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Page 1 of 29
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SKAMANIA COUNTY AUDITOR
J MICHAEL GARVISON
Fee: $60.00

WHEN RECORDED RETURN TO:

Bradley S. Thomas
11100 NE Hwy 99
Vancouver, WA 98686

DOCUMENT TITLE(S)

Geotechnical Investigation Report

REFERENCE NUMBER(S) *of Documents assigned or released:*

[ ] Additional numbers on page _____ of document.

GRANTOR(S):

Marble Creek, LLC

[ ] Additional names on page _____ of document.

GRANTEE(S):

Gerald T. Sauer

[ ] Additional names on page _____ of document.

LEGAL DESCRIPTION *(Abbreviated: i.e. Lot, Block, Plat or Section, Township, Range, Quarter):*

See attached

[ ] Complete legal on page _____ of document. Sec. 23 T7N R5E

TAX PARCEL NUMBER(S):

07-05-26-0-0-0800-00

[ ] Additional parcel numbers on page _____ of document.

The Auditor/Recorder will rely on the information provided on this form. The staff will not read the document to verify the accuracy or completeness of the indexing information.

PARCEL III

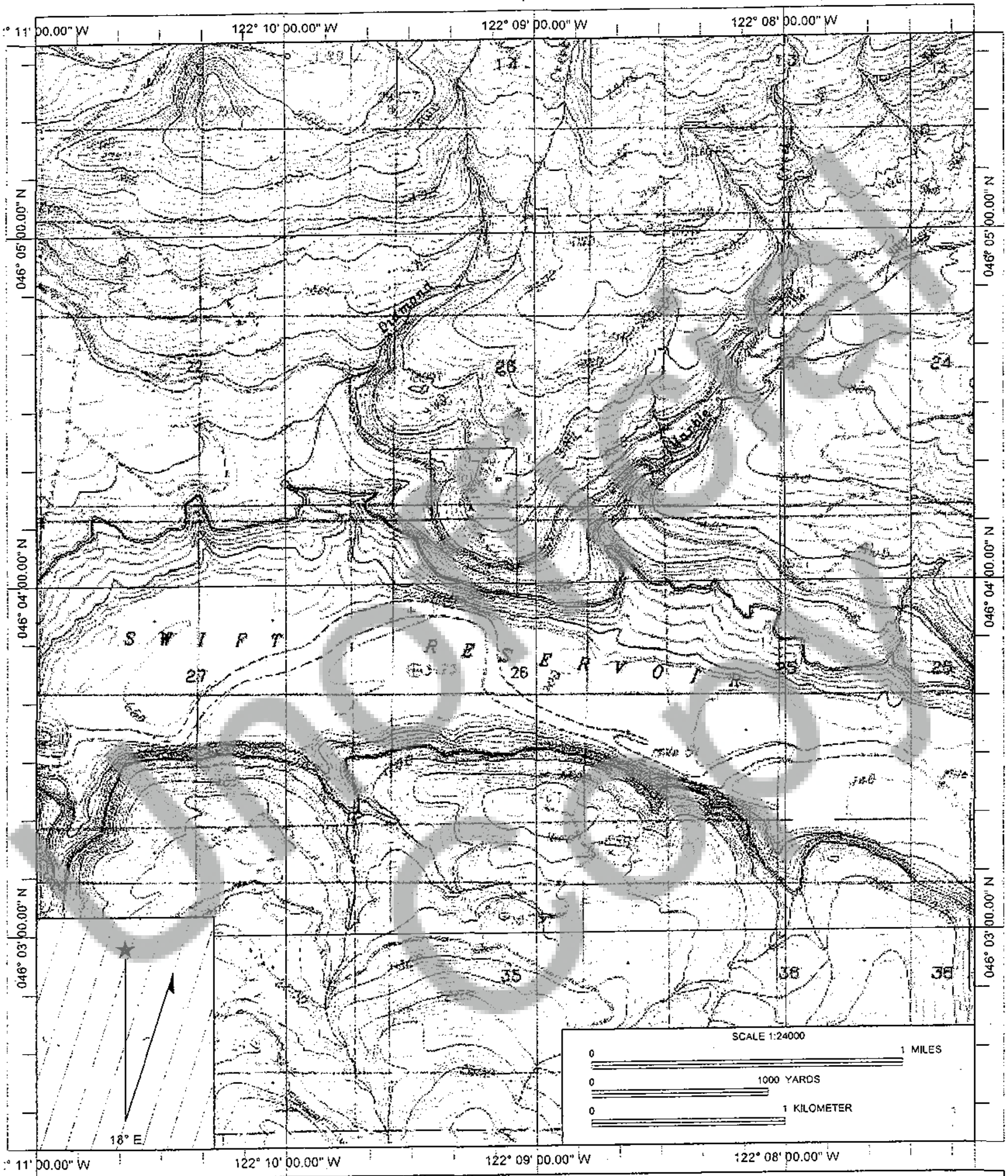
"Exhibit A"

A tract of land in a portion of the Southeast quarter of the Southwest quarter of Section 23, Township 7 North, Range 5 East, of the Willamette Meridian, in the County of Skamania, State of Washington, described as follows:

Beginning at the Southeast corner of the Southwest quarter of said Section 23; thence North 01°39'24" East, along the east line of the Southeast quarter of the Southwest quarter of said Section 23, for a distance of 656.53 feet to the TRUE POINT OF BEGINNING; thence North 88°11'11" West for a distance of 1296.88 feet to the point on the West Line of said Southeast quarter of the Southwest quarter of Section 23; thence North 01°31'49" East, along said West line of the Southeast quarter of the Southwest quarter of said Section 23, for a distance of 670.11 feet to the Northwest corner of said Southeast quarter of the Southwest quarter of Section 23; thence South 88°18'07" East for a distance of 1298.36 feet to Northeast corner of said Southeast quarter of the Southwest quarter of Section 23; thence South 01°39'24" West for a distance of 672.72 feet to the TRUE POINT OF BEGINNING.

Basis of bearings: The East line of the Southwest quarter of said Section 23, Township 7 North, Range 5 East, Skamania County Washington as shown on "DIAMOND CREEK COVE SHOT PLAT" recorded under Book 3 of Short Plats, at Page 432, records of Skamania County, Washington.

800
GST



Name: MT MITCHELL
Date: 4/11/2007
Scale: 1 inch equals 2000 feet

Location: 046° 03' 58.42" N 122° 09' 07.34" W

PBS

Geotechnical Investigation Report

GTS Short Plat

Tax Lot 800, Lots 1 - 3

USFS Road 90

Skamania County, Washington

Prepared for:

Creagan Excavating

1805 Howard Way

Woodland, Washington 98674

October 24, 2006

Revised March 9, 2007

Project # 72333.000

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ENGINEERING AND ENVIRONMENTAL | www.pbsenv.com

Geotechnical Investigation Report

GTS Short Plat
Tax Lot 800, Lots 1 - 3
USFS Road 90
Skamania County, Washington

Prepared for:
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Woodland, Washington 98674

This report is for the exclusive use of the client for design of the development as described in our proposal for this particular project and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced in total or in part without the expressed written consent of the client and PBS.

Prepared by:
PBS Engineering and Environmental
1310 Main Street
Vancouver, Washington 98660
360.690.4331

PBS Project No: 72333.000

October 2006
Revised March 9, 2007

TABLE OF CONTENTS

SUPPORTING DATA

1.0 INTRODUCTION

PBS Engineering & Environmental is pleased to present this geologic hazard and geotechnical engineering study for the GTS short plat (tax lot 800) located north of USFS Road 90 above the Swift Reservoir. The site location is shown on Figure 1. This 20-acre short plat is subdivided into four lots, three of which (Lots 1, 2 and 3) are addressed in this report (Figure 2).

The site is classified as a "Class II (High) Landslide Hazard Area in accordance with Skamania County Code Section 21A.06.020 Landslide Hazard Area. This study is completed to satisfy the requirements of this code section.

The purpose of the work is to evaluate overall stability of the site as required by the Skamania County Code. In addition also evaluate subsurface conditions on each lot and provide recommendations for earthwork, foundations and seismic design.

This report addresses lots within the GTS Short Plat (lots 1, 2 and 3; Skamania County Short Plat Application SP-06-05). The remaining seven lots within the BST and DAC Short Plats are addressed under separate report titles. This work is completed in accordance with our proposal dated September 11, 2006.

2.0 SITE LOCATION AND GENERAL TOPOGRAPHY

The site is located on the Cascade Mountains approximately 30 miles east of Woodland and 10 miles south of Mount St. Helens, Washington (Figure 1). The Development is located above the north shore of Swift Reservoir in mountainous topography in sections 23 and 26, T7N-R5E along USFS Road 90. Based on the USGS topographic map for the area, elevations of the site range from 1,000 ft to 1,760 ft with slopes in the general area ranging from 10-40 degrees with some near-vertical rock outcrop areas along USFS Road 90.

The three lots are located on the northern end of a private driveway paralleling Wapiti Way (pvt.) to the east and extend east to west crossing USFS Road 90 (Figure 2; Appendix A).

3.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

3.1 Regional Geology

Information on general geologic conditions is available from Walsh and others (1987)[1] and Phillips (1987)[1]. This information indicates that the site is underlain by a gray to red-gray, 120 to 180 foot-thick andesitic lava flows that erupted from the south side of Marble Mountain during the Upper Pleistocene (less than 160,000 years ago). The lava forms block flows 30 to 45 feet thick with top and bottom brecciated zones. Volcanic ash (unknown age) overlies the lava flow sequence and probably originated from the scoria cones north of the site area. Pleistocene Marble Mountain basalt flows are mapped east of the Development and older (lower Miocene

[1] Walsh, T. J. et al., 1987, Geologic Map of Washington- Southwest Quadrant, Washington Department of Geology and Earth Resources, Geologic Map GM-34.
[1] Phillips, W. M., 1987, Geologic Map of the Mount St. Helens Quadrangle, Washington and Oregon, Open File Report 87-4, Washington Department of Geology and Earth Resources.

and upper Oligocene) pyroclastic and sedimentary outcrops are present north and west of the area.

3.2 Site Reconnaissance

PBS conducted a geologic site reconnaissance on the property on August 16th and September 18th, 2006 that consisted of walking traverses across the site. Exposed surficial features were mapped and plotted on the topographic base map provided by KPF Surveying Inc. of Camas, Washington. Kyle Feeder of KPF indicated that topographic map elevations are based on an arbitrary elevation of 1,000 feet assigned to a survey point near the intersection of USFS Road 90 and Wapiti Way. The KPF maps use a 2-foot contour interval and coverage is generally limited to the area of the proposed building pads with some coverage on cut and natural slopes near the building pad perimeter, forested areas and property corners.

The project site includes a total of 6.69 acres and varies in elevation from approximately 1,428 to 1,455 feet MSL. Natural slope angles are generally 5 to 15 degrees with some cut and fill slopes of up to 40 degrees. Vegetation around the proposed building pads consists of scattered to dense coniferous trees with undergrowth of leafy plants.

We did not observe signs of slope instability on the site and the slopes immediately above and below it. Our reconnaissance and observations of the local surface topography indicates that the majority of the slopes on the property are erosional in nature. No morphologic landslide features were observed. Site drainage is primarily by sheet flow and via several shallow v-channel drainage ditches along Wapiti Way. Some of the ditches appear to be armored with cobbles. Based on review of geologic maps, and our site reconnaissance, the site appears to be stable.

3.3 Subsurface Investigation

A total of three (3) test pits were excavated by a track-hoe across the three lots to evaluate subsurface conditions. One test pit was located on each lot (Figure 2). A geologist from PBS observed the excavation of test pits and logged the subsurface materials. Excavation depths ranged from 11.0 to 19.0 feet below ground surface (bgs). Test pit logs are presented in Appendix B.

The subsurface materials encountered were logged and field classified in general accordance with the Unified Soil Classification Visual Manual Procedure (ASTM D2488). Soil and rock conditions were observed and sampled within each test pit as test pits were excavated and were logged by an engineering geologist from PBS. Samples were placed in sealed containers and transported to the laboratory for further analysis, as necessary.

The test pit logs are based upon the field logs, with modifications made upon further laboratory examinations of the recovered samples. It should be noted that strata contacts indicated on the logs are approximate and that actual strata boundaries may be variable or gradational.

3.4 Geologic Conditions

The purpose of the subsurface exploration was to observe the existing subsurface geologic conditions and evaluate the engineering characteristics of the materials encountered with respect to the proposed development.

In one of the three test pits (TP-3; Lot 1), we encountered man-made fill material that appears to be logging debris derived from a local source. These materials are mixed randomly in a matrix of local volcanic deposits. Where fill is present, it is underlain by an in-place decomposed volcanic tuff deposited on the underlying bedrock. No fill was encountered in test pits on Lots 2 and 3. In general, the subsurface soils and rock encountered are distributed as indicated above and consist of the following:

> **Fill -** variable consistency, non-engineered, man-made fill that generally consists of loose to medium dense, brown medium to coarse sand with trace to some silt. It contains trace plant roots, charcoal fragments and some lapilli pumice with scattered tree roots, branches and bark. Scattered subsurface voids were noted in areas with abundant tree debris, generally in the top 3.0 feet bgs. The unit was noted to be 9.0 feet thick in TP-3 (Lot 1) and was not encountered on lots 2 and 3.
>
> **Decomposed Tuff Unit** – composed of medium dense, gray to red-brown fine to medium sand with some lapilli pumice and trace subangular to subrounded fine gravel. Root casts and trace wood fragments are also present. The unit is interpreted to be tuff and appears to be in-place. It varies in thickness from 5.0 to 10.5 feet. Moisture levels above 10 feet bgs in this unit were 41 to 50 percent with the 12-foot sample from Lot 2 at 84.8 percent. The average moisture content was 52 percent.
>
> **Bedrock** – medium hard (R3) to hard (R4) gray to red-gray hornblende andesite; fine-grained, fresh to slightly weathered. This unit was not encountered on lots 2 and 3 down to depths of 16.0 and 19.0 feet, respectively. Bedrock was encountered on Lot 1 at 11.0 feet bgs. Excavation of the rock was not possible with the equipment. Descriptions of the rock, interpreted to be andesitic lava flows of Marble Mountain (mapped unit Qvma), are based on nearby outcrops on Lots 1 and 2 of Tax Lot 600, which appear to have been excavated by explosives and heavy equipment.

The unit description above is generalized to highlight the major stratification features and material characteristics. The test pit logs included in the Appendix should be reviewed for specific information at individual test locations. These records contain soil descriptions including consistency data, stratification, and sample locations. The stratifications shown on the exploration logs represent the conditions at the individual boring locations, and some variation should be expected between test locations. The stratifications represent the approximate boundary between adjacent subsurface materials, and the actual transition may be gradual. If subsurface conditions are found to differ from those encountered in the explorations during construction, PBS should be advised at once so that we may review these conditions and reconsider our recommendations where necessary.

Groundwater was not observed in the test pits at the time of field exploration.

4.0 LANDSLIDE HAZARD ISSUES

Figure 3 shows a section through the site based on the survey provided to us by KPF, USGS topographic maps, geologic review, geologic reconnaissance and conditions observed in the test pits. As discussed in Section 3.2, we did not observe any signs of slope instability during our geologic reconnaissance. In addition, the presence of relatively hard soils and shallow bedrock and the lack of groundwater indicated that the slopes are stable. We therefore conclude that the slopes at the site are stable and are suitable for the proposed development.

5.0 GEOLOGIC AND GEOTECHNICAL DESIGN CRITERIA

Three (3) lots are part of this short plat. The specific conditions encountered in each of these lots are discussed below. Detailed foundation recommendations are provided in subsequent sections of the report.

5.1 Subsurface Conditions – Lot 1

The 2.69-acre site is located on the northeastern portion of the plat. The proposed building pad area of the site has been cleared and graded with cut slopes on the east and northeast, fill on the west and grading to accommodate an entry drive from the south along Wapiti Way. Native coniferous trees remain on the northern and eastern edges of the lot. Natural slope angles are north-northwest generally 20 to 25 degrees.

Cross-sections of the site provided by KPF, show the building pad to be sloping gently to the west with cut slopes to the north of the pad at 24 degrees, east at 21 degrees. A fill slope at an angle of approximately 45 degrees is present along the west side of the pad adjoining Wapiti Way.

One test pit (TP-3) was excavated at the location shown on Figure 2. Fill was encountered to a depth of 9.0 feet and is underlain by a 2.0-foot thick fine to medium sand unit. Bedrock was encountered at a depth of 11.0 feet bgs. Logs of tests pits are shown in Appendix B.

5.1.1 Geotechnical Considerations

Due to the depth of the fill and relatively lightly loaded residential structures, we recommend that the soils below the footing be over excavated to a depth equal to two times the width and backfilled with compacted crushed rock. The base width of the excavation should be equal to three times the width of the footing. The building footings can be placed on this compacted crushed rock pad.

5.2 Subsurface Conditions – Lot 2

The 2.0-acre site is located on the eastern portion of the plat. Natural slope angles are north-northwest generally 20 to 25 degrees. The proposed building pad area of the site has been cleared and graded with cut slopes on the west sloping down to Wapiti Way, minor cut slopes on the east and grading to accommodate an entry drive from the south-southwest. Native coniferous trees remain on the eastern edges of the pad. No ma terial that appeared to be fill was observed in the building pad area.

Cross-sections of the site provided by KPF, show the building pad to be sloping gently to the west with minor semi-circular cut slope along the east edge of the pad at 24 degrees and west along Wapiti Way at 31 degrees

One test pit (TP-2) was excavated at the loca tion shown on Figure 2. A thick fine to medium sand unit with coarse sand interbeds was enc ountered down to a depth of 16.0-feet bgs. No bedrock or material that appeared to be fill was encountered. Logs of tests pits are shown in Appendix B.

5.2.1 Geotechnical Considerations

Fill was not encountered in the area of the test pit on the cleared building pad. Conventional foundations can therefore be used.

5.3 Subsurface Conditions – Lot 3

The 2.0-acre site is located on the southeastern portion of the plat. Natural slope angles are north-northwest generally 20 to 25 degrees. The proposed building pad area of the site has been cleared and graded with cut slopes on the west sloping down to Wapiti Way, minor cut slopes on the east and grading to accommodate an entry drive from the south-southwest. Native coniferous trees remain on the eastern edges of the pad. No mate rial that appeared to be fill was noted in the building pad area.

Cross-sections of the site provided by KPF, show the building pad to be sloping gently (5 to 8 degrees) to the west with minor semi-circular cut slope along the east edge of the pad at 12 to 14 degrees and west along Wapiti Way at 29 degrees

One test pit (TP-1) was excavated at the locati on shown on Figure 2. A fine to medium sand unit with a few coarse sand interbeds was encountered down to a depth of 19.0-feet bgs. No bedrock was encountered. Logs of tests pits are shown in Appendix B.

5.3.1 Geotechnical Considerations

Fill was not encountered in the area of the test pit on the cleared building pad. Conventional foundations can therefore be used.

5.4 Foundations

Based on our investigation and experience with similar soils, it is our opinion that the proposed building can be supported on conventional spread footings. All footings should be supported on firm undisturbed native soils or structural fill. Please refer to Section 5.1 to 5.3 for preparation for foundation pads for the three lots. In addition, the closest edge of the building foundation should have a minimum setback of H/3 (but need not exceed 40 feet) from the edge of the fill slope. In addition, the building should also have a minimum setback of H/2 (but need not exceed 15 feet) from cut slope edge (upslope). Where H is the horizontal distance to the vertical cut.

Continuous wall and isolated spread footings should be at least 18 and 24 inches wide, respectively. The bottom of exterior footings should be at least 24 inches below the lowest adjacent exterior grade. The bottom of interior footings should be established at least 18 inches below the base of the floor slab.

Footings bearing on firm native subgrade, structural fill or crushed rock pad should be sized for an allowable bearing capacity of 2,000 pounds per square foot (psf). This is a net bearing pressure. The weight of the footing and overlying backfill can be ignored in calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads and may be doubled for short-term loads such as those resulting from wind or seismic forces.

Based on our analysis the total post-construction settlement is calculated to be less than 1 inch, with post-construction differential settlement of less than ½ inch over a 50-foot span for maximum column and perimeter footing loads of less than 75 kips and 3 kips per linear foot.

Lateral loads on footings can be resisted by passive earth pressure on the sides of the structures and by friction at the base of the footings. An allowable passive earth pressure of 200 pounds per cubic foot (pcf) may be used for footings confined by native soils and new structural fills. Adjacent floor slabs, pavements, or the upper 12-inch depth of adjacent, unpaved areas should not be considered when calculating passive resistance. For footings in contact with native soils, a coefficient of friction equal to 0.30 may be used when calculating resistance to sliding.

A geotechnical engineer or their representative to confirm suitable bearing conditions should evaluate all footing subgrades. Observations should also confirm that loose or soft material, organics, unsuitable fill, old topsoil zones, has been removed. Localized deepening of footing excavations may be required to penetrate any deleterious materials.

If construction is undertaken during wet weather, we recommend a thin layer of compacted, crushed rock be placed over the footing subgrades to help protect them from disturbance due to the elements and foot traffic.

The footings should be founded below an imaginary line projecting at a 1:1 slope from the base of any adjacent, parallel utility trenches.

5.5 Floor Slabs

Satisfactory subgrade support for building floor slabs can be obtained from the native subgrade prepared in accordance with our recommendations presented below. A 6-inch-thick layer of imported floor slab base aggregate should be placed and compacted over the prepared subgrade. Imported floor slab base aggregate should meet specification provided in Section 6.2.5, page 10. The imported granular material should be compacted to at least 95 percent of the maximum dry density as determined by American Society for Testing and Materials (ASTM) D 1557. A subgrade modulus of 125 pounds per cubic inch (pci) may be used to design the floor slab.

5.6 Retaining Structures

The retaining wall design recommendations are based on the following assumptions: (1) the walls consist of conventional, cantilevered retaining walls; (2) the walls are less than 10 feet in height; (3) the backfill is drained; and (4) the backfill has a slope flatter than 4H: 1V. Re-evaluation of our recommendations will be required if the retaining wall design criteria for the project varies from these assumptions.

Unrestrained site walls that retain native soils should be designed to resist active earth pressures of 40 pcf where supporting slopes are flatter than 4H: 1V. If retaining walls are restrained from rotation prior to being backfilled, the active earth pressure shall be increased to 55 pcf. For embedded building walls, a superimposed seismic lateral force should be calculated based on a dynamic force of $6H^2$ pounds per lineal foot of wall, where H is the height of the wall in feet, and applied at 0.6H from the base of the wall.

If other surcharges (for example, slopes steeper than 4H:1V, foundations, vehicles, and so forth) are located within a horizontal distance from the back of a wall equal to twice the height of the wall, then additional pressures will need to be accounted for in the wall design. Our office should be contacted for appropriate wall surcharges based upon the actual magnitude and configuration of the applied loads.

The wall footing should be designed in accordance with recommendations provided above in Section 5.4.

The backfill material placed behind the walls and extending a horizontal distance equal to at least half of the height of the retaining wall should consist of granular retaining wall backfill.

The wall backfill should be compacted to a minimum of 95 percent of the maximum dry density, as determined by ASTM D 1557. Backfill located within a horizontal distance of 3 feet from the retaining walls should only be compacted to approximately 92 percent of the maximum dry density, as determined by ASTM D 1557. Backfill placed within 3 feet of the wall should be compacted in lifts less than 6 inches thick using hand-operated tamping equipment (for example, jumping jack or vibratory plate compactors). If flat work (sidewalks or pavements) will be placed atop the wall backfill, we recommend that the upper 2 feet of material be compacted to 95 percent of the maximum dry density, as determined by ASTM D 1557.

These design parameters assume that wall drains will be installed to prevent buildup of hydrostatic pressures behind all walls. A minimum 12-inch-wide zone of drain rock, extending from the base of the wall to within 6 inches of finished grade, should be placed against the back of all retaining walls. Perforated collector pipes should be embedded at the base of the drain rock. The perforated collector pipes should discharge at an appropriate location away from the base of the wall. The discharge pipe(s) should not be tied directly into storm water drain systems, unless measures are taken to prevent backflow into the wall's drainage system.

Settlements of up to 1 percent of the wall height commonly occur immediately adjacent to the wall as the wall rotates and develops active lateral earth pressures. Consequently, we recommend that construction of flat work adjacent to retaining walls be postponed at least 4 weeks after backfilling of the wall, unless survey data indicates that settlement is complete prior to that time.

5.7 Seismic Design Criteria

We understand that the seismic design criteria for this project is based on the 2003 IBC, Section 1615. The seismic design criteria, in accordance with the 2003 IBC, are summarized in Table 1.

Table 1: IBC 2003 Seismic Design Parameters

	Short Period	1 Second
Maximum Credible Earthquake Spectral Acceleration	$S_s = 0.84$ g	$S_1 = 0.30$ g
Site Class	C	
Site Coefficient	$F_a = 1.08$	$F_v = 1.5$
Adjusted Spectral Acceleration	$S_{MS} = 0.90$ g	$S_{M1} = 0.45$ g
Design Spectral Response Acceleration Parameters	$S_{DS} = 0.61$ g	$S_{D1} = 0.30$ g
Design Spectral Peak Ground Acceleration (PGA)	0.24 g	

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Site Preparation

Site preparation for Lot 1 at this site will include removal and re-compaction of existing fill as an engineered fill. An alternate will be preparation of granular rock pads for the support of structures as discussed in Section 5.1.

Demolition should include removal of existing improvements throughout the project site. Underground utility lines, vaults, basement walls, or tanks should be removed or grouted full if left in place. The voids resulting from removal of footings, buried tanks, and so forth, or loose soil in utility lines, should be backfilled with compacted structural fill. The base of these excavations should be excavated to firm subgrade before filling with sides sloped at a minimum of 1H:1V to allow for uniform compaction.

Materials generated during demolition of existing improvements should be transported off site or stockpiled in areas designated by the owner. Asphalt, concrete, and base rock materials may be crushed and recycled for use as general fill.

The root zone should be stripped and removed from the project site in proposed building, fill, and pavement areas and for a 5-foot margin around such areas. We anticipate an average stripping depth of 4- to 6- inches. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported offsite for disposal or stockpiled for use in landscaped areas.

Trees and their root balls should be grubbed out to the depth of the roots, which could exceed three feet BGS. Depending on the methods used to remove the root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend that soil disturbed during grubbing operations be removed to firm, undisturbed subgrade. The excavations should then be backfilled with compacted structural fill.

6.2 Structural Fills

Fills should be placed over subgrade that has been prepared in conformance with the Section 6.1, of this report. Material used as structural fill should be free of organic matter or other unsuitable materials and should meet specifications provided in WA SS 9-03.14, depending upon the application. These materials are discussed below:

6.2.1 Native Soils

The native soils are suitable for use as general fill, provided they are properly moisture conditioned and meet the requirements of WA SS 9-03.14(3) – Borrow Material. Laboratory testing indicates that the moisture content of the near-surface silts is greater than the soil's optimum moisture content required for satisfactory compaction. In order to adequately compact the soil, it may be necessary to moisture condition the soil to within a 2 to 3 percentage points of the optimum moisture content. Moisture conditioning will be difficult due to the fine-grained nature of the soil.

The native soils should be placed in lifts with a maximum un-compacted thickness of 6 to 8 inches and compacted to at least 92 percent of the maximum dry density, as determined by ASTM D 1557.

6.2.2 Imported Granular Fill

Imported granular material should be pit or quarry run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in WA SS 9-03.9(1) - Ballast, WA SS 9-03.14(1) - Gravel Borrow, or WA SS 9-03.14(2) - Select Borrow. The imported granular material should be fairly well graded between coarse and fine material and have less than 5 percent by weight passing the U.S. Standard No. 200 Sieve.

Imported granular material should be placed in lifts with a maximum un-compacted thickness of 8 to 12 inches and be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D 1557. During the wet season or when wet subgrade conditions exist, the initial lift should be approximately 18 inches in un-compacted thickness and should be compacted with a smooth-drum roller without using vibratory action.

Where imported granular material is placed over wet or soft soil subgrades, we recommend a geotextile be placed as a barrier between the subgrade and imported granular material. The geotextile should meet WA SS 9-33.2 (Table 3) for soil separation and/or stabilization. The geotextile should be installed in conformance with WA SS 2-12 - Construction Geotextile.

6.2.3 Retaining Wall Backfill

Backfill material placed behind retaining walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of select granular material meeting WA SS 9-03.12(2) - Gravel Backfill for Walls. We recommend the select granular wall backfill be separated from general fill, native soil, and/or topsoil using a geotextile fabric that meets the requirements provided in WA SS 9-33.2 for drainage geotextiles. The geotextile should be installed in conformance with WA SS 2-12 - Construction Geotextile.

6.2.4 Trench Drain and Retaining Wall Drain Backfill

Backfill for subsurface trench drains and for a minimum 1-foot-wide zone against the back of retaining walls should consist of drain rock meeting the specifications provided in WA SS 9-03.12(4) - Gravel Backfill for Drains. The drain rock should be wrapped in a geotextile fabric meeting the specifications provided in WA SS 9-33.2 for drainage geotextiles. The geotextile should be installed in conformance with WA SS 2-12 - Construction Geotextile.

6.2.5 Floor Slab Base and Footing Base Aggregate

Base aggregate for floor slabs should be clean, crushed rock or crushed gravel. The base aggregate should contain no deleterious materials, meet specifications provided in WA SS 9-03.9(3) - Crushed Surfacing and WA SS 9-03.10 - Aggregate for Gravel Base, and have less than 5 percent by weight passing the U.S. Standard No. 200 Sieve. The imported granular material should be placed in one lift and compacted to at least 95 percent of the maximum dry density, as determined by ASTM D 1557.

6.2.6 Recycled Concrete, Asphalt and Base Rock

Asphalt pavement, concrete, and base rock from the existing site improvements can be used in general structural fills, provided no particles greater than 6 inches are present. It also must be thoroughly mixed with soil, sand, or gravel such that there are no voids between the fragments. The recycled materials should meet the requirements set forth in WA SS 9-03.21 - Recycled Material.

6.3 Permanent Slopes

Permanent cut and fill slopes should not exceed a gradient of 2H:1V for a maximum height of 10 feet. Taller slopes or steeper slope gradients should be evaluated on a case-by-case basis. Fill slopes should be over-built by at least 12 inches and trimmed back to the required slope to maintain a firm face.

Slopes should be planted with appropriate vegetation to provide protection against erosion as soon as possible after grading. Surface water runoff should be collected and directed away from slopes to prevent water from running down the face of the slope.

6.4 Drainage Considerations

6.4.1 Surface and Subsurface Drainage Requirements

The contractor shall be made responsible for temporary drainage of surface water and groundwater as necessary to prevent standing water and/or erosion at the working surface. We recommend removing only the foliage necessary for construction to help minimize erosion.

The ground surface around the structures should be sloped to create a minimum gradient of 2% away from the building foundations for a distance of at least 5 feet. Surface water should be directed away from all buildings into drainage swales or into a storm drainage system. "Trapped" planting areas should not be created next to any building without providing means for drainage. The roof downspouts should discharge onto splash blocks or paving that direct water away from the buildings, or into smooth-walled underground drain lines that carry the water to appropriate discharge locations at least 10 feet away from any buildings.

6.4.2 Foundation Drains

We recommend foundation drains around the perimeter foundations of all structures, including building and tanks. The foundation drains should be at least 12 inches below the base of the slab. The foundation drain should consist of perforated collector pipes embedded in a minimum 2-foot-wide zone of angular drain rock. The drain rock should meet specifications provided in Section 6.2.4. The drain rock should be wrapped in a geotextile fabric. The collector pipes should discharge at an appropriate location away from the base of the footings. Unless measures are taken to prevent backflow into the wall's drainage system, the discharge pipe should not be tied directly into storm water drain system.

7.0 CONSTRUCTION OBSERVATIONS

Satisfactory earthwork performance depends on the quality of construction. Sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. We recommend that a geotechnical engineer from PBS Engineering be retained to observe general excavation, stripping, fill placement, footing subgrades, and subgrades and base rock for floor slabs and pavements.

Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

8.0 LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their architects and engineers for aiding in the design and construction of the proposed development. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials, and contractors to ensure correct implementation of the recommendations.

The opinions, comments and conclusions presented in this report were based upon information derived from our literature review, field investigation, and laboratory testing. Conditions between, or beyond, our exploratory borings may vary from those encountered. Unanticipated soil conditions and seasonal soil moisture variations are commonly encountered and cannot be fully determined by merely taking soil samples or soil borings. Design changes may need to be made in the field depending on the condition of these structures encountered. Such variations may result in changes to our recommendations and may require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

If there is a substantial lapse of time (years) between the submission of this report and the start of work at the site; if conditions have changed due to natural causes or construction operations at, or adjacent to, the site; or, if the basic project scheme is significantly modified from that assumed, it is recommended this report be reviewed to determine the applicability of the conclusions and recommendations.

Sincerely,
PBS ENGINEERING AND ENVIRONMENTAL

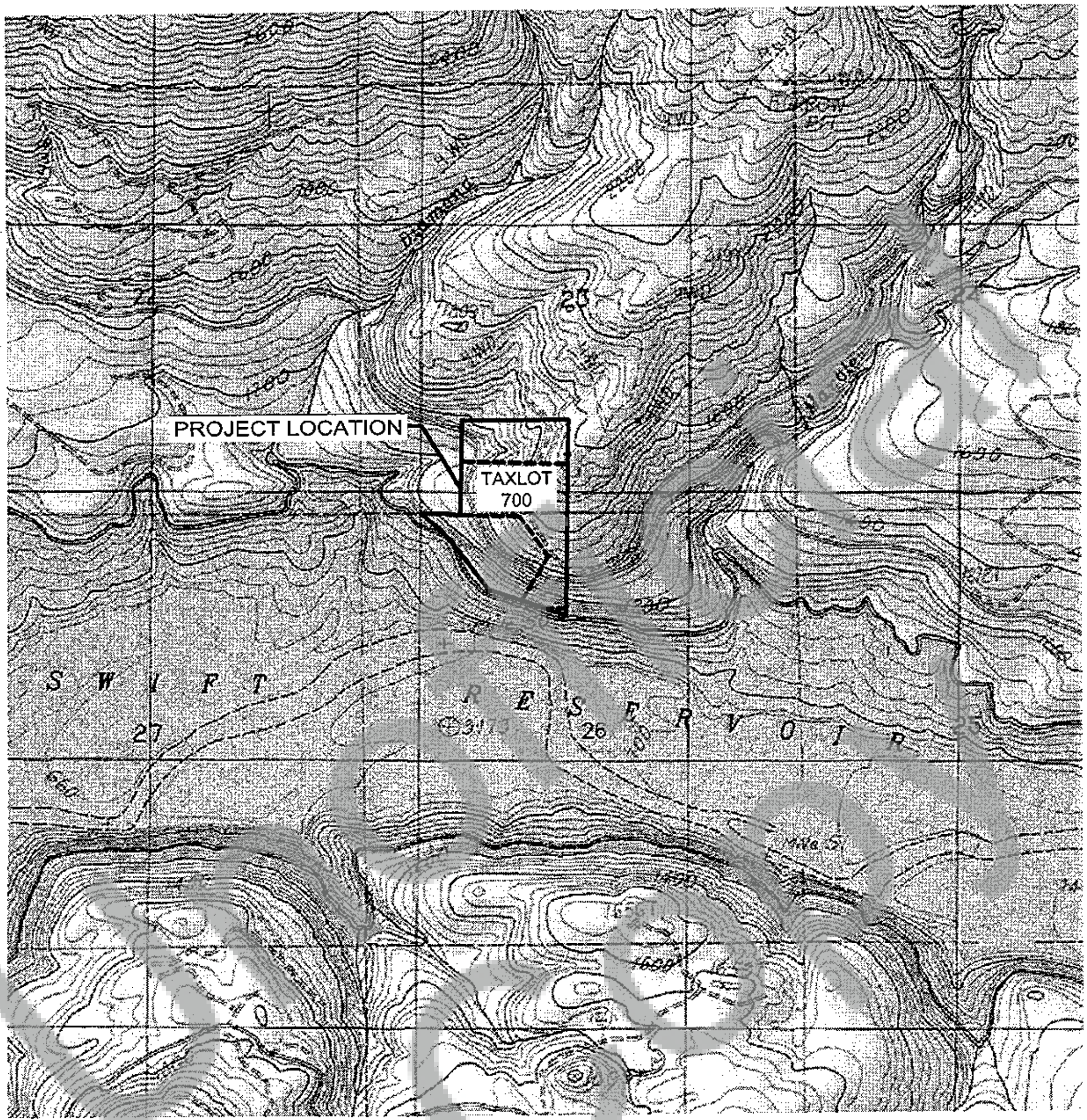
State of Washington
Engineering Geologist
559
Licensed Geologist
Robert J. Deacon

MIA MAHEDY-SEXTON
STATE OF WASHINGTON
42135
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 12-24-08

Robert Deacon, C.E.G.
Senior Geotechnical Engineer

Mia Mahedy-Sexton, P.E.
Managing Construction Engineer

APPENDIX A - FIGURES



SOURCE: USGS MOUNT MITCHELL QUADRANGLE, WA. 1984.
PHOTO REVISED 1982.

0' 1,000' 2,000' 4,000'

SCALE: 1" = 2,000'

Prepared for: CREAGAN EXCAVATING

PBS	Project #: 72333.000	SITE PLAN MAP; DAC SHORT PLAT	FIGURE
	Date: MAR. 2007	USFS ROAD 90 SKAMANIA COUNTY. WASHINGTON	1

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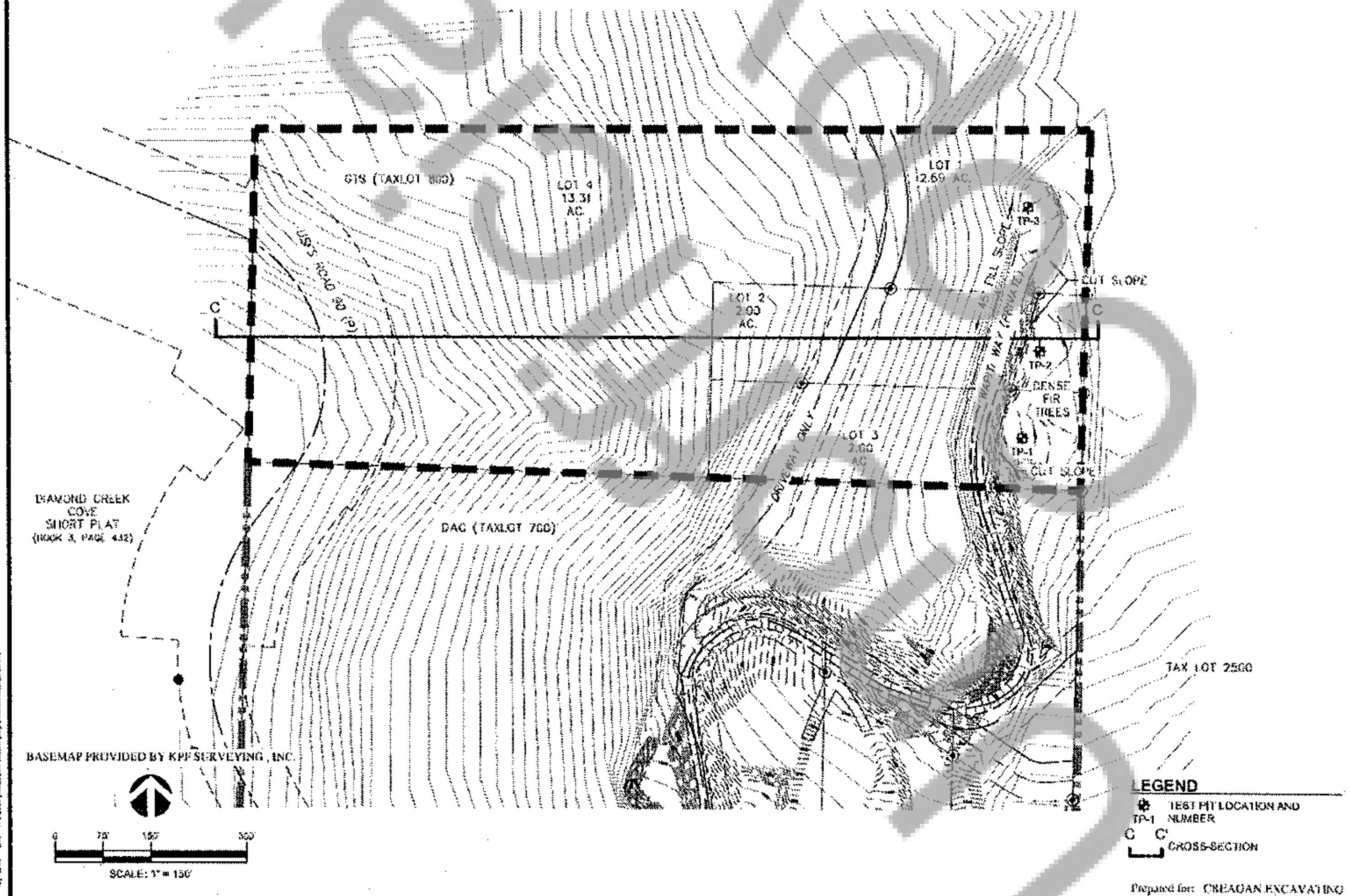

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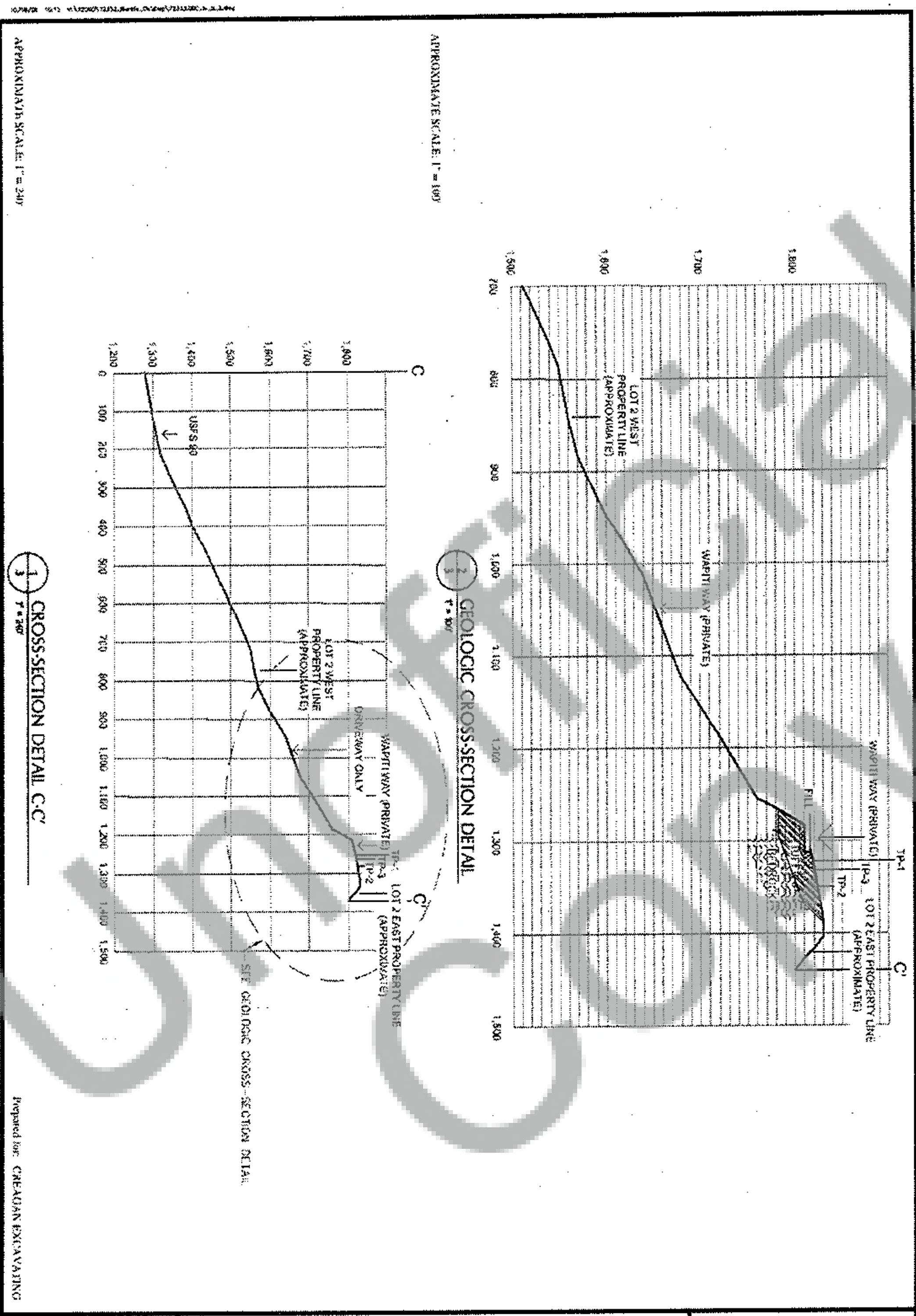
GTS SHORT PLAT
TAX LOT 800
USFS ROAD 90
SKAMANIA COUNTY, WASHINGTON

GEOLOGIC MAP AND
TEST PIT LOCATION PLAN

PROJECT: 72333.000
DATE: MARCH 2007
FIGURE: 2



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TAX LOT 800
USFS ROAD 90
SKAMANIA COUNTY, WASHINGTON

CROSS-SECTION
C-C'
PROJECT: 72333.000
DATE: MARCH 2007
FIGURE: 3

APPENDIX B – TEST PIT LOGS

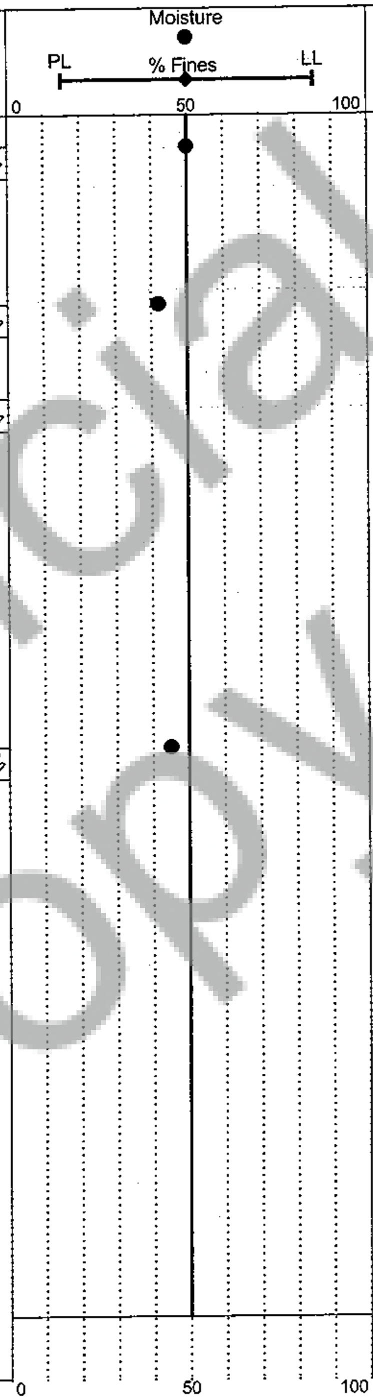
Client: Creagan Excavating
Project: Development
Location: North of USFS Road 90

Date Started: 9/18/2006
Date Completed: 9/18/2006
Logged By: B. Haug

Contractor: Creagan Excavating
Excavator Type/Size: Hitachi EX 220

Test Pit Location: NORTH SHORT PLAT

Depth Feet	Log	Material Description	Elev. Depth	Samples
0		Medium dense, gray to red-brown fine to medium SAND (volcanic ash); dry to moist, some pumice lapilli, homogenous, material consists of in-place, decomposed tuff (Quaternary Volcanoclastic)	0.0	
		10 to 15 degree dipping coarse sand/pumice interbeds at 1.0 and 2.5 feet		
5		Becoming dark brown with large root casts		
		Coarse sand interbed from 8.0 to 10.0 feet		
10		Becoming dark gray with increasing ash component, moist to wet, trace subangular fine gravel		
15				
		No bedrock encountered; bottom of excavation 19.0 feet; test pit backfilled and moderately tamped with backhoe bucket	19.0	
20				



Remarks

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Test Pit -1; Lot 3

Project Number: 72333.000

Client: Creagan Excavating
Project: Development
Location: North of USFS Road 90

Date Started: 9/18/2006
Date Completed: 9/18/2006
Logged By: B. Haug

Contractor: Creagan Excavating
Excavator Type/Size: Hitachi EX 220

Test Pit Location: NORTH SHORT PLAT

Depth Feet	Log	Material Description	Elev. Depth	Samples	Moisture / PL – % Fines – LL (0–50–100)	Remarks
0		Medium dense, gray to red-brown fine to medium SAND (volcanic ash); dry to moist, some pumice lapilli, homogenous, material consists of in-place, decomposed tuff (Quaternary Volcanoclastic)	0.0			
5		6-inch thick coarse sand/pumice interbed				
		Becoming dark gray with increasing ash component at 12.0 feet				
		Becoming wet at 13.0 feet				
15		Scattered charcoal and wood fragments from 15.0 to 16.0 feet				
		No bedrock encountered; bottom of excavation 16.0 feet; test pit backfilled and moderately tamped with backhoe bucket	16.0			
20						

PBS GEOTECH TEST PIT LOG TEST PIT LOG TEST PIT LOGS.GPJ PBS TEST PIT LOG.GDT 3/9/07

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Test Pit -2; Lot 2

Project Number: 72333.000

Client: Creagan Excavating
Project: Development
Location: North of USFS Road 90

Date Started: 9/18/2006
Date Completed: 9/18/2006
Logged By: B. Haug

Contractor: Creagan Excavating
Excavator Type/Size: Hitachi EX 220

Test Pit Location: NORTH SHORT PLAT

Depth Feet	Log	Material Description	Elev. Depth	Samples	Moisture ● PL % Fines LL (0 50 100)	Remarks
0		Variable-consistency, non-engineered FILL; generally consists of loose to medium dense, brown medium to coarse sand with trace to some silt, plant roots and charcoal fragments, damp to moist, contains some lapilli and scattered roots, bark and branches, mainly derived from local tuff (Fill)	0.0			
5		Becoming dark brown with scattered plastic debris				
10		Medium dense, gray to red-brown fine to medium SAND (volcanic ash); dry to moist, some pumice lapilli, homogenous, material consists of in-place, decomposed tuff (Quaternary Volcanoclastic)	9.0			
		Refusal at 11.0 feet at top of bedrock; test pit backfilled and moderately tamped with backhoe bucket	11.0			
15						
20					0 50 100	

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Test Pit -3; Lot 1

Project Number: 72333.000

APPENDIX C – TABLES

PBS

TABLE C1: Soil Classification Criteria and Terminology

Classification of Terms and Content	USC Grain Size		
NAME – MINOR Constituents (12- 50%) MAJOR Constituents (>50%)	Fines		<#200 (.075mm)
Slightly (5-12%)	Sand	Fine	#200 - #40 (.425mm)
Relative Density or Consistency		Medium	#40 - #10 (2.0mm)
Color		Coarse	#10 - #4 (4.75mm)
Moisture Content	Gravel	Fine	#4 - .75 inch
Plasticity		Coarse	.75 inch – 3 inches
Trace Constituents (0-5%)	Cobbles		3 to 12 inches; scattered <15% est., numerous >15% est.
Other: Grain Shape, Approximate Gradation, Organics, Cement, Structure, Odor…			
Geologic Name or Formation: (Fill, Willamette Silt, Till, Alluvium…)	Boulders		>12 inches

Relative Density or Relative Consistency (after Terzaghi and Peck, 1967)

Granular Materials		Fine-Grained (cohesive) Materials				
SPT Blows/ft	Relative Density	SPT Blows/ft	Relative Consistency	Torvane (tsf) Shear Strength	Pocket Pen. (tsf) Unconfin ed	Manual Penetration Test
0-4	Very Loose	<2	Very Soft	<0.13	<0.25	Easy several inches by fist
4-10	Loose	2 – 4	Soft	0.13 – 0.25	0.25 – 0.50	Easy several inches by thumb
10-30	Medium Dense	4 – 8	Medium Stiff	0.25 – 0.50	0.50 – 1. 00	Moderate several inches by thumb
30-50	Dense	8 – 15	Stiff	0.50 – 1.00	1.00 – 2.00	Readily indented by thumb
>50	Very Dense	15 – 30	Very Stiff	1.00 – 2.00	2.00 – 4.00	Readily indented by thumbnail
		>30	Hard	>2.00	>4.00	Difficult by thumbnail

Moisture Content

Dry: Absence of moisture, dusty, dry to the touch
Damp: Some moisture but leaves no moisture on hand
Moist: Leaves moisture on hand
Wet: Visible free water, from below water table

Plasticity	Dry Strength	Dilatancy	Toughness
ML Non – Med	None to Low	Slow to Rapid	Low, can't roll
CL Low – Med	Medium to High	None to Slow	Medium
MH Med – High	Low to Medium	None to Slow	Low to Med.
CH Med – High	High to V. High	None	High

Structure

Stratified: Alternating layers of material or color >6mm
Laminated: Alternating layers <6mm thick
Fissured: Breaks along definite fracture planes
Slickensided: Striated, polished, or glossy fracture planes
Blocky: Cohesive soil that can be broken down into small angular lumps Which resist further breakdown
Lenses: Has small pockets of different soils, note thickness
Homogeneous: Same color and appearance throughout

Unified Soil Classification Chart (Visual-Manual Procedure); (Similar to ASTM Designation D2488)

Major Divisions			Group Symbols	Typical Names
Coarse-Grained Soils: More than 50% Retained on No. 200 sieve	Gravels: 50% or more retained on the No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel -sand mixtures, little or no fines
			GP	Poorly graded grav els and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, grav el-sand-clay mixtures
	Sands: more than 50% passing the No. 4 sieve	Clean Sands	SW	Well-graded sands and grav elly sands, little or no fines
			SP	Poorly graded sands and gr avelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils: 50% or more passes No. 200 sieve	Silt and Clays Low Plasticity Fines		ML	Inorganic silts, rock flour, clayey silts
			CL	Inorganic clay of low to medium plasticity , gravelly clays, sandy clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silt and Clays High Plasticity Fines		MH	Inorganic silts, clayey silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils