GEOTECHNICAL REPORT

Barajas Property
18830 – 134th Street SE
Monroe, Washington

Project No. T-8064

Terra Associates, Inc.

Prepared for:

D.R. Horton
Kirkland, Washington

December 4, 2018

TERRA ASSOCIATES, Inc.

Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

December 4, 2018
Project No. T-8064

Ms. Katie Stecks
D.R. Horton
11241 Slater Avenue NE, Suite 200
Kirkland, Washington 98033

Subject: Geotechnical Report
Barajas Property
18830 – 134th Street SE
Monroe, Washington

Dear Ms. Stecks:

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 soils observed in our subsurface explorations are glacial deposits comprised predominantly of medium dense to dense silty sand with gravel interpreted to be weathered till overlying unweathered till deposits consisting of dense to very dense, moderately- to strongly-cemented silty sand with gravel and occasional cobbles. We observed light to moderate seepage of perched groundwater in eight of the nine test pits.

In our opinion, there are no geotechnical conditions that would preclude development of the site, as currently planned. The residences can be supported on conventional spread footings bearing on competent native soils on structural fill placed on the competent native soils. 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.

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1.0 PROJECT DESCRIPTION

The proposed project is a residential subdivision. An unreferenced, undated site plan provided to us indicates the development will consist of 22 single-family lots with associated infrastructure and access improvements. The site will be accessed off of 134th Street SE by a new roadway that terminates at a cul-de-sac in the south-central portion of the site. Stormwater runoff collected from the development will be conveyed to a detention facility in the southwestern portion of the site. The plan does not indicate the type of detention facility that will be used. Site grading and building plans are currently not available. Based on the sloping surface gradients, we expect that moderate cuts and fills will be required to establish building pad and roadway elevations.

We expect that the residences will be two- to three-story wood-frame structures with the main floor levels constructed at grade or framed over a crawl space. We anticipate that foundation loads would be relatively light, in the range of 2 to 3 kips per foot for bearing walls and 25 to 50 kips for isolated columns.

The recommendations contained in the following sections of this report are based on these design features. We should review design drawings and specifications as they are developed to verify that our recommendations are valid for the proposed construction, and to amend or modify our report, as necessary.

2.0 SCOPE OF WORK

We explored subsurface conditions at the site in nine test pits excavated to depths about four to eight feet below ground surface using a track-mounted excavator. Using the results of our subsurface exploration and laboratory testing, analyses were undertaken to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Geologic hazards per the City of Monroe Municipal Code
- Seismic design parameters per the 2015 International Building Code (IBC)
- Site preparation and grading
- Excavations
- Foundations

- Slab-on-grade floors
- Stormwater facilities
- Infiltration feasibility
- 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 is beyond Terra Associates' purview. A building envelope specialist or contactor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The site is an approximately 4.76-acre parcel located south of and adjacent to 134th Street SE, approximately 670 feet to 1,000 feet west of the intersection with 191st Avenue SE in Monroe, Washington. The site location is shown on Figure 1.

A single-family residence and a detached garage occupy the north-central and northeastern portions of the site, respectively. Existing surface gradients generally slope down to the south at gentle to moderate inclinations. Vegetation in the northern portion of the site consists primarily of grass lawn and landscape trees and shrubs. The southern portion of the site is vegetated primarily with thick brush and scattered mature coniferous and deciduous trees.

We observed a localized wet area in the east-central portion of the site. The wet area is located immediately downgradient from a corrugated plastic pipe emerging from a pad of cobble-size rocks that appears to be a surface discharge point for one or more drains installed at the site.

3.2 Soils

The soils observed in our subsurface explorations are glacial deposits comprised predominantly of medium dense to dense silty sand with gravel interpreted to be weathered till overlying unweathered till deposits consisting of dense to very dense, moderately- to strongly-cemented silty sand with gravel and occasional cobbles. Eight of the nine test pits terminated in dense to very dense till encountered below depths of about 2.5 to 6 feet. Test Pit TP-1 terminated in a dense, weakly to moderately cemented, outwash-like sand with silt and gravel unit that is interpreted to be an ice-contact deposit. We were unable to determine the vertical extent of the sand with silt and gravel unit due to localized groundwater seepage and caving.

We observed about 1 to 3 feet of loose to medium dense silt to sandy silt containing trace to scattered amounts of gravel in Test Pits TP-6 and TP-7. The silt unit overlies till and till-like soils at both locations and is also interpreted to be an ice contact deposit.

The *Surficial geologic map of the Skykomish and Snoqualmie Rivers area, Snohomish and King Counties, Washington*, by D.B. Booth, 1990, shows the site mapped as Vashon till (Qvt). The dense to very dense silty sand with gravel observed in the test pits is consistent with this geologic unit.

Detailed descriptions of the subsurface conditions we observed in our site 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 to moderate groundwater seepage in 8 of the 9 test pits that was generally perched above the till between depths of about 2 and 2.5 feet. Exceptions to this include moderate groundwater seepage observed between about 3 and 4 feet in Test Pit TP-1 that appeared to be perched above the dense outwash-like sand with silt and gravel, and in Test Pit TP-9 where groundwater is perched on dense till-like soil about 0.3 feet below ground surface.

The occurrence of shallow perched groundwater is typical for sites underlain by relatively impermeable till and till-like soils. We expect that perched groundwater levels and flow rates at the site will fluctuate seasonally, with highest levels typically developing during the wet winter months (October through May).

3.4 Geologic Hazards

We evaluated site conditions for the presence of geologic hazards as designated by Chapter 20.05.120 (Geologically hazardous areas) of the City of Monroe Municipal Code (MMC). Geologically hazardous areas are defined by the MMC as areas susceptible to erosion, sliding, earthquake, or other geological events and include erosion hazard areas, landslide hazard areas, seismic hazard areas, and other geological events including tsunami, mass wasting, debris flows, rock falls, and differential settlement.

3.4.1 Erosion Hazard Areas

Section 20.05.120.B.1 of the MMC defines erosion hazard areas as "…at least those areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service as having "severe" or "very severe" rill and inter-rill erosion hazard."

The Natural Resources Conservation Service (NRCS) has mapped the site soils as *Tokul gravelly medial loam, 0 to 8 percent slopes* and *Tokul gravelly medial loam, 8 to 15 percent slopes.* The erosion hazard of both soil types is described by the NRCS as slight, which does not meet the definition of an erosion hazard area given above.

We did not observe any indications of significant active erosion at the site; however, the site soils will be susceptible to erosion when exposed during development. In our opinion, the erosion potential of the site soils would be adequately mitigated with proper implementation and maintenance of Best Management Practices (BMPs) for erosion prevention and sedimentation control in the planned development area. BMPs for erosion prevention and sedimentation control will need to be in place prior to and during site development, and should be maintained until permanent site stabilization measures are in place. All BMPs for erosion prevention and sedimentation control should conform to City of Monroe requirements.

3.4.2 Landslide Hazard Areas

Section 20.05.120.B.2 of the MCC defines landslide hazard areas as "…areas potentially subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include areas susceptible because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors. Examples of these may include, but are not limited to, the following:

a. Areas of historic failure, such as:
    i. Those areas delineated by the U.S. Department of Agriculture's Natural Resources Conservation Service as having a "severe" limitation for building site development.
    ii. Areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the U.S. Geological Survey or Department of Natural Resources.
b. Areas with all three of the following characteristics:
    i. Slopes steeper than 15 percent.
    ii. Hillsides intersecting geologic contacts with a relatively permeable sediment overlaying a relatively impermeable sediment or bedrock.
    iii. Springs or groundwater seepage.
c. Areas that have shown movement during the Holocene epoch (from ten thousand years ago to the present) or that are underlain or covered by mass wastage debris of that epoch.
d. Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and faults) in subsurface materials.
e. Slopes having a gradient steeper than 80 percent subject to rock fall during seismic shaking.
f. Areas potentially unstable because of rapid stream incision, stream bank erosion, and undercutting by wave action.
g. Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding.
h. Any area with a slope of forty percent or steeper and with a vertical relief of ten or more feet except areas composed of consolidated rock. A slope delineated by establishing its toe and top and measured by averaging the inclination over at least ten feet of vertical relief."

We did not observe conditions meeting the above criteria at the site. In our opinion, the site conditions are not susceptible to landsliding and no landslide hazard exists.

3.4.3 Seismic Hazard Areas

Section 20.05.120.B.3 of the MCC defines defines seismic hazard areas as areas that are "…subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface failure."

The closest known Class A fault (existence of Quaternary fault of tectonic origin demonstrated by geologic evidence) to the project site is the southern Whidbey Island fault zone (SWIFZ). The SWIFZ is described as a northwest-trending (average strike N51°W), 5- to 7-kilometer wide fault zone that extends more than 65 kilometers from the Strait of Juan de Fuca southeast to Mukilteo on the eastern side of Possession Sound.

The subject site is located about 7.5 miles northeast of the north fault strand mapped by the USGS. We did not observe any indications of faulting or surface rupture at the project site and are unaware of any reported documentation of surface rupture due to past movement along the SWIFZ in the project area. Considering this, it is our opinion that the potential for ground rupture at the project site during a severe seismic event is negligible.

Based on the soil and groundwater conditions we observed in our subsurface explorations, it is our opinion that there is no risk for damage resulting from seismically induced slope failure, settlement, soil liquefaction, or lateral spreading. In our opinion, unusual seismic hazard areas do not exist at the site and design in accordance with local building codes for determining seismic forces would adequately mitigate impacts associated with ground shaking.

3.4.4 Other Geologically Hazardous Areas

In our opinion, the site is not susceptible to potential hazards resulting from geologically hazardous events described in Section 20.05.120.B.4 of the MCC that include tsunami, mass wasting, debris flows, rock falls, and differential settlement.

3.5 Seismic Design Parameters

Based on the site soil conditions and our knowledge of the area geology, per the 2015 International Building Code (IBC), site class "C" should be used in structural design. Based on this site class, in accordance with the IBC, the following parameters should be used in computing seismic forces:

Seismic Design Parameters (2015 IBC)

Spectral response acceleration (Short Period), S_{Ms}	1.185 g
Spectral response acceleration (1 – Second Period), S_{M1}	0.606 g
Five percent damped .2 second period, S_{Ds}	0.790 g
Five percent damped 1.0 second period, S_{D1}	0.404 g

The above values were determined for Latitude 47.874734°N and Longitude -121.977252°W using the USGS Ground Motion Parameter Calculator web site accessed November 29, 2018 at the web site http://earthquake.usgs.gov/designmaps/us/application.php.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Based on our study, there are no geotechnical conditions that would preclude the planned development. The residences can be supported on conventional spread footings bearing on competent native soils underlying organic topsoil, or on structural fill placed on the competent native soils. 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, and the ability of the contractor to properly moisture condition the soil. If grading activities will take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

Undisturbed bearing surfaces composed of the native silt observed in Test Pits TP-6 and TP-7, or structural fill derived from the native silt, would typically provide suitable support for conventional spread footing foundations, floor slabs, and pavements; however, the soils will be easily disturbed by normal construction activity, particularly when wet. If disturbed, the soil will not be suitable for support, and the affected material would need to be removed with the foundations lowered to obtain support on an undisturbed soil subgrade. Alternatively, the soils can be removed, and grade restored with structural fill.

Based on our observations, it appears that a moderate perched groundwater condition exists beneath the site that may persist throughout much of the year. Considering this, it would be prudent for the contractor to anticipate the need for some initial construction drainage and soil moisture conditioning efforts to facilitate site grading.

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. Terra Associates, Inc. should review proposed building and grading plans for the project when available to verify that our geotechnical recommendations have been properly interpreted and incorporated into the project design, and to provide additional or alternate recommendations, if needed.

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 four to eight inches will generally be required to remove the organic surficial soils in the planned development areas; however, about two feet of dark brown organic silty sand was observed in Test Pit TP-7. 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 limited depths in nonstructural areas or for landscaping purposes.

In the developed portions of the site, demolition of existing structures should include removal of existing foundations 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 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 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.

We anticipate that most of the site soils will be suitable for use as structural fill provided they are properly moisture conditioned when placed. As discussed, the ability to use the native soils, particularly the observed silt soils, as structural fill will depend on the soil's moisture content when excavated, the prevailing weather conditions during site grading, and the ability of the contractor to properly moisture condition the soil. During the normally dry summer months, it may be possible to dry soils that are wet of optimum by aeration. As an alternative, stabilizing the moisture in the native soil with cement or lime can 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. Moisture conditioning of soils that are dry of optimum would require the addition of water to the soils and thoroughly blending the material prior to compaction.

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 consist of properly moisture conditioned material that is 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 our opinion, reducing the lift thickness to a maximum of six inches and using a sheep's-foot roller to compact the fill will improve the ability to achieve adequate compaction of the fine grained soils.

4.3 Slopes and Embankments

All permanent cut and fill slopes should be graded with a finished inclination of no greater than 2:1 (Horizontal:Vertical). Upon completion of grading, the slope face should be appropriately vegetated or provided with other physical means to guard against erosion. Final grades at the top of the slope must promote surface drainage away from the slope crest. Water must not be allowed to flow uncontrolled over the slope face. If surface runoff must be directed towards the top of a slope, it may be necessary to route collected water to an appropriate point of discharge beyond the toe in a closed system.

Embankment fills placed on slopes exceeding a grade of 20 percent must be keyed and benched into competent native soils. A generalized slope fill detail is shown on Figure 3. At a minimum, we recommend constructing a toe drain in the key trench for the fill embankment. The locations and extent of such toe drains will be best determined in the field at the time of construction. All fill placed for embankment construction should meet the structural fill requirements provided in Section 4.2 of this report.

4.4 Excavations

All excavations at the site associated with confined spaces, such as lower building level retaining walls, must be completed in accordance with local, state, and federal requirements. Based on the Washington State Safety and Health Administration (WSHA) regulations the medium dense to dense native soils would typically be classified as Type C soils. Very dense, cemented till and till-like soils would be classified as Type A soil.

Accordingly, for temporary excavations of more than 4 feet and less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5:1 (Horizontal:Vertical) or flatter. 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. If there is insufficient room to complete the excavations in this manner, or if excavations greater than 20 feet deep are planned, you may need to use temporary shoring to support the excavations.

Based on our field observations, seepage of perched groundwater should be anticipated within site excavations completed during the wet winter and spring months. In our opinion, the volume of water and rate of flow into site excavations should be relatively minor and would not be expected to impact the stability of the excavations when completed as described above. 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 in these soils.

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.

4.5 Foundations

The residential structures may be supported on conventional spread footing foundations bearing on competent native materials or on structural fill placed on a competent native material 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 1.5 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 bearing 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 350 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.

4.6 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 three 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 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 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.

4.7 Lateral Earth Pressures for Below-Grade Walls

The magnitude of earth pressures developing on below-grade walls will depend on 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 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 4.5 of this report.

Gravity block or mechanically stabilized earth (MSE) walls can also be used to accommodate vertical breaks in grade that may be required to achieve desired site elevations. We can design or provide soil design parameters for a design build approach for these alternative wall systems, if requested.

4.8 Infiltration Feasibility

Based on our study, it is our opinion that on-site infiltration is not a feasible alternative for management of site stormwater due to the presence of relatively-impermeable till and till-like soils at relatively shallow depths beneath the ground surface.

There may be opportunities to infiltrate limited amounts of site stormwater in the medium dense soils observed in the upper 2 to 2.5 feet of several of the test pits using Low Impact Development (LID) natural drainage practices (NDPs). The feasibility of using NDPs at the site should be based on field conditions observed at the time of site grading.

4.9 Stormwater Facilities

We understand that site stormwater will be routed to a detention vault or detention pond located in the southwestern portion of the planned development area. Conceptual design information is currently not available. Terra Associates, Inc. should review site development plans when available to verify that our recommendations are appropriate for the vault or pond design, and to provide additional or alternate recommendations, if necessary.

Detention Vault

If on-site detention will be provided by a buried vault, we expect that very dense, cemented till would be exposed throughout the bottom of the vault excavation. Vault foundations supported by these native soils may be designed for an allowable bearing capacity of 6,000 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 4.5.

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 4.7 can be used in designing the below-grade 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. 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 design of vault walls.

The vault may be subject to uplift pressures if drainage is not provided 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.

Detention Pond

We anticipate that pond construction would consist primarily of cuts into native soil. If fill berms will be constructed, the berm locations should be stripped of topsoil, duff, existing fill soils, and soils containing organic material prior to the placement of fill. The fill berms should be constructed by placing structural fill in layers no more than 12 inches thick, compacting each layer to a minimum of 95 percent relative compaction, as determined by ASTM Test Designation D-1557 (Modified Proctor). Material used to construct pond berms should consist predominately of granular soils with a maximum size of 3 inches and a minimum of 20 percent fines. The results of laboratory testing indicate that soils meeting this gradational requirement exist on-site. Terra Associates, Inc. should examine and test all on-site 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 gradient of 3:1 (Horizontal:Vertical) 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 (Horizontal:Vertical). Finished slope faces should be thoroughly compacted and vegetated to guard against erosion.

We expect that perched groundwater seepage will be intercepted by the detention pond excavation, particularly during the wet winter months. However, based on our field observations, we anticipate that the volume of groundwater that might find its way into the pond as seepage would likely be small with respect to the design volume capacity of the pond.

4.10 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 structure should be provided.

Surface water from developed areas must not be allowed to flow in an uncontrolled and concentrated manner over the crests of 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 the water should be collected and tightlined to an approved point of controlled discharge.

Subsurface

We recommend installing a continuous drain along the outside lower edge of the perimeter building foundations. The drains can consist of four-inch diameter perforated PVC pipe that is enveloped in washed ½- to ¾-inch gravel-sized drainage aggregate that extends six inches above and to the sides of the pipe. The pipe can be laid to grade at an invert elevation equivalent to the bottom of footing grade.

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.

4.11 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, the native soils are moisture sensitive and will require careful control of moisture to facilitate proper compaction. If utility construction takes place during the winter or if it is not feasible to properly moisture condition the excavated soil at the time of construction, it may be necessary to import suitable wet weather fill for utility trench backfilling.

4.12 Pavements

Pavements should be constructed on subgrades prepared as recommended in Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. Proofrolling the subgrade with heavy construction equipment should be completed 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 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)
- 3 ½ inches full depth HMA over prepared subgrade

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½-inch class HMA and CRB.

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.

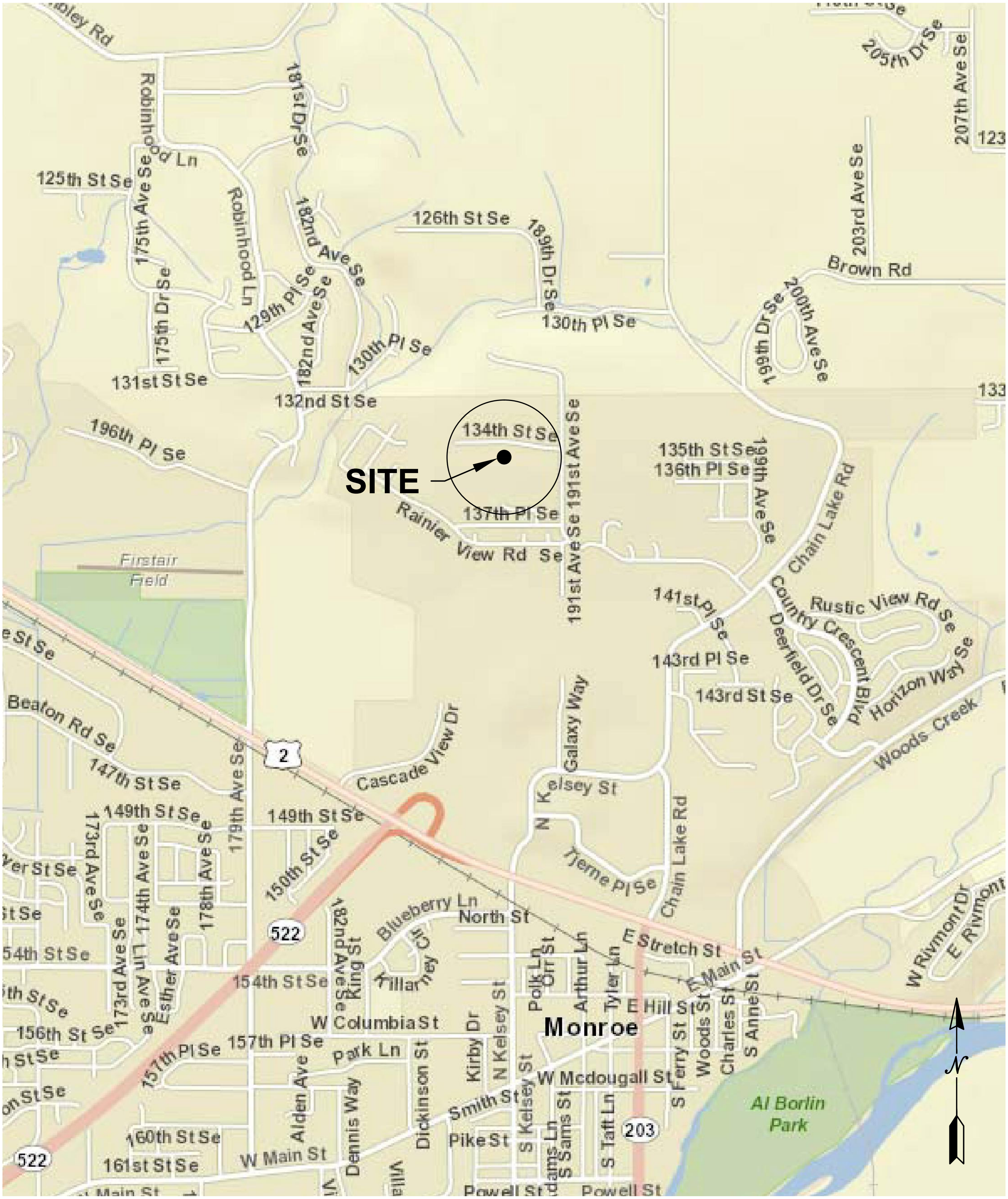
5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final designs and specifications in order to verify that 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. 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 Barajas Property project in Monroe, Washington. This report is for the exclusive use of D.R. Horton and their authorized representatives. No other warranty, expressed or implied, is made.

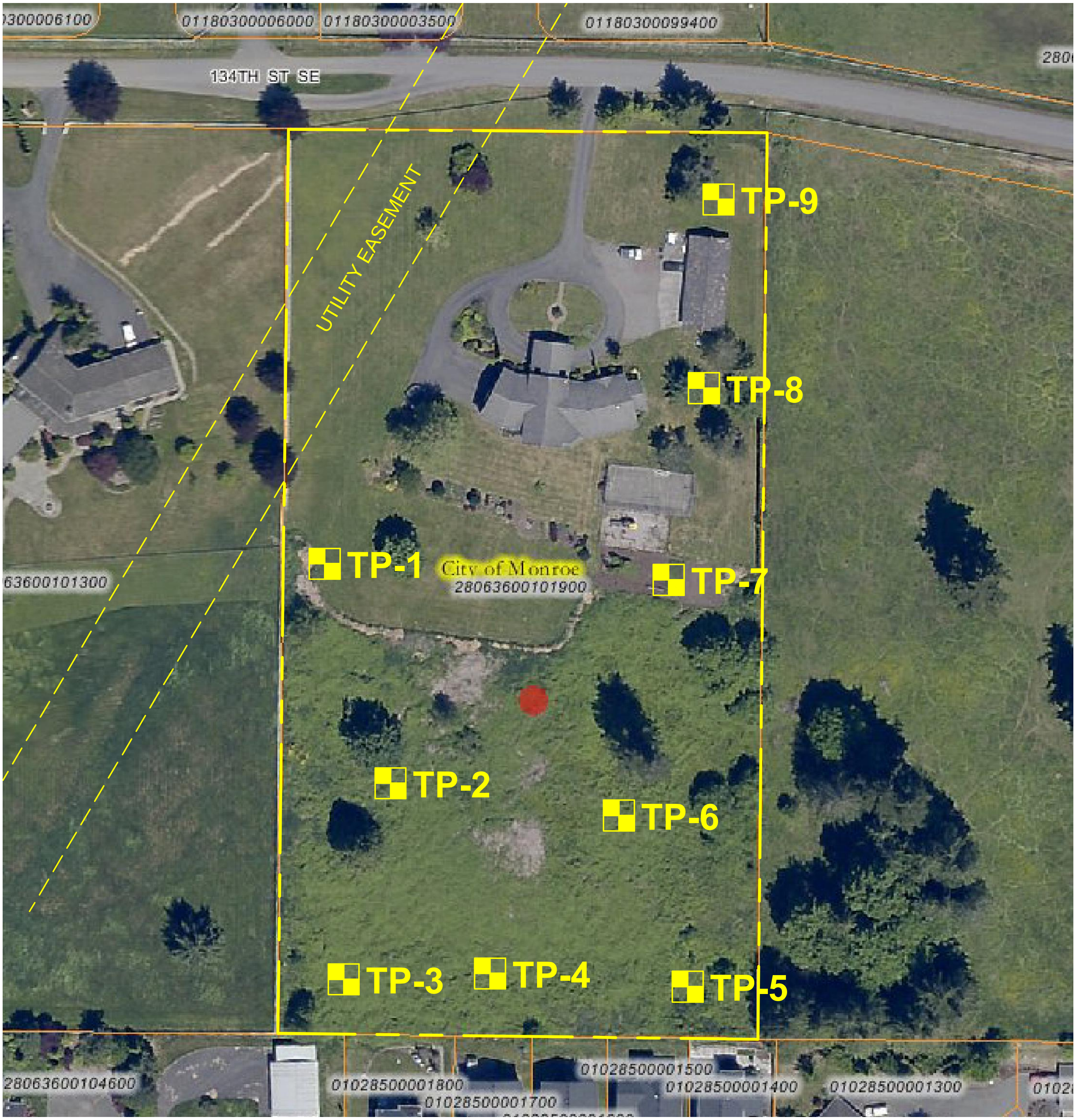
The analyses and recommendations presented in this report are based on data obtained from the subsurface explorations completed at the site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates,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



REFERENCE: WSDOT GEOPORTAL (2018)

NOT TO SCALE

Terra Associates, Inc. Consultants in Geotechnical Engineering Geology and Environmental Earth Sciences	VICINITY MAP BARAJAS PROPERTY MONROE, WASHINGTON		
	Proj. No.T-8064	Date DEC 2018	Figure 1



REFERENCE:

SCOPI

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

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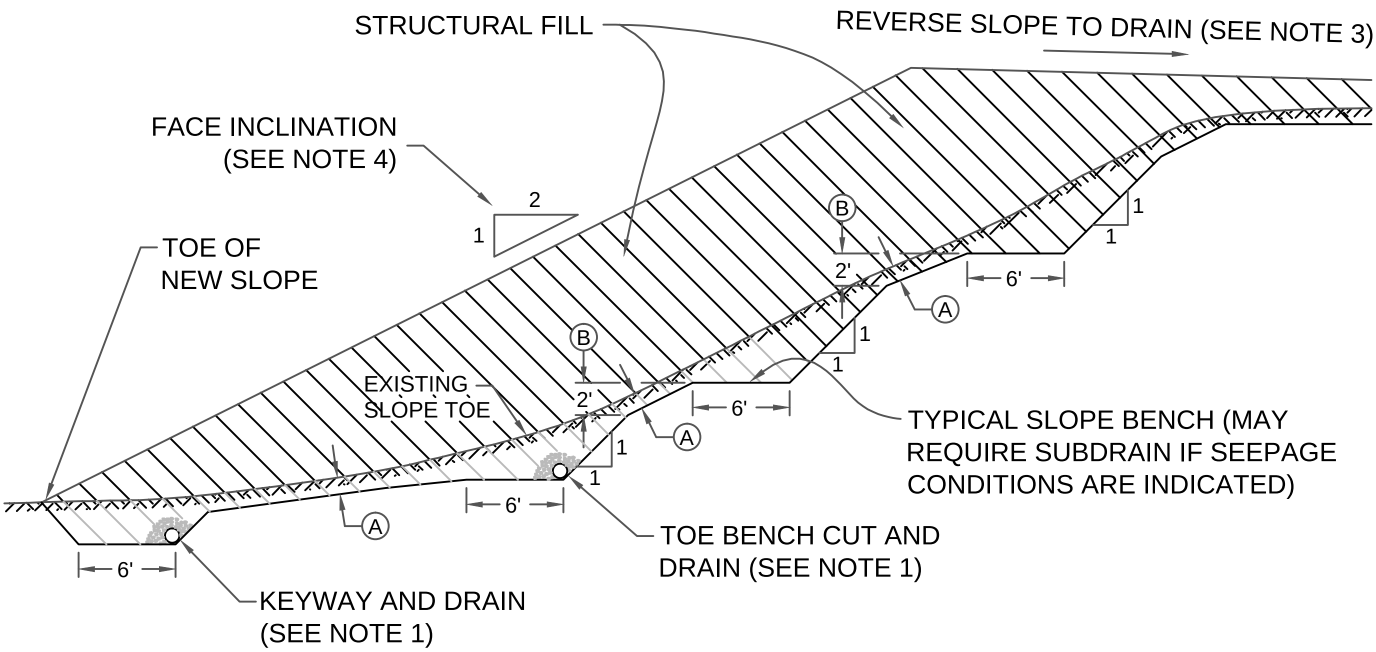
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
BARAJAS PROPERTY
MONROE, WASHINGTON

Proj. No.T-8064	Date DEC 2018	Figure 2



NOT TO SCALE

NOTES:

1) DRAINS SHALL CONSIST OF 6" DIAMETER PERFORATED PVC PIPE ENVELOPED IN 1 cu. ft. OF WASHED 3/4" MINUS DRAINAGE GRAVEL.

2) (A) – TOPSOIL REMOVAL THICKNESS BETWEEN KEYWAY AND BENCHES.

   (B) – VERTICAL ELEVATION DIFFERENCE BETWEEN TOP OF LOWER BENCH BACKCUT AND UPPER BENCH ELEVATION.

3) RECOMMENDED PRIOR TO ESTABLISHMENT OF PERMANENT EROSION CONTROL MEASURES AND SITE DRAINAGE.

4) PERMANENT FACE INCLINATION TO BE ESTABLISHED AT 2:1 (H:V) OR AS RECOMMENDED BY THE GEOTECHNICAL ENGINEER

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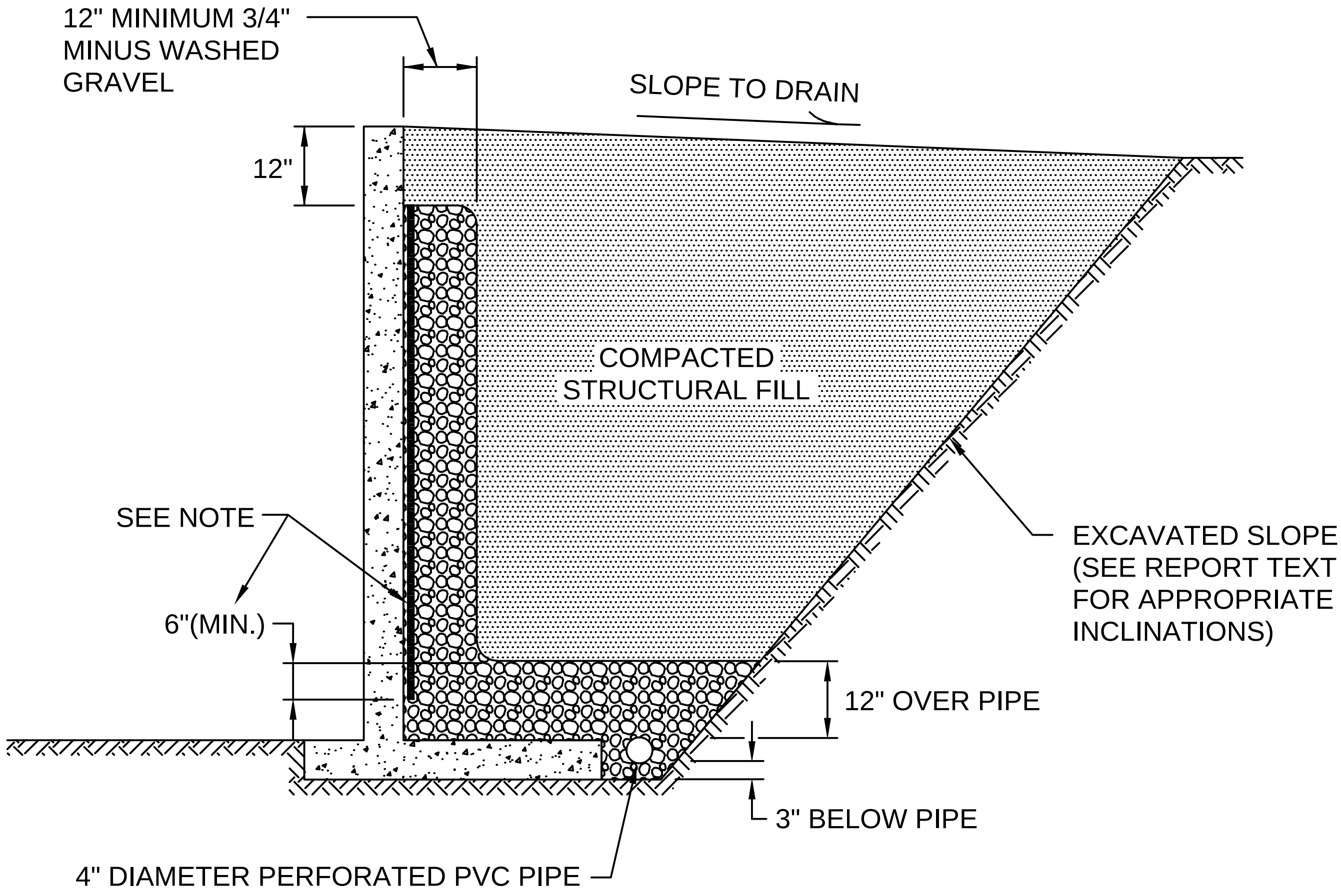
GENERALIZED SLOPE FILL DETAIL
BARAJAS PROPERTY
MONROE, WASHINGTON

Proj. No.T-8064	Date DEC 2018	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 6 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 BARAJAS PROPERTY MONROE, WASHINGTON		
	Proj. No.T-8064	Date DEC 2018	Figure 4

APPENDIX A

FIELD EXPLORATION AND LABORATORY TESTING

Barajas Property
Monroe, Washington

We explored subsurface conditions at the site in 9 test pits excavated to depths about 4.5 to 6.5 feet below ground surface using a track-mounted excavator. The test pit locations are shown on Figure 2. The test pit locations were approximately determined in the field by sighting and pacing relative to existing surface features. The Test Pit Logs are presented as Figures A-2 through A-10.

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

Representative soil samples obtained from the test pits were placed in sealed containers 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 six soil samples. The test results are shown on Figures A-11 and A-12.

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

Symbol	Definition
I	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
II	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

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Environmental Earth Sciences

UNIFIED SOIL CLASSIFICATION SYSTEM
BARAJAS PROPERTY
MONROE, WASHINGTON

Proj. No.T-8064	Date DEC 2018	Figure A-1

LOG OF TEST PIT NO. TP-1

FIGURE A-2

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Lawn **APPROX. ELEV:** N/A

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** 3 to 4 Feet **DEPTH TO CAVING:** 2 to 4 Feet

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0				
0–3.5 (groundwater ▼ at 3)	1	(6 inches SOD and TOPSOIL) Red-brown silty SAND to sandy SILT, fine grained, trace of fine gravel, moist to wet, scattered cobbles. (SM/ML)	Medium Dense	49.1
3.5–6		Gray-brown SAND with silt and gravel, fine to medium sand, fine to coarse gravel, moist to wet, weakly to moderately cemented, scattered cobbles. (SP-SM)	Dense	
6	2	Test pit terminated at 8 feet. Moderate groundwater seepage between about 3 and 4 feet. Minor caving between about 2 and 4 feet.		11.8
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.

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LOG OF TEST PIT NO. TP-2

FIGURE A-3

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Brush **APPROX. ELEV:** N/A

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** 2 Feet **DEPTH TO CAVING:** N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–2.5 (groundwater at 2)	1	(6 inches DUFF and TOPSOIL) Red-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist to wet, scattered cobbles. (SM)	Medium Dense	43.5
2.5–3.5		Gray-brown silty SAND, moist to wet, mottled. (SM)	Medium Dense to Dense	
3.5–5.5	2	Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately to strongly cemented. (SM) (Till)	Dense to Very Dense	12.3
5.5	3			11.8
5.5–10		Test pit terminated at 5.5 feet. Light groundwater seepage at about 2 feet on north side of test pit.		

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.

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LOG OF TEST PIT NO. TP-3

FIGURE A-4

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Brush **APPROX. ELEV:** N/

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–2.5		(6 inches DUFF and TOPSOIL) Red-brown silty SAND, fine grained, trace of fine gravel, moist to wet, scattered cobbles. (SM)	Medium Dense	
2.5–3.5		Gray-brown silty SAND, moist to wet, mottled. (SM)	Medium Dense to Dense	
3.5–6	1 (at 5)	Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, moderately to strongly cemented, trace of cobbles. (SM) (Till)	Very Dense	6.9
6		Test pit terminated at 6 feet. Light groundwater seepage at about 2 feet.		

Depth scale: 0, 1, 2 (groundwater symbol), 3, 4, 5, 6, 7, 8, 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.

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Environmental Earth Sciences

LOG OF TEST PIT NO. TP-4

FIGURE A-5

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Brush **APPROX. ELEV:** N/A

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–2.5		(6 inches DUFF and TOPSOIL) Red-brown silty SAND with gravel, fine sand, fine to coarse gravel, moist to wet, scattered cobbles. (SM)	Medium Dense	
2.5–3.5		Gray-brown silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist, mottled, moderately cemented, scattered cobbles. (SM) (Till-like)	Dense to Very Dense	
3.5–6		Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, strongly cemented, scattered cobbles. (SM) (Till)	Very Dense	
6–10		Test pit terminated at 6 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.

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Environmental Earth Sciences

LOG OF TEST PIT NO. TP-5

FIGURE A-6

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Brush **APPROX. ELEV:** N/A

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** 2 to 2.5 Feet **DEPTH TO CAVING:** N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–1		(6 inches DUFF and TOPSOIL) Dark brown organic silty SAND, fine to medium sand, trace of fine gravel, moist to wet, scattered cobbles. (OL/SM)	Loose to Medium Dense	
1–2.5 (groundwater ▼ 2)		Brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist to wet, mottled. (SM)	Medium Dense	
2.5–3		Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, mottled, moderately cemented. (SM) (Till-like)	Dense to Very Dense	
3–6	1 (at 5)	Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, strongly cemented, scattered cobbles. (SM) (Till)	Very Dense	7.9
6		Test pit terminated at 6 feet. Light groundwater seepage between about 2 and 2.5 feet.		

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 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.

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Environmental Earth Sciences

LOG OF TEST PIT NO. TP-6

FIGURE A-7

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Brush **APPROX. ELEV:** N/A

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** 2 to 2.5 Feet **DEPTH TO CAVING:** N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0				
0–2.5		(8 inches DUFF and TOPSOIL) Brown SILT with sand and gravel to sandy SILT with gravel, fine sand, fine to coarse gravel, moist to wet. (ML)	Loose to Medium Dense	
2 (▼ groundwater)	1			46.5
2.5–3.5		Gray-brown SILT with sand to sandy SILT, fine sand, trace of fine to coarse gravel, moist, trace of cobbles, trace of 1.5-foot diameter boulders. (ML)	Medium Dense	
3.5–6		Gray-brown silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist, numerous cobbles, scattered boulders to 3 feet in diameter. (SM)	Dense	
6–6.5		Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, strongly cemented, scattered cobbles. (SM) (Till)	Very Dense	
6.5–10		Boring terminated at 6.5 feet. Light to moderate groundwater seepage between 2 and 2.5 feet.		
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.

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LOG OF TEST PIT NO. TP-7

FIGURE A-8

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Brush **APPROX. ELEV:** N/A

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** 2 To 2.5 Feet **DEPTH TO CAVING:** N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–2		Dark brown organic silty SAND, moist to wet. (OL/SM)	Medium Dense	
2–3 (▼ 2)	1	Brown sandy SILT, fine grained, wet. (ML)		52.2
3–4		Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, mottled, moderately cemented, numerous cobbles. (SM) (Till-like)	Dense	
4–5		Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, strongly cemented, scattered cobbles. (SM) (Till)	Very Dense	
5	2	Test pit terminated at 5 feet. Light groundwater seepage between about 2 and 2.5 feet.		12.2
6				
7				
8				
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.

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Environmental Earth Sciences

LOG OF TEST PIT NO. TP-8

FIGURE A-9

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Brush **APPROX. ELEV:** N/A

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** 2 Feet **DEPTH TO CAVING:** N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–2		(4 inches SOD and TOPSOIL) Brown silty SAND with gravel, fine sand, fine to coarse gravel, moist to wet. (SM)	Medium Dense	
2 (groundwater) – 3.5		Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered mottling, scattered cobbles. (SM)	Dense to Very Dense	
3.5–4.5	1	Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, strongly cemented, scattered cobbles. (SM) (Till)	Very Dense	12.7
5		Test pit terminated at 4 feet. Light groundwater seepage at about 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.

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Geology and
Environmental Earth Sciences

LOG OF TEST PIT NO. TP-9

FIGURE A-10

PROJECT NAME: Barajas Property **PROJ. NO:** T-8064 **LOGGED BY:** JCS

LOCATION: Monroe, Washington **SURFACE CONDITIONS:** Lawn **APPROX. ELEV:** N/A

DATE LOGGED: November 2, 2018 **DEPTH TO GROUNDWATER:** 0.3 Feet **DEPTH TO CAVING:** N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(4 inches SOD and TOPSOIL) Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, mottled, moderately cemented, numerous cobbles. (SM) (Till-like)	Dense	
1	1			11.0
2				
		Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, strongly cemented, scattered cobbles. (SM) (Till)	Very Dense	
3				
4				
		Test pit terminated at 4.5 feet. Light groundwater seepage at 0.3 feet on north side of test pit.		
5				

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.

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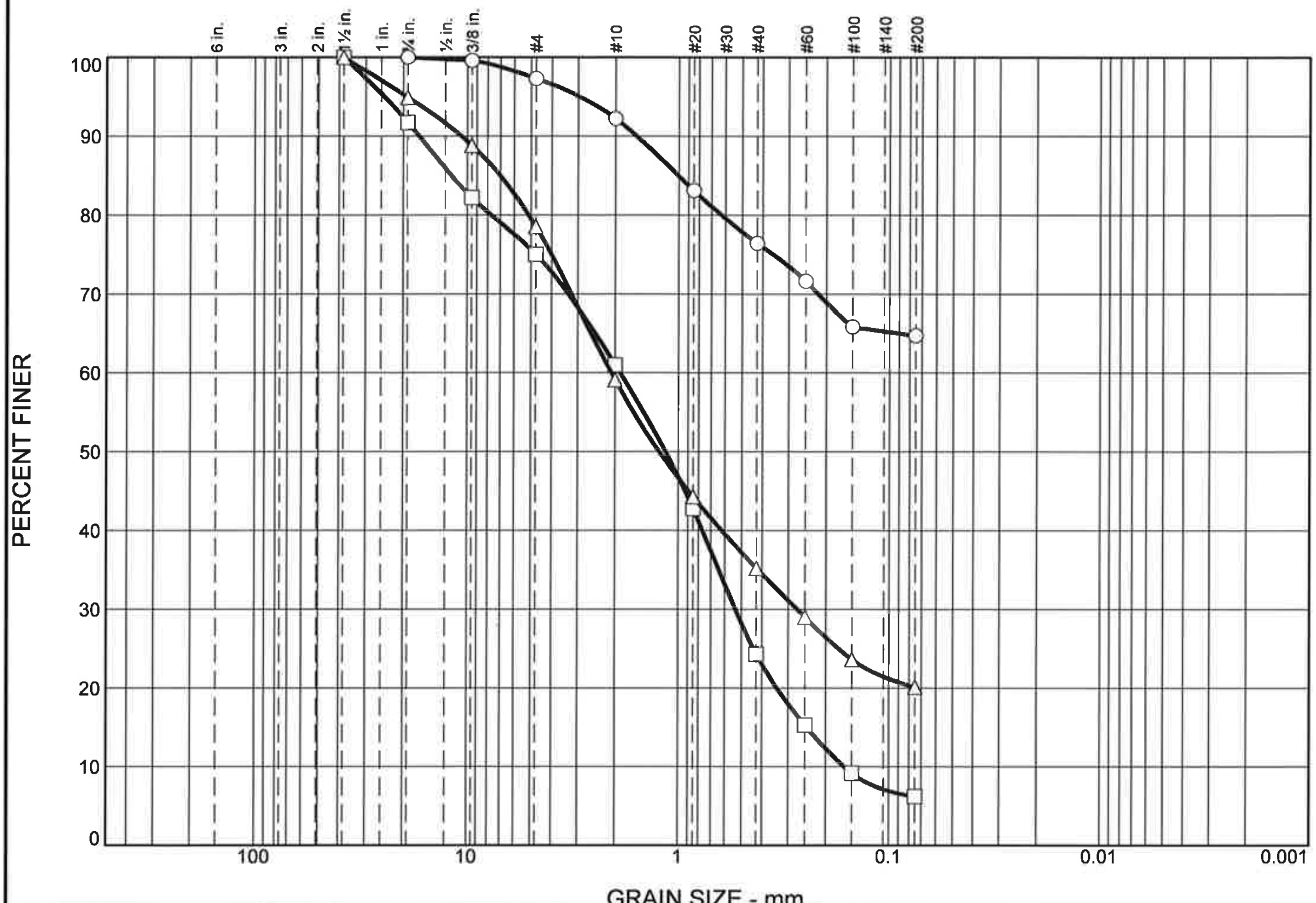
Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	2.7	5.1	15.8	11.7	64.7	
□	0.0	8.3	16.7	14.0	36.7	18.1	6.2	
△	0.0	5.1	16.4	19.4	23.9	15.1	20.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.0083							
□			11.8597	1.8953	1.1483	0.5349	0.2447	0.1634	0.92	11.60
△			7.0146	2.0853	1.2313	0.2725				

Material Description	USCS	AASHTO
○ sandy SILT	ML	
□ SAND with silt and gravel	SP-SM	
△ silty SAND with gravel	SM	

Project No. T-8064 **Client:** D.R. Horton
Project: Barajas Property

○ **Location:** TP-1 **Depth:** 2.5'
□ **Location:** TP-1 **Depth:** 6'
△ **Location:** TP-3 **Depth:** 5'

Remarks:
○ Tested November 13, 2018
□ Tested November 13, 2018
△ Tested November 13, 2018

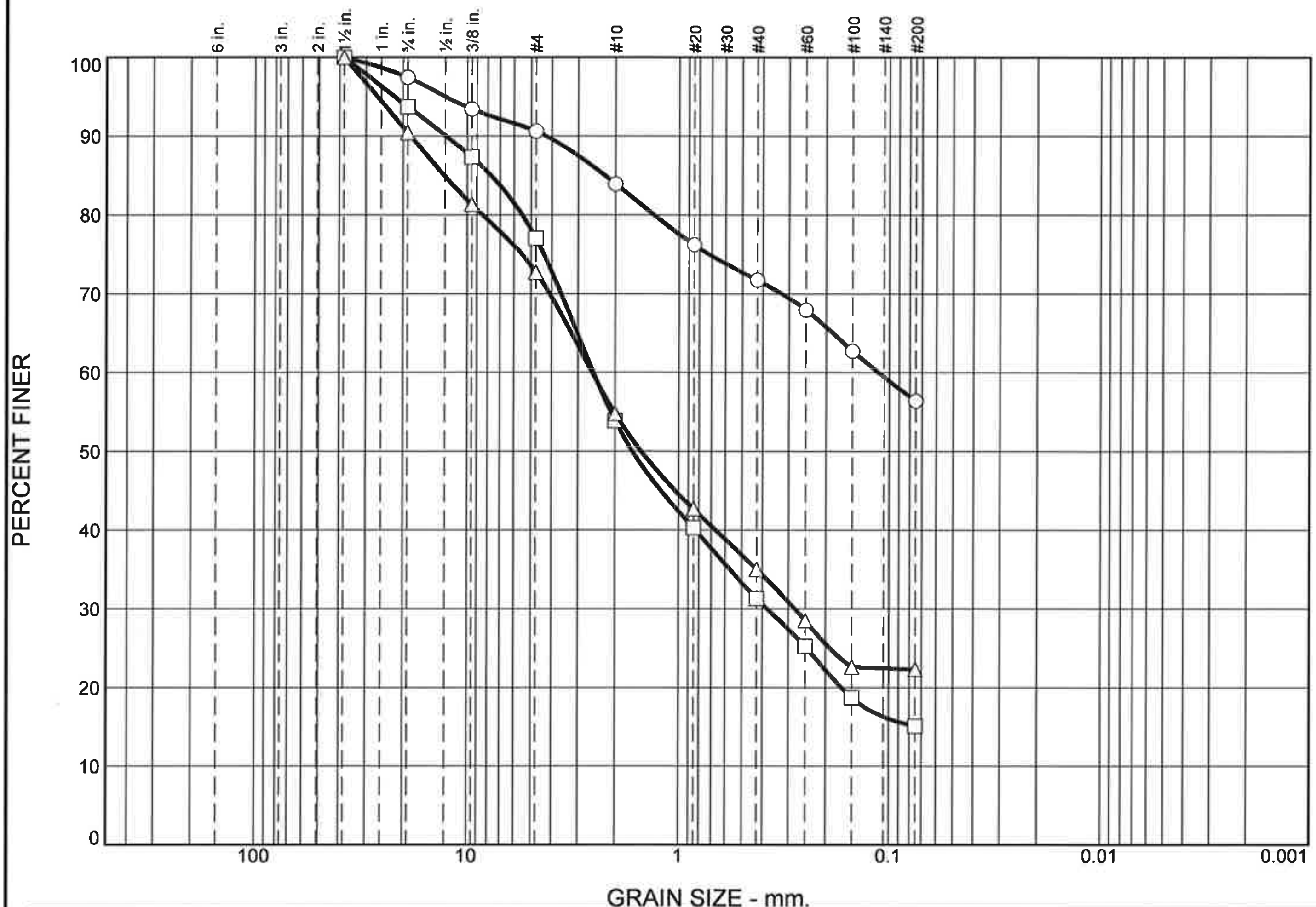
Terra Associates, Inc.

Kirkland, WA

Figure A-11

Tested By: FQ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	2.6	6.8	6.7	12.2	15.3	56.4	
□	0.0	6.3	16.7	23.1	22.6	16.2	15.1	
△	0.0	9.6	17.7	17.9	19.8	12.7	22.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			2.2520	0.1133						
□			7.7327	2.5352	1.6581	0.3795				
△			12.8367	2.5702	1.5085	0.2806				

Material Description	USCS	AASHTO
○ sandy SILT	ML	
□ silty SAND with gravel	SM	
△ silty SAND with gravel	SM	

Project No. T-8064 **Client:** D.R. Horton
Project: Barajas Property

○ **Location:** TP-6 **Depth:** 2'
□ **Location:** TP-7 **Depth:** 5'
△ **Location:** TP-9 **Depth:** 1'

Remarks:
○ Tested November 13, 2018
□ Tested November 13, 2018
△ Tested November 13, 2018

Terra Associates, Inc.

Kirkland, WA

Figure A-12

Tested By: FQ