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

January 11, 2016
Project No. T-6636-3

Mr. Matt Buchanan
Panattoni Development Company
900 SW 16th Street, Suite 330,
Renton WA 98057

Subject: Geotechnical Plan Review
The Reserve @ Woodinville
Woodinville, Washington

Reference: Geotechnical Report, BD Real Estate Distribution Building, 15900 Woodinville-Redmond Road, Woodinville, Washington, prepared by Terra Associates, Inc., Project No. T-6636-1, dated November 15, 2012, revised August 20, 2013

Dear Mr. Buchanan:

As requested we have reviewed a site grading plan prepared by Barghausen Consulting Engineers for the subject project, dated December 2, 2015. The purpose of our review was to verify geotechnical recommendations outlined in the referenced report continue to remain valid for the project and to amend or update the recommendations, if required.

The Barghausen grading plan indicates the property will be re-developed with two industrial buildings. South building A will cover an area of 157,000 square feet. Building B located in the northern portion of the site will cover and area of 42,700 square feet. We expect both buildings will be constructed using precast concrete wall panels at the perimeter with interior isolated columns supporting the roof framing. Floor slabs will be constructed at grade with dock high access provided on the north and south sides of buildings A and B respectively. Development stormwater will be routed for collection and treatment to a stormwater wetland and water quality pond located in the southeast corner of the property.

The previous planned development at the site and the subject of the referenced report consisted of a single 202,880 square foot distribution building. With the exception of the truck court area now proposed between the two buildings, building construction and proposed grading for the development discussed in the referenced report are similar to what is currently proposed. This includes the storm drainage management plan.

12220 113th Avenue NE, Ste. 130, Kirkland, Washington 98034
Phone (425) 821-7777 • Fax (425) 821-4334

Mr. Matt Buchanan
January 11, 2016

Based on our review we conclude that geotechnical engineering recommendations outlined in the referenced report continue to remain applicable to the new proposed project.

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

Sincerely yours,
TERRA ASSOCIATES, INC.

1-11-16

Theodore J. Schepper, P.E.
President

GEOTECHNICAL REPORT

BD Real Estate Distribution Building
15900 Woodinville-Redmond Road
Woodinville, Washington

Project No. T-6636-1

Terra Associates, Inc.

Prepared for:

BD Real Estate, LLC
Woodinville, Washington

November 15, 2012
Revised August 20, 2013

RECEIVED
AUG 30 2013
CITY OF WOODINVILLE
DEVELOPMENT SERVICES

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

November 15, 2012
Revised August 20, 2013
Project No. T-6636-1

Mr. Jay Deutsch
BD Real Estate, LLC
15525 Woodinville-Redmond Road NE
Woodinville, Washington 98072

Subject: Geotechnical Report
BD Real Estate Distribution Building
15900 Woodinville-Redmond Road
Woodinville, Washington

Dear Mr. Deutsch:

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.

Our field exploration indicates the site is generally underlain by 5 to 12 inches of asphalt concrete overlying 2 to 5 ½ feet of granular fill material followed by alluvial sediments. In the central and western site area, the initial alluvium consists of a three- to six-foot layer of soft to stiff silt. Below the silt and the granular fill in the eastern area of the site, loose to medium dense layers of sand and silty sand were observed to the boring completion depths. We observed groundwater at depths ranging from 7 ½ feet to 11 feet below current site grades.

In our opinion, the upper loose fill and alluvial silt will not be suitable for immediate support of building foundations, floor slabs, or site pavements. To establish suitable support, we recommend all foundations be supported on a minimum of two feet of granular structural fill with floor slabs and pavements supported on a minimum of 18 inches of granular structural fill. Detailed discussion regarding implementing this recommendation along with other geotechnical design and construction considerations are summarized in the attached report.

12525 Willows Road, Suite 101, Kirkland, Washington 98034
Phone (425) 821-7777 • Fax (425) 821-4334

Mr. Jay Deutsch
November 15, 2012
Revised August 20, 2013

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

Sincerely yours,
TERRA ASSOCIATES, INC.

Carolyn S. Decker, P.E.
Project Engineer

8/20/13

Theodore J. Schepper, P.E.
President

cc: Mr. Bob Fadden, Lance Mueller Architects
Mr. Dan Balmelli, Barghausen Consulting Engineers
Len Holm

TABLE OF CONTENTS

Page No.

1.0 Project Description 1
2.0 Scope of Work 1
3.0 Site Conditions 2
3.1 Surface 2
3.2 Soils 2
3.3 Groundwater 3
4.0 Geologic Hazards 3
4.1 Seismic Considerations 3
4.2 Erosion Hazard Area 4
5.0 Discussion and Recommendations 5
5.1 General 5
5.2 Site Preparation and Grading 5
5.3 Excavation 6
5.4 Foundations 7
5.5 Slab-on-grade Construction 7
5.6 Lateral Earth Pressures for Wall Design 8
5.7 Water Quality Pond 8
5.8 Drainage 9
5.9 Utilities 9
5.10 Pavements 10
6.0 Additional Services 11
7.0 Limitations 11

Figures

Vicinity Map ..... Figure 1
Exploration Location Plan ..... Figure 2
Typical Wall Drainage Detail ..... Figure 3

Appendix

Field Exploration and Laboratory Testing ..... Appendix A

Geotechnical Report
BD Real Estate Distribution Building
15900 Woodinville-Redmond Road
Woodinville, Washington

1.0 PROJECT DESCRIPTION

The project will consist of redeveloping the property with an approximately 202,880 square-foot distribution warehouse and office building. We expect the building will be constructed using precast concrete wall panels with interior isolated columns supporting the roof framing. The building floor slab will be constructed at grade with dock high access along the west perimeter and in the southeast corner of the building. There is a proposed water quality pond in the southeast corner of the property. Preliminary grading plans prepared by Barghausen Consulting Engineers dated October 24, 2012 indicate grading to achieve finish floor and roadway grades will include cuts and fills from one to four feet.

The water quality pond in the southeast corner of the site will be formed by a combination of excavation below current site grade and construction of a fill containment berm along the east side of the pond. The excavation required to achieve the pond floor elevation of 22 will extend 8 to 9 feet below current site grades. The fill depth required to achieve the berm crest elevation of 30 will range from one to two feet.

Based on our experience with similar construction, we expected foundation loading on the distribution building will be light to moderate with continuous bearing walls caring 6 to 8 kips per foot and isolated column loadings in the range of 80 to 200 kips. Uniform distribution of loading on the slab-on-grade floors is not expected to exceed 300 pounds per square foot (psf).

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

2.0 SCOPE OF WORK

Our work was completed in accordance with our authorized proposal dated October 13, 2012. Using existing soil information obtained from exploration and laboratory testing completed for a previous planned development on-site, we performed analyses to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Seismic site class per 2012 International Building Code (IBC)
- Geologic hazards per the City of Woodinville Municipal Code
- Site preparation and grading
- Structural fill and backfill
- Excavations

- Foundations
- Floor slabs on grade
- Lateral earth pressures for wall design
- Water quality pond
- Drainage
- Utilities
- Pavement

3.0 SITE CONDITIONS

3.1 Surface

The project site consists of 3 tax parcels totaling approximately 13.6 acres of land located at 15900 Woodinville-Redmond Road in Woodinville, Washington. The approximate location of the site is shown on Figure 1.

The property is currently developed as a lumber and related materials sales/service yard and includes several existing buildings and storage areas. Site topography is relatively flat with a gentle slope to the east. Local elevation relief across the building site is on the order of four to five feet. Most of the area outside of the existing buildings is paved with asphalt concrete pavement along with areas of Portland cement concrete pavement adjacent the buildings. The Sammamish River flows north along the east side of the property.

3.2 Soils

Underlying five to ten inches of asphalt concrete soil conditions observed in the upper portion of the test borings varied across the site. In general, at most borings we observed two to five of fill material composed of a mixture of gravel and silty sand with gravel in a loose to medium dense condition. Underlying the fill in the east southeastern site areas medium dense native alluvial sand and silty sand was observed to the termination depth of the test borings. Fill soils were not observed at Test Borings B-1, B-2, B-4, and B-7 to B-9. At these locations and below granular fill soils at Borings B-6, B-11, and B-15 advanced in the central and western site areas, a three- to five-foot thick layer of soft too stiff silt alluvium was observed. Medium dense silty sand alluvial soils followed this upper silt stratum to the boring termination depths.

We reviewed the *Geologic Map of the Kirkland Quadrangle, King County, Washington,* by J.P. Minard (1983). The map classifies the on-site soils as Younger Alluvium (Qyal). This mapped description is consistent with the native soils observed in the test borings.

The preceding discussion is intended as a brief summary of soil conditions observed at the test boring locations. For a more complete description, please refer to the Test Boring Logs attached in Appendix A.

3.3 Groundwater

We observed groundwater in each test boring at depths ranging from 7 ½ to 11 feet below current site grades. These depths correspond to site elevations ranging mostly from Elev. 21 to 22 feet in the central and eastern portions of the site and Elev. 23 to 25 feet to the southwest. The groundwater observed represents a regional groundwater table that is influenced by the Sammamish River flows located just east of the project site. Groundwater levels beneath the site will fluctuate seasonally and with fluctuations in the adjacent river flows. The rise in groundwater levels in response to increase river stages will be relatively rapid as the deeper native alluvium exhibits moderate permeability.

4.0 GEOLOGIC HAZARDS

4.1 Seismic Considerations

Section 21.06.536 of the Woodinville Municipal Code (WMC) defines Seismic Hazard areas as "areas in the City of Woodinville subject to severe risk of earthquake damage as a result of earthquake-induced ground shaking, slope failure, settlement, surface rupture, or soil liquefaction. (Ord. 481 § 6, 2009; Ord. 375 § 2, 2004; Ord. 175 § 1, 1997. Formerly 21.06.535)"

Soil Liquefaction

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure induced by vibrations from a seismic event. Liquefaction mainly affects geologically recent deposits of fine-grained sands that are below 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.

We completed a liquefaction analysis using procedures outlined by Seed and Idriss. The analysis was completed using a ground acceleration of .32g, which represents acceleration that could be expected for an earthquake having a 10 percent probability of occurring in 50 years (return period of once per 500 years). The results of the analysis indicate that the alluvial soils with N_{60} values of 17 and less could liquefy under this acceleration. The impact to site buildings and improvements should liquefaction occur will be in the form of surface subsidence or settlement. Estimated total potential settlement from our analysis is two inches or less. Given the variability of the soils, all of this settlement could be differential in nature. In our opinion, this amount of settlement would not structurally impact the buildings but would result in damage of a cosmetic nature.

Based on the results of our analysis and considering historic earthquakes experienced in the Puget Sound area, in our opinion, the liquefaction hazard at the site and the associated risk to buildings and infrastructure would be low.

Based on soil conditions observed in the test borings and our knowledge of the area geology, per Chapter 16 of the 2012 International Building Code (IBC), site class "D" should be used in structural design. Based on this site class, in accordance with the 2012 IBC, the following parameters should be used in computing seismic forces:

Seismic Design Parameters (IBC 2012)

Spectral response acceleration (Short Period), S_{ms}	1.208
Spectral response acceleration (1 – Second Period), S_{m1}	0.640
Five percent damped .2 second period, S_{Ds}	0.806
Five percent damped 1.0 second period, S_{D1}	0.427

Values determined using the United States Geological Survey (USGS) Ground Motion Parameter Calculator accessed on November 11, 2011 at the web site http://earthquake.usgs.gov/research/hazmaps/design/index.php.

4.2 Erosion Hazard Area

Section 21.06.213 of the WMC defines erosion hazard areas as "areas in City of Woodinville underlain by soils, which are subject to severe erosion when disturbed. Such soils include but are not limited to those classified as having a severe to very severe erosion hazard according to the USDA Natural Resource Conservation Service (NRCS), the 1973 King County Soils Survey or any subsequent revisions or addition by or to these sources. These soils include, but are not limited to, any occurrence of river wash (Rh) and the following when they occur on slopes 15 percent or steeper:

1. The Alderwood gravely sandy loam (AgD)
2. The Alderwood and Kitsap soils (AkF)
3. The Beausite gravely sandy loam (BeD and BeF)
4. The Kitsap silt loam (KpD)
5. The Ovall gravely loam (OvD and OvF)
6. The Ragnar fine sandy loam (RaD)
7. The Ragnar-Indianola Association (RdE). (Ord. 375 § 2, 2004; Ord. 175 § 1, 1997)"

The soils encountered on-site are classified as Earlmont silt loam by the United States Department of Agriculture Natural Resources Conservation Service. With the existing slope gradients, these soils will have a slight potential for erosion when exposed. Therefore, the site is not an erosion hazard as defined by the WMC. Regardless, erosion protection measures as required by the City of Woodinville will need to be in place prior to starting grading activities on the site. This would include perimeter silt fencing to contain erosion on-site and cover measures to prevent or reduce soil erosion during and following construction.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

Based on our study, in our opinion, development of the site as proposed is feasible from a geotechnical engineering standpoint. The primary geotechnical concern at the site is the presence of loose to medium dense granular fill soils and soft to stiff silt alluvium in the upper four to six feet of the soil profile. These soils will not be suitable for direct support of building foundations, slab-on-grade floors, or pavements. To establish suitable support we recommend all foundations bear on a minimum of two feet of structural fill replacing the existing fill or silt soils. Floor slabs and pavements should be supported on a minimum of 18 inches of new structural fill. The exception to this recommendation occurs in the vicinity of Test Boring B-8. Here, the soft silt alluvium observed to a depth of 3 ½ feet should be completely removed below the foundations, floor slabs, and pavements.

The soils observed at the site contain a significant amount of fines and will be difficult to compact as structural fill when too wet or dry. The native silt alluvium would not be suitable for use as structural fill or backfill, in our opinion. The ability to use native granular soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during winter, the owner should be prepared to import clean granular material for use as structural fill and backfill. Alternatively, stabilizing the moisture in the native soil with cement kiln dust (CKD), cement, or lime can be considered.

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

5.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, asphalt, and other deleterious material should be stripped and removed from the site. Demolition of existing structures should include removal of existing foundations, floor slabs, 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. Given current site conditions, we expect minimal stripping will be required to remove the vegetation. Based on the test borings asphalt pavement removal will range from 2 to up to 12 inches. We would note, however that conversations with on-site personal during our exploration indicated that there may be areas where the asphalt pavement thickness could approach 36 inches.

As discussed earlier the existing surface fill and near-surface alluvial silt would not be suitable for immediate support of spread footing foundations, slab-on-grade floors, or site pavements. In establishing building subgrade elevations grading should be completed that results in a minimum of 24 inches of granular structural fill below foundations and 18 inches of granular structural fill below floor slabs and site pavements. The granular structural fill should extend a minimum distance of 12 inches from the outside edge of all spread footings.

Where fill material is needed to establish building grade, prior to placing the fill, existing fill observed at the test borings should be overexcavated a minimum depth of two feet below current site grades and replaced in a structural manner. Existing soft silt alluvium observed to a depth of 3 ½ feet at Test Boring B-8 should be excavated and completely removed from below building elements.

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

The upper silt alluvium will be very difficult to work with and generally is not considered suitable for use as structural fill or utility trench backfill. The ability to use native granular soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If wet soils are encountered, the contractor will need to dry the soils by aeration during dry weather conditions. If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

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

* Based on the 3/4-inch fraction.

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

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-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.

5.3 Excavation

All excavations at the site associated with confined spaces, such as utility trenches, must be completed in accordance with local, state, or federal requirements. Based on current Occupational Safety and Health Administration (OSHA) regulations, the native and existing fill soils would be classified as Type C soils. Temporary excavation side slopes in Type C soils can be laid back at a minimum slope inclination of 1.5:1 (Horizontal:Vertical). If there is insufficient room to complete the excavations in this manner, using temporary shoring to support the excavations may need to be considered. A properly designed and installed shoring trench box can be used to support utility trench excavation sidewalls.

Based on conditions we observed, groundwater will be encountered within excavations extending depths of eight to ten feet below existing surface grades. For excavation depths that extend two feet below the groundwater table, dewatering using conventional sump pumps along with collector trenches should be capable of maintaining a relatively dry excavation and would not be expected to impact the stability of the excavation when completed, as described above. For deeper excavations, dewatering by well point or deep pumped wells will be required to maintain a dry and stable excavation. The dewatering system should be designed and implemented by an experienced dewatering well contractor.

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.

5.4 Foundations

Spread Footings

In our opinion, the building may be supported on conventional spread footing foundations bearing on a minimum of two feet of structural fill, as recommended in Section 5.2 of this report. Foundations exposed to the weather should bear at a minimum depth of 1.5 feet below adjacent grades for frost protection. Interior foundations can be supported at any convenient depth below the floor slab, provided immediate support is obtained on a minimum of two feet of structural fill.

We recommend designing foundations for a net allowable bearing capacity of 3,000 psf. For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. Total and differential settlements should not exceed one-inch and one-half inch, respectively. The predicted settlements would be immediate in nature occurring as building loads are applied.

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 300 pcf. We do not recommend 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 foundation will be backfilled with structural fill, as described in Section 5.2 of this report. The values recommended include a safety factor of 1.5.

5.5 Slab-on-Grade Construction

Slab-on-grade floors may be supported on subgrades prepared 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 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.

We recommend the floors be designed using a subgrade modulus (k_s) of 200 pounds per cubic inch (pci).

5.6 Lateral Earth Pressures for Wall Design

The magnitude of earth pressure development on below-grade 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, wall drainage must also be installed. A typical recommended wall drainage detail is shown on Figure 3.

With wall backfill placed and compacted as recommended and drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pcf. For restrained walls, an additional uniform lateral pressure of 100 psf should be included. For evaluation of below-grade walls under seismic loading, an additional uniform lateral pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall 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 will 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 can be found in the preceding foundation section of this report.

5.7 Water Quality Pond

As mentioned above, a water quality pond is planned for the southeast corner of the site. The proposed pond floor is between eight and nine feet below existing site grades and is formed by a combination of excavation and fill containment berm construction. The fill depth for the berm construction is between one and two feet. Our field exploration indicates that the soils at the base of the proposed pond consist of medium dense sand. We would note that groundwater was observed at ten feet below current site grades in the vicinity of the proposed pond.

Fill used to form containment berms for the water quality pond should consist of silty sand with gravel placed and compacted as structural fill. If requirements of the King County Surface Water Design Manual apply, the fill in this area must be compacted to a minimum of 95 percent of the soils maximum dry density as determined by ASTM Test Designation D-1557 (Modified Proctor). Interior pond slopes below the stored water level are shown as 3:1 with exterior pond slopes at 2:1.

5.8 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the site at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building areas. We recommend providing a gradient of at least three percent for a minimum distance of ten feet from the building perimeters. If this gradient cannot be provided, surface water should be collected adjacent to the structures and disposed to appropriate storm facilities.

Subsurface

We recommend installing perimeter foundation drains adjacent to shallow foundations where paved surfaces do not extend to building perimeter and positive drainage away from the structure is not provided. 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 ¾-inch gravel sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. Roof and foundation drains should be tightlined separately to the storm drains. All drains should be provided with cleanouts at easily accessible locations.

5.9 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA), or City of Woodinville specifications. As a minimum, trench backfill should be placed and compacted as structural fill, as described in Section 5.2 of this report. The native alluvial soils will likely be excavated in a wet condition and would not be suitable for use as trench backfill unless dried back to a moisture content that will facilitate proper compaction. If utility construction takes place during the wet winter months, it will likely be necessary to import suitable wet weather fill for utility trench backfilling.

Excavations into the native soils below the groundwater table may expose soils that will be unstable and would not provide suitable support for the utility pipes when backfilled. When unstable soils are exposed, the utility contractor should be prepared to overexcavate and remove the soils and replace them with crushed rock or bedding aggregate to establish a stable pipe foundation.

5.10 Pavements

Pavement subgrade should be prepared as described in the 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 rubber-tired construction equipment such as a loaded 10-yard dump truck to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. We used the American Association of State Highway Transportation Officials (AASHTO) design methodology to determine the required pavement section. For design considerations, we have assumed traffic in parking and in car/light truck access pavement areas can be represented by an 18-kip Equivalent Single Axle Loading (ESAL) of 50,000 over a 20-year design life. For heavy traffic pavement areas, we have assumed an ESAL of 500,000 would be representative of the expected loading. These ESALs represent loading approximately equivalent to 3 and 29, loaded (80,000 pound GVW) tractor-trailer rigs traversing the pavement daily in each area, respectively.

The supporting capability of the pavement subgrade is represented in the AASHTO procedure by the resilient modulus (M_r). We performed California Bearing Ratio (CBR) tests on a representative sample of the near-surface materials that would serve as subgrade support for the pavement structure. The results of these tests are summarized in tabular form in Appendix A. Based on the results of this testing, we assigned the subgrade a M_r value of 20,000 psi.

Based on our analysis, we recommend the following pavement sections:

Light Traffic and Parking:

- Two inches of hot mix asphalt (HMA) over five inches of crushed rock base (CRB)
- Two inches of HMA over three inches of asphalt-treated base (ATB)

Heavy Traffic:

- Three inches of HMA over seven inches of CRB
- Three inches of HMA over four inches of ATB

AASHTO pavement design calculations are attached in Appendix B.

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

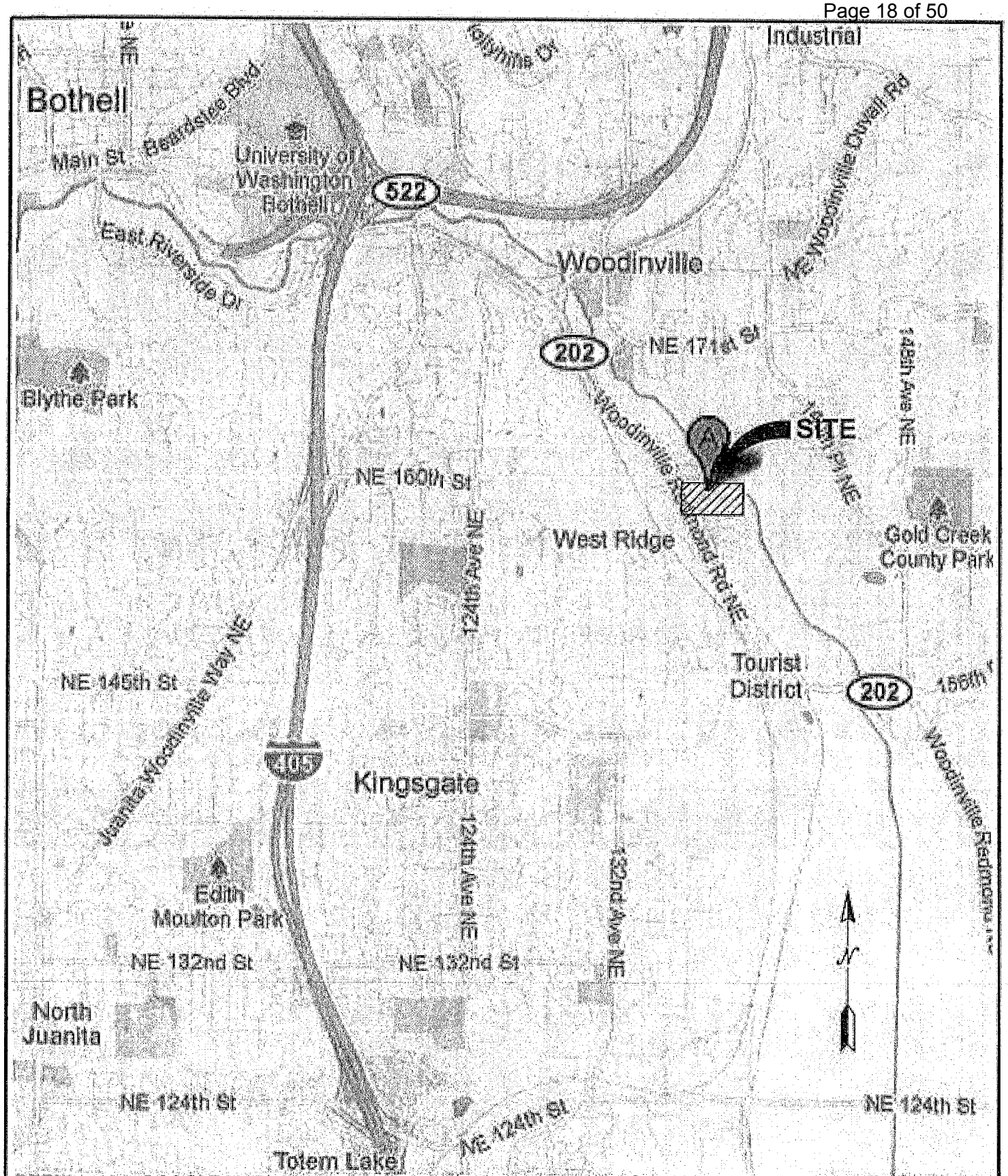
6.0 ADDITIONAL SERVICES

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

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 BD Real Estate Distribution Building project in Woodinville, Washington. This report is for the exclusive use of BD Real Estate, LLC and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the test borings drilled on 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: GOOGLE MAPS, WWW.GOOGLE.COM, ACCESS 11-11-2011

NOT TO SCALE

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

VICINITY MAP
BD REAL ESTATE DISTRIBUTION BUILDING
WOODINVILLE, WASHINGTON

Proj. No.T-6636-1	Date NOV 2012	Figure 1

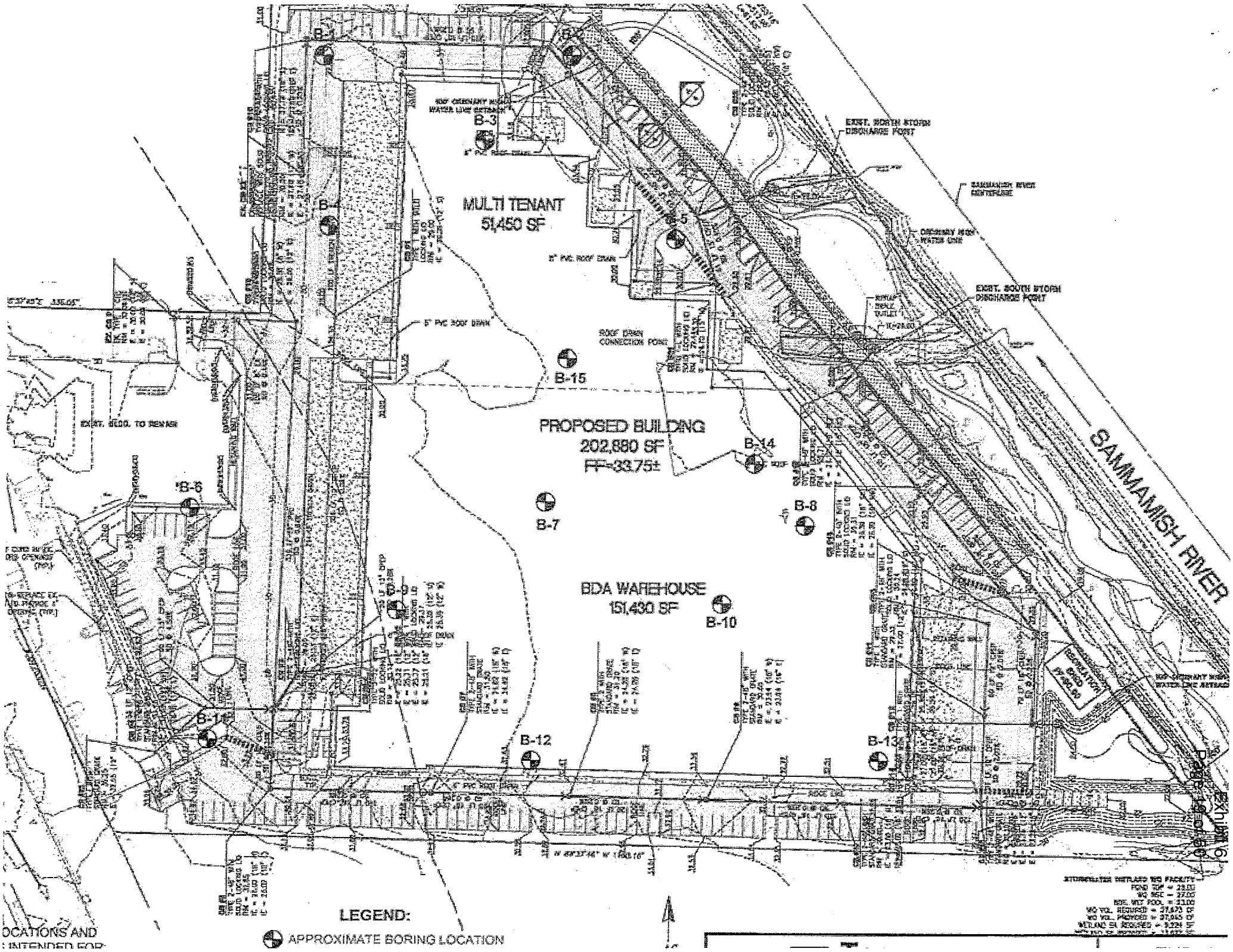
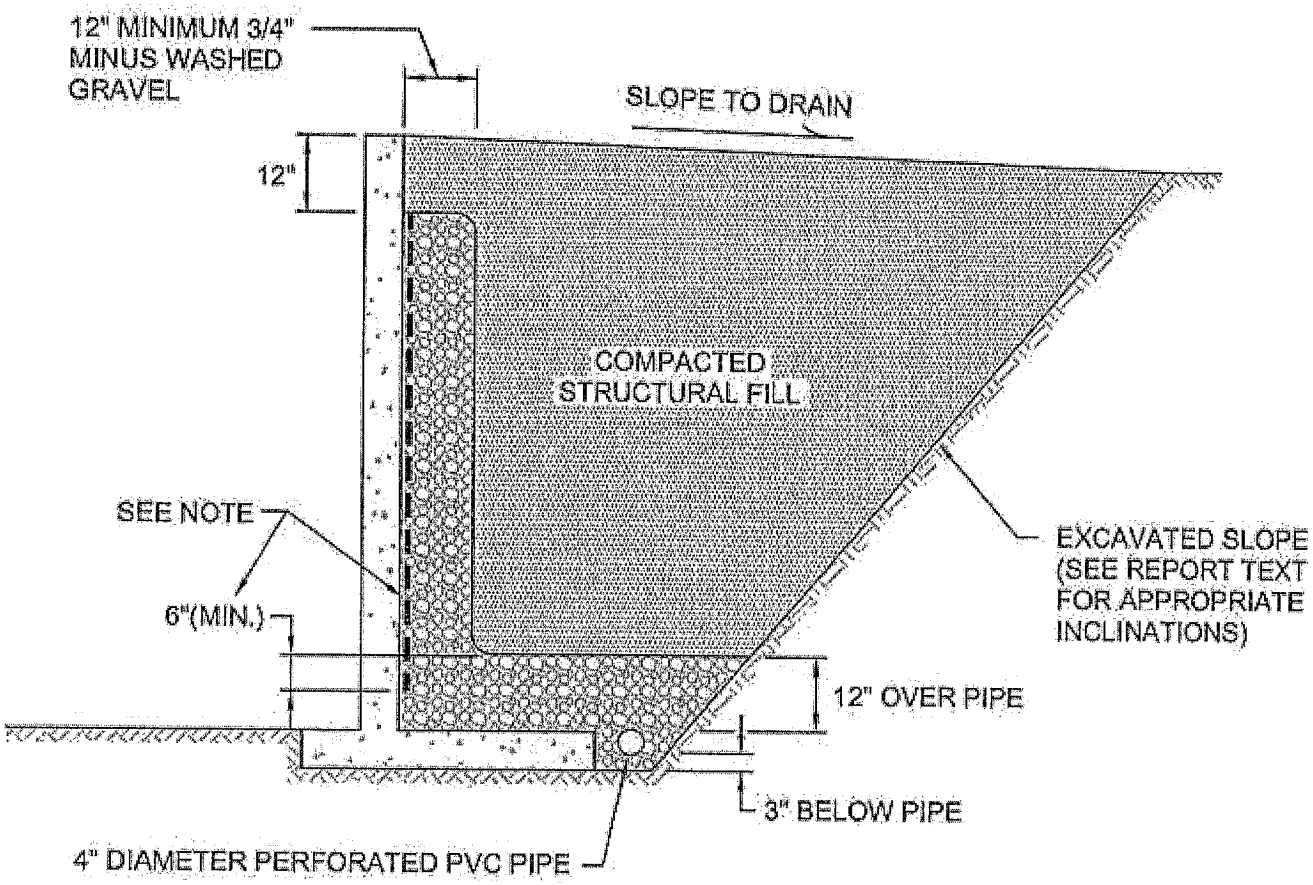


Exhibit 6
Page 19 of 50



NOT TO SCALE

NOTE:

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

Terra Associates, Inc. Consultants in Geotechnical Engineering Geology and Environmental Earth Sciences	TYPICAL WALL DRAINAGE DETAIL BD REAL ESTATE DISTRIBUTION BUILDING WOODINVILLE, WASHINGTON		
	Proj. No.T-6636-1	Date NOV 2012	Figure 3

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Distribution Facility
Woodinville, Washington

On October 27 and October 28, 2011, we observed the drilling of 15 soil test borings to a maximum depth of 41.5 feet below the existing site grades. The boring locations were determined in the field by measurements from existing site features. The approximate location of the test borings are shown on the attached Exploration Location Plan, Figure 2. Test Boring Logs are attached as Figures A-2 through A-16.

A geotechnical engineer from our office conducted the field exploration. Our representative classified the soil conditions encountered, maintained a log of each test boring, obtained representative soil samples, and recorded water levels observed during drilling. During drilling, soil samples were obtained in general accordance with ASTM Test Designation D-1586. Using this procedure, a 2-inch (outside diameter) split barrel sampler is driven into the ground 18 inches using a 140-pound hammer free falling a height of 30 inches. The number of blows required to drive the sampler 12 inches after an initial 6-inch set is referred to as the Standard Penetration Resistance value or N value. This is an index related to the consistency of cohesive soils and relative density of cohesionless materials. N values obtained for each sampling interval are recorded on the Boring Logs, Figures A-2 through A-16. 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 borings were placed in closed containers and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the individual Boring Logs Grain size analyses and California bearing ratios were performed on selected samples. The results of the grain size analyses tests are shown on Figures A-17 through A-20 the results of the California bearing ratios are shown on Figure A-21.

LOG OF BORING NO. B-1

Figure No. A-2

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 32

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(8 inches ASPHALT)			
1		Gray elastic SILT, fine grained, moist, mottled. (MH)			
2			Medium Stiff	17.4	7
3					
4		Gray silty SAND with gravel, fine to medium grained, moist, mottled.	Loose		
5				13.1	10
6		Gray SAND with silt, fine to medium grained, moist. (SP-SM)			
7				9.2	16
8			Medium Dense		
9					
10				23.0	15
11		*At 11 feet soil becomes saturated, fine to coarse grained.			
12				25.4	18
13		*At 12.5 feet drilling mud added to hole to prevent heave.			
14		Brown silty SAND, fine to medium grained, saturated. (SM)			
15		*At 15 feet, soil becomes gray.	Medium Dense	35.0	18
16					
17					
18					
19					
20		*See Next Page		21.1	31

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

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

LOG OF BORING NO. B-1

Figure No. A-2

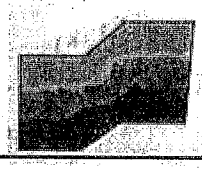
Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 32

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
21					
22					
23					
24					
25			Medium Dense	24.5	27
26		Gray silty SAND, fine to medium grained, saturated. (SM)			
27					
28					
29					
30				23.5	21
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 11 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

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



Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-2

Figure No. A-3

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 29.5

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % (Wp |----x----| Wl, 10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(6 inches ASPHALT)			
1		Gray elastic SILT with some sand, fine to medium grained, moist to wet.	Stiff		
2				26.8	10
3					
4					
5		Brown SAND with silt, fine to medium grained, moist, trace silt. (SP-SM)		6.7	22
6					
7					
8		*At 7.5 feet soil becomes saturated, fine to coarse grained.		20.9	20
9					
10			Medium Dense	24.7	24
11					
12					
13		*At 12.5 feet drilling mud was added to the hole to prevent heave.		26.4	26
14					
15				23.3	20
16					
17					
18					
19		Gray silty SAND, fine to medium grained, saturated. (SM)	Medium Dense		
20		*See Next Page		26.2	23

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

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

LOG OF BORING NO. B-2

Figure No. A-3

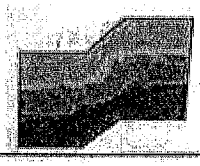
Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 29.5

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |----x----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
21					
22					
23					
24					
25		Gray silty SAND, fine to medium grained, saturated. (SM)	Medium Dense	21.6	30
26					
27					
28					
29					
30				26.1	27
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 7.5 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

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



Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-3

Figure No. A-4

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % (Wp |---x---| Wl; 10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(5 inches ASPHALT)			
1, 2		FILL: mix of gray sand and gray silty sand with gravel, fine to medium grained, moist.	Loose	17.4	6
3, 4, 5, 6			Medium Dense	15.6	13
7		Brown SAND with silt, fine to medium grained, moist. (SP-SM)		21.8	17
8, 9, 10		*At 10 feet soil becomes saturated.		23.1	20
11, 12, 13		*At 12.5 feet drilling mud was added to the hole to prevent heave.	Dense	21.9	34
14, 15, 16				22.9	36
17, 18, 19, 20		*See Next Page		22.0	31

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

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

LOG OF BORING NO. B-3

Figure No. A-4

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
21		Gray SAND with silt, fine to medium grained, saturated. (SP-SM)	Dense		
22					
23					
24					
25				23.3	37
26					
27		Gray silty SAND, fine to medium grained, saturated. (SM)			
28			Medium Dense		
29					
30				28.9	24
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 10 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

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

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-4

Figure No. A-5

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 32.3

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(10 Inches ASPHALT)			
1					
2		Gray elastic SILT, fine grained, wet, mottled. (MH)	Medium Stiff	36.4	6
3					
4					
5				15.1	10
6					
7				14.8	12
8		Brown SAND with silt, fine to coarse grained, saturated. (SP-SM)			
9					
10				21.3	14
11			Medium Dense		
12				20.3	21
13		*At 12.5 feet drilling mud was added to the hole to prevent heave.			
14					
15				22.7	18
16					
17					
18					
19					
20		*See Next Page		23.9	23

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

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

LOG OF BORING NO. B-4

Figure No. A-5

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 32.3

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
21		Gray SAND with silt, fine to medium grained, saturated. (SP-SM)	Medium Dense		
22					
23					
24					
25				26.0	15
26					
27		Gray silty SAND, fine to medium grained, saturated. (SM)			
28			Medium Dense		
29					
30				24.9	21
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 10 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

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

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-5

Figure No. A-6

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.7

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(5 inches ASPHALT)			
1–4		FILL: mix of brown gravel and gray silty sand with gravel, fine to coarse grained, moist.	Loose	16.6	6
5–6		Gray silt and sand, fine to coarse grained, moist to wet. (ML)	Stiff	16.7	14
7–9		Gray SAND with silt, fine to medium grained, moist. (SP-SM)	Medium Dense	6.1	18
10–11		*At 10 feet soil becomes saturated.		24.7	21
12–13		*At 12.5 feet drilling mud was added to the hole to prevent heave.		23.7	22
14–16		Brown SAND with silt, fine to coarse grained, saturated. (SP-SM)	Medium Dense	23.0	31
17–19		Gray silty SAND, fine to medium grained, saturated. (SM)	Medium Dense	26.7	24
20		*See Next Page			

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

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

LOG OF BORING NO. B-5

Figure No. A-6

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.7

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
21					
22					
23					
24					
25		Gray silty SAND, fine to medium grained, saturated. (SM)	Medium Dense	13.8	27
26					
27					
28					
29					
30				26.2	17
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 10 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

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

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-6

Figure No. A-7

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 35

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(10 inches ASPHALT)			
1–4		FILL: gray silty sand with gravel, fine to medium grained, wet.	Medium Dense	19.2	19
5–6		Gray SILT, fine grained, moist to wet, mottled. (ML)	Stiff	27.2	8
7–9		Layered brown and gray sand and sand with silt, fine grained, moist to wet. (SP) and (SP-SM)	Medium Dense	27.0	11
10		Gray SAND, fine to medium grained, saturated. (SP)	Loose	28.0	9
11				29.3	
12–14		*At 12.5 feet drilling mud added to the hole to prevent heave.		22.3	18
15–21		Brown SAND with silt, fine to coarse grained, saturated. (SP-SM)	Medium Dense	27.6	19
				22.3	31
22–25		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			

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

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

LOG OF BORING NO. B-7

Figure No. A-8

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.3

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % (Wp |—x—| Wl)	Pocket Penetrometer TSF / SPT (N) Blows/ft
1		(9 inches ASPHALT)			
2		Gray elastic SILT, fine grained, moist to wet, mottled. (MH)		41.8	7
3			Medium Stiff		
4					
5				20.4	11
6					
7		Brown SAND with silt, fine grained, wet. (SP-SM)	Medium Dense	23.0	16
8		*At 7.5 feet soil becomes fine to medium grained.			
9					
10				26.5	14
11		*At 10 feet drilling mud added to the hole to prevent heave.			
12				20.1	22
13					
14		Gray SAND with silt, fine to coarse grained, saturated. (SP-SM)		23.5	24
15			Medium Dense		
16					
17					
18					
19					
20		*At 20 feet, soil becomes fine to medium grained.		21.3	30
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			
23					
24					
25					

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

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

LOG OF BORING NO. B-8

Figure No. A-9

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 30.7

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % (Wp |----x----| Wl, 10 30 50)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(8 inches ASPHALT)			
1					
2		Dark brown to brown silt, fine grained, wet, mottled, organics. (MH)	Soft	>7	20
3					
4		Gray SAND, fine to medium grained, moist. (SP)	Medium Dense	8.4	19
5					
6		Brown SAND with silt, fine to medium grained, moist, trace silt. (SP-SM)			
7				20.2	19
8		*At 8.5 feet soil becomes saturated.	Medium Dense		
9					
10				17.3	33
11					
12				25.1	28
13					
14					
15				19.8	27
16		Gray SAND with silt, fine to medium grained, saturated. (SP-SM)	Medium Dense		
17					
18					
19					
20			Dense	25.7	37
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 8.5 feet during drilling.			
23					
24					
25					

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

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

LOG OF BORING NO. B-9

Figure No. A-10

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 33.6

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |----x----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(12 inches ASPHALT)			
1					
2		Brown and gray elastic SILT, fine grained, moist, mottled. (MH)	Medium Stiff	42.4	7
3					
4					
5		Brown SAND with silt, fine to medium grained, moist. (SP-SM)		11.5	15
6					
7		*At 7.5 feet, soil becomes fine grained, wet.	Medium Dense	22.6	17
8					
9					
10		*At 10 feet added drilling mud to the hole to prevent heave.		21.8	20
11					
12		Gray silty SAND, fine grained, saturated. (SM)	Medium Dense	23.0	27
13					
14					
15				23.8	29
16		Brown silty SAND, fine to medium grained, saturated. (SM)	Medium Dense		
17					
18					
19		Gray silty SAND, fine grained, saturated. (SM)		24.2	28
20			Medium Dense		
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			
23					
24					
25					

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

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

LOG OF BORING NO. B-10

Figure No. A-11

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 30.6

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
1		(6 inches ASPHALT) FILL: brown gravel, fine to coarse grained, moist.	Medium Dense		
2		FILL: gray silty sand with gravel, fine to medium grained, moist to wet.	Medium Dense	26.5	15
3					
4					
5				7.9	28
6		Brown SAND with silt, fine to medium grained, moist. (SP-SM)			
7			Medium Dense	24.5	19
8					
9		*At 8.5 feet soil becomes saturated.			
10				21.3	28
11					
12		Gray SAND with silt, fine to coarse grained, saturated, trace gravel. (SP-SM)		23.6	32
13					
14					
15		*At 15 feet added drilling mud to the hole to prevent heave.	Medium Dense	20.0	27
16					
17					
18					
19					
20				26.4	25
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 8.5 feet during drilling.			
23					
24					
25					

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

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

LOG OF BORING NO. B-11

Figure No. A-12

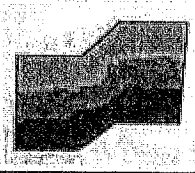
Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 34.5

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % (Wp |-----x-----| Wl, 10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
1		(2.5 inches ASPHALT) FILL: brown silty sand with gravel, fine to medium grained, moist.	Medium Dense		
2				33.8	7
3					
4		Gray elastic SILT, fine grained, wet, mottled. (MH)	Medium Stiff		
5				32.7	6
6					
7				11.3	10
8		Brown SAND with silt, fine to medium grained, moist. (SP-SM)			
9					
10				23.7	11
11		*At 11 feet soil becomes saturated.			
12			Medium Dense	25.8	21
13					
14					
15		*At 15 feet soil becomes fine to coarse grained.		20.1	29
16					
17					
18					
19					
20		*At 20 feet, soil becomes gray.		27.4	23
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 11 feet during drilling.			
23					
24					
25					

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



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

LOG OF BORING NO. B-12

Figure No. A-13

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.7

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % (Wp |-----x-----| Wl, 10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
1		(6 inches ASPHALT) FILL: gray gravel, fine to coarse grained, moist.	Medium Dense		
2				9.5	15
3					
4		(FILL?): mix of brown and gray sand with silt, fine to medium grained, moist.	Medium Dense		
5				8.8	16
6					
7		Brown SAND with silt, fine grained, moist. (SP-SM) *At 7.5 feet, soil becomes fine to medium grained.		16.6	22
8			Medium Dense		
9					
10		*At 10 feet soil becomes fine to coarse grained, saturated. Drilling mud was added to the hole to prevent heave.		21.3	28
11					
12				24.4	22
13					
14					
15				21.8	33
16		Gray SAND with silt, fine to medium grained, saturated. (SP-SM)	Medium Dense		
17					
18					
19					
20				24.5	22
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			
23					
24					
25					

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

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

LOG OF BORING NO. B-13

Figure No. A-14

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 30.3

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(6 inches ASPHALT)			
1–2		FILL; gray silty sand with gravel, fine to medium grained, moist.	Medium Dense	12.1	13
3–4					
5–6		Gray SAND fine to medium grained, moist. (SP)	Medium Dense	5.0	27
7				5.1	17
8–9		Brown SAND, fine to medium grained, saturated. (SP)			
10–11		*At 10 feet soil becomes saturated. Drilling mud added to the hole to prevent heave.	Medium Dense	18.7	25
12				17.0	26
13–14					
15–16		Gray SAND with silt, fine to coarse grained, saturated. (SP-SM)	Medium Dense	22.0	24
17–18					
19–20		*At 20 feet soil becomes fine to medium grained.		27.6	24
21					
22–23		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			
24–25					

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

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

LOG OF BORING NO. B-14

Figure No. A-15

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 30

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
		(7 inches ASPHALT)		7.9	18
1		FILL: mix of brown and gray silty sand with gravel and brown sand with silt and gravel, fine to medium grained, moist to wet.			
2			Medium Dense	15.8	26
3					
4					
5		Brown SAND with silt, fine to coarse grained, moist. (SP-SM)	Medium Dense	9.9	23
6					
7		Test boring terminated at 6.5 feet.			
8					
9					
10					
11					
12					
13					
14					
15					

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

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

LOG OF BORING NO. B-15

Figure No. A-16

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.6

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
1		(8 inches ASPHALT) FILL: mix of brown and gray gravel with sand and silt, fine to coarse grained, wet.	Medium Dense	6.4	14
2					
3		Brown SILT, fine grained, wet. (ML)	Soft	42.0	4
4					
5				11.3	10
6					
7		Brown SAND with silt, fine to medium grained, moist. (SP-SM)			
8					
9					
10		*At 10 feet soil becomes saturated.	Medium Dense		
11					
12					
13					
14					
15		*At 15 feet drilling mud added to the hole to prevent heave.			
16					
17					
18					
19					
20					
21					
22		Gray silty SAND, fine grained, saturated. (SM)	Medium Dense		
23					
24					
25		*See Next Page			

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

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

LOG OF BORING NO. B-15

Figure No. A-16

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

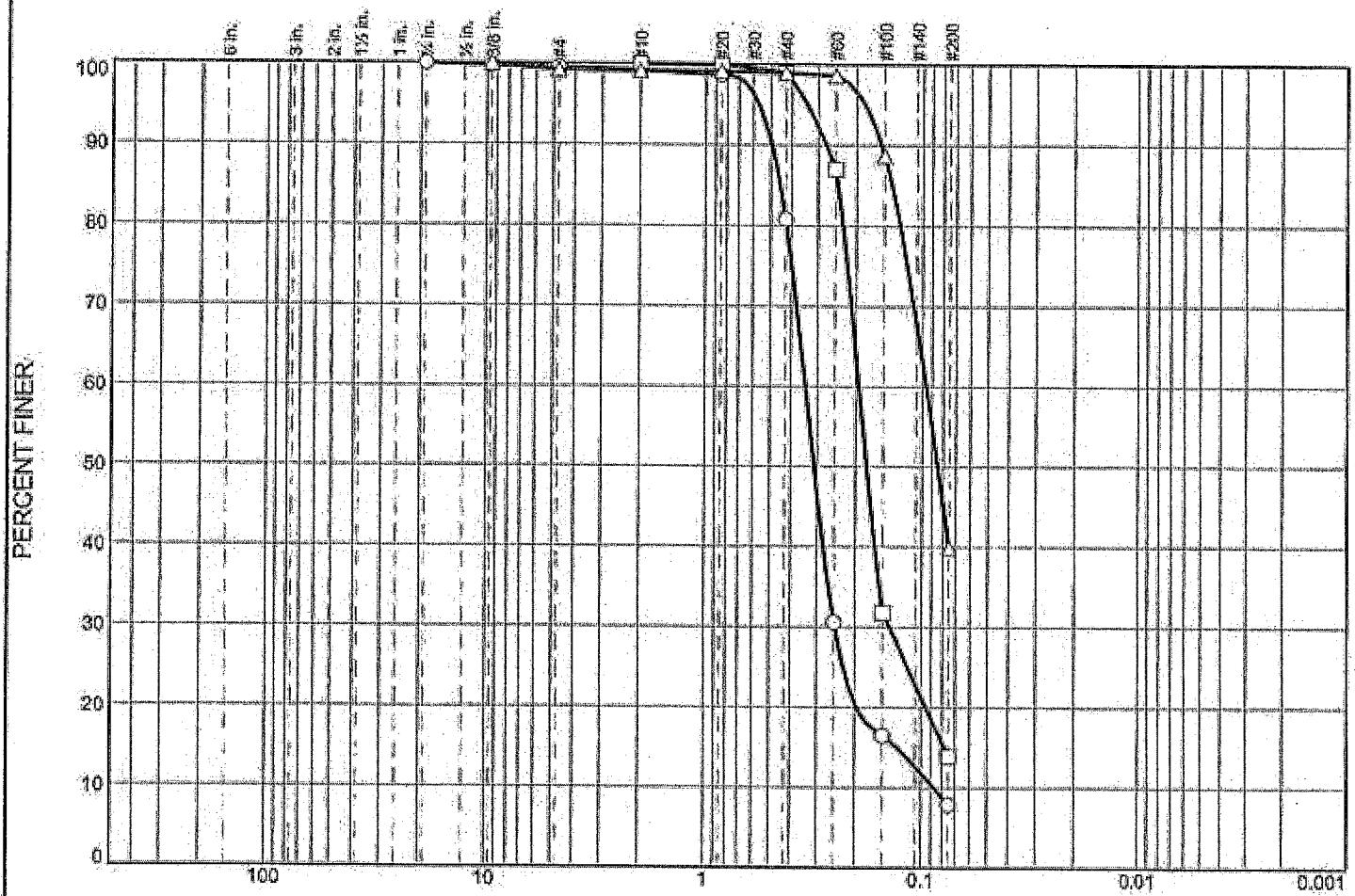
Location: Woodinville, Washington **Approx. Elev:** 31.6

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |----x----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
26					
27					
28					
29					
30				25.1	29
31		Gray silty SAND, fine grained, saturated. (SM)			
32			Medium Dense		
33					
34					
35				25.0	19
36					
37					
38					
39		Gray SILT to sandy SILT, fine grained, saturated. (ML)			
40			Very Stiff	31.7	21
41					
42		Test boring terminated at 41.5 feet. Groundwater observed at 10 feet during drilling.			
43					
44					
45					
46					
47					
48					
49					
50					

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

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.5	0.3	18.4	72.9	7.9	
□	0.0	0.0	0.0	0.0	1.1	85.0	13.9	
△	0.0	0.0	0.8	0.1	0.2	59.0	39.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4509	0.3413	0.3102	0.2478	0.1288	0.0870	2.07	3.92
□			0.2439	0.1934	0.1780	0.1399	0.0783			
△			0.1386	0.0956	0.0846					

Material Description	USCS	AASHTO
○ Poorly graded SAND with silt	SP-SM	
□ Silty SAND	SM	
△ Silty SAND	SM	

Project No. T-6636-1 **Client:** BD Real Estate, LLC
Project: BD Real Estate Distribution Building
Woodinville, Washington
○ **Location:** Test Boring B-1 **Depth:** 7.5' **Sample Number:** 3
□ **Location:** Test Boring B-1 **Depth:** 12.5' **Sample Number:** 5
△ **Location:** Test Boring B-2 **Depth:** 30 **Sample Number:** 8

Remarks:
○ Tested on 11-3-11
□ Tested on 11-3-11
△ Tested on 11-3-11

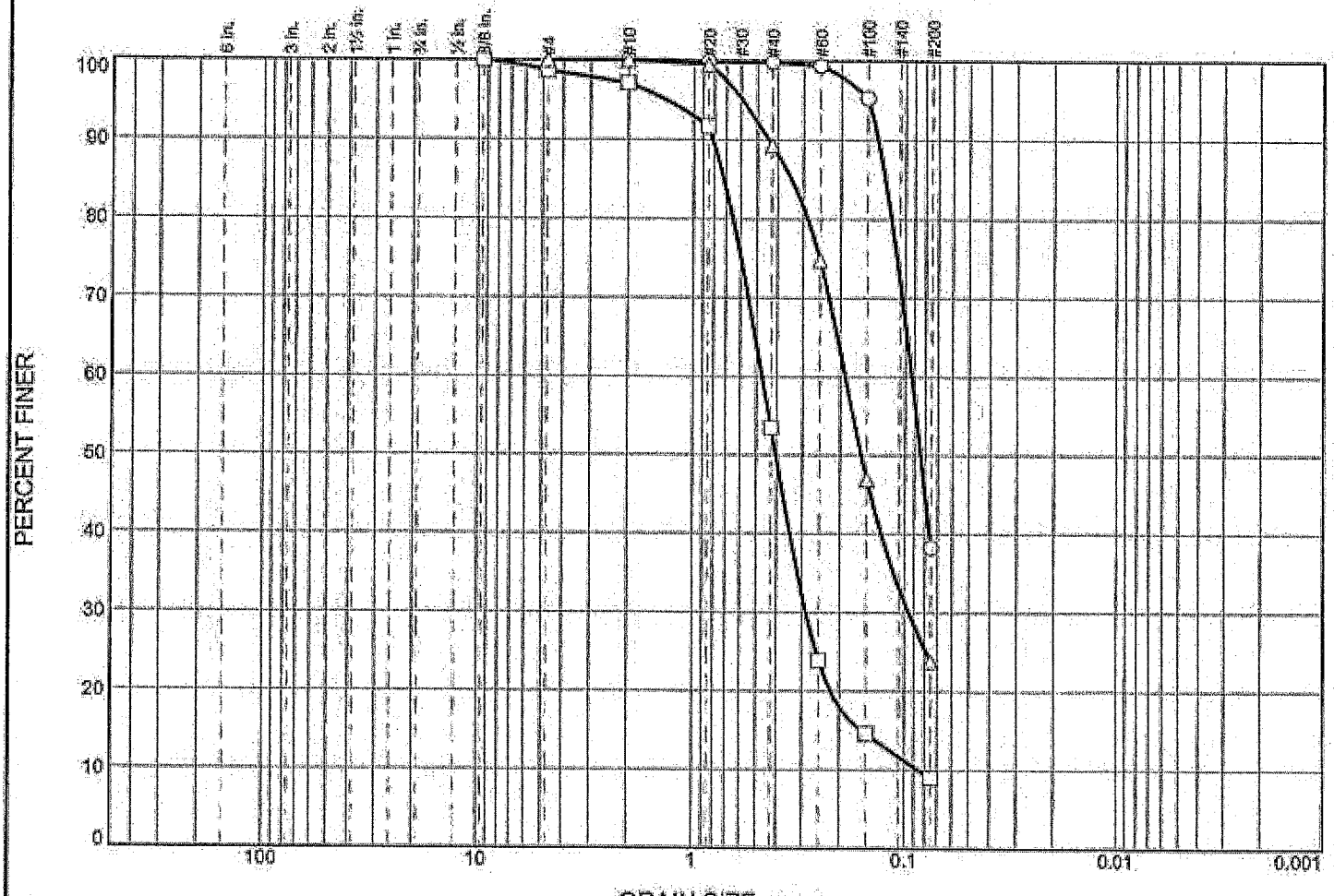
Terra Associates, Inc.

Kirkland, WA

Figure A-17

Tested By: CSD

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.2	61.5	38.3	
□	0.0	0.0	1.3	1.6	43.6	44.5	9.0	
△	0.0	0.0	0.0	0.0	10.7	65.5	23.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1242	0.0927	0.0840					
□			0.7190	0.4691	0.4029	0.2877	0.1570	0.0853	2.07	5.50
△			0.3430	0.1896	0.1592	0.0953				

Material Description	USCS	AASHTO
○ Silty SAND	SM	
□ Poorly graded SAND with silt	SP-SM	
△ Silty SAND	SM	

Project No. T-6636-1 **Client:** BD Real Estate, LLC
Project: BD Real Estate Distribution Building
Woodinville, Washington
○ **Location:** Test Boring B-3 **Depth:** 30 **Sample Number:** 9
□ **Location:** Test Boring B-8 **Depth:** 10 **Sample Number:** 4
△ **Location:** Test Boring B-9 **Depth:** 10 **Sample Number:** 4

Remarks:
○ Tested on 11-3-11
□ Tested on 11-3-11
△ Tested on 11-3-11

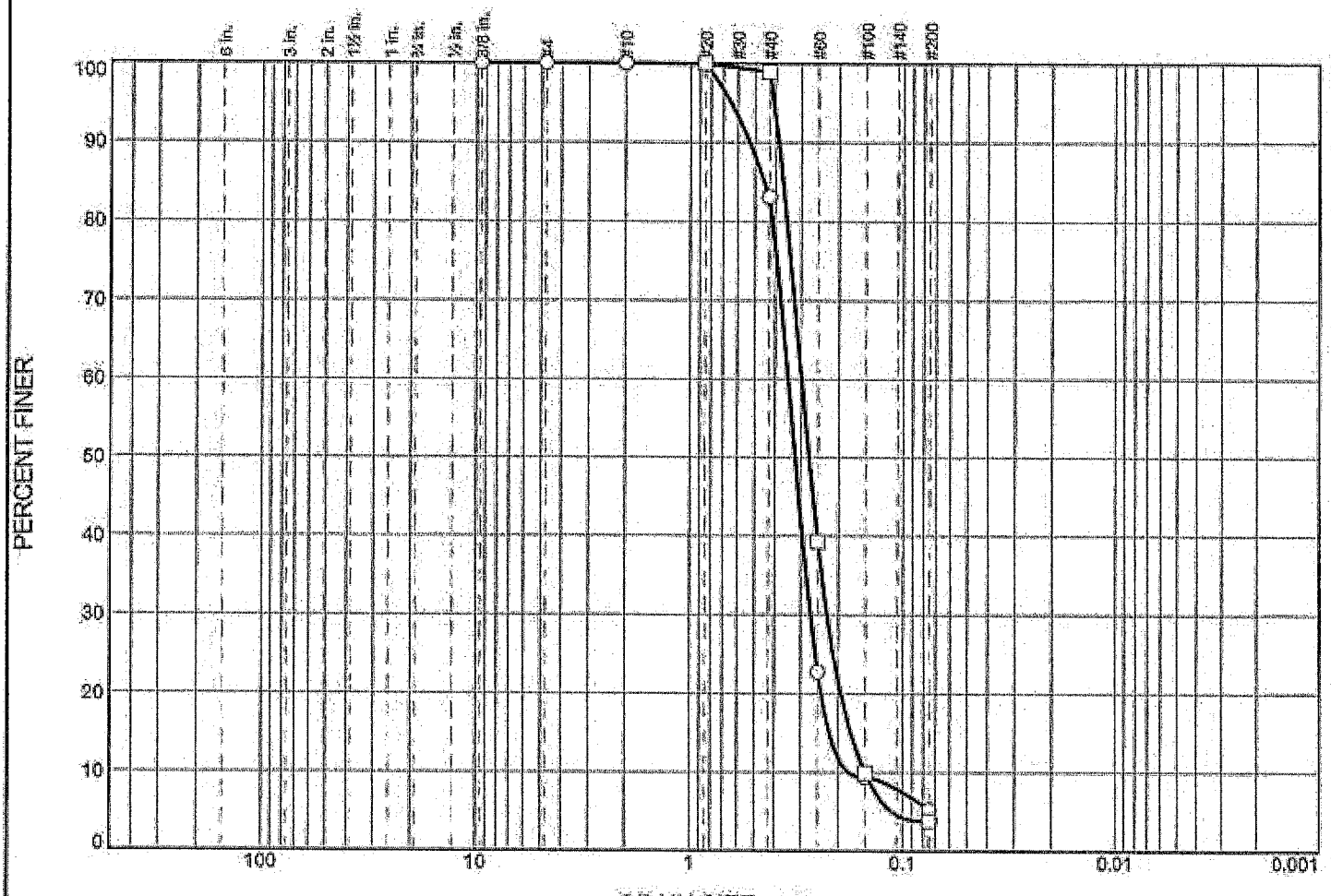
Terra Associates, Inc.

Kirkland, WA

Figure A-18

Tested By: CSD

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	16.9	77.8	5.3	
□	0.0	0.0	0.0	0.0	1.1	95.1	3.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4493	0.3462	0.3200	0.2702	0.2205	0.1799	1.17	1.92
□			0.3672	0.2989	0.2754	0.2256	0.1751	0.1506	1.13	1.99

Material Description	USCS	AASHTO
○ Poorly graded SAND with silt	SP-SM	
□ Poorly graded SAND with silt	SP-SM	

Project No. T-6636-1 **Client:** BD Real Estate, LLC
Project: BD Real Estate Distribution Building
Woodinville, Washington
○ **Location:** Test Boring B-10 **Depth:** 12.5 **Sample Number:** 5
□ **Location:** Test Boring B-12 **Depth:** 20 **Sample Number:** 7

Remarks:
○ Tested on 11-3-11
□ Tested on 11-3-11

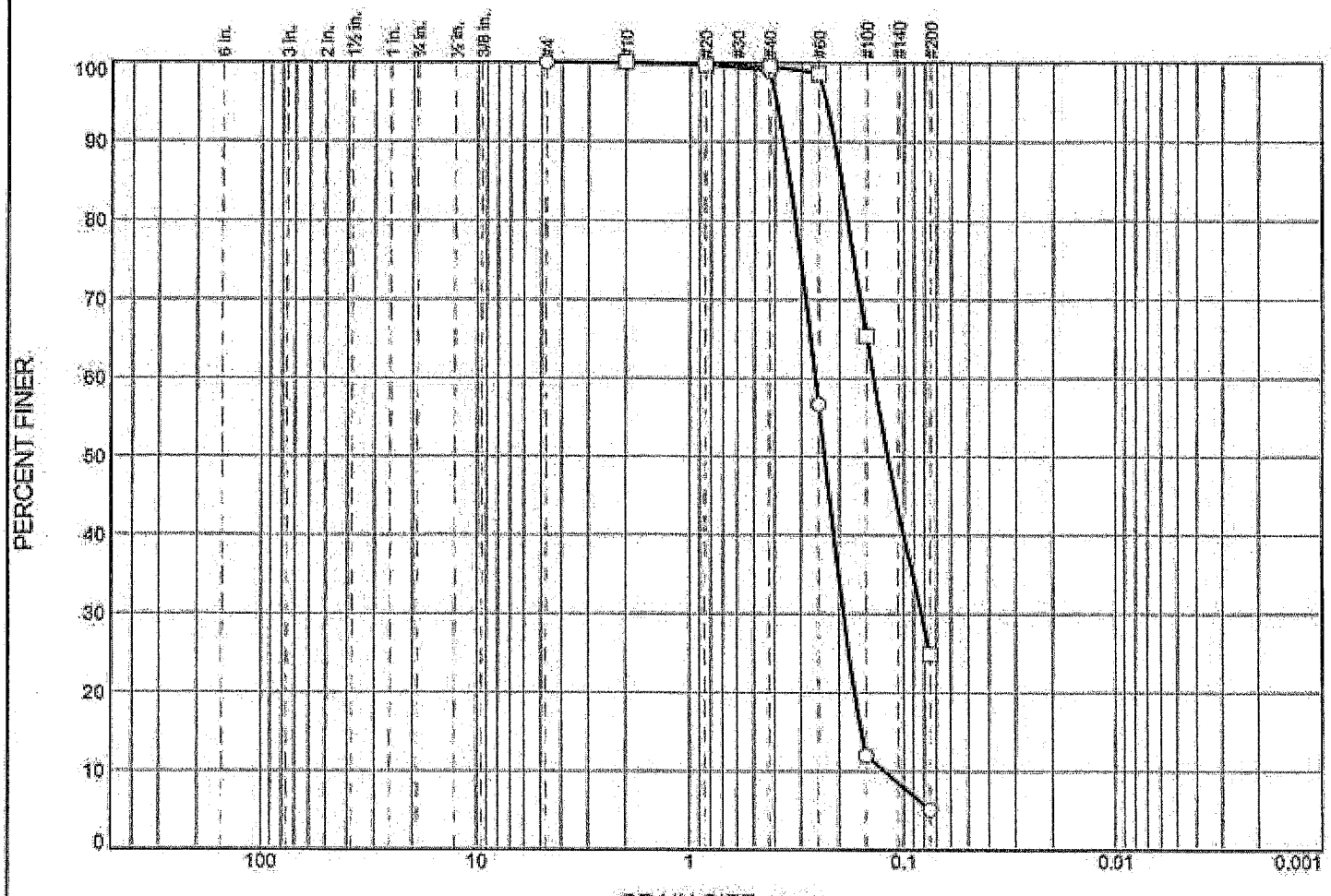
Terra Associates, Inc.

Kirkland, WA

Figure A-19

Tested By: CSD

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.9	93.9	5.1	
□	0.0	0.0	0.0	0.0	0.5	74.6	24.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3392	0.2583	0.2340	0.1906	0.1577	0.1227	1.15	2.11
□			0.1953	0.1389	0.1189	0.0828				

Material Description	USCS	AASHTO
○ Poorly graded SAND with silt	SP-SM	
□ Silty SAND	SM	

Project No. T-6636-1 **Client:** BD Real Estate, LLC
Project: BD Real Estate Distribution Building
Woodinville, Washington
○ **Location:** Test Boring B-13 **Depth:** 20 **Sample Number:** 7
□ **Location:** Test Boring B-15 **Depth:** 35 **Sample Number:** 5

Remarks:
○ Tested on 11-3-11
□ Tested on 11-3-11

Terra Associates, Inc.

Kirkland, WA

Figure A-20

Tested By: CSD

APPENDIX B

AASHTO PAVEMENT DESIGN CALCULATIONS

==========

AASHTO -- Pavement Analysis Program

==========

Crushed Rock Base Heavy Traffic

********** Flexible Analysis **********

* Structural Number	=	2.28	Required
* Design E 18's	=	500,000	
* Reliability	=	95.00	percent
* Overall Deviation	=	0.45	
* Resilient Modulus	=	20,000.0	psi
* Initial Serviceability	=	4.50	
* Terminal Serviceablity	=	3.00	

Layer Number	Layer Coefficient	Drainage Coefficient	Layer Thickness	a(i)*Cd*t
======	== a (i) ==	==== Cd ===	=== t ===	=========
1	0.44	1.00	3.00	1.32
2	0.14	1.00	7.00	0.98

Total SN = 2.30 > 2.28

==========

AASHTO -- Pavement Analysis Program

==========

Asphalt Treated Base Heavy Traffic

********** Flexible Analysis **********

* Structural Number	=	2.28	Required
* Design E 18's	=	500,000	
* Reliability	=	95.00	percent
* Overall Deviation	=	0.45	
* Resilient Modulus	=	20,000.0	psi
* Initial Serviceability	=	4.50	
* Terminal Serviceablity	=	3.00	

Layer Number	Layer Coefficient	Drainage Coefficient	Layer Thickness	a(i)*Cd*t
======	== a (i) ==	==== Cd ===	=== t ===	=========
1	0.44	1.00	3.00	1.32
2	0.30	1.00	3.50	1.05

Total SN = 2.37 > 2.28

==========

AASHTO -- Pavement Analysis Program

==========

Crushed Rock Base Light Traffic

********** Flexible Analysis **********

* Structural Number	=	1.52	Required
* Design E 18's	=	50,000	
* Reliability	=	95.00	percent
* Overall Deviation	=	0.45	
* Resilient Modulus	=	20,000.0	psi
* Initial Serviceability	=	4.50	
* Terminal Serviceablity	=	3.00	

Layer Number	Layer Coefficient	Drainage Coefficient	Layer Thickness	a(i)*Cd*t
======	== a (i) ==	==== Cd ===	=== t ===	=========
1	0.44	1.00	2.00	0.88
2	0.14	1.00	5.00	0.70

Total SN = 1.58 > 1.52

==========

AASHTO -- Pavement Analysis Program

==========

Asphalt Treated Base Light Traffic

********** Flexible Analysis **********

* Structural Number	=	1.52	Required
* Design E 18's	=	50,000	
* Reliability	=	95.00	percent
* Overall Deviation	=	0.45	
* Resilient Modulus	=	20,000.0	psi
* Initial Serviceability	=	4.50	
* Terminal Serviceablity	=	3.00	

Layer Number	Layer Coefficient	Drainage Coefficient	Layer Thickness	a(i)*Cd*t
======	== a (i) ==	==== Cd ===	=== t ===	=========
1	0.44	1.00	2.00	0.88
2	0.30	1.00	3.00	0.90

Total SN = 1.78 > 1.52

California Bearing Ratio
Soil Tests Summary
BD Real Estate Distribution Building
Woodinville, WA

Sample Number:	1
Sample Location:	Test Boring B-14
Sample Depth (feet):	0'-5'
Soil Type:	Silty SAND with gravel
USCS Classification:	SM
Grain Size Distribution:	
Gravel Fraction:	17
Sand Fraction:	58
Fines Fraction:	25
Laboratory Moisture Density:	
Method of Test:	ASTM D1557
Maximum Dry Density (pcf):	122.8
Optimum Moisture Content (%):	12.5
California Bearing Ratio (CBR):	
Remolded Unit Weight (pcf):	122.4
Remolded Moisture Content (%):	12.5
Surcharge Weight (lbs.):	10
Percent Swell (48 hrs. soak):	0
CBR .1" penetration:	24
CBR .2" penetration:	34
Soaked Moisture Content (%):	13.4