ATTACHMENT 17

# GEOTECHNICAL REPORT

Beuca Plat
16628 NE 122nd Street
Redmond, Washington

Project No. T-6709

Terra Associates, Inc.

Prepared for:

Quadrant Homes
Bellevue, Washington

April 27, 2012
Revised February 12, 2014

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

April 27, 2012
Revised February 12, 2014
Project No. T-6709

Mr. Corey Watson
Quadrant Homes
14725 SE 36th Street, Suite 200
Bellevue, Washington 98006

Subject: Geotechnical Report
Beuca Plat
16628 NE 122nd Street
Redmond, Washington

Dear Mr. Watson:

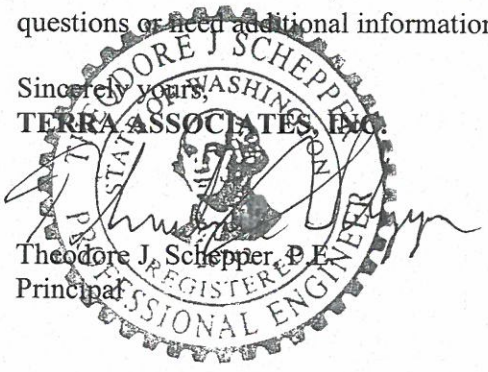
As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

In general, soil conditions we observed in the test pits consisted of 6 to 12 inches of organic surface soils and roots overlying native weathered and unweathered horizons of glacial till consisting of silty sand with gravel. We observed slight groundwater seepage in two of our five on-site explorations.

In our opinion, the soil and groundwater conditions at the site are suitable for the proposed residential construction provided recommendations contained herein are incorporated into project design and construction. Undisturbed, native soil subgrades or compacted structural fill placed above these native soils will provide suitable bearing for standard spread footing foundations, floor slabs, and pavements.

We trust the information provided in the attached report is sufficient for your current needs. If you have any questions or need additional information, please call.

Sincerely yours,
**TERRA ASSOCIATES, Inc.**




2-12-14

Theodore J. Schepper, P.E.
Principal

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## 1.0 PROJECT DESCRIPTION

The project will consist of developing the site into a residential plat. Based on review of site plan prepared by CORE Design the development will consist of constructing 14 lots with associated infrastructure. Site grading required to achieve design roadway and lot elevations will consist of excavation cuts ranging from two to seven feet below current site elevations in the eastern portion of the property with fills of similar depth placed in the west-central site area. The cut along the eastern property line and access roadway will be faced with rockery construction with a maximum exposed rockery height of eight feet.

Development stormwater will be collected and routed for treatment and discharge in a stormwater detention vault located in the southwestern corner of the site. As we understand, the vault floor will be at approximately elevation 273 feet. When accounting for floor thickness and foundations the excavation for the vault will extend 21 to 27 feet below existing site grades.

New residential structures will likely be two-story, wood-framed buildings. We expect each buildings main floor level will be framed over a crawl space with attached or detached garage floors constructed as slabs on grade. Foundation loads should be light, in the range of 2 to 3 kips per foot for bearing walls and 10 to 20 kips for isolated columns.

The recommendations contained in the following sections of this report are based on the above design features. We should review any changes in the grading, utility, and drainage plans 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

On April 13, 2012, we observed the excavation of 5 soil test pits to maximum depths of 10 feet below existing site grades. Using the information obtained from the subsurface explorations and laboratory testing, we performed analyses to develop geotechnical recommendations for development at the site.

Specifically, this report addresses the following:

- Soil and groundwater conditions
- Geologic hazards
- Site preparation and grading
- Excavations
- Foundations

- Floor slabs
- Lateral earth pressures for below-grade walls
- Stormwater detention vault
- Drainage
- Utilities
- Pavements

It should be noted that the 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 (i.e., humidity, mildew, mold) are 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 a 3.59-acre irregularly shaped parcel located at 16628 NE 122nd Street in Redmond, Washington. The approximate site location is shown on the attached Figure 1.

The project site is bordered to the north by undeveloped forested land and a residential lot, to the east by residential developments, the terminus of NE 123rd Way, and a green space, to the south by NE 122nd Street, and to the west by a residential lot. Access to the site is currently gained from the south off of NE 122nd Street.

The site is partially developed with two residences and associated sheds located near the southeastern margin and mid-northern portions of the property. Water and septic services extend north and southwest, respectively, from the southern residence into the central portion of the property where they connect to a drinking water well and septic drainfield.

In general, the site is gently sloping down to the west. The majority and development portion of the property is inclined at approximately five percent to ten percent down to the west. Overall topographic relief is around 25 feet.

Ground cover consists primarily of grass with medium growth trees around the various structures. Ground cover on the northern third of the property consists of a forested area of medium growth trees.

### 3.2 Soils

On April 13, 2012, we observed soil conditions at 5 test pits excavated to depths of 10 feet below existing surface grades. In general, we observed 6 to 12 inches of organic surface soils and roots overlying weathered and unweathered horizons of glacial till. The glacial till consists of loose to very dense silty sand with gravel. We expect that there are fill soils immediately adjacent each structure associated with previous site grading and development.

More detailed descriptions of the subsurface conditions we encountered are summarized on the Test Pit Logs in Appendix A. The approximate locations of the borings are shown on Figure 2.

The Geologic Map of the Redmond Quadrangle, King County, Washington, by James P. Minard, and Derek B. Booth (1988), maps the soils at the site as Fraser-age Till (Qvt). The native site soils we observed at the site are consistent with the mapped geology.

### 3.3 Groundwater

We observed shallow groundwater seepage in two of the five test pits. The development of a perched groundwater table is typical for sites underlain by glacial till, particularly during the wet winter and spring months. In general, surface water that infiltrates through the upper weathered soil zone becomes perched on the underlying, dense, cemented till. The cemented till has a relatively low permeability that impedes the downward migration of the infiltrated surface water. As a result, groundwater will accumulate, and when combined with a positive gradient, will tend to flow laterally along the till contact. Locally, such seepage is referred to as interflow.

## 4.0 GEOLOGIC HAZARDS

### 4.1 Erosion

Section 20D.140.60(1)(a) of the City of Redmond Community Development Guide, classifies erosion hazard areas as, "...lands or areas underlain by soils identified by the U.S. Department of Agriculture Soil Conservation Service (SCS) as having "severe" or "very severe" rill and inter-rill erosion hazards. This includes, but is not limited to, the following group of soils when they occur on slopes of 15 percent or greater Alderwood-Kitsap (AkF), Alderwood gravelly sandy loam (AgD), Kitsap silt loam (KpD), Everett (EvD), and Indianola (InD)".

The Soil Conservation Service (SCS) has classified the majority of the site soils as Alderwood gravelly sandy loam, 6 to 15 percent slopes (AgC) having a slight to moderate potential for erosion. Based on the City of Redmond definition, the site would not classify as an erosion hazard area. Regardless, temporary erosion and sedimentation control elements must be implemented in accordance with state and city requirements during construction.

## 4.2 Landslide Hazard Area

Section 20D.140.60(1)(b) of the City of Redmond Community Development Guide, classifies landslide hazard areas as, "...lands or areas potentially subject to significant or severe risk of landslides based on a combination of geologic, topographic, and hydrogeologic factors...." These areas include but are not limited to the following:

(ii) Areas containing a combination of slopes steeper than 15 percent, springs or groundwater seepage, and hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock.

(vii) Any area with a slope 40 percent or steeper with a vertical relief of 10 feet or more.

We did not observe indications of instability, emergent groundwater seepage, significant erosion, or historical movement on or adjacent the site. Site specific survey data is not available for our review, however based on our site observations and reconnaissance, we estimate slope inclinations vary from five to approximately ten percent. In light of this, the current developed condition of the site, and considering the sites gentle slope inclinations, it is our opinion that the site conditions do not meet the City of Redmond's definition of a landslide hazard area.

## 4.3 Seismic

Section 20D.140.60(1)© of the City of Redmond Community Development Guide, classifies seismic hazard areas as, "...lands or areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, or surface faulting".

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations. Liquefaction mainly affects geologically recent deposits of fine-grained sands underlying the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction; thus, eliminating the soil's strength. Based on the very dense, cohesive nature of the native site soils and the small amounts of groundwater in our explorations, it is our opinion that the risk for liquefaction to occur at this site during an earthquake is negligible. The site conditions do not meet the City of Redmond's definition of a seismic hazard area, in our opinion.

### *IBC Seismic Soil Site Class*

Based on the soil conditions encountered and the local geology, the 2012 International Building Code (IBC) indicates that site class "C" should be used in structural design.

**Seismic Design Parameters (IBC 2012)**

| | |
|---|---|
| Spectral response acceleration (Short Period), $S_{MS}$ | 1.181 |
| Spectral response acceleration (1 – Second Period), $S_{M1}$ | 0.561 |
| Five percent damped 0.2-second period, $S_{DS}$ | 0.787 |
| Five percent damped 1-second period, $S_{D1}$ | 0.374 |

Values based on Latitude 47.710N and Longitude -122.118W. Values obtained from United States Geologic Service (USGS) Ground Motion Parameter Calculator accessed February 12, 2014 on the web site http://earthquake.usgs.gov/research/hazmaps/design/index.php

## 5.0 DISCUSSION AND RECOMMENDATIONS

### 5.1 General

Based on our study, there are no geotechnical conditions that would preclude development of the site as planned. The residences can be supported on conventional spread footings bearing on competent native soils or on structural fill placed on competent native soils. Floor slabs and pavements can be similarly supported.

The native glacial deposits encountered at the site contain a sufficient amount of fines (silt- and clay-sized particles) that will make compaction to structural fill requirements difficult or impossible when the soils are too wet. Accordingly, the ability to use 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 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.

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.

### 5.2 Site Preparation and Grading

To prepare the site for construction, demolition of existing structures should include removal of existing building foundations, floor slabs, abandoned utility pipes, and vaults. Abandoned utilities that are outside the limits of the new building construction can be left in place, provided they are sealed to prevent intrusion of groundwater seepage and soils. In the remaining portions of the site, vegetation, organic surface soils, organic fill soils, if any, and other deleterious materials should be stripped and removed from below areas of new construction. Vegetation debris from clearing operations should be removed from the site. Organic topsoil will not be suitable for use as structural fill, but may be used for limited depths in nonstructural areas or for landscaping purposes.

Once clearing and stripping operations are complete, cut and fill operations can be initiated to establish desired building grades. Prior to placing fill, all exposed surfaces should be observed by a representative of Terra Associates, Inc. to verify that soil conditions are as expected and suitable for support of new fill or building elements. These observations may require proofrolling the subgrade with heavy rubber-tired machinery to determine if any isolated soft and yielding areas are present.

If excessively yielding areas are observed and cannot be stabilized in place by compaction, the affected soils should be excavated and removed to firm bearing and grade restored with new structural fill. If the depth of excavation to remove unstable soils is excessive, use of a geotextile reinforcing/separation fabric, such as Mirafi 500X or equivalent can be considered in conjunction with structural fill. Our experience has shown that, in general, a minimum of 18 inches of a clean, granular structural fill over the geotextile fabric should establish a stable bearing surface.

Our study indicates that the native soils contain a sufficient percentage of fines (silt and clay size particles) that will make them difficult to compact as structural fill if they are too wet or too dry. Accordingly, the ability to use these native soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions when site grading activities take place. At the time of our investigation, the near-surface native soils were wet of optimum and the deeper unweathered soils were at or near optimum moisture content. If native soils become too wet to properly compact they could be dried by aeration during dry weather conditions or mixed with an additive such as cement or lime to stabilize the soil and facilitate compaction. If an additive is used, additional Best Management Practices (BMPs) for its use will need to be incorporated into the Temporary Erosion and Sedimentation Control plan (TESC) for the project.

If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the contractor 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, a qualified geotechnical engineer should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent. All structural fill in City of Redmond rights-of-way must conform to City materials and compaction specifications.

## 5.3 Excavations and Slopes

### *Excavation*

All excavations at the site associated with confined spaces, such as utility trenches or detention vaults must completed in accordance with local, state, or federal requirements. Based on current Washington Industrial Safety and Health Act (WISHA) regulations, the near-surface medium dense weathered soils would be classified as Type C soils. The native dense to very dense unweathered glacial deposits would be classified as Type A soils.

Accordingly, for temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5H:1V (Horizontal:Vertical) or flatter from the toe to the crest of the slope. Excavations in Type A soils can be laid back at a slope inclination of 0.75H:1V or flatter. All temporary exposed slopes on excavations that will remain open for an extended time period should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation.

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.

***Slopes***

All permanent cut and fill slopes should be graded with a finished inclination of no greater than 2H:1V. 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 slope, the runoff should be controlled at the top of the slope, piped in a closed conduit installed on the slope face, and taken to an appropriate point of discharge beyond the toe. All fill placed for embankment construction should meet the structural fill requirements in the Site Preparation and Grading Section.

## 5.4 Rockeries

As noted earlier, rockery construction will be used to face near-vertical grade transitions along the eastern property line and internal access roadway. The native till soil conditions at the site are well suited for rockery construction to the planned maximum height of eight feet. A typical cut rockery detail is attached as Figure 3.

## 5.5 Foundations

The planned residential structures may be supported on conventional spread footing foundations bearing on competent native soils or on structural fill placed above competent native soils. Perimeter foundations exposed to the weather should bear at a minimum depth of 18 inches below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab.

Allowable design bearing capacities will be dependent on design elevations with higher bearing capacities typically available in the lower dense to very dense unweathered glacial till. For shallow foundations bearing on the native medium dense weathered till soils in the upper five feet or structural fill placed above these soils, we recommend designing foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). Foundations bearing on the unweathered very dense till below a depth of approximately 5 feet can be designed for an allowable soil bearing capacity of 6,000 psf. For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. With structural loading as anticipated and these bearing stresses applied, we estimate total foundation settlement would be less than one-half inch.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the sides of the footings can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 350 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because it can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent soil and backfilled with structural fill, as described in Section 5.2 of this report. The values recommended include a safety factor of 1.5.

## 5.6 Slab-on-Grade Floors

Slab-on-grade floors may be supported on subgrades, as recommended in Section 5.2 of this report. Immediately below the floor slabs, we recommend placing a four-inch thick capillary break layer of clean, free-draining, 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 slabs.

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 in uniform curing of the slab, and can actually serve as a water supply for moisture transmission 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. We recommend floor designers and contractors refer to the 2003 American Concrete Institute (ACI) Manual of Concrete Practice, Part 2, 302.1R-96, for further information regarding vapor barrier installation below slab-on-grade floors.

## 5.7 Lateral Earth Pressures for Below-Grade Walls

The magnitude of earth pressure development on below-grade walls, such as basement or detention vault walls, will partly depend on the quality of the wall backfill. We recommend placing and compacting wall backfill as structural fill as described in Section 5.2 of this report.

To guard against hydrostatic pressure development, drainage must be installed behind the wall. A typical wall drainage detail is shown on Figure 4.

With wall backfill placed and compacted as recommended and drainage properly installed, unrestrained walls can be designed 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 included. For evaluating the walls under seismic loading, a uniform earth pressure equivalent to 8H psf, where H is the height of the retained earth in feet, can be used. 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 the wall foundation and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 5.4 of this report.

## 5.8 Stormwater Detention Vault

As previously discussed, plans show on-site stormwater detention will be provided by a buried vault. With a design floor elevation of 273 feet the excavation for the vault will extend 21 to 27 feet below current site grades. This is well below the depth of our test pit exploration which terminated at a depth ten feet. Based on our experience, we expect that the thickness of the glacial till sediments would extend to and below the depth of the vault excavation. However, we would recommend this be confirmed by additional exploration prior to construction. The primary concern is not the soils capability to support the vault design but rather the possibility of encountering more significant groundwater flow than that indicated by the current exploration.

If there is insufficient room to complete the excavation with temporary excavation slopes as described in Section 5.3 temporary shoring to support the excavation will be required. We can provide soil parameters for design of the temporary shoring should that become necessary.

Vault foundations and below-grade walls should be designed in accordance with the recommendations given in Sections 5.4 and 5.6 of this report. If drainage of vault walls is not possible, the un-drained portion of the walls should be designed to support an earth pressure equivalent to a fluid weighing of 85 pcf.

We expect the vault will extend below the perched water table. If drainage is not provided, the structure will be subject to uplift pressures. The weight of the structure and the backfill soil overlying it will provide resistance to the uplift force. For native soils used as backfill, a soil unit weight of 120 pcf can be used in design to resist uplift forces, provided the backfill is placed and compacted as recommended in Section 5.2 of this report.

## 5.9 Drainage

### *Surface*

Final exterior grades should promote free and positive drainage away from the building areas. We recommend providing a gradient of at least three percent for a minimum distance of ten feet from the building perimeter, except in paved locations. In paved locations, a minimum gradient of two percent should be provided, unless provisions are included for collection and disposal of surface water adjacent to the structure.

### *Subsurface*

We recommend installing a continuous drain along the outside lower edge of shallow 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 that is enveloped in washed pea gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. The foundation drains should be tightlined to an approved point of controlled discharge independent of the roof drain system. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once every year.

### *Infiltration*

The native glacial till soils exhibit very low permeability and would not be suitable for discharge of development stormwater using retention elements that rely on infiltration.

## 5.10 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or City of Redmond specifications. As a minimum, trench backfill should be placed and compacted as structural fill, as described in Section 5.2 of this report.

As noted, based on the condition of the soils at the time of our study, most of the native soils excavated on-site should be suitable for use as backfill during dry weather conditions. If utility construction takes place during the wet winter months, it may be necessary to import suitable wet weather fill for utility trench backfilling.

### 5.11 Pavements

Suitable support for site pavements will be provided by subgrade soils prepared as recommended in Section 5.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy construction equipment 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 asphalt concrete (AC) over four inches of crushed rock base (CRB)
- Three and one-half inches full depth HMA

All paving materials should conform to the current WSDOT specifications for "Hot Mix Asphalt" (HMA). Crushed surfacing base course material should conform to 2010 WSDOT 9-03.9(3) "Crushed Surfacing" specifications.

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. To improve pavement performance, we recommend surface drainage gradients of at least two percent. Some longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

## 6.0 ADDITIONAL SERVICES

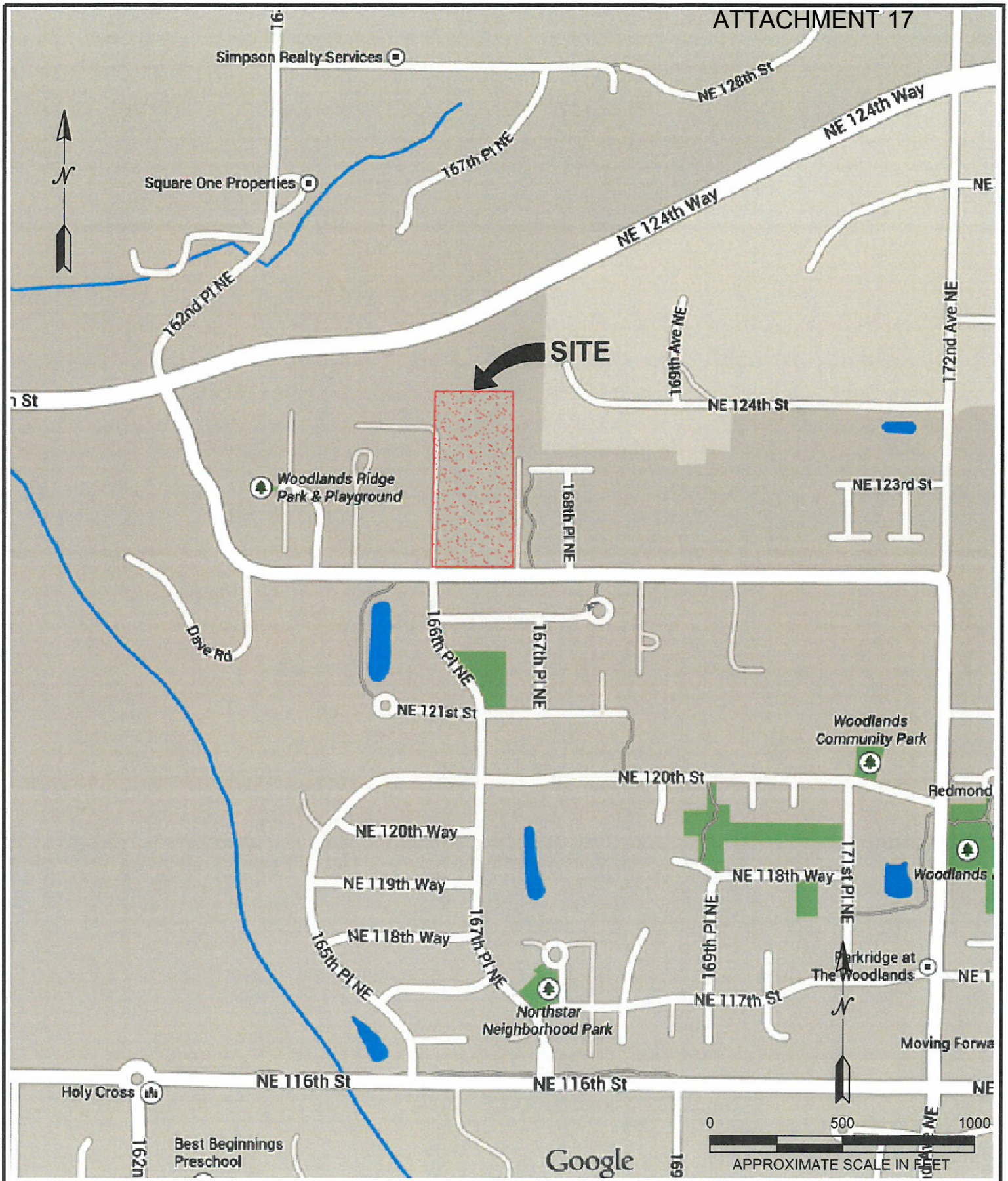
Terra Associates, Inc. should review project designs and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and incorporated into project design. We should also provide geotechnical services during construction to observe compliance with our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

## 7.0 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 Beuca Plat project in Redmond, Washington. This report is for the exclusive use of Quadrant Homes and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the on-site soil test pits. 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.

ATTACHMENT 17




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

# VICINITY MAP
# BEUCA PLAT
# REDMOND, WASHINGTON

| Proj. No.T-6709 | Date FEB 2014 | Figure 1 |
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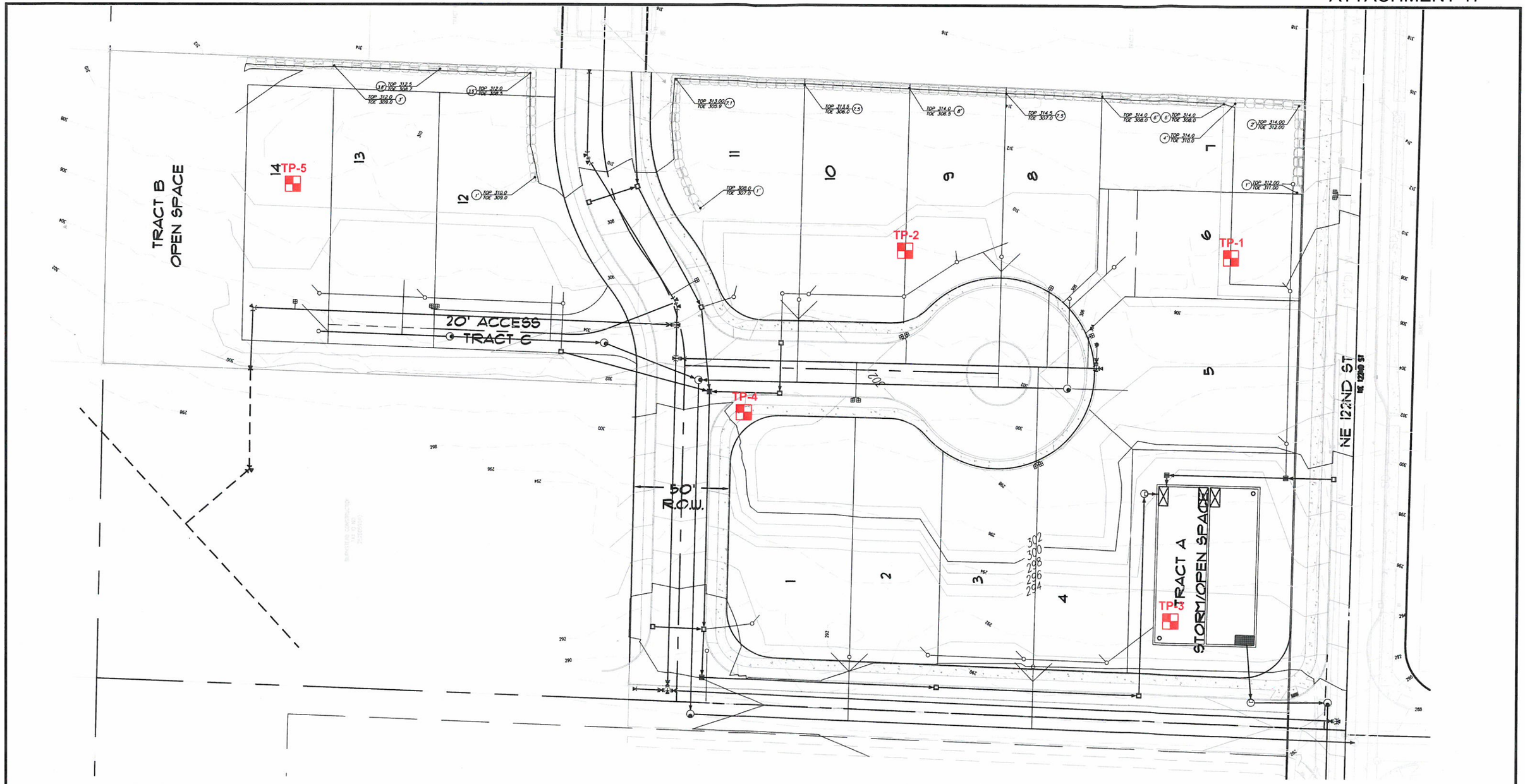



0 50 100

APPROXIMATE SCALE IN FEET

**NOTE:**

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

**REFERENCE:**

SITE PLAN PROVIDED BY CLIENT

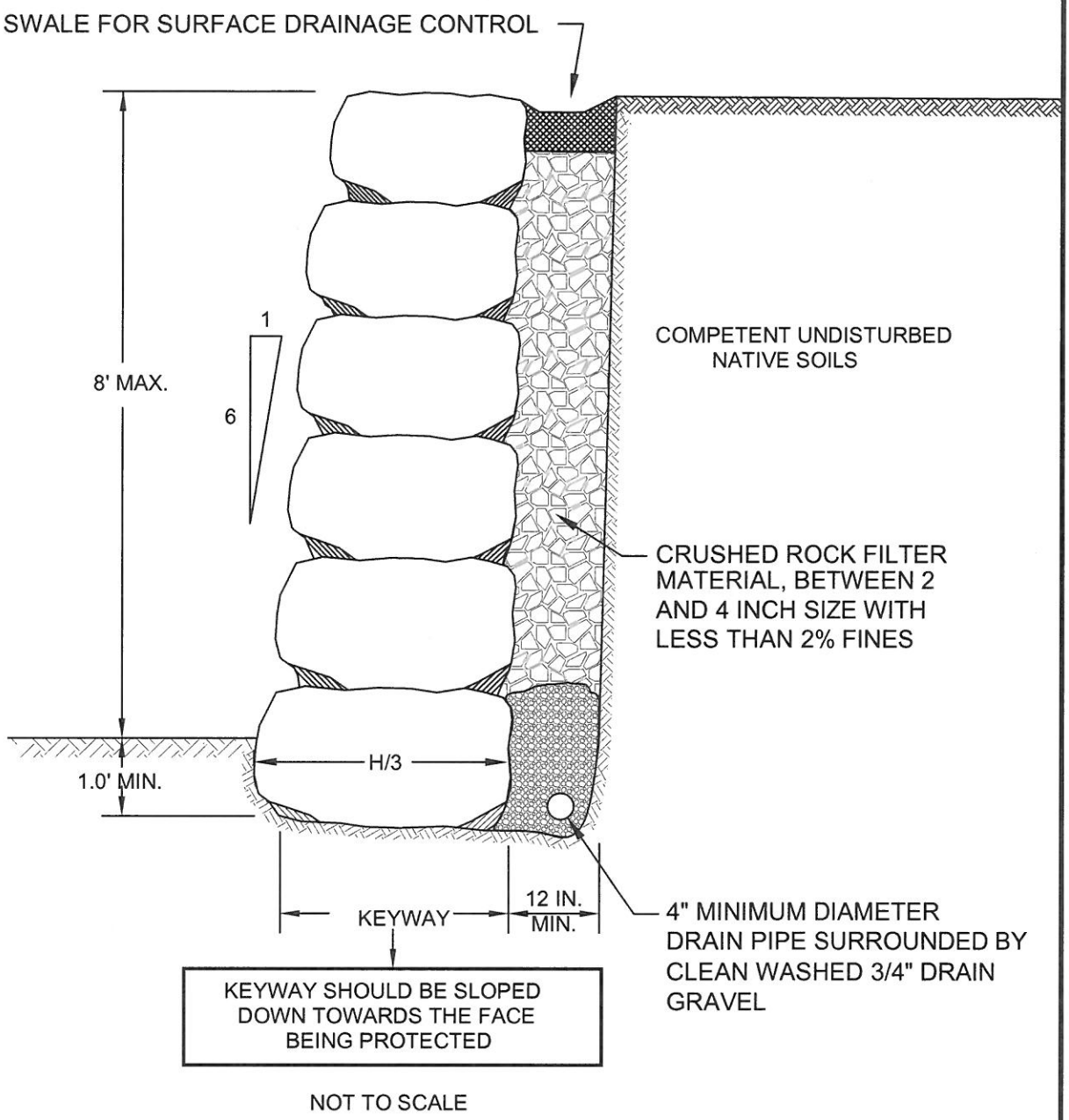
**LEGEND:**

APPROXIMATE TEST PIT LOCATION - TERRA 2012

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

EXPLORATION LOCATION PLAN
BEUCA PLAT
REDMOND, WASHINGTON

| Proj. No.T-6709 | Date FEB 2014 | Figure 2 |
|---|---|---|




NOT TO SCALE

## ROCKERY NOTES:

1. ROCKERY CONSTRUCTION SHALL BE COMPLETED IN ACCORDANCE WITH THE ASSOCIATION OF ROCKERY (ARC) CONTRACTORS GUIDELINES.

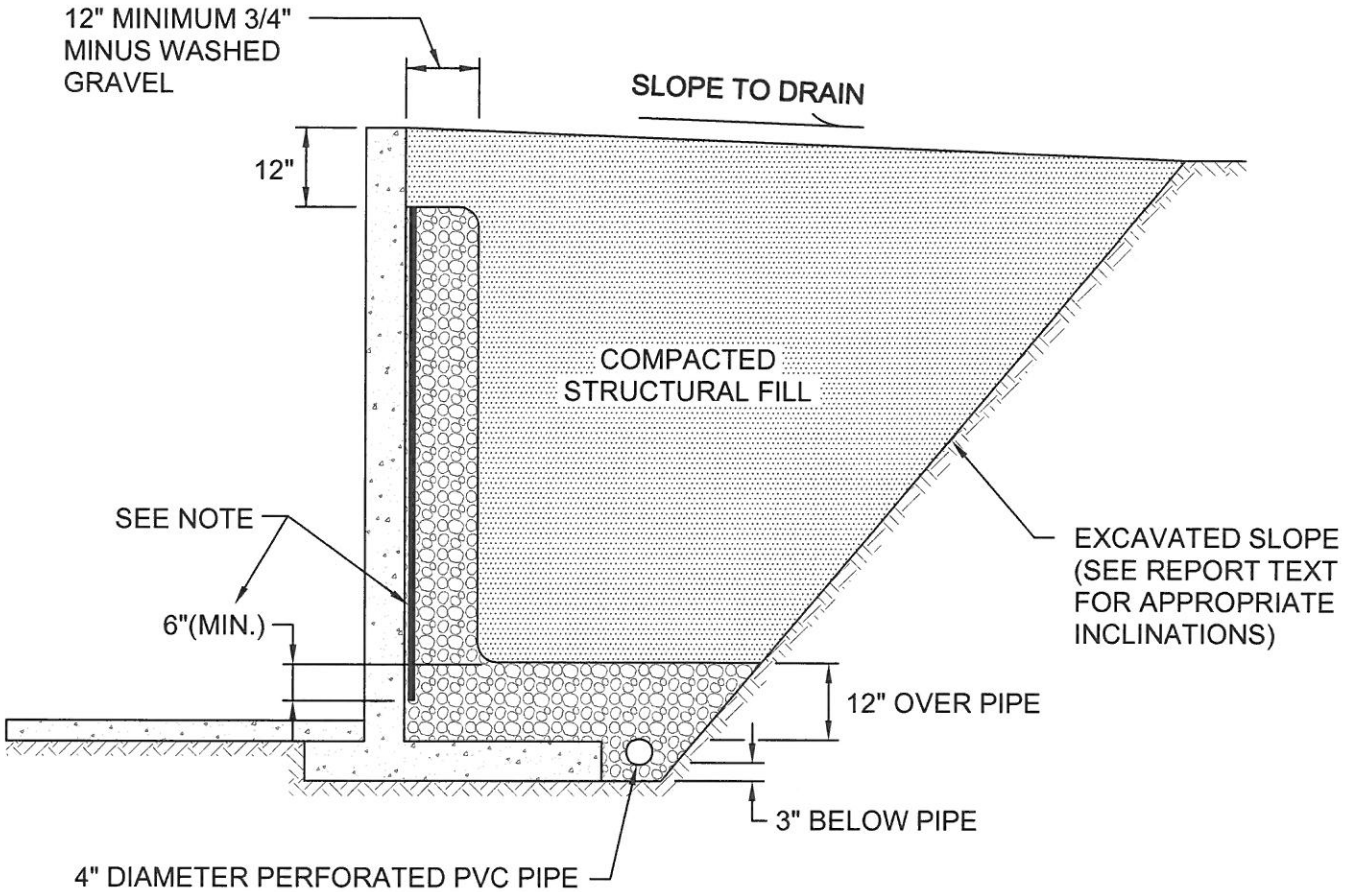
2. ROCK USED MUST MEET THE REQUIREMENTS FOR ROCK QUALITY SPECIFIED IN SECTIONS 9-13.7(1) OF THE WSDOT STANDARDS SPECIFICATIONS (2004).

3. ALL CAP ROCKS MUST BE SECURE AND NOT ABLE TO BE DISLODGED BY HAND.

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

CUT ROCKERY WALL DETAIL
BEUCA PLAT
REDMOND, WASHINGTON

| Proj. No.T-6709 | Date FEB 2014 | Figure 3 |
|---|---|---|




**NOT TO SCALE**

**NOTE:**

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

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TYPICAL WALL DRAINAGE DETAIL
BEUCA PLAT
REDMOND, WASHINGTON

| Proj. No.T-6709 | Date FEB 2014 | Figure 4 |
|---|---|---|

# APPENDIX A
# FIELD EXPLORATION AND LABORATORY TESTING

**Beuca Plat**
**Redmond, Washington**

On April 13, 2012, we observed the excavation of 5 test pits to a maximum depth of 10 feet below existing site grades. The test pits were excavated using a trackhoe. The test pit locations are shown on Figure 2. The locations were approximately determined by measuring from existing site features. The Test Pit Logs are presented on Figures A-2 through A-6.

A geotechnical engineer from our office conducted the field exploration, maintained a log of each test pit, classified the soils encountered, collected representative soil samples, and observed pertinent site features. 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 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 corresponding Test Pit Logs. Three grain size analyses were run and the results are shown on Figure A-7.

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

## DEFINITION OF TERMS AND SYMBOLS

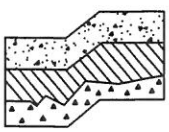
**COHESIONLESS**

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

**COHESIVE**

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

| | |
|---|---|
| I | 2" OUTSIDE DIAMETER SPILT SPOON SAMPLER |
| 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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UNIFIED SOIL CLASSIFICATION SYSTEM
BEUCA PLAT
REDMOND, WASHINGTON

| Proj. No.T-6709 | Date FEB 2014 | Figure A-1 |
|---|---|---|

# LOG OF TEST PIT NO. 1

FIGURE A-2

PROJECT NAME: Beuca Plat PROJ. NO: T-6709 LOGGED BY: SN

LOCATION: Redmond, Washington SURFACE CONDS: Grass APPROX. ELEV: 309 Feet

DATE LOGGED: April 13, 2012 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

| DEPTH (FT.) | SAMPLE NO. | DESCRIPTION | CONSISTENCY/ RELATIVE DENSITY | W (%) | POCKET PEN. (TSF) | REMARKS |
|---|---|---|---|---|---|---|
| | | Dark brown TOPSOIL, silty sand, organic, moist. | Soft | | | |
| | | Brown silty SAND with gravel (weathered till), fine to medium sand, fine to coarse gravel, damp to moist. (SM) | Medium Dense | | | |
| | 1 | | | 23.4 | | |
| | | Gray silty SAND (till), fine to medium sand, trace fine to coarse gravel, trace cobbles, moist. (SM) | Dense | | | |
| | 2 | | Very Dense | 11.1 | | |
| 5 | | Difficult excavation, 5 to 10 feet. | | | | |
| 10 | | Terminated at 10 feet. No groundwater encountered. | | | | |
| 15 | | | | | | |

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. 2

FIGURE A-3

PROJECT NAME: Beuca Plat PROJ. NO: T-6709 LOGGED BY: SN

LOCATION: Redmond, Washington SURFACE CONDS: Grass APPROX. ELEV: 307 Feet

DATE LOGGED: April 13, 2012 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

| DEPTH (FT.) | SAMPLE NO. | DESCRIPTION | CONSISTENCY/ RELATIVE DENSITY | W (%) | POCKET PEN. (TSF) | REMARKS |
|---|---|---|---|---|---|---|
| | | Dark brown TOPSOIL, silty sand, organic, moist. | Soft | | | |
| | 1 | Brown silty SAND with gravel (weathered till), fine to medium SAND, trace fine to medium roots, fine to coarse gravel, damp to moist. (SM) | Medium Dense | 16.4 | | |
| 5 | 2 | Gray silty SAND with gravel (till), fine to medium SAND, fine to coarse gravel, trace cobbles, moist. (SM) | Dense<br>Very Dense | 10.2 | | |
| 10 | | Terminated at 10 feet.<br>No groundwater encountered. | | | | |
| 15 | | | | | | |

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. 3

FIGURE A-4

PROJECT NAME: Beuca Plat PROJ. NO: T-6709 LOGGED BY: SN

LOCATION: Redmond, Washington SURFACE CONDS: Grass APPROX. ELEV: 294 Feet

DATE LOGGED: April 13, 2012 DEPTH TO GROUNDWATER: 5 Feet DEPTH TO CAVING: N/A

| DEPTH (FT.) | SAMPLE NO. | DESCRIPTION | CONSISTENCY/ RELATIVE DENSITY | W (%) | POCKET PEN. (TSF) | REMARKS |
|---|---|---|---|---|---|---|
| | | Dark brown TOPSOIL, silty, sandy, organic, moist. | Soft | | | |
| | 1 | Brown silty SAND with gravel (weathered till), fine to coarse SAND, fine to coarse gravel, moist. (SM) | Loose to Medium Dense | 18.6 | | |
| 5 ▼ | | Gray silty SAND with gravel (till), fine to medium SAND, fine to coarse gravel, trace cobbles, moist. (SM) Light seepage. | Medium Dense to Dense Very Dense | | | |
| | 2 | | | 9.4 | | |
| 10 | | Terminated at 10 feet. | | | | |
| 15 | | | | | | |

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. 4

FIGURE A-5

PROJECT NAME: Beuca Plat PROJ. NO: T-6709 LOGGED BY: SN

LOCATION: Redmond, Washington SURFACE CONDS: Grass APPROX. ELEV: 301 Feet

DATE LOGGED: April 13, 2012 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

| DEPTH (FT.) | SAMPLE NO. | DESCRIPTION | CONSISTENCY/ RELATIVE DENSITY | W (%) | POCKET PEN. (TSF) | REMARKS |
|---|---|---|---|---|---|---|
| | | Dark brown TOPSOIL, silty, sandy organic, moist. | Soft | | | |
| | 1 | Brown silty SAND with gravel (weathered till), fine to medium sand, fine to coarse gravel, trace cobbles, trace fine roots, moist. (SM) | Medium Dense | 21.1 | | |
| 5 | 2 | Gray silty SAND with gravel (till), fine to medium sand, fine to coarse gravel, weakly cemented, trace cobbles, moist. (SM) | Medium Dense<br>Dense<br>Very Dense | 7.1 | | |
| 10 | | Terminated at 10 feet.<br>No groundwater encountered. | | | | |
| 15 | | | | | | |

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. 5

FIGURE A-6

PROJECT NAME: Beuca Plat PROJ. NO: T-6709 LOGGED BY: SN

LOCATION: Redmond, Washington SURFACE CONDS: Grass and Weeds APPROX. ELEV: 308 Feet

DATE LOGGED: April 13, 2012 DEPTH TO GROUNDWATER: 6 Feet DEPTH TO CAVING: N/A

| DEPTH (FT.) | SAMPLE NO. | DESCRIPTION | CONSISTENCY/ RELATIVE DENSITY | W (%) | POCKET PEN. (TSF) | REMARKS |
|---|---|---|---|---|---|---|
| | | Dark blackish-brown TOPSOIL and DUFF, organic, silty, sandy, fine to medium roots, moist. | Soft | | | |
| | | Brown silty SAND with gravel (weathered till), fine to medium sand, fine to coarse gravel, damp to moist. (SM) | Medium Dense | | | |
| | 1 | | | 13.4 | | |
| | | Gray silty SAND with gravel (till), fine to medium sand, fine to coarse gravel, trace cobbles, moist. (SM) | Medium Dense | | | |
| | | Weakly cemented at 4 feet. | Dense | | | |
| 5 | | Light seepage. | Very Dense | | | |
| | 2 | | | 10.0 | | |
| 10 | | Terminated at 10 feet. | | | | |
| 15 | | | | | | |

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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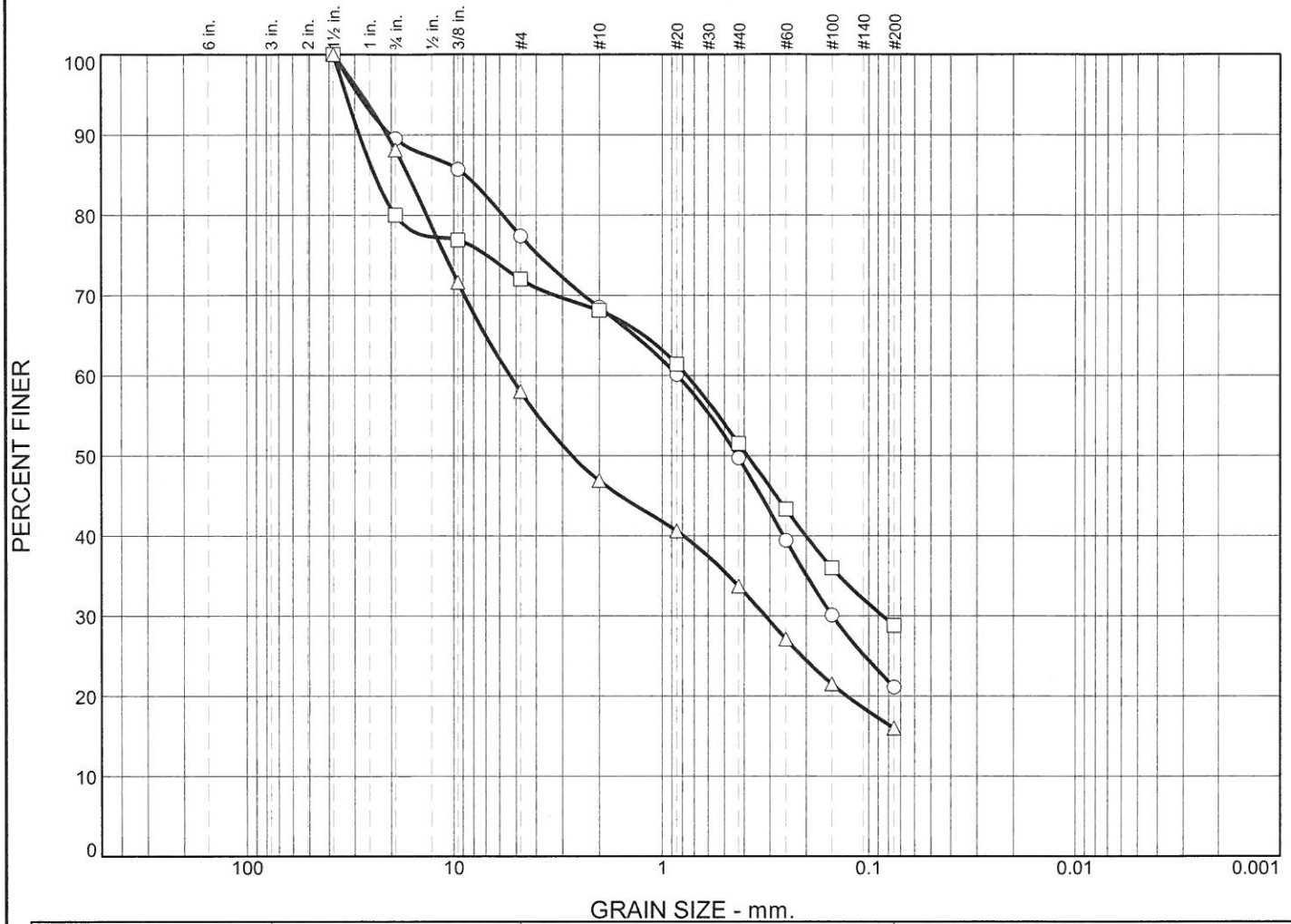
# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 10.5 | 12.1 | 8.9 | 18.8 | 28.6 | 21.1 | |
| □ | 0.0 | 20.0 | 8.0 | 3.9 | 16.6 | 22.7 | 28.8 | |
| △ | 0.0 | 11.9 | 30.1 | 11.1 | 13.2 | 17.7 | 16.0 | |

| | Colloids | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | | 8.7721 | 0.8430 | 0.4322 | 0.1491 | | | | |
| □ | | | | 24.0640 | 0.7590 | 0.3859 | 0.0853 | | | | |
| △ | | | | 16.5695 | 5.3477 | 2.6940 | 0.3153 | | | | |

| | Material Description | USCS | AASHTO |
|---|---|---|---|
| ○ | Silty Sand with Gravel | SM | |
| □ | Silty Sand with Gravel | SM | |
| △ | Silty Sand with Gravel | SM | |

**Project No.** T-6709 **Client:** Quadrant Homes

**Project:** Beuca Plat

○ **Location:** TP-3 **Depth:** 1'

□ **Location:** TP-4 **Depth:** 6.5'

△ **Location:** TP-5 **Depth:** 2'

**Date:** ○ □ △

**Remarks:**

**Terra Associates, Inc.**

**Kirkland, WA**

**Figure** A-7