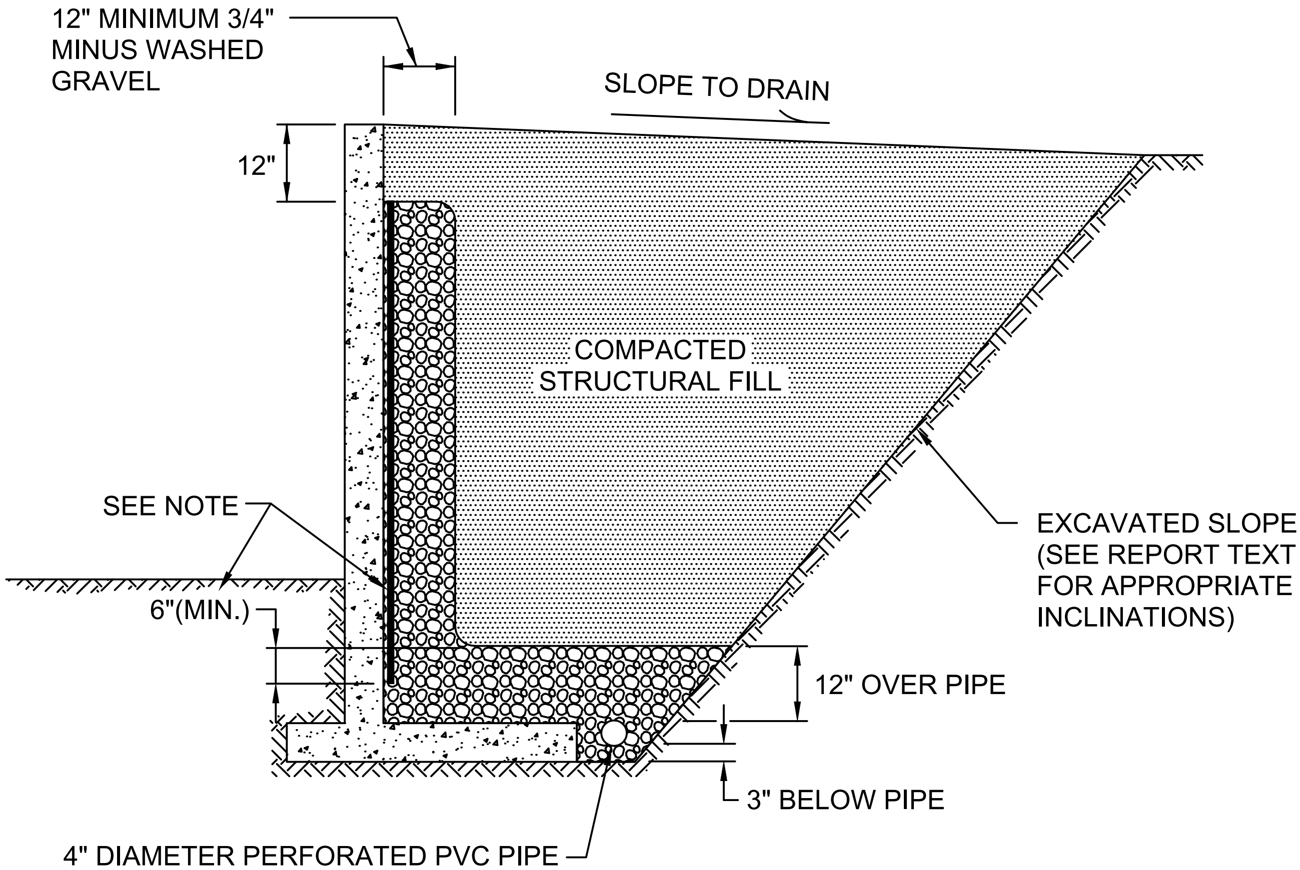
N

Terra Associates, Inc.

Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
MINOR MARYSVILLE PROPERTY
MARYSVILLE, WASHINGTON

Proj. No.T-8970	Date JAN 2024	Figure 2



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
MINOR MARYSVILLE PROPERTY
MARYSVILLE, WASHINGTON

Proj. No.T-6970	Date JAN 2024	Figure 3

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Minor Marysville Property
Marysville, Washington

On November 9, 2023, we explored subsurface conditions at the site in seven test pits excavated to maximum depths of about 7 to 8 feet using a track-mounted excavator. The approximate test pit locations are shown on Figure 2. The test pit locations were approximately determined in the field by sighting and pacing from existing surface features. The Test Pit Logs are presented on Figures A-2 through A-8.

An engineering geologist from our office maintained a log of each test pit as it was excavated, classified the soil conditions encountered, and obtained representative soil samples. All soil samples were visually classified in the field in accordance with the Unified Soil Classification System. A copy of this classification is presented as Figure A-1.

Representative soil samples obtained from the test pits were placed in sealed plastic bags and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the Test Pit Logs. Grain size analyses were performed on seven of the soil samples. The results are shown on Figures A-9 through A-11.

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 symbol)	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
(double I symbol)	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
MINOR MARYSVILLE PROPERTY
MARYSVILLE, WASHINGTON

Proj. No.T-8970 | Date JAN 2024 | Figure A-1

LOG OF TEST PIT NO. 1

FIGURE A-2

PROJECT NAME: Minor Marysville Property **PROJ. NO:** T-8970 **LOGGED BY:** JCS

LOCATION: Marysville, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: November 9, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		4 inches Sod and Topsoil.		
0–3	1 (at 2)	Brown silty SAND to sandy SILT, fine sand, scattered fine to coarse gravel, moist to wet. (SM/ML)	Medium Dense	35.9
3–4.5	2 (at 3.5)	Brown to gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, mottled, trace of cobbles and 1-foot diameter boulders. (SM)	Medium Dense to Dense	13.5
4.5–6		Gray-brown to brown silty SAND, fine sand, trace of fine to coarse gravel, moist. (SM) (Till-like texture)	Dense	
6–9	3 (at 7)	Brown silty SAND, fine sand, trace of fine to coarse gravel, moist, scattered fine sand layers and pockets. (SM)	Medium Dense to Dense	16.8
9	4 (at 9)			15.1
9–10		Test pit terminated at 9 feet. No groundwater seepage.		

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-3

PROJECT NAME: Minor Marysville Property **PROJ. NO:** T-8970 **LOGGED BY:** JCS

LOCATION: Marysville, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: November 9, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–1.5		5 inches Sod and Topsoil. Brown silty SAND to sandy SILT, fine sand, scattered fine to coarse gravel, moist to wet. (SM/ML)	Medium Dense	
1.5–3.5	1 (at 2)	Brown to gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, mottled, trace of cobbles and 1-foot diameter boulders. (SM)	Medium Dense to Dense	16.6
3.5–5.5	2 (at 5)	Gray-brown to brown silty SAND, fine sand, trace of fine to coarse gravel, moist. (SM) (Till-like texture)	Dense	14.0
5.5–8		Gray-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist. (SM) (Till like)	Dense to Very Dense	
8–10		Test pit terminated at 8 feet. No groundwater seepage.		

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-4

PROJECT NAME: Minor Marysville Property **PROJ. NO:** T-8970 **LOGGED BY:** JCS

LOCATION: Marysville, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: November 9, 2023 **DEPTH TO GROUNDWATER:** 2 ft **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–1.5		5 inches Sod and Topsoil. Dark brown silty SAND to organic silty SAND, fine grained, moist. (SM/OL)	Medium Dense	
1.5–3.5 (groundwater at 2)		Gray-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist (locally wet). (SM)	Medium Dense to Dense	
3.5–7	1 (at 4)	Gray-brown silty SAND with gravel to sandy SILT with gravel, fine sand, fine to coarse gravel, moist, moderately cemented. (SM/ML) (Till)	Very Dense	11.5
7–10		Test pit terminated at 7 feet. Light groundwater seepage at 2 feet.		

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-5

PROJECT NAME: Minor Marysville Property **PROJ. NO:** T-8970 **LOGGED BY:** JCS

LOCATION: Marysville, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: November 9, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–2		5 inches Sod and Topsoil. Dark brown silty SAND to organic silty SAND, fine grained, moist. (SM/OL)	Medium Dense	
2–4		Gray-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, scattered cobbles, trace of 1- to 1.5-foot diameter boulders. (SM)	Medium Dense to Dense	
4–7		Gray-brown silty SAND with gravel to sandy SILT with gravel, fine sand, fine to coarse gravel, moist, moderately cemented. (SM/ML) (Till)	Very Dense	
7–10		Test pit terminated at 7 feet. No groundwater seepage.		

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-6

PROJECT NAME: Minor Marysville Property **PROJ. NO:** T-8970 **LOGGED BY:** JCS

LOCATION: Marysville, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: November 9, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0 – 1.5	1	7 inches Sod and Topsoil. Brown silty SAND, fine sand, trace of fine to coarse gravel, moist to wet. (SM)	Medium Dense	33.5
1.5 – 5	2	Gray-brown to brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, mottled, scattered fine to medium sand layers and pockets, trace of cobbles. (SM)	Medium Dense to Dense	19.2
5 – 7	3	Gray, slightly clayey, sandy SILT, fine sand, scattered fine to coarse gravel, moist. (ML)	Medium Stiff to Stiff	33.4
7 – 8	4	Gray-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, mottled, scattered iron-oxide stained pockets. (SM)	Dense	13.5
8 – 10		Test pit terminated at 8 feet. No groundwater seepage.		

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-7

PROJECT NAME: Minor Marysville Property **PROJ. NO:** T-8970 **LOGGED BY:** JCS

LOCATION: Marysville, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

DATE LOGGED: November 9, 2023 **DEPTH TO GROUNDWATER:** 2 - 6.5 ft **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		10 inches Sod and Topsoil. Brown silty SAND, fine sand, trace of fine to coarse gravel, moist. (SM)	Medium Dense	
2		Gray-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist (locally wet), mottled, scattered iron-oxide stained pockets, trace of cobbles and 1-foot diameter boulders. Interbedded with gray-brown, wet, fine to medium sand layers. (SM and SP)	Medium Dense to Dense	
6.5		Gray-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, moderately cemented. (SM) (Till)	Dense to Very Dense	
8		Test pit terminated at 8 feet. Light groundwater seepage from multiple sand layers between 2 and 6.5 feet.		

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-8

PROJECT NAME: Minor Marysville Property **PROJ. NO:** T-8970 **LOGGED BY:** JCS

LOCATION: Marysville, Washington **SURFACE CONDITIONS:** Grass **APPROX. ELEV:** NA

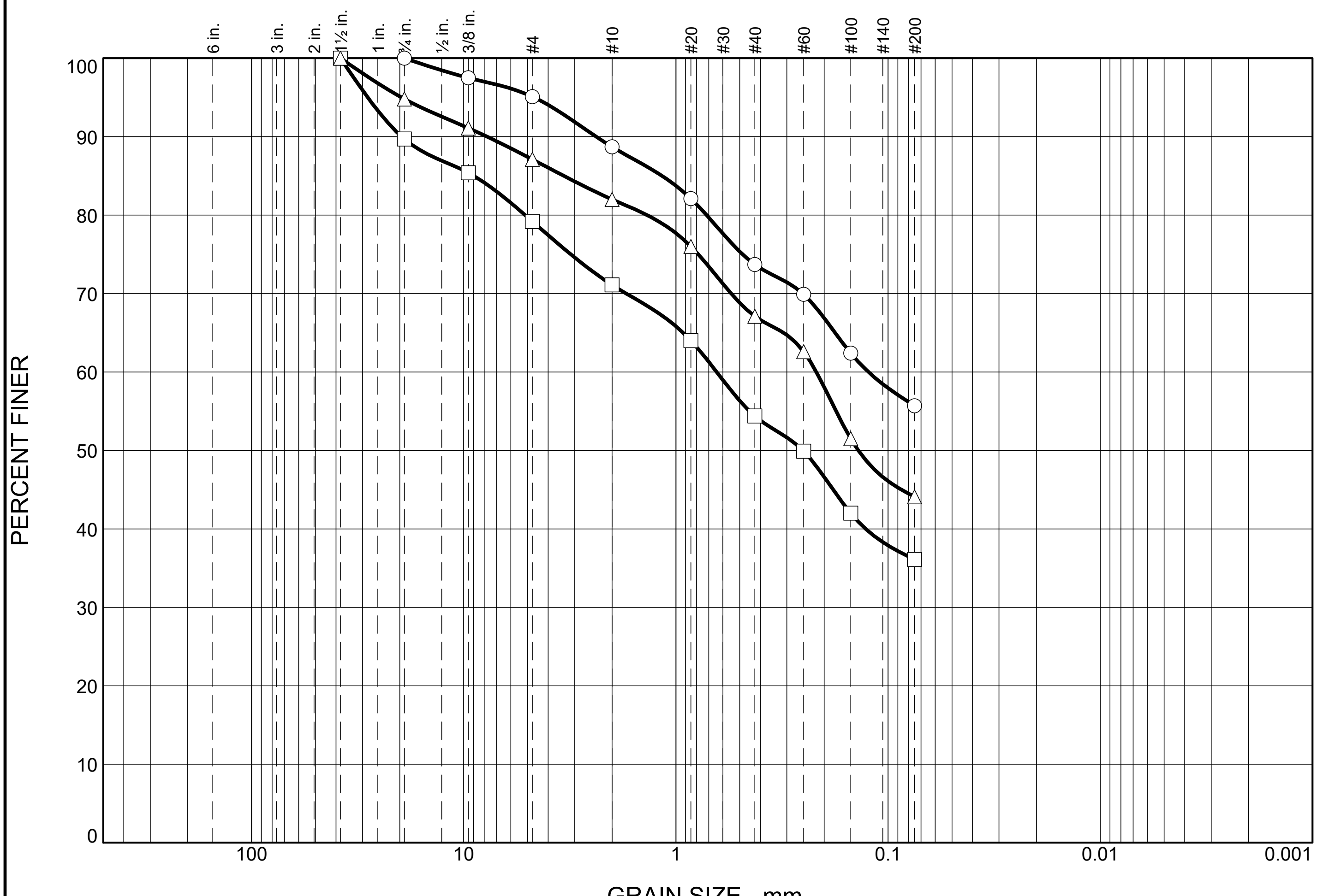
DATE LOGGED: November 9, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		7 inches Sod and Topsoil. Red-brown silty SAND, fine sand, trace of fine to coarse gravel, moist to wet. (SM)		
1			Medium Dense	
	1			29.7
2		Gray-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, mottled, trace of cobbles and 1-foot diameter boulders. (SM)		
3				
4		Interbedded, gray-brown SAND with silt to silty SAND and silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist. (SP-SM/SM and SM)		
5	2		Medium Dense to Dense	8.0
6				
7	3			11.1
8		Test pit terminated at 8 feet. No groundwater seepage.		
9				
10				

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	0.0	4.9	6.4	15.0	18.0	55.7	
□	0.0	10.3	10.5	8.1	16.7	18.3	36.1	
△	0.0	5.2	7.7	5.1	14.9	23.0	44.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.1618	0.1237						
□			8.9671	0.6426	0.2521					
△			3.3754	0.2179	0.1381					

Material Description	USCS	AASHTO
○ sandy SILT (USDA Textural - Silt Loam)	ML	
□ silty SAND with gravel (USDA Textural - Silt Loam)	SM	
△ silty SAND (USDA Textural - Silt Loam)	SM	

Project No. T-8970 **Client:** South Lake Ridge, LLC
Project: Minor Marysville Property

○ **Location:** TP-1 **Depth:** 2'
□ **Location:** TP-1 **Depth:** 3.5'
△ **Location:** TP-1 **Depth:** 7'

Remarks:
○ Tested November 10, 2023
□ Tested November 10, 2023
△ Tested November 10, 2023

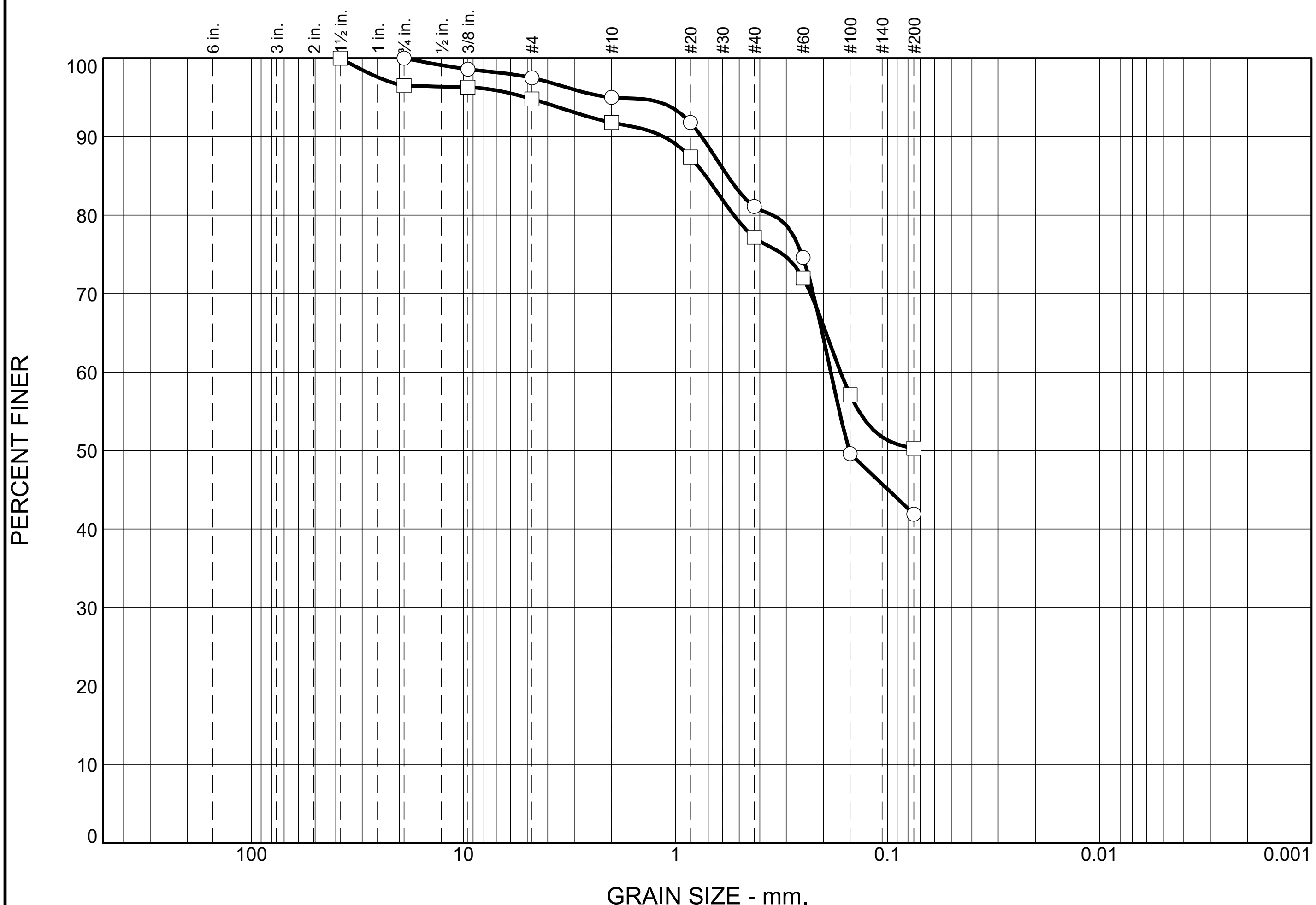
Terra Associates, Inc.

Kirkland, WA

Figure A-9

Tested By: KJ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	2.5	2.5	13.9	39.2	41.9	
□	0.0	3.5	1.7	3.0	14.6	26.9	50.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.5671	0.1851	0.1515					
□			0.7199	0.1665						

Material Description	USCS	AASHTO
○ silty SAND (USDA Textural - Sandy Loam)	SM	
□ sandy SILT (USDA Textural - Silt Loam)	ML	

Project No. T-8970 **Client:** South Lake Ridge, LLC

Project: Minor Marysville Property

○ **Location:** TP-1 **Depth:** 9'

□ **Location:** TP-3 **Depth:** 4'

Terra Associates, Inc.

Kirkland, WA

Remarks:

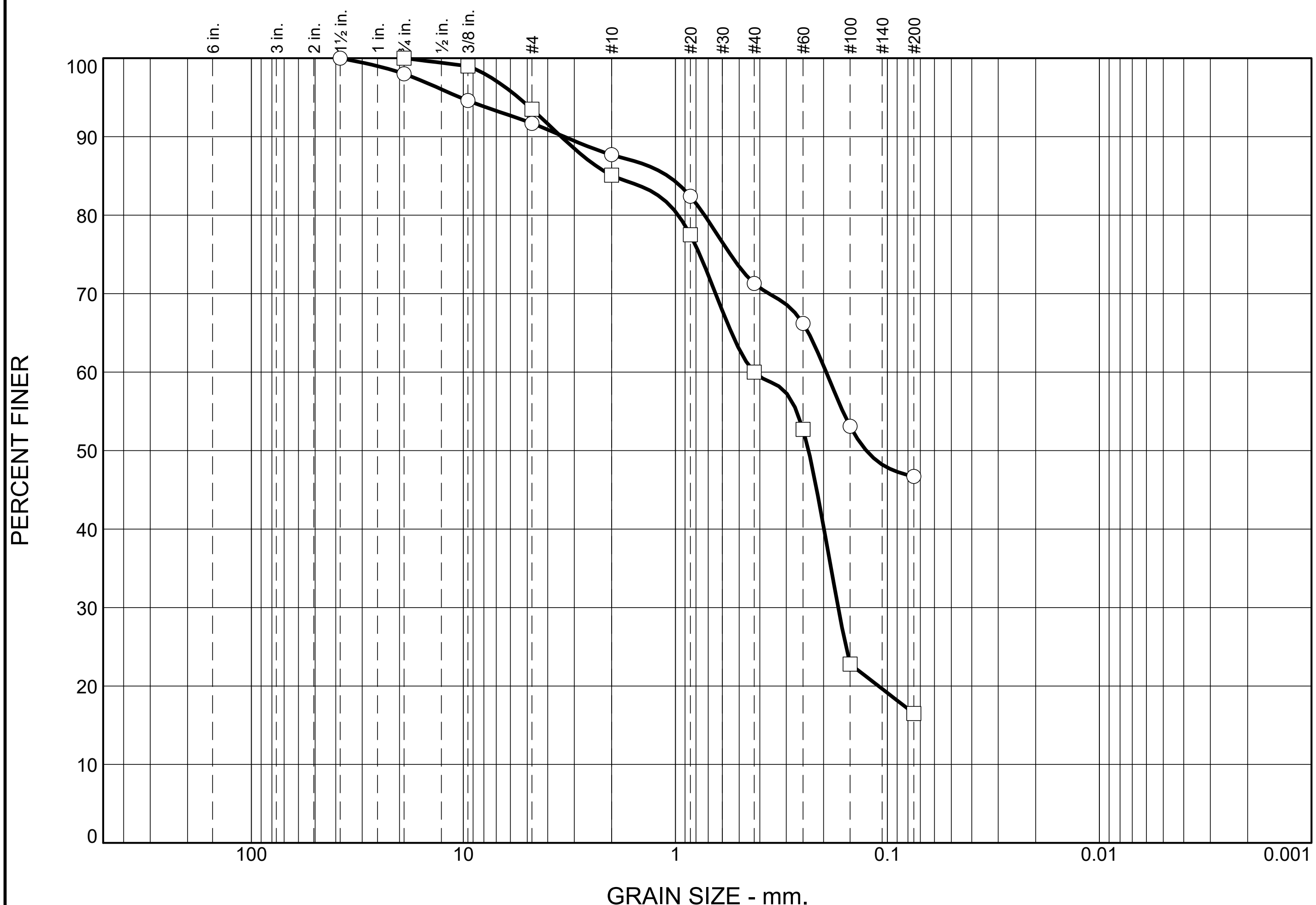
○ Tested November 10, 2023

□ Tested November 10, 2023

Figure A-10

Tested By: KJ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	2.0	6.3	4.0	16.4	24.6	46.7	
□	0.0	0.0	6.5	8.4	25.1	43.5	16.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.0865	0.1945	0.1258					
□			1.9643	0.4250	0.2355	0.1708				

Material Description	USCS	AASHTO
○ silty SAND (USDA Textural - Silt Loam)	SM	
□ silty SAND (USDA Textural - Loamy Sand)	SM	

Project No. T-8970 **Client:** South Lake Ridge, LLC

Project: Minor Marysville Property

○ **Location:** TP-5 **Depth:** 4.5'

□ **Location:** TP-7 **Depth:** 5'

Terra Associates, Inc.

Kirkland, WA

Remarks:

○ Tested November 10, 2023

□ Tested November 10, 2023

Figure A-11

Tested By: KJ