\Tillamook County

DEPARTMENT OF COMMUNITY DEVELOPMENT
BUILDING, PLANNING & ON-SITE SANITATION SECTIONS

1510 – B Third Street
Tillamook, Oregon 97141
www.tillamook.or.us
Building (503) 842-3407
Planning (503) 842-3408
Sanitation (503) 842-3409
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Toll Free 1(800) 488-8280

Land of Cheese, Trees and Ocean Breeze

Neskowin Coastal Hazard Area Permit #851-21-000130-PLNG: Kircher

NOTICE TO MORTGAGEE, LIENHOLDER, VENDOR OR SELLER:
ORS 215 REQUIRES THAT IF YOU RECEIVE THIS NOTICE,
IT MUST BE PROMPTLY FORWARDED TO THE PURCHASER

NOTICE OF ADMINISTRATIVE REVIEW
Date of Notice: October 22, 2021

Notice is hereby given that the Tillamook County Department of Community Development is considering the following:

#851-21-000130-PLNG: A request for approval of a Neskowin Coastal Hazard Area Permit for the construction of a single-family dwelling on a property located within the Unincorporated Community Boundary of Neskowin, zoned Neskowin Low Density Residential (NeskR-1) and within the Neskowin Coastal Hazards Overlay (Nesk-CH) Zone. The subject property is accessed via Rocky Cove Lane, a private road, and designated as Tax Lot 4400 of Section 35DA in Township 5 South, Range 11 West of the Willamette Meridian, Tillamook County, Oregon.

Notice of the application, a map of the subject area, and the applicable criteria are being mailed to all property owners within 250 feet of the exterior boundaries of the subject parcel for which the application has been made and other appropriate agencies at least 14 days prior to this Department rendering a decision on the request.

Written comments received by the Department of Community Development prior to 4:00p.m. on November 5, 2021, will be considered in rendering a decision. Comments should address the criteria upon which the Department must base its decision. A decision will be rendered no sooner than November 8, 2021.

A copy of the application, along with a map of the request area and the applicable standards/criteria for review are available for inspection on the Tillamook County Department of Community Development website: https://www.co.tillamook.or.us/commdev/landuseapps and is also available for inspection at the Department of Community Development office located at 1510-B Third Street, Tillamook, Oregon, 97141.

If you have any questions about this application, please contact Sarah Absher, CFM, Director at 503-842-3408 x 3317 or by email: sabsher@co.tillamook.or.us.

Sincerely,

Sarah Absher

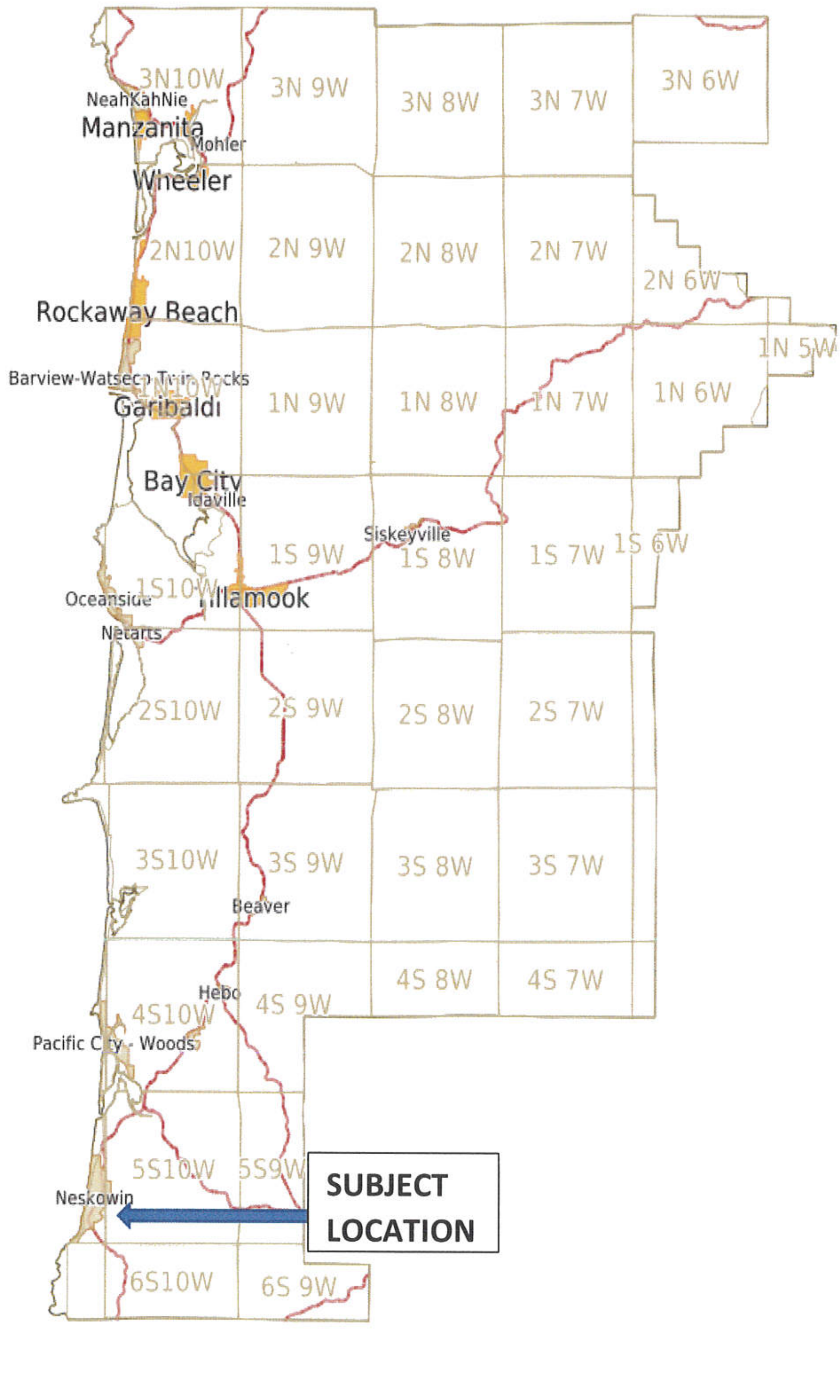
Sarah Absher, CFM, Director

Enc. Applicable Ordinance Standards/Criteria
Maps

TCLUO SECTION 3.570(4)(e): A decision to approve a Neskowin Coastal Hazard Area Permit shall be based upon findings of compliance with the following standards:

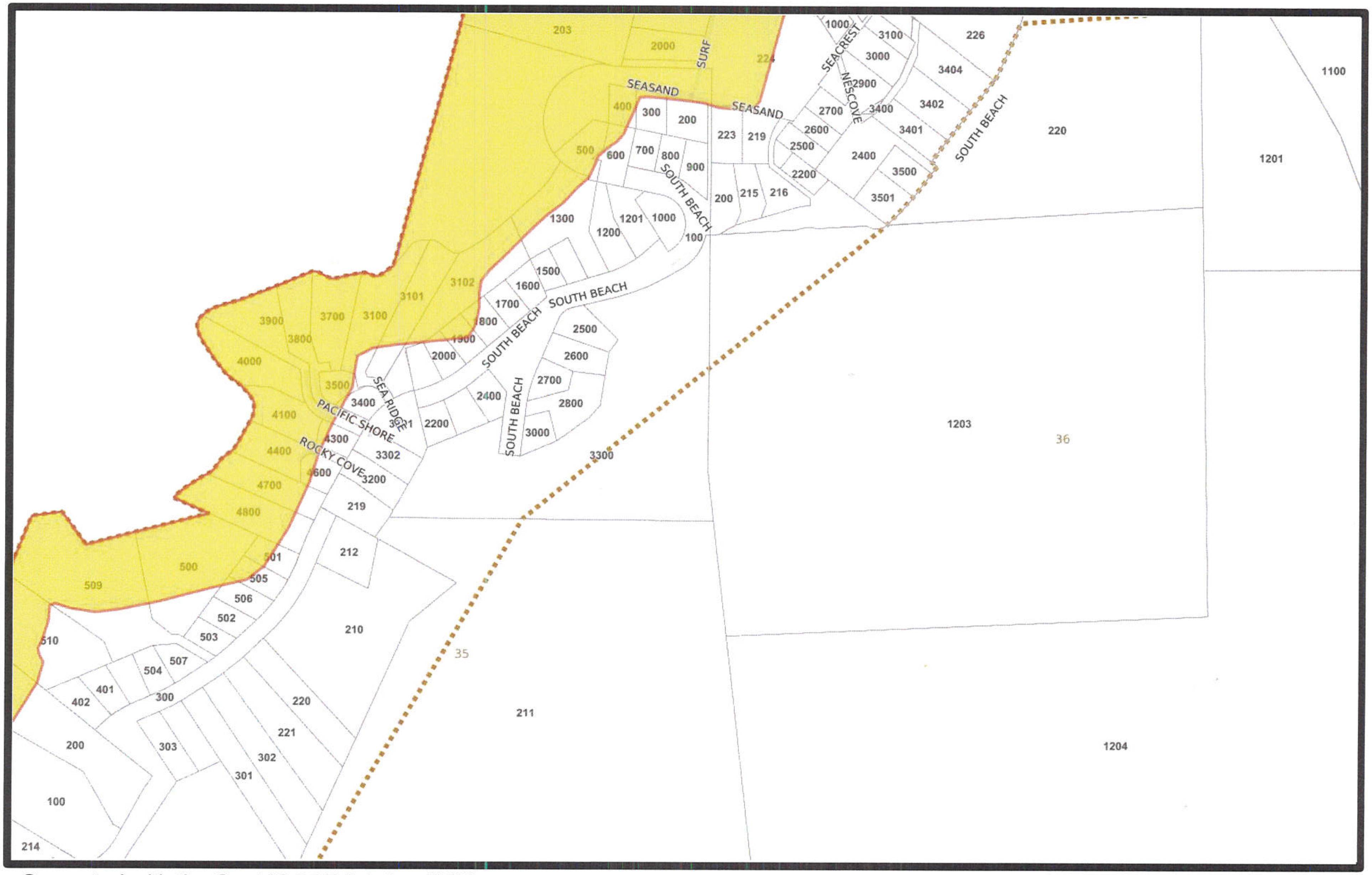
(A) The proposed development is not subject to the prohibition of development on beaches and certain dune forms as set forth in subsection (8) of this section;
(B) The proposed development complies with the applicable requirements and standards of subsections (6), (7), (8), and (10) of this section;
(C) The geologic report conforms to the standards for such reports set forth in subsection (5) of this section;
(D) The development plans for the application conform, or can be made to conform, with all recommendations and specifications contained in the geologic report; and
(E) The geologic report provides a statement that, in the professional opinion of the engineering geologist, the proposed development will be within the acceptable level of risk established by the community, as defined in subsection (5)(c) of this section, considering site conditions and the recommended mitigation.

VICINITY MAP



#851-21-000254-PLNG: TRAN

Map



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BY: ....

Tillamook County Department of Community Development
1510-B Third Street. Tillamook, OR 97141 | Tel: 503-842-3408 Fax: 503-842-1819
www.co.tillamook.or.us

PLANNING APPLICATION

OFFICE USE ONLY	
Date Stamp	
☐Approved	☐Denied
Received by: SS	
Receipt #: 120155	
Fees: 615.00	
Permit No: 851-21-00030-PLNG	

Applicant ☑ *(Check Box if Same as Property Owner)*

Name: Lawrence Kircher Phone: 206-502-5857
Address: PMB 179 2150 S.E. HWY 101
City: Lincoln City State: OR Zip: 97367
Email: coastalcubz54@gmail.com

Property Owner

Name: Phone:
Address:
City: State: Zip:
Email:

Request: NESKOWIN COASTAL HAZARD PERMIT.

Type II	Type III	Type IV
☐ Farm/Forest Review	☐ Extension of Time	☐ Ordinance Amendment
☐ Conditional Use Review	☐ Detailed Hazard Report	☐ Large-Scale Zoning Map Amendment
☐ Variance	☐ Conditional Use (As deemed by Director)	☐ Plan and/or Code Text Amendment
☐ Exception to Resource or Riparian Setback	☐ Ordinance Amendment	
☐ Nonconforming Review (Major or Minor)	☐ Map Amendment	
☐ Development Permit Review for Estuary Development	☐ Goal Exception	
☐ Non-farm dwelling in Farm Zone		
☐ Foredune Grading Permit Review		
☒ Neskowin Coastal Hazards Area		

Location:

Site Address: OR 97149
Map Number: 5S1135DA04400
Township Range Section Tax Lot(s)

Clerk's Instrument #: ____________________

Authorization

This permit application does not assure permit approval. The applicant and/or property owner shall be responsible for obtaining any other necessary federal, state, and local permits. The applicant verifies that the information submitted is complete, accurate, and consistent with other information submitted with this application.

Property Owner Signature (Required) Lawrence S Kircher 4-20-2021
Date

Applicant Signature Lawrence S Kircher 4-20-2021
Date

Chris@halvorsonmason.com

From:	Lawrence Kircher <coastalcubz54@gmail.com>
Sent:	Tuesday, April 20, 2021 10:58 AM
To:	Chris Fairfield
Subject:	Neskowin Parcel# 397752R Site address OR97149 - Hazard Discloser Statement

I Lawrence S Kircher, the legal owner of Neskowin Parcel# 397752R, Tax Lot: 5S1135DA04400, Site address OR 97149 am providing for application of Coastal Hazards Area Permit per section (d) subsection (F) - (i), (ii), and (iii) a Hazard Disclosure Statement to the following:

(i) - I understand that property is subject to potential natural hazards, and by developing parcel# 397752R there is risk of damage from such hazards. Owner fully understands and accepts such risks.

(ii) On December 6th 2017 I received the Geologic report, Project #Y174044 from H.G. Schlicker & Associates, Inc . whom I commissioned to perform a geotechnical investigation for the above subject property. I have reviewed the geologic report with Douglas Gless (principal engineering geologist) and am aware of risks associated with developing this property according to the report.

(iii) As legal property owner I accept and assume risks of damage from hazards associated with the development of Tax Lot 4400, Map 5S-11-35DA Tillamook County, Oregon.

Signed; Lawrence s Kircher

Geologic Hazards and Geotechnical Investigation Report
Tax Lot 4400, Map 5S-11-35DA
Tillamook County, Oregon

Prepared for:
Mr. Lawrence Kircher
249 Seneca Place NW
Renton, Washington 98057

Project #Y174044

December 6, 2017

H.G. Schlicker & Associates, Inc.

H.G. Schlicker & Associates, Inc.
607 Main Street, Suite 200 · Oregon City, Oregon 97045
(503) 655-8113 · FAX (503) 655-8173

Project #Y174044

December 6, 2017

To: **Mr. Lawrence Kircher**
249 Seneca Place NW
Renton, Washington 98057

Subject: **Geologic Hazards and Geotechnical Investigation Report**
Tax Lot 4400, Map 5S-11-35DA
Tillamook County, Oregon

Dear Mr. Kircher:

The accompanying report presents the results of our geologic hazards and geotechnical investigation for the above subject site.

After you have reviewed our report, we would be pleased to discuss the report and to answer any questions you might have.

This opportunity to be of service is sincerely appreciated. If we can be of any further assistance, please contact us.

H.G. SCHLICKER & ASSOCIATES, INC.

J. Douglas Gless, MSc, RG, CEG, LHG
President/Principal Engineering Geologist

JDG:aml

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H.G. Schlicker & Associates, Inc.
607 Main Street, Suite 200 · Oregon City, Oregon 97045
(503) 655-8113 · FAX (503) 655-8173

Project #Y174044 December 6, 2017

To: **Mr. Lawrence Kircher**
249 Seneca Place NW
Renton, Washington 98057

Subject: **Geologic Hazards and Geotechnical Investigation Report**
Tax Lot 4400, Map 5S-11-35DA
Tillamook County, Oregon

Dear Mr. Kircher:

1.0 Introduction

At your request and authorization, representatives of H.G. Schlicker and Associates, Inc. (HGSA) visited the subject site on April 11, June 27 and 30, July 10, August 9 and 16, 2017 to complete a geologic hazards investigation of Tax Lot 4400, Map 5S-11-35DA located in the Neskowin area, Tillamook County, Oregon (Figures 1 and 2; Appendix A). It is our understanding that you would like to construct a single family residential home on the site.

This report addresses the engineering geology and geologic hazards at the site with respect to constructing a home. The scope of our work consisted of site visits, site observations and measurements, subsurface exploration with two drilled borings, laboratory analysis of rock samples from drilled borings, a topographic survey, acquisition and analysis of oblique photographs and an aerial drone video of the bluff face, a slope profile, limited review of the geologic literature, interpretation of topographic maps and lidar, analysis of stereo pair aerial photographs and satellite imagery, and preparation of this report of our findings, conclusions and geotechnical recommendations for home construction.

2.0 Site Description

The subject site lies at an elevation of approximately 225 feet MSL and ¾ mile south of the center of Neskowin in Tillamook County, Oregon. The site consists of an approximately 0.49 acre irregular shaped lot which lies on the west side of a southerly trending ridge with a generally west-facing, steeply sloping oceanfront bluff on the western part of the lot (Figures 1 and 2). The property is bound to its north and east by adjacent improved lots, to its west by the bluff slope and Pacific Ocean, and to its south by an unimproved lot. South Beach Road provides access from the east by way of an asphalt driveway that also provides access to the neighboring property to the north. At the time of our site visits the site was densely vegetated with brush and a few spruce trees (Figure 5; Appendix A).

2.1 The history of the site and surrounding areas, such as previous riprap or dune grading permits, erosion events, exposed trees on the beach, or other relevant local knowledge of the site.

The site is located on a basalt breccia bluff. Riprap placement is not feasible and no dunes are present on the site. No tree stumps were exposed on the beach when we reviewed aerial photographs and video taken on August 16, 2017 (Appendix A). Evidence of minor sloughing along the bluff was observed in aerial photographs, but the timing of these events is uncertain.

2.2 Topography, including elevations and slopes on the property itself.

The site is located at the top of a basalt bluff that is part of the Cascade Head headlands. A topographic survey completed on August 9, 2017 determined the elevation at top of the cliff to be at approximately 190 feet MSL and approximately 220 feet MSL (NAVD 88) at the lower end of the driveway (Figures 4 and 5). The site slopes approximately 30 degrees to the west for approximately 50 to 60 feet from the driveway to the bluff edge at which point the slope increases to 60 to 75 degrees to the west. Additional observations are addressed and illustrated in Section 3.3, Figures 3, 4, 5, and Appendix A of this report.

2.3 Vegetation cover.

The site is densely vegetated with brush and at least 5 spruce trees along the slope (Figure 5 and Appendix A).

2.4 Subsurface materials – the nature of the rocks and soils.

Subsurface exploration was completed by advancing two wireline core barrel drilled borings to depths of up to 41.5 feet below ground surface. The borings generally encountered clayey, sandy, gravely soils to depths of approximately 7 feet below ground surface (bgs) overlying hard, well-cemented, fresh to relatively fresh basaltic brecciated flows to the final depth of the borings. Subsurface materials are discussed in detail in Section 4.0 and Appendix B.

2.5 Conditions of the seaward front of the property, particularly for sites having a sea cliff.

The seaward front of the property is a hard basalt breccia bluff. The bluff face is unvegetated in the swash zone and aerial imagery shows that the basalt breccia is fractured and variably weathered. The bluff face below the site appears to be more resistant to wave attack than immediately north where waves are undercutting the bluff face, and to the south where undercutting presumably caused a bluff failure at an unknown time in the past. The rock at the subject lot is a large block of much harder rock than adjacent sites. Additional observations are addressed and illustrated in Sections 3.3 and 3.5, and Appendix A

2.6 Presence of drift logs or other flotsam on or within the property.

No drift logs or flotsam were observed in aerial imagery of the property or on the small pocket beach immediately south of the site (Appendix A).

2.7 Description of streams or other drainage that might influence erosion or locally reduce the level of the beach.

We did not observe streams or springs at the time of our site visits. The nearest stream is approximately 500 feet to the east on the other side of the ridge. This stream flows to the north and joins Neskowin Creek approximately 3500 feet to the northeast (Figure 1). A catch basin near the end of the driveway discharges on to the subject lot at an elevation of 210 feet (Figure 5)

2.8 Proximity of nearby headlands that might block the long shore movement of beach sediments, thereby affecting the level of the beach in front of the property.

The site is located on a bluff that is part of the Cascade Head headlands. The pocket beach below the site is generally a rocky beach; however, satellite imagery taken in July 2014 and available on Google Earth indicates that sand deposition at the base of the bluff occasionally occurs. Additional observations are illustrated in Figure 1, and Appendix A.

2.9 Description of any shore protection structures that may exist on the property or on nearby properties.

No shoreline protective structures exist at the base of the bluff fronting the site or nearby sites. The closest shoreline protective structures are riprap revetments located approximately 1000 feet to the north along the north end of the ridge and south of Proposal Rock.

2.10 Presence of pathways or stairs from the property to the beach.

None present at this site. The closest access to the beach is located approximately 1500 feet to the north at the private beach access for Neskowin Height residents.

2.11 Existing human impacts on the site, particularly any that might alter the resistance to wave attack.

Human impacts are not contributing to alteration of the resistance of the bluff face to wave attack at this site.

3.0 Description of the Fronting Beach

The fronting beach lies at the base of a bluff within a small cove at the northern end of the Cascade Head headlands. The beach is generally a rocky beach that is exposed during lower tides, but historic satellite imagery shows that sand deposition can occur within the cove and extend the width of the beach seaward.

3.1 Average widths of the beach during the summer and winter.

Satellite imagery indicates the beach at the site has a variable width which is primarily dependent upon tide levels; it tends to be more narrow in the winter than in the summer. Although the beach can be more than 100 feet wide, at high tide there is often no walkable beach. Images of the fronting beach are presented in Appendix A.

3.2 Median grain size of beach sediment.

We were not able to access the fronting beach during our site visits, however aerial photographs taken by a drone on August 16, 2017 indicate that the beach consisted of cobbles and boulders at that time. Images of the fronting beach are presented in Appendix A.

3.3 Average beach slopes during the summer and winter.

Access to the beach was not possible during our site visits. Nearby beaches tend to slope from approximately 2 to 5 degrees depending upon recent accretion or erosion of sand. This beach is likely steeper.

3.4 Elevations above mean sea level of the beach at the seaward edge of the property during summer and winter.

The elevation of the beach at the seaward edge of the property is presumed to vary seasonally between 0 and 7 feet MSL depending on sand accretion or erosion.

3.5 Presence of rip currents and rip embayments that can locally reduce the elevation of the fronting beach.

At the time of our site visits and in review of satellite photos we did not observe any rip currents or rip current embayments that could reduce the elevation of the fronting beach.

3.6 Presence of rock outcrops and sea stacks, both offshore and within the beach zone.

The site is located at the northern end of the Cascade Head headlands atop a hard basalt breccia bluff (Figure 1 and Appendix A). Rock outcrops exist at the site, for approximately 0.2 miles north of the site and approximately 3.2 miles south of the site. Proposal rock is located approximately 0.5 miles north of the site. The beach at the site is cut into hard rock with a seasonal veneer of sand.

3.7 Information regarding the depth of beach sand down to bedrock at the seaward edge of the property.

We observed no sand on the beach in aerial photographs taken August 16, 2017 at the seaward edge of the property (Appendix A). A thin veneer of sand can develop as seen in some of the aerial photography. We estimate that the beach sand rarely, if ever, exceeds a depth of 7 feet.

4.0 Geologic Hazards Analysis

Our geologic hazards analysis is presented below.

4.1 Subsurface Materials

The site lies in an area which has been mapped as undifferentiated Eocene volcanic rocks (Schlicker et al., 1972). These volcanics generally consist of up to several thousand feet of chloritized basalt flows and basalt breccias, and are characterized by wide variability in type and strength. Snavely et al. (1996) mapped these materials as Basalt of Cascade Head. In the Cascade Head area these rocks display widespread red baked zones and scoriaceous upper flow surfaces that are indicative of a subaerial origin (Schlicker et al., 1972). Exposed rock in the cut slopes at the subject site is severely fractured, weathered and altered basaltic breccia exhibiting various colors (Appendix A).

At the time of our June 30 and July 10, 2017 site visits we explored subsurface conditions by advancing two drilled borings to depths of up to 41.5 feet below the ground surface (bgs). Drilling was accomplished using a CME 75 drill rig with the rotary wash method using a tri-cone bit for the first approximately 10 feet and diamond drilling with an HQ core to approximately 41.5 feet. Sampling was completed by obtaining and observing cuttings brought up in the drilling fluid (bentonite mud), Standard Penetration Tests (SPTs) and wireline methods of rock core sampling. Samples and cuttings were visually classified in the field by a geologist from our office according to the Unified Soil Classification System (USCS) and U.S. Bureau of Reclamation (USBR, 2001) standards for Rock. Additionally, core samples were tested for compressive strength (see Section 4.1.2). Approximate locations of the borings are shown on Figures 2, 3, 4 and 5.

Boring B-1 was drilled to a depth of 16.5 feet and boring B-2 was drilled to a depth of 41.5 feet. The borings generally encountered clayey, sandy, gravely soils to depths of approximately 7 feet bgs overlying hard, well-cemented, fresh to relatively fresh basaltic brecciated flows to the final depth of the borings.

4.1.1 Rock Quality Designation and Rock Mass Quality

The Rock Quality Designation (RQD) and Rock Mass Quality (RMQ) values range from 60% to 100%, moderately weathered to fresh rock, from depths of approximately 10 to 31.5 feet bgs. From approximately 31.5 to 41.5 feet the RQD and RMQ values range from 23% to 51%, completely weathered rock to moderately weathered rock. RQD and RMQ values for each of the boring core runs are provided in Appendix B.

4.1.2 Unconfined Compressive Strength

Two rock core samples were submitted for unconfined compressive strength analysis. Rock core from boring B-1 sampled at a depth of 11.5 feet bgs had an uniaxial compressive strength of 3,571 psi. Rock core from boring B-2 sampled at a depth of 27.5 feet bgs had an uniaxial compressive strength of 10,474 psi. these strengths are comparable to high strength concrete and better. The laboratory technical reports for the unconfined compressive strength analysis are in Appendix C.

4.2 Structure

Structural deformation and faulting along the Oregon Coast is dominated by the Cascadia Subduction zone (CSZ) which is a convergent plate boundary extending for approximately 680 miles from northern Vancouver Island to northern California. This convergent plate boundary is defined by the subduction of the Juan de Fuca plate beneath the North America Plate, and forms an offshore north-south trench approximately 60 miles west of the Oregon coast shoreline. A resulting deformation front consisting of north-south oriented reverse faults is present along the western edge of an accretionary wedge east of the trench, and a zone of margin-oblique folding and faulting extends from the trench to the Oregon Coast (Geomatrix, 1995).

An east-west trending normal fault has been mapped approximately ¼ mile north of the site (Snavely et al., 1996). Based on mapping this fault is approximately ½ mile long, cuts Tertiary rock units with no indications of recent movement, and intersects with a longer, northwest trending normal fault approximately 0.6 miles east-northeast of the site along Neskowin Creek.

4.3 Slopes

The site is located along a westerly trending oceanfront bluff slope which is approximately 30 degrees steep in the proposed building area and rapidly becomes much steeper, 60 to 75 degrees, down slope to the west.

4.4 Orientation of Bedding Planes in Relation to the Dip of the Surface Slope

Determination of bedding plane orientations in the Eocene volcanic and sedimentary rocks which underlie the site is difficult due to the fractured/brecciated nature of the rock units, lack of good exposures, and deformation. Mapping completed by Schlicker et al. (1972) indicates that Eocene volcanic rocks in the area of Cascade Head generally dip down toward the north-northeast from 5 to 45 degrees. This generally corresponds with the orientation and downward slope of the ridge crest. Bedding orientations in basalt breccia exposed in a road cut southeast of the site generally dip toward the northeast from 25 to 35 degrees. Mapping by Snavely et al. (1996) indicates that bedding attitudes are highly variable. The side slopes of the ridge were formed primarily by stream downcutting to the southeast and by ocean wave erosion to the northwest; formation of the ridge side slopes therefore does not appear to be strongly correlated to the dip of the underlying bedrock units. Based on our observations and review of aerial imagery, very steep fractures, and possibly faults, within the basaltic rock appear to influence the pattern of bluff retreat in the site area.

4.5 Site Surface Water Drainage Patterns

Storm water at the site generally flows towards the west and down the bluff. A stormwater catch basin is located at the southeast corner of the asphalt driveway. Stormwater collected by the catch basin is discharged to the slope to the west (Appendix A). Stormwater collection methods and discharge locations for the property located upslope to the east are unknown, but likely discharge to South Beach Road and the driveway accessing the subject lot. This catch basin discharges at an elevation of 210 feet on the subject lot.

4.6 Slope Stability and Erosion

As discussed above, the site is located on a steep oceanfront bluff. The steeply sloping bluff formed as the result of erosion and landsliding caused by continuous exposure to wind, rain and ocean wave activity. Based on our review of aerial photography, progressive failure has been occurring approximately 50 feet to the south of the site but the timing and frequency of these failures is unknown. These failures appeared to have failed back and upslope a few feet at a time as they are limited by the underlying hard rock, and have also gradually increased the overall width of the bluff landslide area. We did not observe any evidence of recent movement of the upper bluff slope at the site, however shallow debris slides west of the proposed building have likely occurred in the past.

Continued recession of the bluff is anticipated, and future landslides that fail back up to a few or more feet at a time can occur along the bluff. Large landslides can also occur, particularly along weak fracture zones that may be present within the rock units. Predicting the size of future failures along the bluff is difficult, and cannot be fully quantified even with extensive subsurface exploration, testing and modeling. However, the rate of bluff recession here has not been nearly as rapid as other sites nearby because of the very hard rock underlying this lot.

Mapping by Allen and Priest (2001) identifies the upper bluff slope within the High Hazard Zone and the lower bluff slope of the site lies within the Active Erosion Hazard Zone. Coastal erosion hazard zone definitions and methodology are provided below.

The methodology provided by Allan and Priest (2001) defines four coastal erosion hazard zones for bluffs of Tillamook County, Oregon as follows:

"*Four bluff erosion hazard zones will be specified on the Tillamook County coastline:*

> *1. <u>Active Erosion Hazard Zone:</u> Currently active erosion area (rapid soil creep on steep bluff or headwall slopes plus active or potentially active landslides).*
>
> *2. <u>High Hazard Zone:</u> High probability that the area could be affected by active erosion in the next ~60-100 years. This zone boundary will, in effect, be the minimum distance that the bluff top (or landslide headwall) might retreat in the next 60-100 years.*
>
> *3. <u>Moderate Hazard Zone:</u> Moderate probability that the area could be affected by active erosion in the next ~100 years. This zone boundary will, in effect, be the mean distance that the bluff top (or landslide headwall) is likely to retreat in the next 60-100 years. In general this distance was approximately halfway between the high and low hazard zones.*
>
> *c. <u>Low Hazard Zone:</u> Low but significant probability that the area could be affected by active erosion in the next ~60-100 years. This includes; bluff tops that may retreat by maximum block failure at the end of an interval of gradual*

erosion, including some sub-aerial erosion, slope failures induced by Cascadia subduction zone earthquakes, or unusually high groundwater conditions. This zone boundary will, in effect, be the maximum distance that the bluff top (or landslide headwall) is likely to retreat in the next 60-100 years." (Allan and Priest, 2001).

It should be noted that mapping done for the 2001 study was intended for regional planning use, not for site specific hazard identification.

The site is also mapped in an area of high landslide susceptibility, based on the DOGAMI methodology (Burns, Mickelson, and Madin, 2016).

4.7 Regional Seismic Hazards

Abundant evidence indicates that a series of geologically recent large earthquakes related to the Cascadia Subduction Zone have occurred along the coastline of the Pacific Northwest. Evidence suggests that more than 40 great earthquakes of magnitude 8 and larger have struck western Oregon during the last 10,000 years. The calculated odds that a Cascadia earthquake will occur in the next 50 years range from 7–15 percent for a great earthquake affecting the entire Pacific Northwest, to about a 37 percent chance that the southern end of the Cascadia Subduction Zone will produce a major earthquake in the next 50 years (OSSPAC, 2013; OSU News and Research Communications, 2010; Goldfinger et al., 2012). Evidence suggests the last major earthquake occurred on January 26, 1700 and may have been of magnitude 8.9 to 9.0 (Clague et al., 2000).

There is now increasing recognition that great earthquakes do not necessarily result in a complete rupture along the full 1,200 km fault length of the Cascadia subduction zone. Evidence in the paleorecords indicates that partial ruptures of the plate boundary have occurred due to smaller earthquakes with moment magnitudes (Mw) < 9 (Witter et al., 2003; Kelsey et al., 2005). These partial segment ruptures appear to occur more frequently on the southern Oregon coast, as determined from paleotsunami studies. Furthermore, the records have documented that local tsunamis from Cascadia earthquakes recur in clusters (~250–400 years) followed by gaps of 700–1,300 years, with the higher tunamis associated with earthquakes occurring at the beginning and end of a cluster (Allan et al., 2015).

These major earthquake events were accompanied by widespread subsidence of a few centimeters to 1–2 meters (Leonard et al., 2004). Tsunamis appear to have been associated with many of these earthquakes. In addition, settlement, liquefaction and landsliding of some earth materials are believed to have been commonly associated with these seismic events.

Other earthquakes related to shallow crustal movements or earthquakes related to the Juan de Fuca plate have the potential to generate magnitude 6.0 to 7.5 earthquakes.

The recurrence interval for these types of earthquakes is difficult to determine from present data, but estimates of 100 to 200 years have been given in the literature (Rogers et al., 1996).

The nearest mapped potentially active fault is the Netarts Bay fault which lies at the north end of Netarts Bay, approximately 21 miles north of the site (Geomatrix, 1995). This fault is a west-northwest trending, high angle reverse fault which cuts Miocene basaltic and Pleistocene channel deposits. This fault is believed to have been active approximately 125,000 years ago, however it does not appear to cut 80,000 year old marine terrace deposits which suggests that the fault has not been active for at least 80,000 years (Geomatrix, 1995).

4.8 Flooding Hazards

Based on the 1978 Flood Insurance Rate Map (FIRM, Panel #4101960380A) the site lies in an area rated as Zone C which is defined as an area of minimal flooding. Saturated surface soil conditions can be expected at the site, particularly during wetter times of the year.

Based on the Oregon Department of Geology and Mineral Industries mapping (DOGAMI, 2012) the subject lot at lower elevations lies within the tsunami inundation zone resulting from an approximately 9.1 and greater magnitude Cascadia Subduction Zone (CSZ) earthquake. However, the proposed building site lies well above the tsunami inundation zone. The 2012 DOGAMI mapping is based upon 5 computer modeled scenarios for shoreline tsunami inundation caused by potential CSZ earthquake events ranging in magnitude from approximately 8.7 to 9.1. The January 1700 earthquake event (discussed in Section 5.0 above) has been rated as an approximate 8.9 magnitude in DOGAMI's methodology. More distant earthquakes can also generate tsunamis.

4.9 Climate Change

According to most of the recent scientific studies, the Earth's climate is believed to be changing as the result of human activities which are altering the chemical composition of the atmosphere through the buildup of greenhouse gases, primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons (EPA, 1998). Although there are uncertainties about exactly how and when the Earth's climate will respond to enhanced concentrations of greenhouse gases, scientific observations indicate that detectable changes are under way (EPA, 1998; Church and White, 2006). Global sea level rise, caused by melting polar ice caps and ocean thermal expansion, could lead to flooding of low-lying coastal property, loss of coastal wetlands, erosion of beaches and bluffs, and saltwater contamination of drinking water. Global climate change and the resultant sea level rise will likely impact the subject site through accelerated coastal erosion and more frequent and severe flooding. It can also lead to increased rainfall which can result in an increase in landslide occurrence.

4.10 Analyses of Erosion and Flooding Potential

4.10.1 Analysis of DOGAMI beach monitoring data available for the site (if available).

DOGAMI beach monitoring data is unavailable for this stretch of the beach.

4.10.2 Analysis of human activities affecting shoreline erosion.

We did not observe any human activities along the bluff that are affecting the shoreline erosion. See Section 2.11 above.

4.10.3 Analysis of possible mass wasting, including weathering processes, landsliding or slumping.

The site is located on the top of a basalt bluff that is part of a small cove along this stretch of the beach. Minor sloughing is evident in aerial photographs captured on August 16, 2017 towards the western edge of the site where the slope is steeper however we are unable to determine when this may have occurred.

A small rocky pocket beach within the cove has also formed approximately 50 feet to the south of the site that also shows evidence of sloughing at the top of the bluff. Materials in the bluff at that location are much weaker than the hard rock composing the bluff at the subject site.

Aerial video acquired on August 16, 2017 shows minor undercutting of the bluff just to the north of the base of the site. It appears that the undercutting has begun eroding sea caves in weaker material at the base of the bluff north of the site. Aerial imagery presented in Appendix A.

4.10.4 Calculation of wave run-up beyond mean water elevation that might result in erosion of the sea cliff or foredune.

As a very high bluff-backed site, wave run-up is restricted to the base of the bluff approximately 180 feet below the site. Aerial photographs of the bluff and beach are presented in Appendix A.

4.10.5 Evaluation of frequency that erosion-inducing processes could occur, considering the most extreme potential conditions of unusually high water levels together with severe storm wave energy.

On this stretch of bluff-backed shoreline erosion inducing processes are daily in the form of constant wave attack at the base of the bluff at high tide (Appendix A).

4.10.6 For dune-backed shoreline, use an established geometric model to assess the potential distance of property erosion, and compare the results with direct evidence obtained during site visit, aerial photo analysis, or analysis of DOGAMI beach monitoring data.

Not applicable to the site which is in a bluff-backed shoreline area.

4.10.7 For bluff-backed shoreline, use a combination of published reports, such as DOGAMI bluff and dune hazard risk zone studies, aerial photo analysis, and field work, to assess the potential distance of property erosion.

No published reports are available from DOGAMI with erosion rates for this stretch of bluff-backed shoreline. Review of aerial stereo-pair photographs from 1971, 1984, 1991, 1994 and 1998 did not indicate any measurable recession of the bluff.

Observations made during our site visits and analysis of the rock cores obtained during subsurface exploration indicate that the bluff at this site consists of hard basalt that is very resistant to erosion.

Additional observations are addressed in Sections 3.1, 3.4, 3.6, 4.2 and Appendices A, B and C.

4.10.8 Description of potential for sea level rise, estimated for local area by combining local tectonic subsidence or uplift with global rates of predicted sea level rise.

Based on data from NOAA monitoring stations at South Beach and Garibaldi this general area of Oregon's coastline has a sea level rise of approximately 2 mm/year, which includes the combined effects of global rates of sea level rise and land mass elevation changes (NOAA Tides & Currents Sea Level Trends http://tidesandcurrents.noaa.gov/sltrends/sltrends.html). Additional observations are addressed in Sections 3.9 (Climate Change) of this report.

4.11 Assessment of Potential Reactions to Erosion episodes.

4.11.1 Determination of legal restrictions of shoreline protective structures (Goal 18 prohibition, local conditional use requirements, priority for non-structural erosion control methods).

The site is not eligible for oceanfront protection under Goal 18.

4.11.2 Assessment of potential reactions to erosion events, addressing the need for future erosion control measures, building relocation, or building foundation and utility repairs.

Residential development recommendations including erosion control and foundation design recommendations are presented in Section 5, which note the need for deep foundations at the site. There will be insufficient available area to relocate the house on site due to required oceanfront setbacks. Moving the house off site may be possible because the depth of the house may be less than typical. The potential to move the house will be dependent upon design.

5.0 Conclusions and Recommendations

The main engineering geologic concerns at the site are:

1. The site lies adjacent to a steep, high oceanfront bluff slope which has formed from ocean wave, wind and rain erosion, sloughing and landsliding.

2. There is an inherent regional risk of earthquakes and associated tsunamis along the Oregon Coast which could cause harm and damage structures. These risks must be accepted by the owner, future owners and residents of the site.

Please note, the Oregon Coast is a dynamic and energetic environment. Most of the coastline along this bluff is slowly receding and will continue to recede in the future. Geologic conditions and the rates of geologic processes can change in the future. The setback recommendations presented in this report are based on past average erosion rates as determined from aerial photography, and past and current geologic conditions and processes. These setbacks are intended to protect the structure(s) for their typical life (50 to 70 years). Setbacks greater than our recommended minimum setbacks would provide the proposed structure(s) with a greater anticipated life and a lower risk from some geologic hazards. However, the area available for construction is already very limited.

5.1 Development Density

It is our understanding that only one single family residence will be located at the site.

5.2 Bluff Setback

The very steep nature of the bluff slope dictates a conservative setback for proposed construction, even though the slope is underlain by hard basaltic breccia rock. Although the bluff edge does not appear to have experienced any recession as observed in the aerial photo review, the upper slope west of the line labeled "Bluff Edge" on Figures 4 and 5 is an unstable soil slope which is prone to thin debris slides, as can be seen from the shallow, vegetated old debris slide scars along this slope. As a result, we recommend a 20 feet setback from the top of bluff along with the deep foundations recommendations below. In addition, the Neskowin Coastal Hazards Overlay Zone's regulatory requirements mandate a 20 feet setback from the bluff edge. According to Tillamook County Land Use Ordinance Article 3.500, Section 3.570(7)(b), "the required yard setback opposite the oceanfront may be reduced by one foot for each one foot of oceanfront setback provided beyond the minimum, down to a minimum of 10 feet."

We do not believe that shallow foundations are suitable for use at the site. The use of deep foundations may allow for cantilevering of the home beyond the western foundation line to provide for a larger home and improve views. Deep foundations will also provide protection from undermining of foundations in the event of a relatively shallow slope failure encroaching into the foundation area.

5.3 Grading Practices

We recommend the following grading practices:

5.3.1 Site Preparation

All loose, soft and organic-rich soils, and existing fills downslope of the driveway should be stripped from building, slab and driveway areas prior to construction.

We anticipate that native weathered rock will be encountered at approximately 5 feet, however depths may vary. Equipment capable of excavating through rock materials may be required depending on final design.

5.3.2 Cut and Fill Slopes

Temporary unsupported cut slopes less than 8 feet high should be no steeper than 1 horizontal to 1 vertical (1H:1V). All cuts greater than 8 feet high should be approved by a representative of our firm. All permanent cut and fill slopes should be no steeper than 2 horizontal to 1 vertical (2H:1V), or as approved by a representative of our firm.

TEMPORARY AND PERMANENT CUTS	
Temporary Cuts	1H:1V (maximum) [a]
Permanent Cuts	2H:1V (maximum) [a]
[a] All cuts greater than 8 feet high, or cuts where water seepage is encountered, should be approved by a representative of H.G. Schlicker & Associates, Inc.	

If the above cut and fill slope recommendations cannot be achieved due to construction and/or property line constraints, temporary or permanent retention of cut slopes may be required, as determined by a representative of our firm.

5.3.3 Structural Fill

Structural fills supporting building loads should consist of granular material, free of organics and deleterious materials, and contain no particles greater than 1½ inches in diameter so that nuclear methods (ASTM D2922 &ASTM D3017) can be easily used for field density testing. All areas to receive fill should be stripped of all organic soils, organic debris and existing fill.

Proper test frequency and earthwork documentation usually requires daily observation during stripping, rough grading, and placement of structural fill. Field density testing should generally conform to ASTM D2922 and D3017, or D1556. To minimize the number of field and laboratory tests, fill materials should be from a single source and of a consistent character. Structural fill should be approved and periodically observed by HGSA and tested by a qualified testing firm. Test results will need to be reviewed and approved by HGSA. We recommend that one density test be performed for at least every 18 inches of fill placed and every 200 cubic yards, whichever requires more testing. Because testing is performed on an on-call basis, we recommend that the earthwork contractor schedule the testing. Relatively more testing is typically necessary on smaller projects.

STRUCTURAL FILL	
Compaction Requirements	92% ASTM D1557, compacted in 8 inch lifts maximum, at or near the optimum moisture content (± 2%).
Benching Requirements [a]	Slopes steeper than 5H:1V that are to receive fill should be benched. Fills should not be placed along slopes steeper than 3H:1V, unless approved by H.G. Schlicker & Associates, Inc.
[a] Benches should be cut into native, non-organic, firm soils. Benches should be a minimum of 6 feet wide with side cuts no steeper than 1H:1V and no higher than 6 feet. The lowest bench should be keyed in a minimum of 2 feet into native, non-organic, firm soils.	

5.4 Vegetation Removal and Re-Vegetation Practices

Vegetation should be removed only as necessary and exposed areas should be replanted following construction. Disturbed ground surfaces exposed during the wet season (November 1 through April 30) should be temporarily planted with grasses, or protected with erosion control blankets or hydromulch. Existing vegetation should be left undisturbed as much as possible.

Temporary sediment fences should be installed downslope of any disturbed areas of the site until permanent vegetation cover can be established. See Figure 6 for design criteria for the construction of a sediment fence.

Exposed sloping areas steeper than 3 horizontal to 1 vertical (3H:1V) should be hydroseeded to provide erosion protection until permanent vegetation can be established. Erosion control blankets should be installed as per the manufacturer's recommendations.

5.5 Foundation Recommendations

Foundations will need to support vertical loads and provide lateral support in the event of the slope encroaching into the western and north-northwestern foundation area.

Foundations will also need to resist uplift forces, particularly for any cantilever type house design. Deep foundation elements at the site should be drilled and grouted in place. We recommend the use of bored and grouted micropile, bored and grouted H-pile (HP) sections or wide flange (WF) sections. The advantage of micropile is that smaller size equipment can complete the work. The advantage of bored and grouted HP or WF sections is that they would provide greater lateral resistance in the event of slope encroachment, and allow for greater on-center spacing. The disadvantage of all but micropile is the larger equipment needed to operate in the relatively small area of the subject lot.

Pile should be embedded a minimum of 40 feet deep into rock. The home can be placed either on grade beams supported by pile, or on elevated beams supported on the pile. Beams should be oriented so that they generally tie the western pile to eastern pile. Pile spacing can vary with type of pile utilized, and HGSA should work with the structural engineer and architect to determine a suitable spacing for the type(s) of pile selected. Prior to construction the contractor should provide a work plan for HGSA's review.

We provide the following allowable pile loads based on grout-to-ground bond strengths at various drilled hole diameters for 40 feet length gravity grouted pile:

GRAVITY GROUTED PILE ALLOWABLE LOADS[b]			
Pile (Drilled Hole) Diameter	6 inches	8 inches	12 inches
Allowable Pile Loads (Compression) (FOS = 3)[a]	301 kips	401 kips	603 kips
Allowable Pile Loads (Tension) (FOS = 3)[a]	196 kips	262 kips	394 kips
[a] A representative of HGSA should observe pile installation operations and verify achieved embedment depths on-site. Please provide us with at least five (5) days notice prior to any needed site observations. [b] An increase of one-third is allowed for short term wind and seismic loads.			

Pile utilizing the above recommended bond strengths will have negligible settlement. A representative of HGSA should observe all pile construction and installation operations to ensure that suitable materials have been encountered and address any issues that may arise during construction (Appendix D).

Any structures and all structural elements should be designed to meet current Oregon Residential Specialty Code (ORSC) seismic requirements, as specified in Section 4.11 of our June 18, 2015 report for the site (HGSA #Y153828); and meet Oregon Structural

Specialty Codes (OSSC) for all foundation elements not covered by residential code.

5.6 Retaining Wall Recommendations

For static conditions free standing retaining walls should be designed for a lateral static active earth pressure expressed as an equivalent fluid density (EFD) of 35 pounds per cubic foot, assuming level backfill behind the wall equal to a distance of at least half the height of the wall. An EFD of 45 pounds per cubic foot should be used assuming sloping backfill of 2H:1V.

At rest retaining walls should be designed for a lateral static at-rest pressure expressed as an EFD of 60 pounds per cubic foot, assuming level backfill behind the wall equal to a distance of at least half of the height of the wall. Walls need to be fully drained to prevent the build-up of hydrostatic pressures.

The above EFDs assume static conditions, and no surcharge loads from vehicles or structures. If surcharge loads will be applied to the retaining walls, forces on the walls resulting from these loads will need to be added to the pressures given above.

For seismic loading a unit pseudostatic force equal to 11.97 pcf $(H)^2$; where H is the height of the wall in feet, should be added to the static lateral earth pressure. The location of the pseudostatic force can be assumed to act at a distance of 0.6H above the base of the wall.

Backfill for walls should be placed in 8 inch horizontal lifts and machine compacted to 92 percent of the maximum dry density as determined by ASTM D1557. Compaction within 2 feet of the wall should be accomplished with light weight hand operated compaction equipment to avoid applying additional lateral pressure on the walls. Drainage of the retaining wall should consist of slotted drains placed at the base of the wall on the backfilled side and backfilled with free-draining crushed rock (less than 5% passing the 200 mesh sieve using a washed sieve method) protected by non-woven filter fabric (Mirafi 140N or equivalent) placed between the native soil and the backfill.

RETAINING WALL EARTH PRESSURE PARAMETERS	
Static Case, Active Wall (level backfill/grades)	35 psf/linear foot [a]
Static Case, Active Wall (2H:1V backfill/grades)	45 psf/linear foot [a]
Static Case, At-Rest Wall (level backfill/grades)	60 psf/linear foot [a]
Seismic Loading (level backfill/grades)	11.97 pcf $(H)^2$ [b]
[a] Earth pressure expressed as an equivalent fluid pressure (EFD). The location of the earth pressure can be assumed to act at a distance of 0.33H above the base of the wall. [b] Seismic loading expressed as a pseudostatic force, where H is the height of the wall in feet. The location of the pseudostatic force can be assumed to act at a distance of 0.6H above the base of the wall.	

Filter fabric protected free-draining crushed rock should extend to within 2 feet of the ground surface behind the wall, and the filter fabric should be overlapped at the top per the manufacturer's recommendations. All walls should be fully drained to prevent the build-up of hydrostatic pressures. All retaining walls should have a minimum of 2 feet of embedment at the toe, or be designed without passive resistance.

5.7 Drainage and Storm Water Management

Surface water should be diverted from building foundations to approved disposal points by grading the ground surface to slope away from the foundation to prevent ponding near the structures. Footing drains should be installed adjacent to the perimeter footings and sloped to drain.

In addition to the perimeter foundation drain system, drainage of any crawlspace areas is recommended. Each crawlspace should be graded to a low point for installation of a crawlspace drain that is tied into the perimeter footing drain and tightlined to an approved disposal point. It may be possible to omit footing and crawlspace drains depending upon house design.

All roof drains should be collected and tight-lined in a separate system independent of the footing drains. All roof and footing drains should be tight-lined and discharged, in separate systems or with an approved backflow prevention device, to an approved disposal point such as hard rock on the bluff or a rock apron near the bluff edge. Water collected on the site should not be concentrated and discharged to adjacent properties.

The catch basin stormwater outflow at the site currently discharges to an area near the proposed house footprint. This discharge point should be moved further downslope away from the house.

5.8 Erosion Control

As detailed above (Section 4.4), vegetation should be removed only as necessary and exposed areas should be replanted following construction. Disturbed ground surfaces exposed during the wet season (November 1 through April 30) should be temporarily planted with grasses, or protected with erosion control blankets.

A temporary sediment fence should be installed downslope of any disturbed areas of the site until permanent vegetation cover can be established. See Figure 6 for design criteria for the construction of a sediment fence.

As recommended above, exposed sloping areas steeper than 3 horizontal to 1 vertical (3H:1V) should be protected by hydroseeding or the use of rolled erosion control products (RECP's) aka "erosion control blankets", to provide erosion protection until permanent vegetation can be established. Erosion control blankets should be installed as per the manufacturer's recommendations.

5.9 Flooding Considerations

Provided that all drainage recommendations detailed in this report are adhered to during design and construction, we do not anticipate flooding hazards at the site.

5.10 Seismic Considerations

The structure and all structural elements should be designed to meet current Oregon Residential Specialty Code (ORSC) seismic requirements. Based on our knowledge of subsurface conditions at the site, and our analysis using the guidelines recommended in the ORSC, the structure should be designed to meet the following seismic parameters:

SEISMIC DESIGN PARAMETERS	
Site Class	D
Seismic Design Category	D_2
Mapped Spectral Response Acceleration for Short Periods	S_S = 1.301 g
Site Coefficients	F_a = 0.800 F_v = 0.800
Design Spectral Response Acceleration at Short Periods	S_{DS} = 0.694 g

5.11 Plan Review and Construction Observations

Prior to construction, we should be provided the opportunity to review all site development, foundation, drainage, erosion control and grading plans to assure conformance with the intent of our recommendations (Appendix D). HGSA should also be provided with a pile construction work plan for review prior to construction. All site plans, details and specifications should clearly show that the above recommendations have been implemented into the design.

A representative of HGSA should observe grade beam and slab excavations prior to placing structural fill, forming and pouring concrete to assure that suitable bearing materials have been reached (Appendix D). At the time of our observations we may recommend additional excavation if suitable bearing materials have not been reached. We should also observe pile installation operations (Appendix D). Please provide us with at least 5 (five) days notice prior to any needed site observations. There will be additional costs for these services.

5.12 Worker Safety

All construction activities should be completed in accordance with OSHA standards, and all State and local laws, rules, regulations and codes.

6.0 Additional Services

Design Review

This report pertains to a specific site and development. It is not applicable to adjacent sites nor is it valid for types of development other than that to which it refers. Any variation from the site or development plans necessitates a geotechnical review in order to determine the validity of the design concepts evolved herein.

HGSA's review of final plans and specifications is necessary to determine whether the recommendations detailed in this report for the site have been properly interpreted and incorporated in the design and construction documents. At the completion of our review we will issue a letter of conformance to the client for the plans and specifications.

Construction Monitoring

Because of the judgmental character of geotechnics, as well as the potential for adverse circumstances arising from construction activity, observations during site preparation, excavation, and construction will need to be carried out by a representative of HGSA or our designate. These observations may then serve as a basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein to the benefit of the project. Field observations become increasingly important should earthwork proceed during adverse weather conditions.

7.0 Limitations

The Oregon Coast is a dynamic environment with inherent unavoidable risks to development. Landsliding, erosion, tsunamis, storms, earthquakes and other natural events can cause severe impacts to structures built within this environment and can be detrimental to the health and welfare of those who choose to place themselves within this environment. The client is warned that, although this report is intended to identify the geologic hazards causing these risks, the scientific and engineering communities knowledge and understanding of geologic hazards processes is not complete.

Our investigation was based on engineering geological reconnaissance, limited review of published information, and our subsurface exploration and analyses. The data presented in this report are believed to be representative of the site. The conclusions herein are professional opinions derived in accordance with current standards of professional practice and budget constraints. No warranty is expressed or implied. The performance of the site during a seismic event has not been evaluated. If you would like us to do so, please contact us.

The boring logs and related information depict generalized subsurface conditions only at these specific locations and at the particular time the subsurface exploration was completed. Soil, rock and groundwater conditions at other locations may differ from the conditions at these boring locations. Also, the passage of time may result in a change in the soil and groundwater conditions at the site.

This report pertains to the subject site only, and is not applicable to adjacent sites nor is it valid for types of development other than that to which it refers. Geologic conditions including materials, processes and rates can change with time and therefore a review of the site and/or this report may be necessary as time passes to assure its accuracy and adequacy. This report may only be copied in its entirety.

8.0 Disclosure

H.G. Schlicker & Associates, Inc. and the undersigned Certified Engineering Geologist have no financial interest in the subject site, the project or the Client's organization.

9.0 References Cited

Allan, J. C. and Priest, G. R., 2001, Evaluation of coastal erosion hazard zones along dune and bluff backed shorelines in Tillamook County, Oregon: Cascade Head to Cape Falcon: Oregon Department of Geology and Mineral Industries, Open File Report O-01-03, 126p., maps.

Allan, J. C., Ruggiero, P., Cohn, N., Garcia, G., O'Brien, F. E., Serafin, K., Stimely, L. L. and Roberts, J. T., 2015, Coastal Flood Hazard Study, Lincoln County, Oregon: Oregon Department of Geology and Mineral Industries, Open-File Report O-15-06, 351 p.

Burns, W. J., Mickelson, K. A., and Madin, I. P., 2016, Landslide susceptibility overview map of Oregon: Oregon Department of Geology and Mineral Industries, Open-File Report O-16-02, 48 p., 1 plate.

Church, J. A., and White, N. J., 2006, A 20th century acceleration in global sea-level rise; Geophysical Research Letters, v. 22, LO1601, 4 p.

Clague, J. J., Atwater, B. F., Wang, K., Wang, Y., and Wong, I., 2000, Penrose Conference 2000 - Great Cascadia Earthquake Tricentennial, Programs Summary and Abstracts: Oregon Department of Geology and Mineral Industries, Special Paper 33, 156 p.

DOGAMI, 2012, Tsunami inundation maps for Neskowin, Tillamook County, Oregon: Oregon Department of Geology and Mineral Industries, TIM-Till-14, maps.

EPA, 1998, Climate Change and Oregon: Environmental Protection Agency, EPA 236-98-007u, 4 p.

Geomatrix Consultants, 1995, Seismic design mapping, State of Oregon, final report: Prepared for the Oregon Department of Transportation, Project No. 2442.

Goldfinger, C., Nelson, C. H., Morey, A. E., Johnson, J. E., Patton, J. R., Karabanov, E., Gutiérrez-Pastor, J., Eriksson, A. T., Gràcia, E., Dunhill, G., Enkin, R. J., Dallimore, A., and Vallier, T., 2012, Turbidite event history—Methods and implications for Holocene paleoseismicity of the Cascadia subduction zone: U.S. Geological Survey Professional Paper 1661–F, 170 p.

Kelsey, H. M., Nelson, A. R., Hemphill-Haley, E., and Witter, R. C., 2005, Tsunami history of an Oregon coastal lake reveals a 4600 yr record of great earthquakes on the Cascadia subduction zone: Geological Society of America Bulletin, v. 117, no. 7/8, p. 1009-1032.

Leonard, L. J., Hyndman, R. D., and Mazzotti, S., 2004, Coseismic subisdence in the 1700 great Cascadia earthquake: Coastal estimates versus elastic dislocation models: Geological Society of America Bulletin, May/June 2004, v. 116, no. 5/6, pp. 655–670.

Oregon Seismic Safety Policy Advisory Commission (OSSPAC), February 2013, The Oregon Resilience Plan: Reducing Risk and Improving Recovery for the next Cascadia Earthquake and Tsunami—Report to the 77th Legislative Assembly: State of Oregon Office of Emergency Management, 341 p.

OSU News and Research Communications, May 24, 2010, Odds are 1-in-3 that a huge quake will hit Northwest in next 50 years: Oregon State University, Corvallis http ://oregonstate.edu/ua/ncs/archives/2010/may/odds-huge-quake-Northwest-next-50-years

Priest, G. R., 1995, Explanation of mapping methods and use of the tsunami hazard maps of the Oregon Coast: Oregon Department of Geology and Mineral Industries, Open-File Report O-95-67, 95 p.

Priest, G. R., 1995, Tsunami hazard map of the Neskowin Quadrangle, Tillamook and Lincoln Counties, Oregon: Oregon Department of Geology and Mineral Industries, Open-File Report O-95-24.

Rogers, A. M., Walsh, T. J., Kockelman, J., and Priest, G. R., 1996, Earthquake hazards in the Pacific Northwest - an overview: U.S. Geological Survey, Professional Paper 1560, p. 1-54.

Schlicker, H. G., Deacon, R. J., Beaulieu, J. D., and Olcott, G. W., 1972, Environmental geology of the coastal region of Tillamook and Clatsop Counties, Oregon: Oregon Department of Geology and Mineral Industries, Bulletin 74, 164 p., maps.

Snavely, P. D., Niem, A., Wang, F. L., MacLeod, N. S., and Calhoun, T. K., 1996, Geologic map of the Cascade Head Area, Northwestern Oregon Coast Range (Neskowin, Nestucca Bay, Hebo, and Dolph 7.5 minute Quadrangles): U.S. Geological Survey, Open File Report 96-0534, 16 p., maps.

Witter, R. C., Kelsey, H. M., and Hemphill-Haley, E., 2003, Great Cascadia earthquakes and tsunamis of the past 6700 years, Coquille River estuary, southern coastal Oregon: Geological Society of America Bulletin, v. 115, p. 1289-1306.

It has been our pleasure to serve you. If you have any questions concerning this report, or the site, please contact us.

Respectfully submitted,

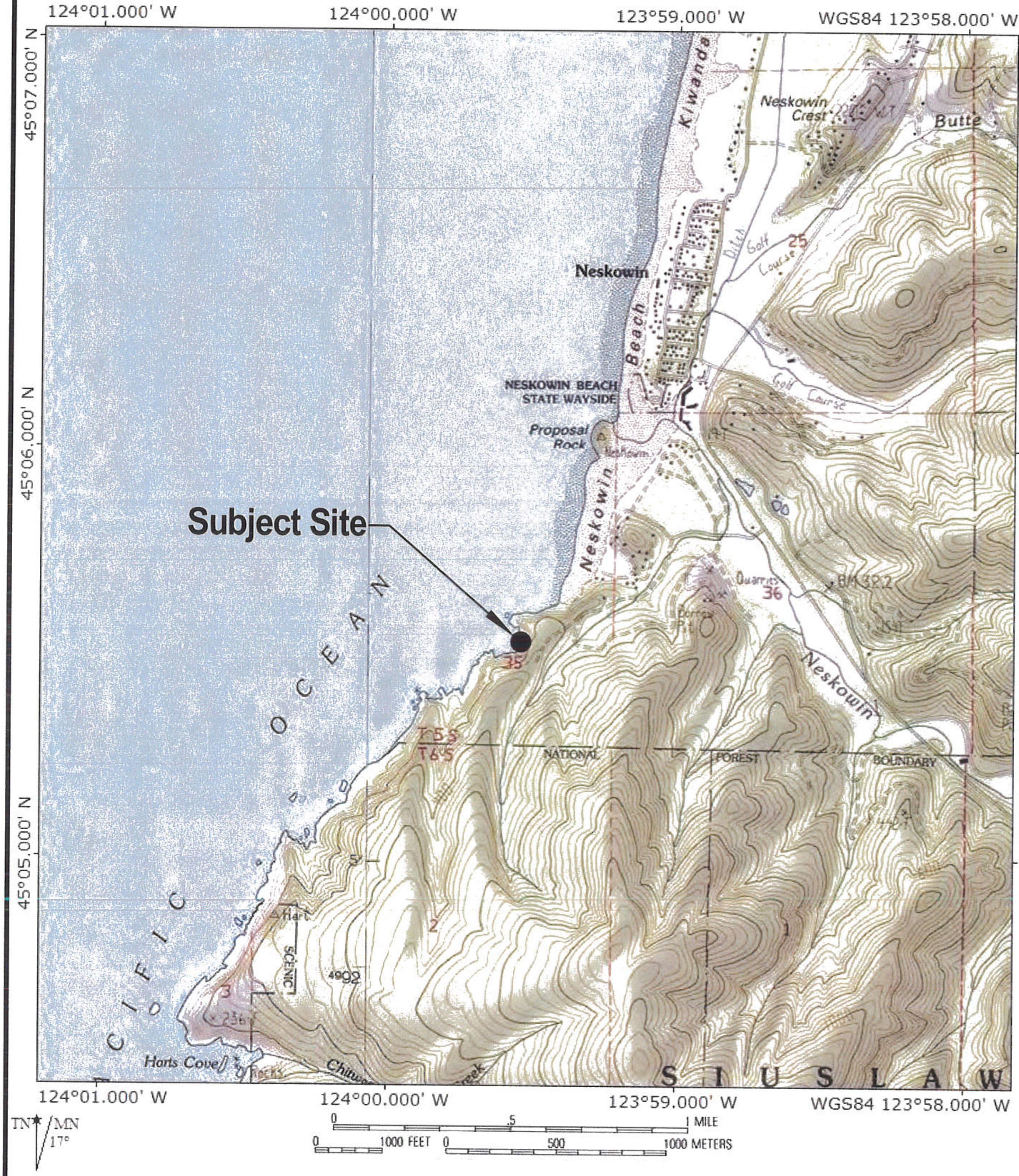
H.G. SCHLICKER AND ASSOCIATES, INC.

CERTIFIED
OREGON
ENGINEERING GEOLOGIST

EXPIRES: 11/01/2018

J. Douglas Gless, MSc, RG, CEG, LHG
President/Principal Engineering Geologist

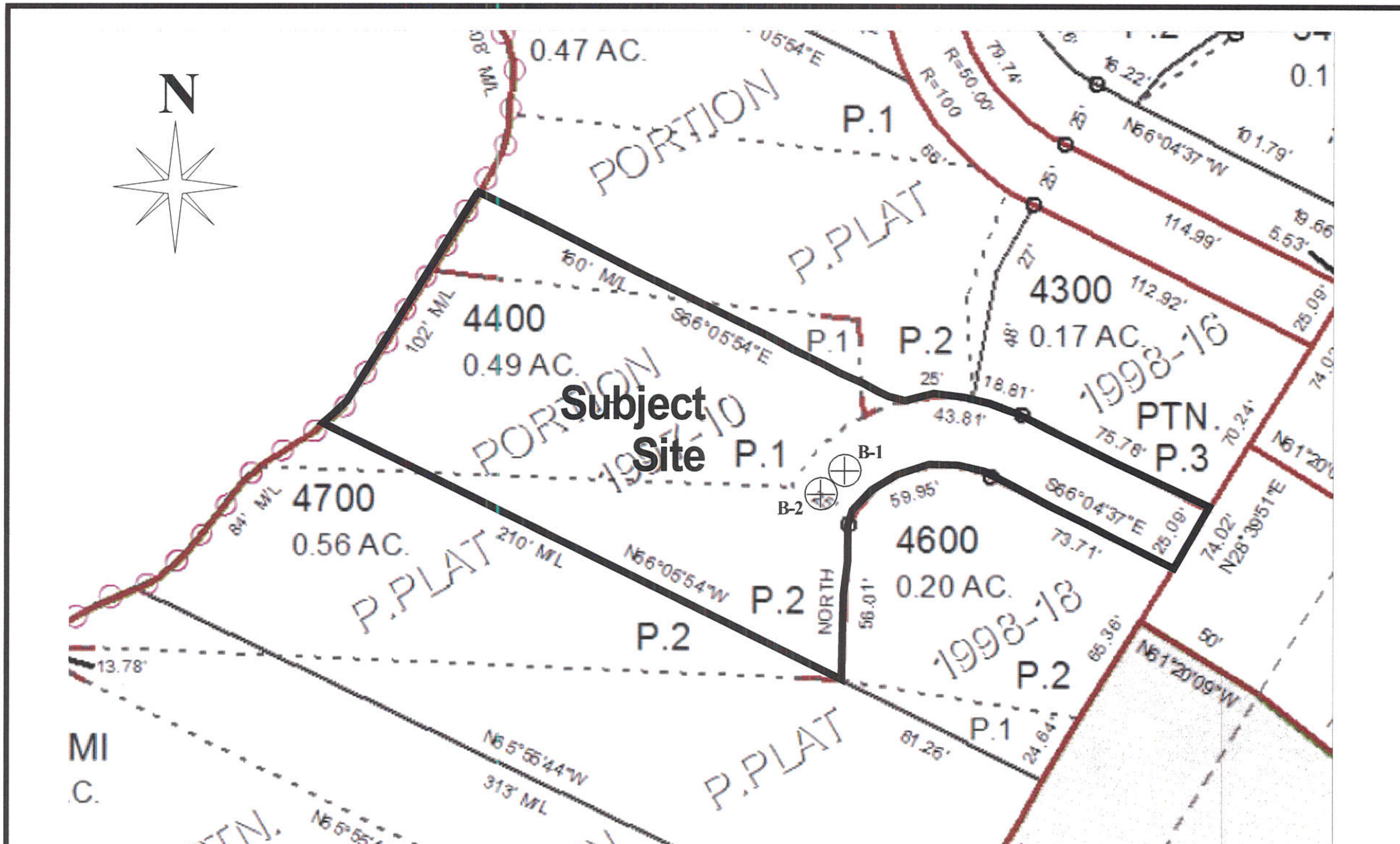
JDG:aml



Date: 12/06/2017	**Project #Y174044**	Prepared by: AML
Scale: 1" = 2,000'		Approved by: JDG

Location Map
Tax Lot 440, Map 5S-11-35DA
Tillamook County, Oregon

H.G. Schlicker & Associates, Inc. — **Figure 1**



B-1

= Approximate location of boring

A A'

= Approximate trend of profile line

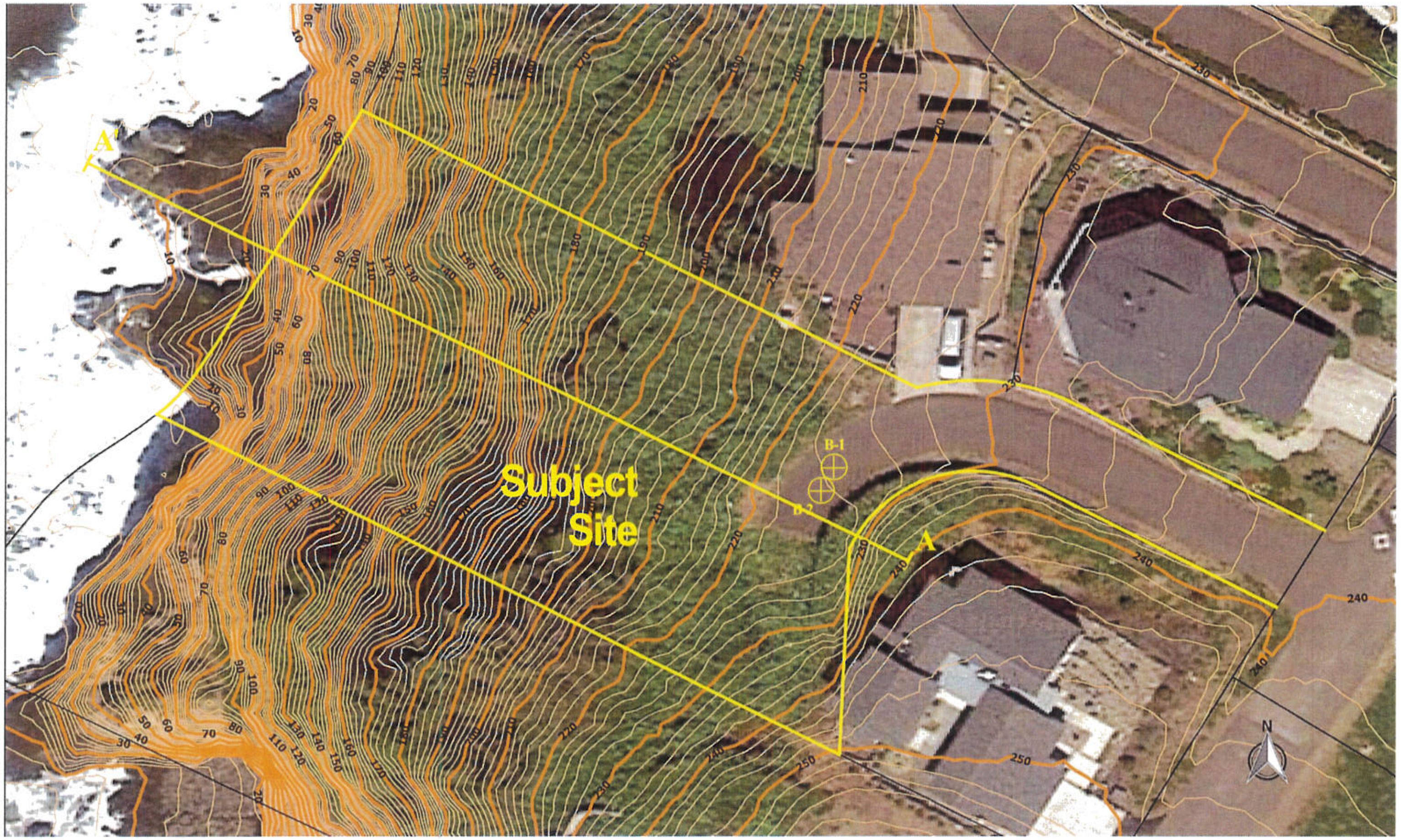
Modified from Plat Map 05S11W35DA.
All locations and dimensions are approximate.

Date: 12/06/2017	Project #Y174044	Prepared by: AML
Scale: 1" = 50'		Approved by: JDG

Site Map
Tax Lot 440, Map 5S-11-35DA
Tillamook County, Oregon

H.G. Schlicker & Associates, Inc.

Figure 2



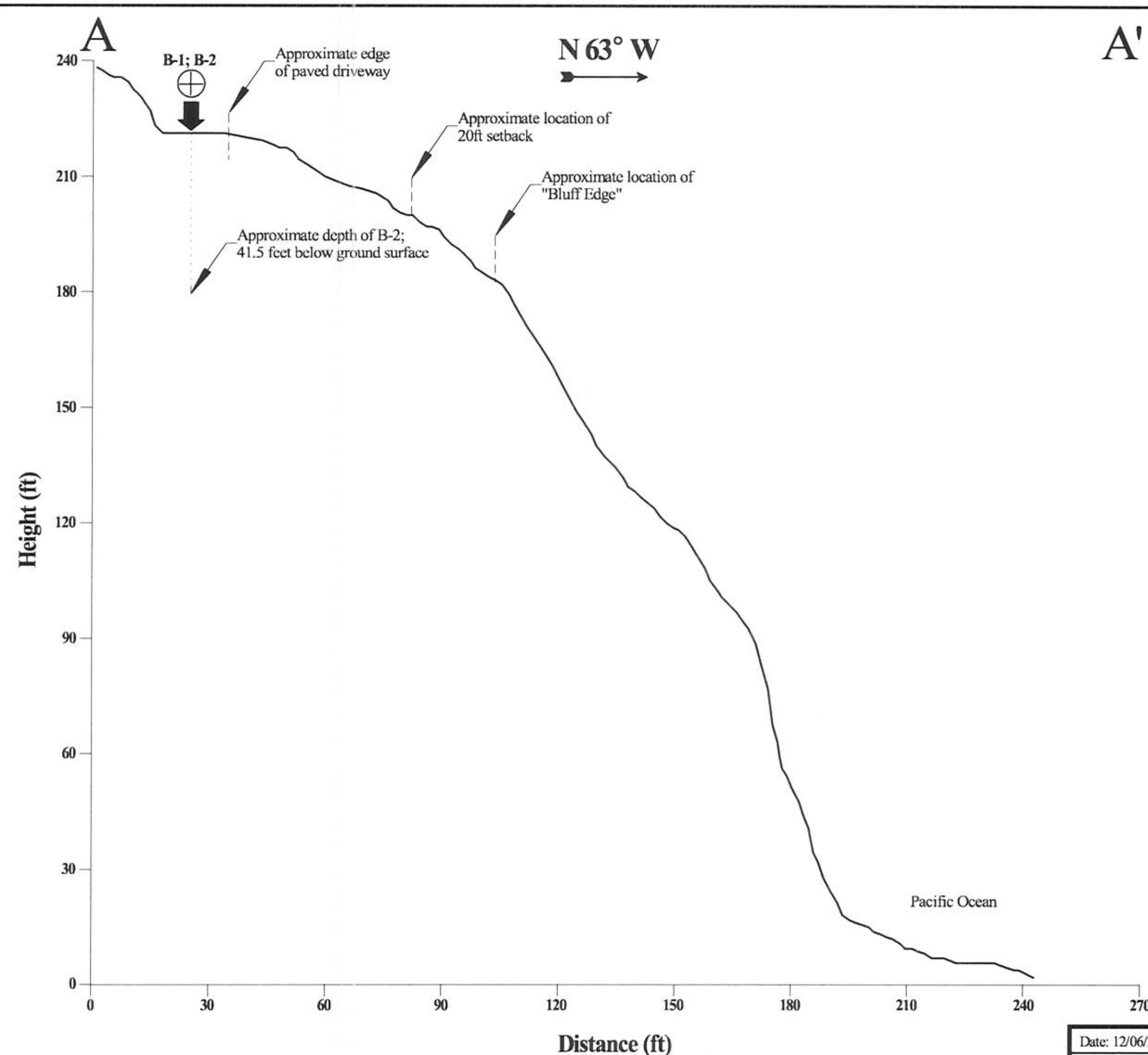
B-1 = Approximate location of boring

A — A' = Approximate trend of profile line

Imagery from Google. Topographic data derived from 2009_OLC_North Coast lidar data provided byDOGAMI.
Elevation Vertical Datum is NAVD 88.
All locations and dimensions are approximate.

30 0 30 60 ft

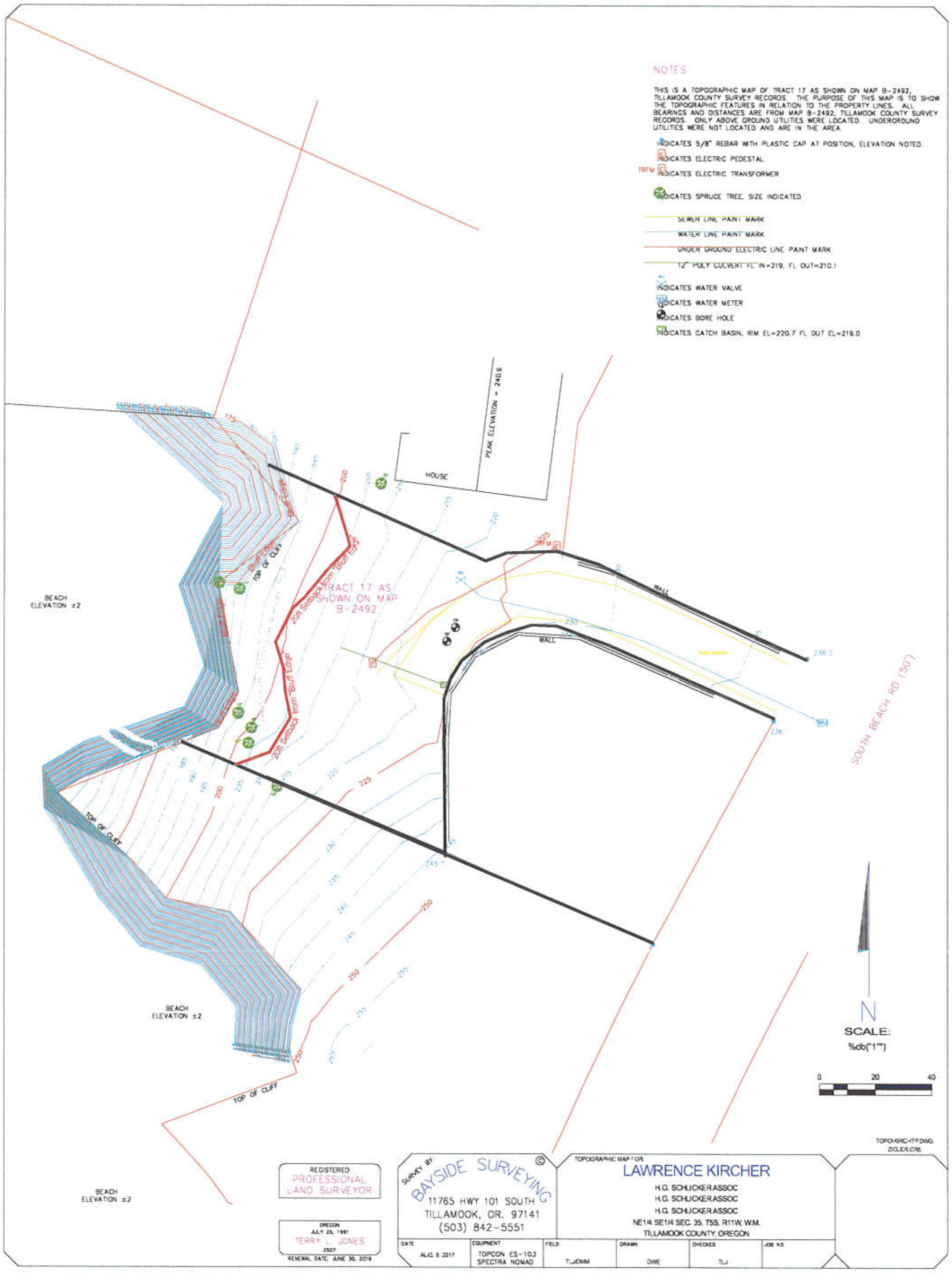
Date: 12/06/2017 Scale: 1" = 30	**Project #Y174044**	Prepared by: AML Approved by: JDG
Site Topographic Map Tax Lot 440, Map 5S-11-35DA Tillamook County, Oregon		
H.G. Schlicker & Associates, Inc.		**Figure 3**



B-1 = Approximate location of boring

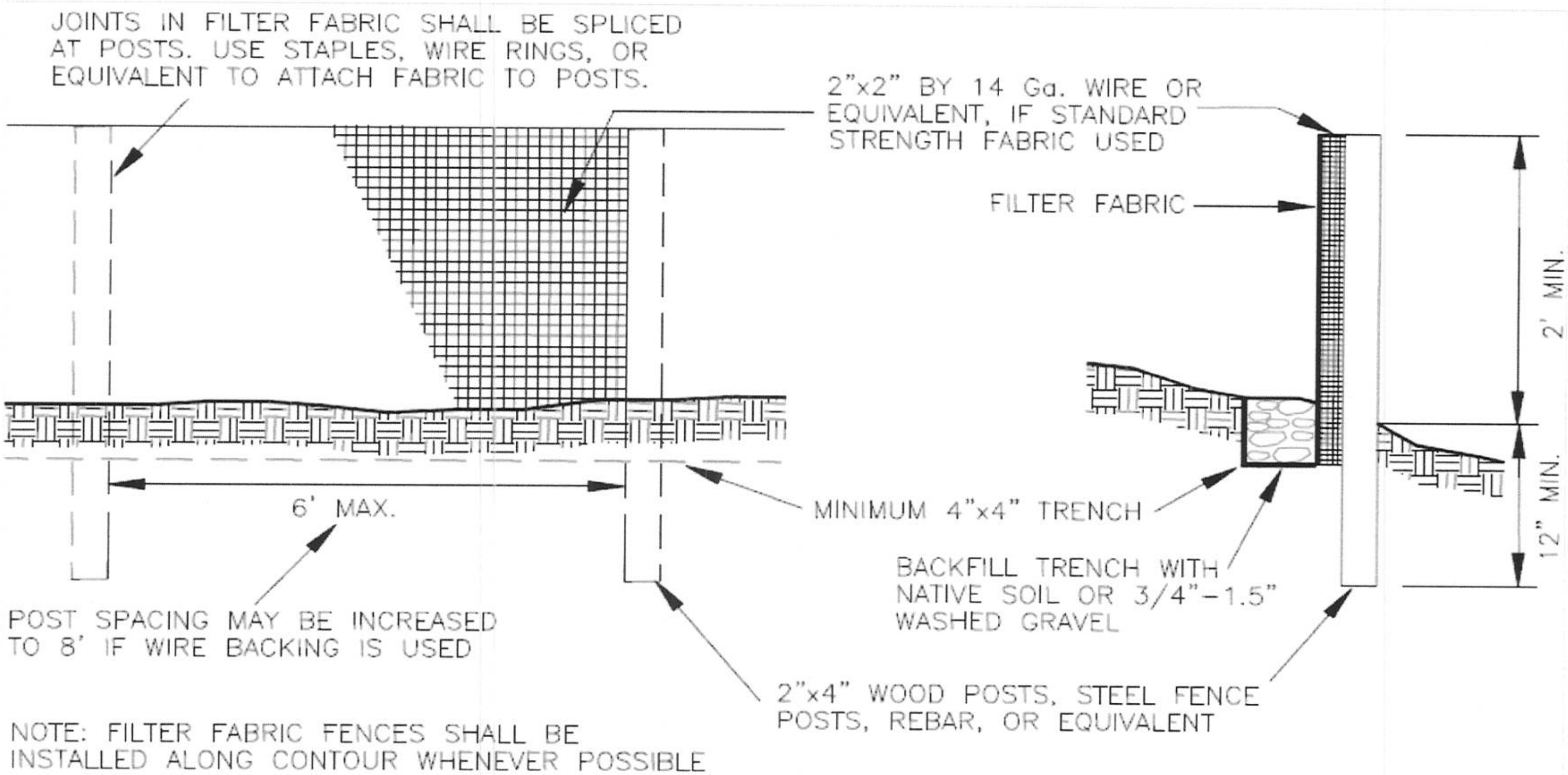
All dimensions and locations are approximate.
Heights derived from 2009 OLC North Coast lidar data from DOGAMI.

Date: 12/06/2017	Project #Y174044	Prepared by: AML
Scale: 1" = 30'		Approved by: JDG
Slope Profile, A-A' Tax Lot 440, Map 5S-11-35DA Tillamook County, Oregon		
H.G. Schlicker & Associates, Inc.		Figure 4



Modified from drawing provided by Bayside Surveying.
All locations and dimensions are approximate.

Date: 12/06/2017	Project #Y174044	Prepared by: AML
Scale: 1" = 40'		Approved by: JDG
	Site Topographic Survey Tax Lot 440, Map 5S-11-35DA Tillamook County, Oregon	
H.G. Schlicker & Associates, Inc.		**Figure 5**



Date: 12/06/2017	**Project #Y174044**	Prepared by: AML Approved by: JDG
Sediment Fence Detail Tax Lot 440, Map 5S-11-35DA Tillamook County, Oregon		
H.G. Schlicker & Associates, Inc.		**Figure 6**

Appendix A
- Site Photographs -

Photo 1 - Southerly view of the driveway leading to the site.

Photo 2 - View of the vegetation on the site.

Photo 3 - Oblique aerial photograph of the site, nearby lots and the Pacific Ocean to the west.

Photo 4 - Oblique aerial photograph of the bluff in the area of the site.

Photo 5 - Oblique aerial photograph of the base of the bluff below the site.

Photo 6 - Close-up view of basalt breccia exposed upslope to the east of the site.

Photo 7 - Close-up view of rock core samples from boring B-2 recovered from approximately 10 to 19.5 feet below ground surface.

Appendix B
- Boring Logs -

Location: Neskowin, OR	**Job Name: Kircher**	**Project #**Y174044
Drilling Co.: Hardcore Driller: Sam Drill Rig: Truck #102, CME 75 Mud rotary with HQ core		**Boring #:** 1 Sheet 1 of 1
Field Personnel: Adam Large		Ground Elevation: ~220

Water Level	**Depth (ft.)**	**Time**	**Date**	**Start**	**Finish**
NONE ENCOUNTERED				Time: 10:30 am	Time: 3:30 pm
				Date: 6/30/2017	Date: 6/30/2017

Attempt. Sample Length (ft.)	Core Recovery (ft.)	Sum >4" (ft.)	RQD	Depth (ft.)	Description
				0	Asphalt surface approximately 6" thick.
					Approximately 6" of gravel road base.
					SILTY SANDY GRAVEL/WEATHERED BASALT BRECCIA - Brown/gray, with extensively weathered/altered basalt breccia
				2.5	
				5	SPT at 5-6.5' : 16, 22, 52, sandy with highly weathered basalt gravel. Slightly cemented, Red/Brown.
				7.5	
					CLAYEY SAND WITH GRAVEL/WEATHERED BASALT BRECCIA - Blue-gray, moist, dense to very dense, coarse sand and gravel with extensively weathered/altered basalt breccia
				10	SPT at 10': 50 blows for 4" inches then refusal. BASALT BRECCIA
1.00	1.00	1.00	100		Core from 10.5' to 11.5', BASALT/BASALT BRECCIA, slightly vesiculated at top of core, zeolite infilling in fractures and vesicles. RQD: 100%, RMQ: Fresh Rock
5.00	4.75	4.75	95		Core from 11.5' to 16.5', BASALT/BASALT BRECCIA. Zeolite infilling in fractures. RQD: 95%, RMQ: Fresh Rock
				12.5	
				15	
					HQ core locked up downhole - breaking saver sub.
					Boring terminated at 16.5' in fresh basalt/basalt breccia
				17.5	

Location: Neskowin, OR	Job Name: Kircher	Project #Y174044
Drilling Co.: Hardcore Driller: Sam Drill Rig: Truck #102, CME 75 Mud rotary with HQ core		Boring #: 2 Sheet 1 of 3
Field Personnel: Adam Large		Ground Elevation: ~220

Water Level	Depth (ft.)	Time	Date	Start	Finish
NONE ENCOUNTERED				Time: 9:45 am	Time: 6:30 pm
				Date: 7/10/2017	Date: 7/10/2017

Attempt. Sample Length (ft.)	Core Recovery (ft.)	Sum >4" (ft.)	RQD	Depth (ft.)	Description
				0	Asphalt surface approximately 6" thick.
					Approximately 6" of gravel road base.
					SILTY SANDY GRAVEL/WEATHERED BASALT BRECCIA - Brown/gray, with extensively weathered/altered basalt breccia
				2.5	No SPT. Used Tri-cone bit to get down to hard rock faster. See Boring log 1 for first 10'
				5	
				7.5	
				10	Core from 10' to 12', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 84%, RMQ: Hard Rock
2.00	1.68	1.67	84		
1.00	1.00	.67	67		Core from 12' to 13', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 67%, RMQ: Moderately Weathered Rock
				12.5	
2.00	1.83	1.83	92		Core from 13' to 15', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 92%, RMQ: Fresh Rock
3.00	3.00	2.42	81	15	Core from 15' to 18', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 81%, RMQ: Hard Rock
				17.5	

H.G. Schlicker & Associates, Inc.

Location: Neskowin, OR	**Job Name: Kircher**	**Project #**Y174044
Drilling Co.: Hardcore Driller: Sam Drill Rig: Truck #102, CME 75 Mud rotary with HQ core		**Boring #:** 2 Sheet 2 of 3
Field Personnel: Adam Large		Ground Elevation: ~220

Water Level	Depth (ft.)	Time	Date	Start	Finish
NONE ENCOUNTERED				Time: 9:45 am	Time: 6:30 pm
				Date: 7/10/2017	Date: 7/10/2017

Attempt. Sample Length (ft.)	Core Recovery (ft.)	Sum >4" (ft.)	RQD	Depth (ft.)	Description
3.00	3.00	2.16	72	18	Core from 18' to 21', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 72%, RMQ: Moderately Weathered Rock
				20.5	
4.00	3.50	2.83	71		Core from 21' to 25', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 71%, RMQ: Moderately Weathered Rock
				22.5	
1.25	1.25	0.75	60	25	Core from 25' to ~26', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 60%, RMQ: Moderately Weathered Rock
2.75	2.63	2.38	87		Core from ~26' to 29', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 87%, RMQ: Hard Rock
				27.5	
2.50	2.50	2.25	90		Core from 29' to 31.5', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 90%, RMQ: Hard Rock
				30	
5.00	5.00	2.54	51		Core from 31.5' to 36.5', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 51%, RMQ: Moderately Weathered Rock
				32.5	
				35	

Location: Neskowin, OR	Job Name: Kircher	Project #Y174044
Drilling Co.: Hardcore Driller: Sam Drill Rig: Truck #102, CME 75 Mud rotary with HQ core		Boring #: 2 Sheet 3 of 3
Field Personnel: Adam Large		Ground Elevation: ~220

Water Level	Depth (ft.)	Time	Date	Start	Finish
NONE ENCOUNTERED				Time: 9:45 am	Time: 6:30 pm
				Date: 7/10/2017	Date: 7/10/2017

Attempt. Sample Length (ft.)	Core Recovery (ft.)	Sum >4" (ft.)	RQD	Depth (ft.)	Description
				36	
5.00	5.00	1.16	23		Core from 36.5' to 41.5', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 23%, RMQ: Completely Weathered Rock
				38.5	
				40	
					Boring terminated at 41.5' in weathered fractured basalt
				42.5	

H.G. Schlicker & Associates, Inc.

Appendix C

- Unconfined Compressive Strength of Rock Cores -

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B, Wilsonville, Oregon 97070 | ph: 503.682.1880 fax: 503.682.2753 | www.nwgeotech.com

TECHNICAL REPORT

Report To:	Mr. J. Douglas Gless, R.G., C.E.G. H. G. Schlicker & Associates, Inc. 607 Main Street Oregon City, Oregon 97045	**Date:** **Lab No.:**	7/28/17 17-152
Project:	Laboratory Testing Project No. Y174044	**Project No.:**	1824.1.1

Report of: Compressive strength of rock

Sample Identification

NTI completed compressive strength of rock testing on samples delivered to our laboratory on July 26, 2017. Testing was performed in accordance with the standards indicated. Our laboratory test results are summarized on the attached pages.

Attachments: Laboratory Test Results

Copies: Addressee

 BKA

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B, Wilsonville, Oregon 97070 | ph: 503.682.1880 fax: 503.682.2753 | www.nwgeotech.com

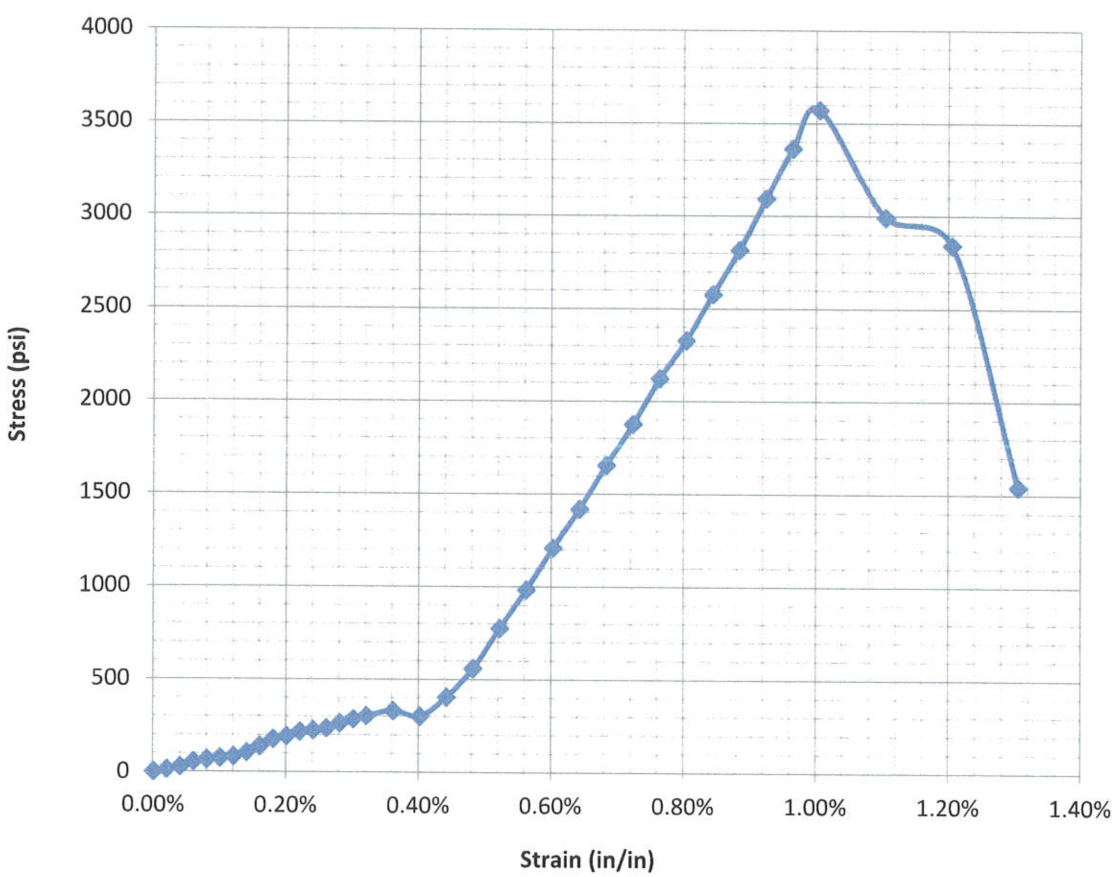
TECHNICAL REPORT

Report To:	Mr. J. Douglas Gless, R.G., C.E.G. H. G. Schlicker & Associates, Inc. 607 Main Street Oregon City, Oregon 97045	**Date:** **Lab No.:**	7/28/17 17-152
Project:	Laboratory Testing Project No. Y174044	**Project No.:**	1824.1.1

Laboratory Testing

Compressive Strength of Intact Rock Core Specimens (ASTM D 7012 Method C)

Sample ID	Diameter (inches)	Height (inches)	Rate of Loading (lbs/s)	Uniaxial Compressive Strength (psi)
B-1 @ 11.5 ft.	2.39	4.98	50	3571



REVIEWED BY: Bridgett Adame

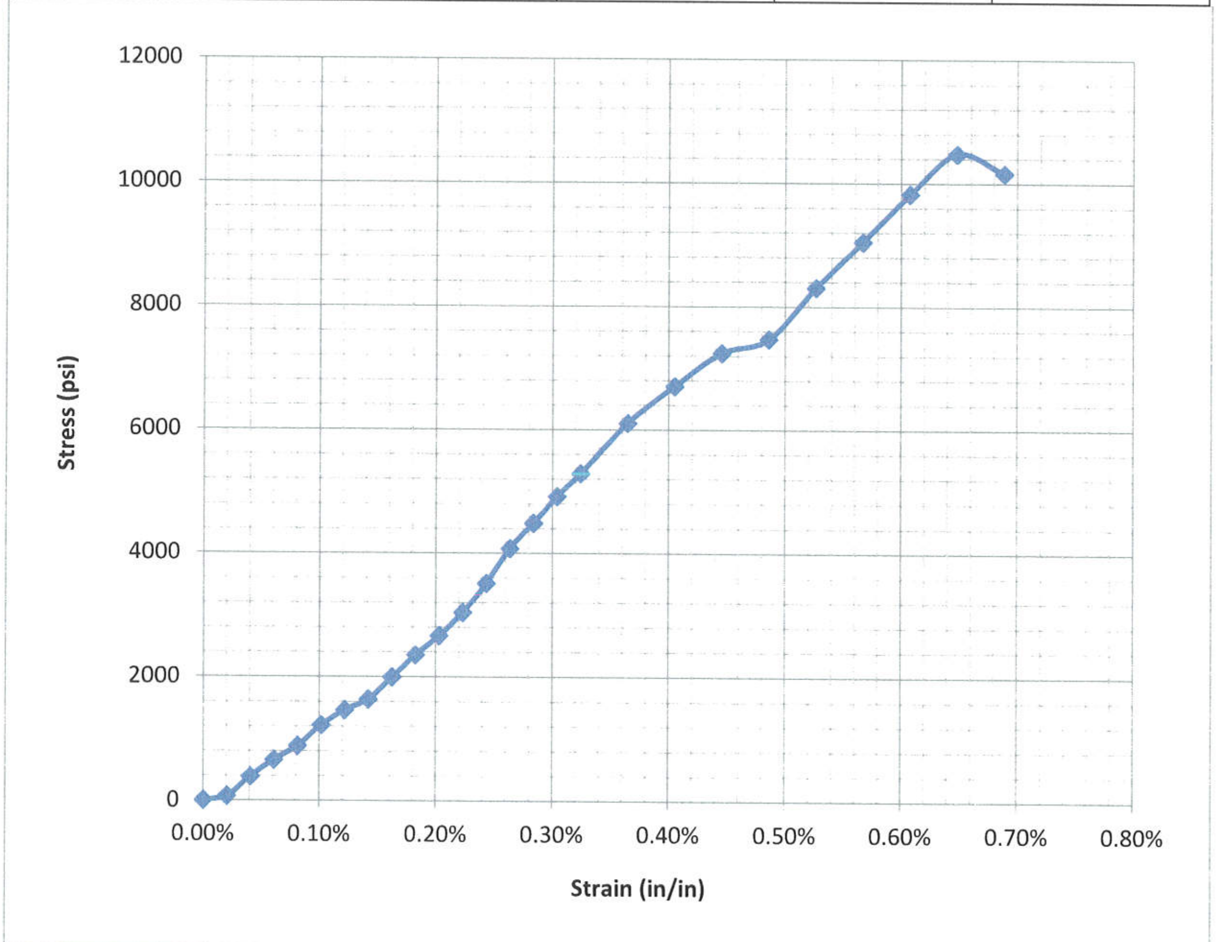
Northwest Testing, Inc.
A Division of Northwest Geotech, Inc
9120 SW Pioneer Court, Suite B, Wilsonville, Oregon 97070 | ph: 503.682.1880 fax: 503.682.2753 | www.nwgeotech.com

TECHNICAL REPORT

Report To:	Mr. J. Douglas Gless, R.G., C.E.G. H. G. Schlicker & Associates, Inc. 607 Main Street Oregon City, Oregon 97045	**Date:** **Lab No.:**	7/28/17 17-152
Project:	Laboratory Testing Project No. Y174044	**Project No.:**	1824.1.1

Laboratory Testing

Compressive Strength of Intact Rock Core Specimens (ASTM D 7012 Method C)				
Sample ID	**Diameter (inches)**	**Height (inches)**	**Rate of Loading (lbs/s)**	**Uniaxial Compressive Strength (psi)**
B-2 @ 27.5 ft.	2.38	4.94	100	10,474



REVIEWED BY: Bridgett Adame

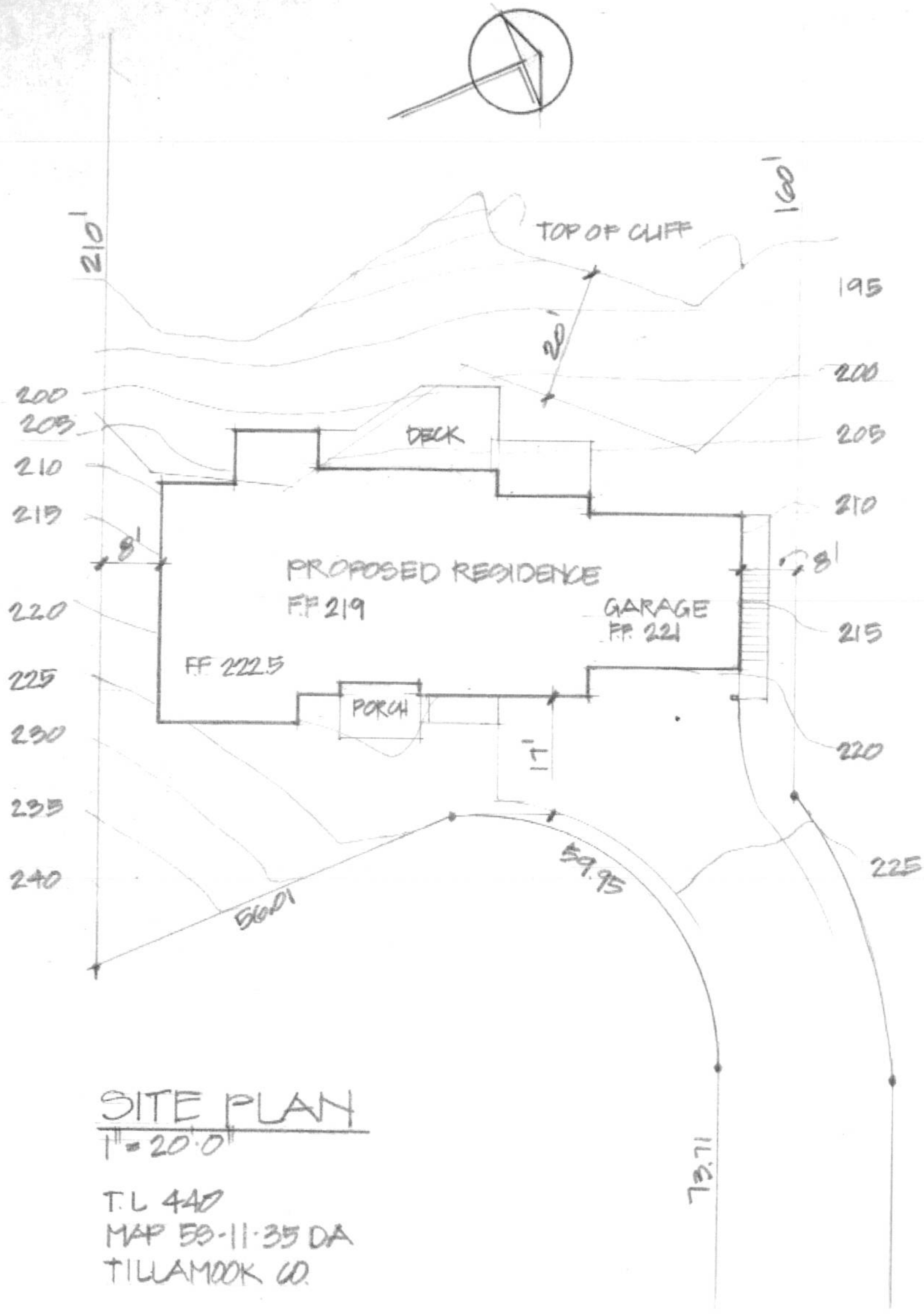
Appendix D

- Checklist of Recommended Additional Work, Plan Reviews and Site Observations -

APPENDIX D
Checklist of Recommended Additional Work, Plan Reviews and Site Observations To Be Completed by a Representative of H.G. Schlicker & Associates, Inc.

Item No.	Date Done	Procedure	Timing
1*		Review site development, foundation, drainage, grading and erosion control plans.	Prior to construction.
2*		Observe foundation excavations and setbacks.	Following excavation of foundations, and prior to placing fill, and forming and pouring concrete.**
3*		Review Proctor (ASTM D1557) and density test results for all fills placed at the site.	Following compaction, and prior to forming and pouring.

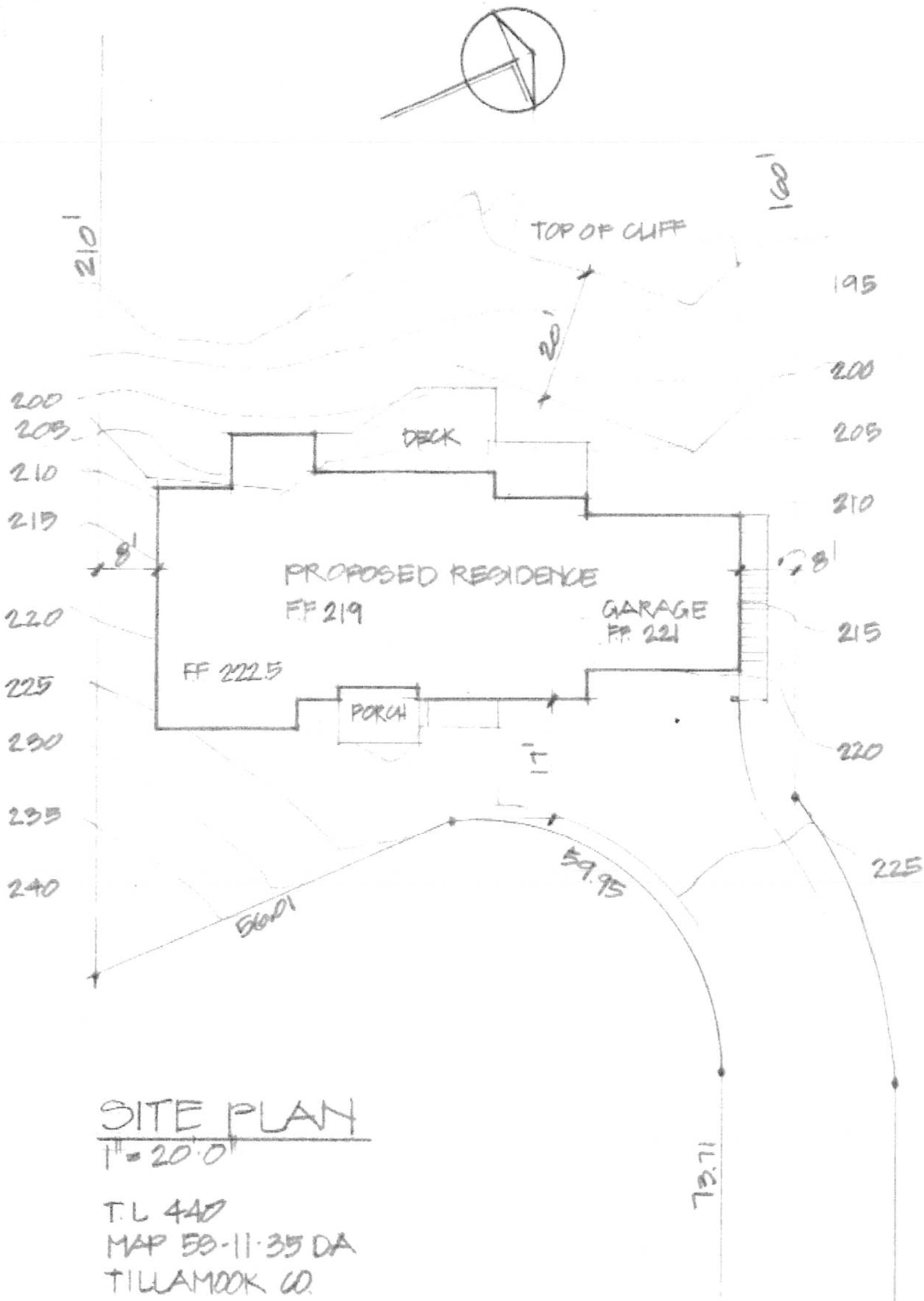
* There will be additional charges for these services.
** Please provide us with at least 5 days notice prior to all site observations.



SITE PLAN

1" = 20'-0"

T.L 440
MAP 5S-11-35 DA
TILLAMOOK CO.



SITE PLAN
1" = 20'0"

T.L. 440
MAP 5S-11-35 DA
TILLAMOOK CO.

Chris@halvorsonmason.com

From:	Lawrence Kircher <coastalcubz54@gmail.com>
Sent:	Tuesday, April 20, 2021 10:58 AM
To:	Chris Fairfield
Subject:	Neskowin Parcel# 397752R Site address OR97149 - Hazard Discloser Statement

I Lawrence S Kircher, the legal owner of Neskowin Parcel# 397752R, Tax Lot: 5S1135DA04400, Site address OR 97149 am providing for application of Coastal Hazards Area Permit per section (d) subsection (F) - (i), (ii), and (iii) a Hazard Disclosure Statement to the following:

(i) - I understand that property is subject to potential natural hazards, and by developing parcel# 397752R there is risk of damage from such hazards. Owner fully understands and accepts such risks.

(ii) On December 6th 2017 I received the Geologic report, Project #Y174044 from H.G. Schlicker & Associates, Inc . whom I commissioned to perform a geotechnical investigation for the above subject property. I have reviewed the geologic report with Douglas Gless (principal engineering geologist) and am aware of risks associated with developing this property according to the report.

(iii) As legal property owner I accept and assume risks of damage from hazards associated with the development of Tax Lot 4400, Map 5S-11-35DA Tillamook County, Oregon.

Signed; Lawrence s Kircher

Geologic Hazards and Geotechnical Investigation Report
Tax Lot 4400, Map 5S-11-35DA
Tillamook County, Oregon

Prepared for:
Mr. Lawrence Kircher
249 Seneca Place NW
Renton, Washington 98057

Project #Y174044

December 6, 2017

H.G. Schlicker & Associates, Inc.

H.G. Schlicker & Associates, Inc.
607 Main Street, Suite 200 · Oregon City, Oregon 97045
(503) 655-8113 · FAX (503) 655-8173

Project #Y174044

December 6, 2017

To: **Mr. Lawrence Kircher**
249 Seneca Place NW
Renton, Washington 98057

Subject: **Geologic Hazards and Geotechnical Investigation Report**
Tax Lot 4400, Map 5S-11-35DA
Tillamook County, Oregon

Dear Mr. Kircher:

The accompanying report presents the results of our geologic hazards and geotechnical investigation for the above subject site.

After you have reviewed our report, we would be pleased to discuss the report and to answer any questions you might have.

This opportunity to be of service is sincerely appreciated. If we can be of any further assistance, please contact us.

H.G. SCHLICKER & ASSOCIATES, INC.

J. Douglas Gless, MSc, RG, CEG, LHG
President/Principal Engineering Geologist

JDG:aml

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H.G. Schlicker & Associates, Inc.
607 Main Street, Suite 200 · Oregon City, Oregon 97045
(503) 655-8113 · FAX (503) 655-8173

Project #Y174044

December 6, 2017

To: **Mr. Lawrence Kircher**
249 Seneca Place NW
Renton, Washington 98057

Subject: **Geologic Hazards and Geotechnical Investigation Report**
Tax Lot 4400, Map 5S-11-35DA
Tillamook County, Oregon

Dear Mr. Kircher:

1.0 Introduction

At your request and authorization, representatives of H.G. Schlicker and Associates, Inc. (HGSA) visited the subject site on April 11, June 27 and 30, July 10, August 9 and 16, 2017 to complete a geologic hazards investigation of Tax Lot 4400, Map 5S-11-35DA located in the Neskowin area, Tillamook County, Oregon (Figures 1 and 2; Appendix A). It is our understanding that you would like to construct a single family residential home on the site.

This report addresses the engineering geology and geologic hazards at the site with respect to constructing a home. The scope of our work consisted of site visits, site observations and measurements, subsurface exploration with two drilled borings, laboratory analysis of rock samples from drilled borings, a topographic survey, acquisition and analysis of oblique photographs and an aerial drone video of the bluff face, a slope profile, limited review of the geologic literature, interpretation of topographic maps and lidar, analysis of stereo pair aerial photographs and satellite imagery, and preparation of this report of our findings, conclusions and geotechnical recommendations for home construction.

2.0 Site Description

The subject site lies at an elevation of approximately 225 feet MSL and ¾ mile south of the center of Neskowin in Tillamook County, Oregon. The site consists of an approximately 0.49 acre irregular shaped lot which lies on the west side of a southerly trending ridge with a generally west-facing, steeply sloping oceanfront bluff on the western part of the lot (Figures 1 and 2). The property is bound to its north and east by adjacent improved lots, to its west by the bluff slope and Pacific Ocean, and to its south by an unimproved lot. South Beach Road provides access from the east by way of an asphalt driveway that also provides access to the neighboring property to the north. At the time of our site visits the site was densely vegetated with brush and a few spruce trees (Figure 5; Appendix A).

2.1 The history of the site and surrounding areas, such as previous riprap or dune grading permits, erosion events, exposed trees on the beach, or other relevant local knowledge of the site.

The site is located on a basalt breccia bluff. Riprap placement is not feasible and no dunes are present on the site. No tree stumps were exposed on the beach when we reviewed aerial photographs and video taken on August 16, 2017 (Appendix A). Evidence of minor sloughing along the bluff was observed in aerial photographs, but the timing of these events is uncertain.

2.2 Topography, including elevations and slopes on the property itself.

The site is located at the top of a basalt bluff that is part of the Cascade Head headlands. A topographic survey completed on August 9, 2017 determined the elevation at top of the cliff to be at approximately 190 feet MSL and approximately 220 feet MSL (NAVD 88) at the lower end of the driveway (Figures 4 and 5). The site slopes approximately 30 degrees to the west for approximately 50 to 60 feet from the driveway to the bluff edge at which point the slope increases to 60 to 75 degrees to the west. Additional observations are addressed and illustrated in Section 3.3, Figures 3, 4, 5, and Appendix A of this report.

2.3 Vegetation cover.

The site is densely vegetated with brush and at least 5 spruce trees along the slope (Figure 5 and Appendix A).

2.4 Subsurface materials – the nature of the rocks and soils.

Subsurface exploration was completed by advancing two wireline core barrel drilled borings to depths of up to 41.5 feet below ground surface. The borings generally encountered clayey, sandy, gravely soils to depths of approximately 7 feet below ground surface (bgs) overlying hard, well-cemented, fresh to relatively fresh basaltic brecciated flows to the final depth of the borings. Subsurface materials are discussed in detail in Section 4.0 and Appendix B.

2.5 Conditions of the seaward front of the property, particularly for sites having a sea cliff.

The seaward front of the property is a hard basalt breccia bluff. The bluff face is unvegetated in the swash zone and aerial imagery shows that the basalt breccia is fractured and variably weathered. The bluff face below the site appears to be more resistant to wave attack than immediately north where waves are undercutting the bluff face, and to the south where undercutting presumably caused a bluff failure at an unknown time in the past. The rock at the subject lot is a large block of much harder rock than adjacent sites. Additional observations are addressed and illustrated in Sections 3.3 and 3.5, and Appendix A

2.6 Presence of drift logs or other flotsam on or within the property.

No drift logs or flotsam were observed in aerial imagery of the property or on the small pocket beach immediately south of the site (Appendix A).

2.7 Description of streams or other drainage that might influence erosion or locally reduce the level of the beach.

We did not observe streams or springs at the time of our site visits. The nearest stream is approximately 500 feet to the east on the other side of the ridge. This stream flows to the north and joins Neskowin Creek approximately 3500 feet to the northeast (Figure 1). A catch basin near the end of the driveway discharges on to the subject lot at an elevation of 210 feet (Figure 5)

2.8 Proximity of nearby headlands that might block the long shore movement of beach sediments, thereby affecting the level of the beach in front of the property.

The site is located on a bluff that is part of the Cascade Head headlands. The pocket beach below the site is generally a rocky beach; however, satellite imagery taken in July 2014 and available on Google Earth indicates that sand deposition at the base of the bluff occasionally occurs. Additional observations are illustrated in Figure 1, and Appendix A.

2.9 Description of any shore protection structures that may exist on the property or on nearby properties.

No shoreline protective structures exist at the base of the bluff fronting the site or nearby sites. The closest shoreline protective structures are riprap revetments located approximately 1000 feet to the north along the north end of the ridge and south of Proposal Rock.

2.10 Presence of pathways or stairs from the property to the beach.

None present at this site. The closest access to the beach is located approximately 1500 feet to the north at the private beach access for Neskowin Height residents.

2.11 Existing human impacts on the site, particularly any that might alter the resistance to wave attack.

Human impacts are not contributing to alteration of the resistance of the bluff face to wave attack at this site.

3.0 Description of the Fronting Beach

The fronting beach lies at the base of a bluff within a small cove at the northern end of the Cascade Head headlands. The beach is generally a rocky beach that is exposed during lower tides, but historic satellite imagery shows that sand deposition can occur within the cove and extend the width of the beach seaward.

3.1 Average widths of the beach during the summer and winter.

Satellite imagery indicates the beach at the site has a variable width which is primarily dependent upon tide levels; it tends to be more narrow in the winter than in the summer. Although the beach can be more than 100 feet wide, at high tide there is often no walkable beach. Images of the fronting beach are presented in Appendix A.

3.2 Median grain size of beach sediment.

We were not able to access the fronting beach during our site visits, however aerial photographs taken by a drone on August 16, 2017 indicate that the beach consisted of cobbles and boulders at that time. Images of the fronting beach are presented in Appendix A.

3.3 Average beach slopes during the summer and winter.

Access to the beach was not possible during our site visits. Nearby beaches tend to slope from approximately 2 to 5 degrees depending upon recent accretion or erosion of sand. This beach is likely steeper.

3.4 Elevations above mean sea level of the beach at the seaward edge of the property during summer and winter.

The elevation of the beach at the seaward edge of the property is presumed to vary seasonally between 0 and 7 feet MSL depending on sand accretion or erosion.

3.5 Presence of rip currents and rip embayments that can locally reduce the elevation of the fronting beach.

At the time of our site visits and in review of satellite photos we did not observe any rip currents or rip current embayments that could reduce the elevation of the fronting beach.

3.6 Presence of rock outcrops and sea stacks, both offshore and within the beach zone.

The site is located at the northern end of the Cascade Head headlands atop a hard basalt breccia bluff (Figure 1 and Appendix A). Rock outcrops exist at the site, for approximately 0.2 miles north of the site and approximately 3.2 miles south of the site. Proposal rock is located approximately 0.5 miles north of the site. The beach at the site is cut into hard rock with a seasonal veneer of sand.

3.7 Information regarding the depth of beach sand down to bedrock at the seaward edge of the property.

We observed no sand on the beach in aerial photographs taken August 16, 2017 at the seaward edge of the property (Appendix A). A thin veneer of sand can develop as seen in some of the aerial photography. We estimate that the beach sand rarely, if ever, exceeds a depth of 7 feet.

4.0 Geologic Hazards Analysis

Our geologic hazards analysis is presented below.

4.1 Subsurface Materials

The site lies in an area which has been mapped as undifferentiated Eocene volcanic rocks (Schlicker et al., 1972). These volcanics generally consist of up to several thousand feet of chloritized basalt flows and basalt breccias, and are characterized by wide variability in type and strength. Snavely et al. (1996) mapped these materials as Basalt of Cascade Head. In the Cascade Head area these rocks display widespread red baked zones and scoriaceous upper flow surfaces that are indicative of a subaerial origin (Schlicker et al., 1972). Exposed rock in the cut slopes at the subject site is severely fractured, weathered and altered basaltic breccia exhibiting various colors (Appendix A).

At the time of our June 30 and July 10, 2017 site visits we explored subsurface conditions by advancing two drilled borings to depths of up to 41.5 feet below the ground surface (bgs). Drilling was accomplished using a CME 75 drill rig with the rotary wash method using a tri-cone bit for the first approximately 10 feet and diamond drilling with an HQ core to approximately 41.5 feet. Sampling was completed by obtaining and observing cuttings brought up in the drilling fluid (bentonite mud), Standard Penetration Tests (SPTs) and wireline methods of rock core sampling. Samples and cuttings were visually classified in the field by a geologist from our office according to the Unified Soil Classification System (USCS) and U.S. Bureau of Reclamation (USBR, 2001) standards for Rock. Additionally, core samples were tested for compressive strength (see Section 4.1.2). Approximate locations of the borings are shown on Figures 2, 3, 4 and 5.

Boring B-1 was drilled to a depth of 16.5 feet and boring B-2 was drilled to a depth of 41.5 feet. The borings generally encountered clayey, sandy, gravely soils to depths of approximately 7 feet bgs overlying hard, well-cemented, fresh to relatively fresh basaltic brecciated flows to the final depth of the borings.

4.1.1 Rock Quality Designation and Rock Mass Quality

The Rock Quality Designation (RQD) and Rock Mass Quality (RMQ) values range from 60% to 100%, moderately weathered to fresh rock, from depths of approximately 10 to 31.5 feet bgs. From approximately 31.5 to 41.5 feet the RQD and RMQ values range from 23% to 51%, completely weathered rock to moderately weathered rock. RQD and RMQ values for each of the boring core runs are provided in Appendix B.

4.1.2 Unconfined Compressive Strength

Two rock core samples were submitted for unconfined compressive strength analysis. Rock core from boring B-1 sampled at a depth of 11.5 feet bgs had an uniaxial compressive strength of 3,571 psi. Rock core from boring B-2 sampled at a depth of 27.5 feet bgs had an uniaxial compressive strength of 10,474 psi. these strengths are comparable to high strength concrete and better. The laboratory technical reports for the unconfined compressive strength analysis are in Appendix C.

4.2 Structure

Structural deformation and faulting along the Oregon Coast is dominated by the Cascadia Subduction zone (CSZ) which is a convergent plate boundary extending for approximately 680 miles from northern Vancouver Island to northern California. This convergent plate boundary is defined by the subduction of the Juan de Fuca plate beneath the North America Plate, and forms an offshore north-south trench approximately 60 miles west of the Oregon coast shoreline. A resulting deformation front consisting of north-south oriented reverse faults is present along the western edge of an accretionary wedge east of the trench, and a zone of margin-oblique folding and faulting extends from the trench to the Oregon Coast (Geomatrix, 1995).

An east-west trending normal fault has been mapped approximately ¼ mile north of the site (Snavely et al., 1996). Based on mapping this fault is approximately ½ mile long, cuts Tertiary rock units with no indications of recent movement, and intersects with a longer, northwest trending normal fault approximately 0.6 miles east-northeast of the site along Neskowin Creek.

4.3 Slopes

The site is located along a westerly trending oceanfront bluff slope which is approximately 30 degrees steep in the proposed building area and rapidly becomes much steeper, 60 to 75 degrees, down slope to the west.

4.4 Orientation of Bedding Planes in Relation to the Dip of the Surface Slope

Determination of bedding plane orientations in the Eocene volcanic and sedimentary rocks which underlie the site is difficult due to the fractured/brecciated nature of the rock units, lack of good exposures, and deformation. Mapping completed by Schlicker et al. (1972) indicates that Eocene volcanic rocks in the area of Cascade Head generally dip down toward the north-northeast from 5 to 45 degrees. This generally corresponds with the orientation and downward slope of the ridge crest. Bedding orientations in basalt breccia exposed in a road cut southeast of the site generally dip toward the northeast from 25 to 35 degrees. Mapping by Snavely et al. (1996) indicates that bedding attitudes are highly variable. The side slopes of the ridge were formed primarily by stream downcutting to the southeast and by ocean wave erosion to the northwest; formation of the ridge side slopes therefore does not appear to be strongly correlated to the dip of the underlying bedrock units. Based on our observations and review of aerial imagery, very steep fractures, and possibly faults, within the basaltic rock appear to influence the pattern of bluff retreat in the site area.

4.5 Site Surface Water Drainage Patterns

Storm water at the site generally flows towards the west and down the bluff. A stormwater catch basin is located at the southeast corner of the asphalt driveway. Stormwater collected by the catch basin is discharged to the slope to the west (Appendix A). Stormwater collection methods and discharge locations for the property located upslope to the east are unknown, but likely discharge to South Beach Road and the driveway accessing the subject lot. This catch basin discharges at an elevation of 210 feet on the subject lot.

4.6 Slope Stability and Erosion

As discussed above, the site is located on a steep oceanfront bluff. The steeply sloping bluff formed as the result of erosion and landsliding caused by continuous exposure to wind, rain and ocean wave activity. Based on our review of aerial photography, progressive failure has been occurring approximately 50 feet to the south of the site but the timing and frequency of these failures is unknown. These failures appeared to have failed back and upslope a few feet at a time as they are limited by the underlying hard rock, and have also gradually increased the overall width of the bluff landslide area. We did not observe any evidence of recent movement of the upper bluff slope at the site, however shallow debris slides west of the proposed building have likely occurred in the past.

Continued recession of the bluff is anticipated, and future landslides that fail back up to a few or more feet at a time can occur along the bluff. Large landslides can also occur, particularly along weak fracture zones that may be present within the rock units. Predicting the size of future failures along the bluff is difficult, and cannot be fully quantified even with extensive subsurface exploration, testing and modeling. However, the rate of bluff recession here has not been nearly as rapid as other sites nearby because of the very hard rock underlying this lot.

Mapping by Allen and Priest (2001) identifies the upper bluff slope within the High Hazard Zone and the lower bluff slope of the site lies within the Active Erosion Hazard Zone. Coastal erosion hazard zone definitions and methodology are provided below.

The methodology provided by Allan and Priest (2001) defines four coastal erosion hazard zones for bluffs of Tillamook County, Oregon as follows:

"*Four bluff erosion hazard zones will be specified on the Tillamook County coastline:*

> *1. <u>Active Erosion Hazard Zone:</u> Currently active erosion area (rapid soil creep on steep bluff or headwall slopes plus active or potentially active landslides).*
>
> *2. <u>High Hazard Zone:</u> High probability that the area could be affected by active erosion in the next ~60-100 years. This zone boundary will, in effect, be the minimum distance that the bluff top (or landslide headwall) might retreat in the next 60-100 years.*
>
> *3. <u>Moderate Hazard Zone:</u> Moderate probability that the area could be affected by active erosion in the next ~100 years. This zone boundary will, in effect, be the mean distance that the bluff top (or landslide headwall) is likely to retreat in the next 60-100 years. In general this distance was approximately halfway between the high and low hazard zones.*
>
> *c. <u>Low Hazard Zone:</u> Low but significant probability that the area could be affected by active erosion in the next ~60-100 years. This includes; bluff tops that may retreat by maximum block failure at the end of an interval of gradual*

erosion, including some sub-aerial erosion, slope failures induced by Cascadia subduction zone earthquakes, or unusually high groundwater conditions. This zone boundary will, in effect, be the maximum distance that the bluff top (or landslide headwall) is likely to retreat in the next 60-100 years." (Allan and Priest, 2001).

It should be noted that mapping done for the 2001 study was intended for regional planning use, not for site specific hazard identification.

The site is also mapped in an area of high landslide susceptibility, based on the DOGAMI methodology (Burns, Mickelson, and Madin, 2016).

4.7 Regional Seismic Hazards

Abundant evidence indicates that a series of geologically recent large earthquakes related to the Cascadia Subduction Zone have occurred along the coastline of the Pacific Northwest. Evidence suggests that more than 40 great earthquakes of magnitude 8 and larger have struck western Oregon during the last 10,000 years. The calculated odds that a Cascadia earthquake will occur in the next 50 years range from 7–15 percent for a great earthquake affecting the entire Pacific Northwest, to about a 37 percent chance that the southern end of the Cascadia Subduction Zone will produce a major earthquake in the next 50 years (OSSPAC, 2013; OSU News and Research Communications, 2010; Goldfinger et al., 2012). Evidence suggests the last major earthquake occurred on January 26, 1700 and may have been of magnitude 8.9 to 9.0 (Clague et al., 2000).

There is now increasing recognition that great earthquakes do not necessarily result in a complete rupture along the full 1,200 km fault length of the Cascadia subduction zone. Evidence in the paleorecords indicates that partial ruptures of the plate boundary have occurred due to smaller earthquakes with moment magnitudes (Mw) < 9 (Witter et al., 2003; Kelsey et al., 2005). These partial segment ruptures appear to occur more frequently on the southern Oregon coast, as determined from paleotsunami studies. Furthermore, the records have documented that local tsunamis from Cascadia earthquakes recur in clusters (~250–400 years) followed by gaps of 700–1,300 years, with the higher tunamis associated with earthquakes occurring at the beginning and end of a cluster (Allan et al., 2015).

These major earthquake events were accompanied by widespread subsidence of a few centimeters to 1–2 meters (Leonard et al., 2004). Tsunamis appear to have been associated with many of these earthquakes. In addition, settlement, liquefaction and landsliding of some earth materials are believed to have been commonly associated with these seismic events.

Other earthquakes related to shallow crustal movements or earthquakes related to the Juan de Fuca plate have the potential to generate magnitude 6.0 to 7.5 earthquakes.

The recurrence interval for these types of earthquakes is difficult to determine from present data, but estimates of 100 to 200 years have been given in the literature (Rogers et al., 1996).

The nearest mapped potentially active fault is the Netarts Bay fault which lies at the north end of Netarts Bay, approximately 21 miles north of the site (Geomatrix, 1995). This fault is a west-northwest trending, high angle reverse fault which cuts Miocene basaltic and Pleistocene channel deposits. This fault is believed to have been active approximately 125,000 years ago, however it does not appear to cut 80,000 year old marine terrace deposits which suggests that the fault has not been active for at least 80,000 years (Geomatrix, 1995).

4.8 Flooding Hazards

Based on the 1978 Flood Insurance Rate Map (FIRM, Panel #4101960380A) the site lies in an area rated as Zone C which is defined as an area of minimal flooding. Saturated surface soil conditions can be expected at the site, particularly during wetter times of the year.

Based on the Oregon Department of Geology and Mineral Industries mapping (DOGAMI, 2012) the subject lot at lower elevations lies within the tsunami inundation zone resulting from an approximately 9.1 and greater magnitude Cascadia Subduction Zone (CSZ) earthquake. However, the proposed building site lies well above the tsunami inundation zone. The 2012 DOGAMI mapping is based upon 5 computer modeled scenarios for shoreline tsunami inundation caused by potential CSZ earthquake events ranging in magnitude from approximately 8.7 to 9.1. The January 1700 earthquake event (discussed in Section 5.0 above) has been rated as an approximate 8.9 magnitude in DOGAMI's methodology. More distant earthquakes can also generate tsunamis.

4.9 Climate Change

According to most of the recent scientific studies, the Earth's climate is believed to be changing as the result of human activities which are altering the chemical composition of the atmosphere through the buildup of greenhouse gases, primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons (EPA, 1998). Although there are uncertainties about exactly how and when the Earth's climate will respond to enhanced concentrations of greenhouse gases, scientific observations indicate that detectable changes are under way (EPA, 1998; Church and White, 2006). Global sea level rise, caused by melting polar ice caps and ocean thermal expansion, could lead to flooding of low-lying coastal property, loss of coastal wetlands, erosion of beaches and bluffs, and saltwater contamination of drinking water. Global climate change and the resultant sea level rise will likely impact the subject site through accelerated coastal erosion and more frequent and severe flooding. It can also lead to increased rainfall which can result in an increase in landslide occurrence.

4.10 Analyses of Erosion and Flooding Potential

4.10.1 Analysis of DOGAMI beach monitoring data available for the site (if available).

DOGAMI beach monitoring data is unavailable for this stretch of the beach.

4.10.2 Analysis of human activities affecting shoreline erosion.

We did not observe any human activities along the bluff that are affecting the shoreline erosion. See Section 2.11 above.

4.10.3 Analysis of possible mass wasting, including weathering processes, landsliding or slumping.

The site is located on the top of a basalt bluff that is part of a small cove along this stretch of the beach. Minor sloughing is evident in aerial photographs captured on August 16, 2017 towards the western edge of the site where the slope is steeper however we are unable to determine when this may have occurred.

A small rocky pocket beach within the cove has also formed approximately 50 feet to the south of the site that also shows evidence of sloughing at the top of the bluff. Materials in the bluff at that location are much weaker than the hard rock composing the bluff at the subject site.

Aerial video acquired on August 16, 2017 shows minor undercutting of the bluff just to the north of the base of the site. It appears that the undercutting has begun eroding sea caves in weaker material at the base of the bluff north of the site. Aerial imagery presented in Appendix A.

4.10.4 Calculation of wave run-up beyond mean water elevation that might result in erosion of the sea cliff or foredune.

As a very high bluff-backed site, wave run-up is restricted to the base of the bluff approximately 180 feet below the site. Aerial photographs of the bluff and beach are presented in Appendix A.

4.10.5 Evaluation of frequency that erosion-inducing processes could occur, considering the most extreme potential conditions of unusually high water levels together with severe storm wave energy.

On this stretch of bluff-backed shoreline erosion inducing processes are daily in the form of constant wave attack at the base of the bluff at high tide (Appendix A).

4.10.6 For dune-backed shoreline, use an established geometric model to assess the potential distance of property erosion, and compare the results with direct evidence obtained during site visit, aerial photo analysis, or analysis of DOGAMI beach monitoring data.

Not applicable to the site which is in a bluff-backed shoreline area.

4.10.7 For bluff-backed shoreline, use a combination of published reports, such as DOGAMI bluff and dune hazard risk zone studies, aerial photo analysis, and field work, to assess the potential distance of property erosion.

No published reports are available from DOGAMI with erosion rates for this stretch of bluff-backed shoreline. Review of aerial stereo-pair photographs from 1971, 1984, 1991, 1994 and 1998 did not indicate any measurable recession of the bluff.

Observations made during our site visits and analysis of the rock cores obtained during subsurface exploration indicate that the bluff at this site consists of hard basalt that is very resistant to erosion.

Additional observations are addressed in Sections 3.1, 3.4, 3.6, 4.2 and Appendices A, B and C.

4.10.8 Description of potential for sea level rise, estimated for local area by combining local tectonic subsidence or uplift with global rates of predicted sea level rise.

Based on data from NOAA monitoring stations at South Beach and Garibaldi this general area of Oregon's coastline has a sea level rise of approximately 2 mm/year, which includes the combined effects of global rates of sea level rise and land mass elevation changes (NOAA Tides & Currents Sea Level Trends http://tidesandcurrents.noaa.gov/sltrends/sltrends.html). Additional observations are addressed in Sections 3.9 (Climate Change) of this report.

4.11 Assessment of Potential Reactions to Erosion episodes.

4.11.1 Determination of legal restrictions of shoreline protective structures (Goal 18 prohibition, local conditional use requirements, priority for non-structural erosion control methods).

The site is not eligible for oceanfront protection under Goal 18.

4.11.2 Assessment of potential reactions to erosion events, addressing the need for future erosion control measures, building relocation, or building foundation and utility repairs.

Residential development recommendations including erosion control and foundation design recommendations are presented in Section 5, which note the need for deep foundations at the site. There will be insufficient available area to relocate the house on site due to required oceanfront setbacks. Moving the house off site may be possible because the depth of the house may be less than typical. The potential to move the house will be dependent upon design.

5.0 Conclusions and Recommendations

The main engineering geologic concerns at the site are:

1. The site lies adjacent to a steep, high oceanfront bluff slope which has formed from ocean wave, wind and rain erosion, sloughing and landsliding.

2. There is an inherent regional risk of earthquakes and associated tsunamis along the Oregon Coast which could cause harm and damage structures. These risks must be accepted by the owner, future owners and residents of the site.

Please note, the Oregon Coast is a dynamic and energetic environment. Most of the coastline along this bluff is slowly receding and will continue to recede in the future. Geologic conditions and the rates of geologic processes can change in the future. The setback recommendations presented in this report are based on past average erosion rates as determined from aerial photography, and past and current geologic conditions and processes. These setbacks are intended to protect the structure(s) for their typical life (50 to 70 years). Setbacks greater than our recommended minimum setbacks would provide the proposed structure(s) with a greater anticipated life and a lower risk from some geologic hazards. However, the area available for construction is already very limited.

5.1 Development Density

It is our understanding that only one single family residence will be located at the site.

5.2 Bluff Setback

The very steep nature of the bluff slope dictates a conservative setback for proposed construction, even though the slope is underlain by hard basaltic breccia rock. Although the bluff edge does not appear to have experienced any recession as observed in the aerial photo review, the upper slope west of the line labeled "Bluff Edge" on Figures 4 and 5 is an unstable soil slope which is prone to thin debris slides, as can be seen from the shallow, vegetated old debris slide scars along this slope. As a result, we recommend a 20 feet setback from the top of bluff along with the deep foundations recommendations below. In addition, the Neskowin Coastal Hazards Overlay Zone's regulatory requirements mandate a 20 feet setback from the bluff edge. According to Tillamook County Land Use Ordinance Article 3.500, Section 3.570(7)(b), "the required yard setback opposite the oceanfront may be reduced by one foot for each one foot of oceanfront setback provided beyond the minimum, down to a minimum of 10 feet."

We do not believe that shallow foundations are suitable for use at the site. The use of deep foundations may allow for cantilevering of the home beyond the western foundation line to provide for a larger home and improve views. Deep foundations will also provide protection from undermining of foundations in the event of a relatively shallow slope failure encroaching into the foundation area.

5.3 Grading Practices

We recommend the following grading practices:

5.3.1 Site Preparation

All loose, soft and organic-rich soils, and existing fills downslope of the driveway should be stripped from building, slab and driveway areas prior to construction.

We anticipate that native weathered rock will be encountered at approximately 5 feet, however depths may vary. Equipment capable of excavating through rock materials may be required depending on final design.

5.3.2 Cut and Fill Slopes

Temporary unsupported cut slopes less than 8 feet high should be no steeper than 1 horizontal to 1 vertical (1H:1V). All cuts greater than 8 feet high should be approved by a representative of our firm. All permanent cut and fill slopes should be no steeper than 2 horizontal to 1 vertical (2H:1V), or as approved by a representative of our firm.

TEMPORARY AND PERMANENT CUTS	
Temporary Cuts	1H:1V (maximum) [a]
Permanent Cuts	2H:1V (maximum) [a]
[a] All cuts greater than 8 feet high, or cuts where water seepage is encountered, should be approved by a representative of H.G. Schlicker & Associates, Inc.	

If the above cut and fill slope recommendations cannot be achieved due to construction and/or property line constraints, temporary or permanent retention of cut slopes may be required, as determined by a representative of our firm.

5.3.3 Structural Fill

Structural fills supporting building loads should consist of granular material, free of organics and deleterious materials, and contain no particles greater than 1½ inches in diameter so that nuclear methods (ASTM D2922 &ASTM D3017) can be easily used for field density testing. All areas to receive fill should be stripped of all organic soils, organic debris and existing fill.

Proper test frequency and earthwork documentation usually requires daily observation during stripping, rough grading, and placement of structural fill. Field density testing should generally conform to ASTM D2922 and D3017, or D1556. To minimize the number of field and laboratory tests, fill materials should be from a single source and of a consistent character. Structural fill should be approved and periodically observed by HGSA and tested by a qualified testing firm. Test results will need to be reviewed and approved by HGSA. We recommend that one density test be performed for at least every 18 inches of fill placed and every 200 cubic yards, whichever requires more testing. Because testing is performed on an on-call basis, we recommend that the earthwork contractor schedule the testing. Relatively more testing is typically necessary on smaller projects.

STRUCTURAL FILL	
Compaction Requirements	92% ASTM D1557, compacted in 8 inch lifts maximum, at or near the optimum moisture content (± 2%).
Benching Requirements [a]	Slopes steeper than 5H:1V that are to receive fill should be benched. Fills should not be placed along slopes steeper than 3H:1V, unless approved by H.G. Schlicker & Associates, Inc.
[a] Benches should be cut into native, non-organic, firm soils. Benches should be a minimum of 6 feet wide with side cuts no steeper than 1H:1V and no higher than 6 feet. The lowest bench should be keyed in a minimum of 2 feet into native, non-organic, firm soils.	

5.4 Vegetation Removal and Re-Vegetation Practices

Vegetation should be removed only as necessary and exposed areas should be replanted following construction. Disturbed ground surfaces exposed during the wet season (November 1 through April 30) should be temporarily planted with grasses, or protected with erosion control blankets or hydromulch. Existing vegetation should be left undisturbed as much as possible.

Temporary sediment fences should be installed downslope of any disturbed areas of the site until permanent vegetation cover can be established. See Figure 6 for design criteria for the construction of a sediment fence.

Exposed sloping areas steeper than 3 horizontal to 1 vertical (3H:1V) should be hydroseeded to provide erosion protection until permanent vegetation can be established. Erosion control blankets should be installed as per the manufacturer's recommendations.

5.5 Foundation Recommendations

Foundations will need to support vertical loads and provide lateral support in the event of the slope encroaching into the western and north-northwestern foundation area.

Foundations will also need to resist uplift forces, particularly for any cantilever type house design. Deep foundation elements at the site should be drilled and grouted in place. We recommend the use of bored and grouted micropile, bored and grouted H-pile (HP) sections or wide flange (WF) sections. The advantage of micropile is that smaller size equipment can complete the work. The advantage of bored and grouted HP or WF sections is that they would provide greater lateral resistance in the event of slope encroachment, and allow for greater on-center spacing. The disadvantage of all but micropile is the larger equipment needed to operate in the relatively small area of the subject lot.

Pile should be embedded a minimum of 40 feet deep into rock. The home can be placed either on grade beams supported by pile, or on elevated beams supported on the pile. Beams should be oriented so that they generally tie the western pile to eastern pile. Pile spacing can vary with type of pile utilized, and HGSA should work with the structural engineer and architect to determine a suitable spacing for the type(s) of pile selected. Prior to construction the contractor should provide a work plan for HGSA's review.

We provide the following allowable pile loads based on grout-to-ground bond strengths at various drilled hole diameters for 40 feet length gravity grouted pile:

GRAVITY GROUTED PILE ALLOWABLE LOADS[b]			
Pile (Drilled Hole) Diameter	6 inches	8 inches	12 inches
Allowable Pile Loads (Compression) (FOS = 3)[a]	301 kips	401 kips	603 kips
Allowable Pile Loads (Tension) (FOS = 3)[a]	196 kips	262 kips	394 kips

[a] A representative of HGSA should observe pile installation operations and verify achieved embedment depths on-site. Please provide us with at least five (5) days notice prior to any needed site observations.
[b] An increase of one-third is allowed for short term wind and seismic loads.

Pile utilizing the above recommended bond strengths will have negligible settlement. A representative of HGSA should observe all pile construction and installation operations to ensure that suitable materials have been encountered and address any issues that may arise during construction (Appendix D).

Any structures and all structural elements should be designed to meet current Oregon Residential Specialty Code (ORSC) seismic requirements, as specified in Section 4.11 of our June 18, 2015 report for the site (HGSA #Y153828); and meet Oregon Structural

Specialty Codes (OSSC) for all foundation elements not covered by residential code.

5.6 Retaining Wall Recommendations

For static conditions free standing retaining walls should be designed for a lateral static active earth pressure expressed as an equivalent fluid density (EFD) of 35 pounds per cubic foot, assuming level backfill behind the wall equal to a distance of at least half the height of the wall. An EFD of 45 pounds per cubic foot should be used assuming sloping backfill of 2H:1V.

At rest retaining walls should be designed for a lateral static at-rest pressure expressed as an EFD of 60 pounds per cubic foot, assuming level backfill behind the wall equal to a distance of at least half of the height of the wall. Walls need to be fully drained to prevent the build-up of hydrostatic pressures.

The above EFDs assume static conditions, and no surcharge loads from vehicles or structures. If surcharge loads will be applied to the retaining walls, forces on the walls resulting from these loads will need to be added to the pressures given above.

For seismic loading a unit pseudostatic force equal to 11.97 pcf $(H)^2$; where H is the height of the wall in feet, should be added to the static lateral earth pressure. The location of the pseudostatic force can be assumed to act at a distance of 0.6H above the base of the wall.

Backfill for walls should be placed in 8 inch horizontal lifts and machine compacted to 92 percent of the maximum dry density as determined by ASTM D1557. Compaction within 2 feet of the wall should be accomplished with light weight hand operated compaction equipment to avoid applying additional lateral pressure on the walls. Drainage of the retaining wall should consist of slotted drains placed at the base of the wall on the backfilled side and backfilled with free-draining crushed rock (less than 5% passing the 200 mesh sieve using a washed sieve method) protected by non-woven filter fabric (Mirafi 140N or equivalent) placed between the native soil and the backfill.

RETAINING WALL EARTH PRESSURE PARAMETERS	
Static Case, Active Wall (level backfill/grades)	35 psf/linear foot [a]
Static Case, Active Wall (2H:1V backfill/grades)	45 psf/linear foot [a]
Static Case, At-Rest Wall (level backfill/grades)	60 psf/linear foot [a]
Seismic Loading (level backfill/grades)	11.97 pcf $(H)^2$ [b]
[a] Earth pressure expressed as an equivalent fluid pressure (EFD). The location of the earth pressure can be assumed to act at a distance of 0.33H above the base of the wall. [b] Seismic loading expressed as a pseudostatic force, where H is the height of the wall in feet. The location of the pseudostatic force can be assumed to act at a distance of 0.6H above the base of the wall.	

Filter fabric protected free-draining crushed rock should extend to within 2 feet of the ground surface behind the wall, and the filter fabric should be overlapped at the top per the manufacturer's recommendations. All walls should be fully drained to prevent the build-up of hydrostatic pressures. All retaining walls should have a minimum of 2 feet of embedment at the toe, or be designed without passive resistance.

5.7 Drainage and Storm Water Management

Surface water should be diverted from building foundations to approved disposal points by grading the ground surface to slope away from the foundation to prevent ponding near the structures. Footing drains should be installed adjacent to the perimeter footings and sloped to drain.

In addition to the perimeter foundation drain system, drainage of any crawlspace areas is recommended. Each crawlspace should be graded to a low point for installation of a crawlspace drain that is tied into the perimeter footing drain and tightlined to an approved disposal point. It may be possible to omit footing and crawlspace drains depending upon house design.

All roof drains should be collected and tight-lined in a separate system independent of the footing drains. All roof and footing drains should be tight-lined and discharged, in separate systems or with an approved backflow prevention device, to an approved disposal point such as hard rock on the bluff or a rock apron near the bluff edge. Water collected on the site should not be concentrated and discharged to adjacent properties.

The catch basin stormwater outflow at the site currently discharges to an area near the proposed house footprint. This discharge point should be moved further downslope away from the house.

5.8 Erosion Control

As detailed above (Section 4.4), vegetation should be removed only as necessary and exposed areas should be replanted following construction. Disturbed ground surfaces exposed during the wet season (November 1 through April 30) should be temporarily planted with grasses, or protected with erosion control blankets.

A temporary sediment fence should be installed downslope of any disturbed areas of the site until permanent vegetation cover can be established. See Figure 6 for design criteria for the construction of a sediment fence.

As recommended above, exposed sloping areas steeper than 3 horizontal to 1 vertical (3H:1V) should be protected by hydroseeding or the use of rolled erosion control products (RECP's) aka "erosion control blankets", to provide erosion protection until permanent vegetation can be established. Erosion control blankets should be installed as per the manufacturer's recommendations.

5.9 Flooding Considerations

Provided that all drainage recommendations detailed in this report are adhered to during design and construction, we do not anticipate flooding hazards at the site.

5.10 Seismic Considerations

The structure and all structural elements should be designed to meet current Oregon Residential Specialty Code (ORSC) seismic requirements. Based on our knowledge of subsurface conditions at the site, and our analysis using the guidelines recommended in the ORSC, the structure should be designed to meet the following seismic parameters:

SEISMIC DESIGN PARAMETERS	
Site Class	D
Seismic Design Category	D_2
Mapped Spectral Response Acceleration for Short Periods	S_S = 1.301 g
Site Coefficients	F_a = 0.800 F_v = 0.800
Design Spectral Response Acceleration at Short Periods	S_{DS} = 0.694 g

5.11 Plan Review and Construction Observations

Prior to construction, we should be provided the opportunity to review all site development, foundation, drainage, erosion control and grading plans to assure conformance with the intent of our recommendations (Appendix D). HGSA should also be provided with a pile construction work plan for review prior to construction. All site plans, details and specifications should clearly show that the above recommendations have been implemented into the design.

A representative of HGSA should observe grade beam and slab excavations prior to placing structural fill, forming and pouring concrete to assure that suitable bearing materials have been reached (Appendix D). At the time of our observations we may recommend additional excavation if suitable bearing materials have not been reached. We should also observe pile installation operations (Appendix D). Please provide us with at least 5 (five) days notice prior to any needed site observations. There will be additional costs for these services.

5.12 Worker Safety

All construction activities should be completed in accordance with OSHA standards, and all State and local laws, rules, regulations and codes.

6.0 Additional Services

Design Review

This report pertains to a specific site and development. It is not applicable to adjacent sites nor is it valid for types of development other than that to which it refers. Any variation from the site or development plans necessitates a geotechnical review in order to determine the validity of the design concepts evolved herein.

HGSA's review of final plans and specifications is necessary to determine whether the recommendations detailed in this report for the site have been properly interpreted and incorporated in the design and construction documents. At the completion of our review we will issue a letter of conformance to the client for the plans and specifications.

Construction Monitoring

Because of the judgmental character of geotechnics, as well as the potential for adverse circumstances arising from construction activity, observations during site preparation, excavation, and construction will need to be carried out by a representative of HGSA or our designate. These observations may then serve as a basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein to the benefit of the project. Field observations become increasingly important should earthwork proceed during adverse weather conditions.

7.0 Limitations

The Oregon Coast is a dynamic environment with inherent unavoidable risks to development. Landsliding, erosion, tsunamis, storms, earthquakes and other natural events can cause severe impacts to structures built within this environment and can be detrimental to the health and welfare of those who choose to place themselves within this environment. The client is warned that, although this report is intended to identify the geologic hazards causing these risks, the scientific and engineering communities knowledge and understanding of geologic hazards processes is not complete.

Our investigation was based on engineering geological reconnaissance, limited review of published information, and our subsurface exploration and analyses. The data presented in this report are believed to be representative of the site. The conclusions herein are professional opinions derived in accordance with current standards of professional practice and budget constraints. No warranty is expressed or implied. The performance of the site during a seismic event has not been evaluated. If you would like us to do so, please contact us.

The boring logs and related information depict generalized subsurface conditions only at these specific locations and at the particular time the subsurface exploration was completed. Soil, rock and groundwater conditions at other locations may differ from the conditions at these boring locations. Also, the passage of time may result in a change in the soil and groundwater conditions at the site.

This report pertains to the subject site only, and is not applicable to adjacent sites nor is it valid for types of development other than that to which it refers. Geologic conditions including materials, processes and rates can change with time and therefore a review of the site and/or this report may be necessary as time passes to assure its accuracy and adequacy. This report may only be copied in its entirety.

8.0 Disclosure

H.G. Schlicker & Associates, Inc. and the undersigned Certified Engineering Geologist have no financial interest in the subject site, the project or the Client's organization.

9.0 References Cited

Allan, J. C. and Priest, G. R., 2001, Evaluation of coastal erosion hazard zones along dune and bluff backed shorelines in Tillamook County, Oregon: Cascade Head to Cape Falcon: Oregon Department of Geology and Mineral Industries, Open File Report O-01-03, 126p., maps.

Allan, J. C., Ruggiero, P., Cohn, N., Garcia, G., O'Brien, F. E., Serafin, K., Stimely, L. L. and Roberts, J. T., 2015, Coastal Flood Hazard Study, Lincoln County, Oregon: Oregon Department of Geology and Mineral Industries, Open-File Report O-15-06, 351 p.

Burns, W. J., Mickelson, K. A., and Madin, I. P., 2016, Landslide susceptibility overview map of Oregon: Oregon Department of Geology and Mineral Industries, Open-File Report O-16-02, 48 p., 1 plate.

Church, J. A., and White, N. J., 2006, A 20th century acceleration in global sea-level rise; Geophysical Research Letters, v. 22, LO1601, 4 p.

Clague, J. J., Atwater, B. F., Wang, K., Wang, Y., and Wong, I., 2000, Penrose Conference 2000 - Great Cascadia Earthquake Tricentennial, Programs Summary and Abstracts: Oregon Department of Geology and Mineral Industries, Special Paper 33, 156 p.

DOGAMI, 2012, Tsunami inundation maps for Neskowin, Tillamook County, Oregon: Oregon Department of Geology and Mineral Industries, TIM-Till-14, maps.

EPA, 1998, Climate Change and Oregon: Environmental Protection Agency, EPA 236-98-007u, 4 p.

Geomatrix Consultants, 1995, Seismic design mapping, State of Oregon, final report: Prepared for the Oregon Department of Transportation, Project No. 2442.

Goldfinger, C., Nelson, C. H., Morey, A. E., Johnson, J. E., Patton, J. R., Karabanov, E., Gutiérrez-Pastor, J., Eriksson, A. T., Gràcia, E., Dunhill, G., Enkin, R. J., Dallimore, A., and Vallier, T., 2012, Turbidite event history—Methods and implications for Holocene paleoseismicity of the Cascadia subduction zone: U.S. Geological Survey Professional Paper 1661–F, 170 p.

Kelsey, H. M., Nelson, A. R., Hemphill-Haley, E., and Witter, R. C., 2005, Tsunami history of an Oregon coastal lake reveals a 4600 yr record of great earthquakes on the Cascadia subduction zone: Geological Society of America Bulletin, v. 117, no. 7/8, p. 1009-1032.

Leonard, L. J., Hyndman, R. D., and Mazzotti, S., 2004, Coseismic subisdence in the 1700 great Cascadia earthquake: Coastal estimates versus elastic dislocation models: Geological Society of America Bulletin, May/June 2004, v. 116, no. 5/6, pp. 655–670.

Oregon Seismic Safety Policy Advisory Commission (OSSPAC), February 2013, The Oregon Resilience Plan: Reducing Risk and Improving Recovery for the next Cascadia Earthquake and Tsunami—Report to the 77th Legislative Assembly: State of Oregon Office of Emergency Management, 341 p.

OSU News and Research Communications, May 24, 2010, Odds are 1-in-3 that a huge quake will hit Northwest in next 50 years: Oregon State University, Corvallis http ://oregonstate.edu/ua/ncs/archives/2010/may/odds-huge-quake-Northwest-next-50-years

Priest, G. R., 1995, Explanation of mapping methods and use of the tsunami hazard maps of the Oregon Coast: Oregon Department of Geology and Mineral Industries, Open-File Report O-95-67, 95 p.

Priest, G. R., 1995, Tsunami hazard map of the Neskowin Quadrangle, Tillamook and Lincoln Counties, Oregon: Oregon Department of Geology and Mineral Industries, Open-File Report O-95-24.

Rogers, A. M., Walsh, T. J., Kockelman, J., and Priest, G. R., 1996, Earthquake hazards in the Pacific Northwest - an overview: U.S. Geological Survey, Professional Paper 1560, p. 1-54.

Schlicker, H. G., Deacon, R. J., Beaulieu, J. D., and Olcott, G. W., 1972, Environmental geology of the coastal region of Tillamook and Clatsop Counties, Oregon: Oregon Department of Geology and Mineral Industries, Bulletin 74, 164 p., maps.

Snavely, P. D., Niem, A., Wang, F. L., MacLeod, N. S., and Calhoun, T. K., 1996, Geologic map of the Cascade Head Area, Northwestern Oregon Coast Range (Neskowin, Nestucca Bay, Hebo, and Dolph 7.5 minute Quadrangles): U.S. Geological Survey, Open File Report 96-0534, 16 p., maps.

Witter, R. C., Kelsey, H. M., and Hemphill-Haley, E., 2003, Great Cascadia earthquakes and tsunamis of the past 6700 years, Coquille River estuary, southern coastal Oregon: Geological Society of America Bulletin, v. 115, p. 1289-1306.

It has been our pleasure to serve you. If you have any questions concerning this report, or the site, please contact us.

Respectfully submitted,

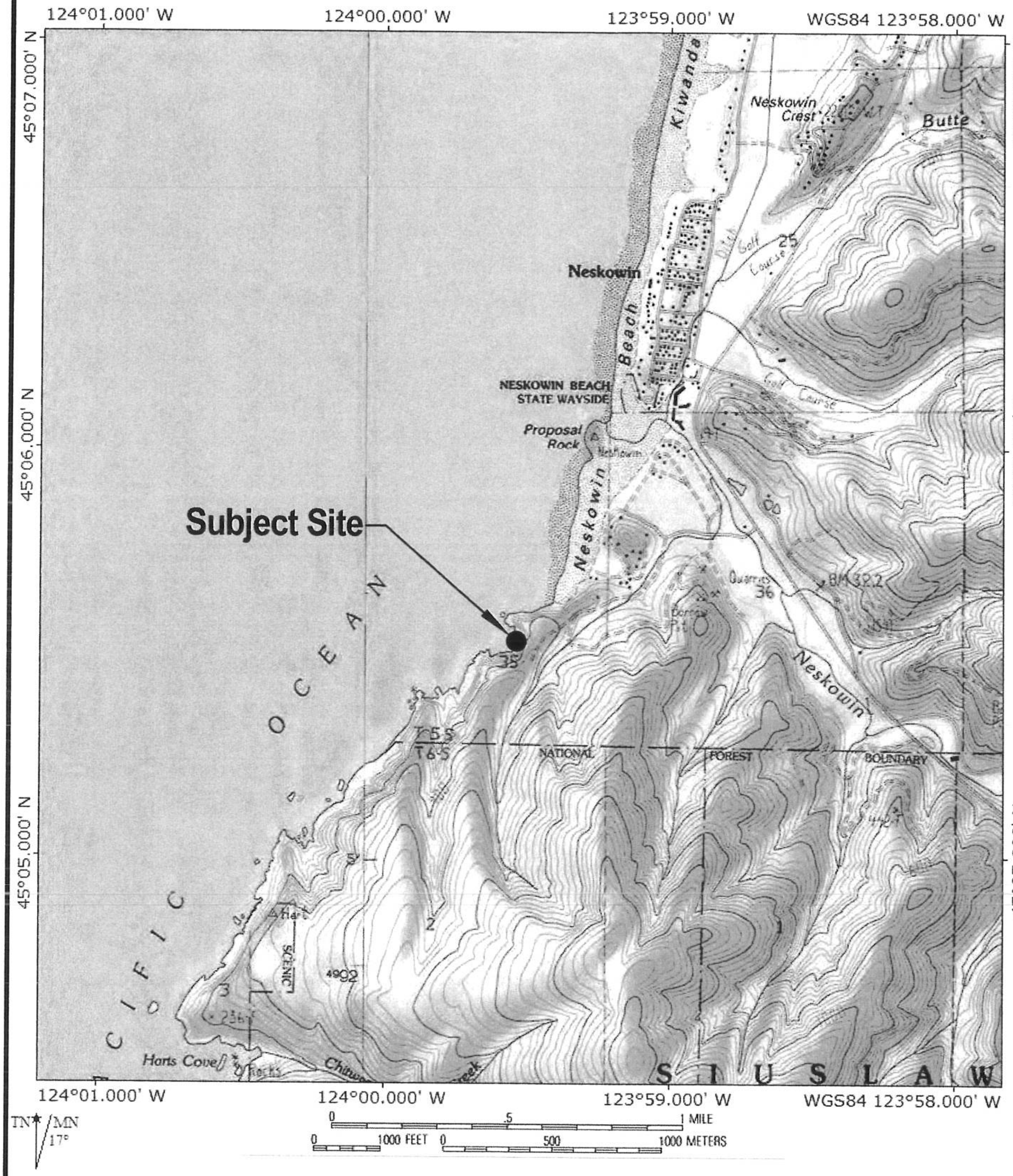
H.G. SCHLICKER AND ASSOCIATES, INC.

CERTIFIED OREGON E-902 ENGINEERING GEOLOGIST

EXPIRES: 11/01/2018

J. Douglas Gless, MSc, RG, CEG, LHG
President/Principal Engineering Geologist

JDG:aml

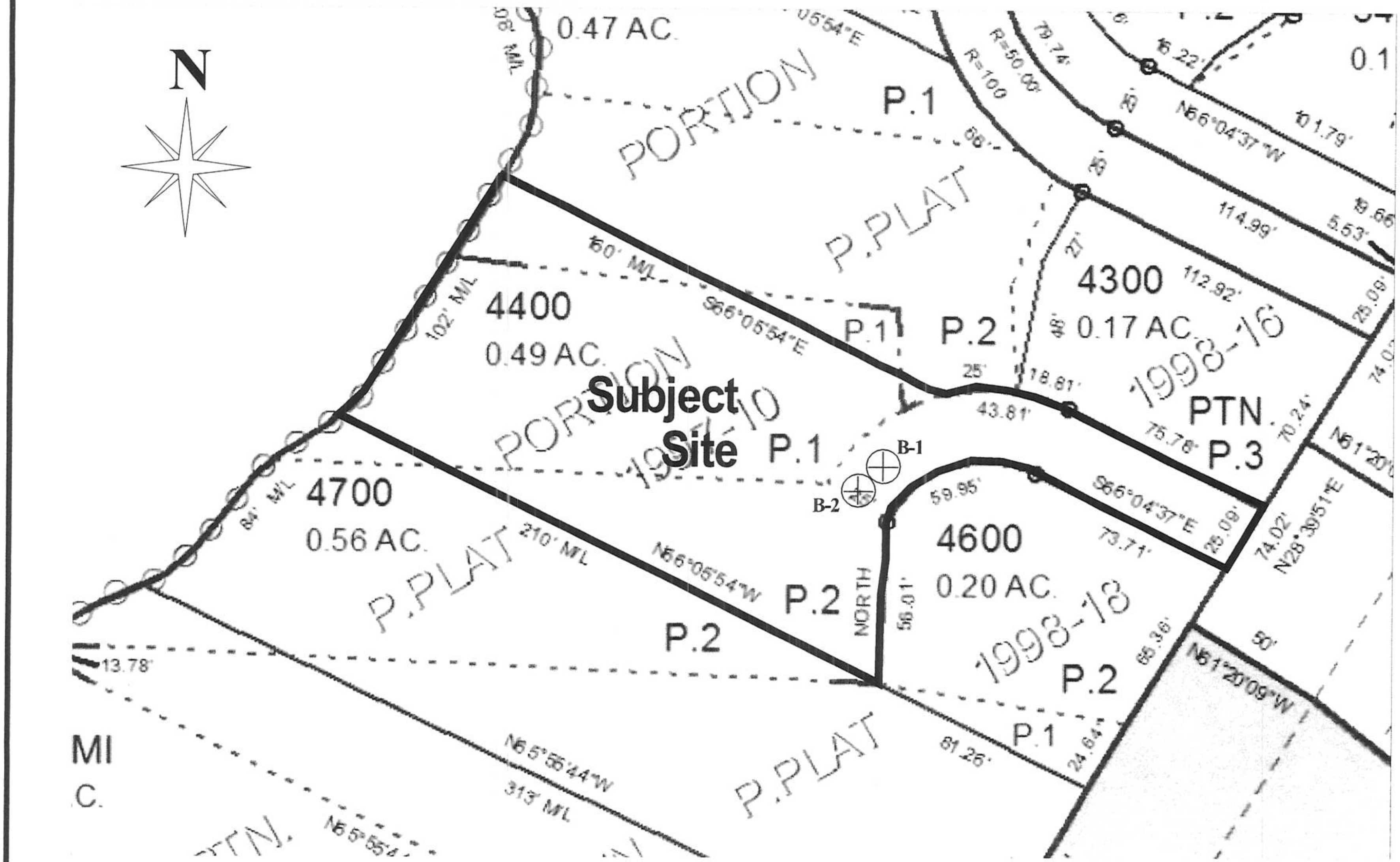


Date: 12/06/2017	**Project #Y174044**	Prepared by: AML
Scale: 1" = 2,000'		Approved by: JDG

Location Map
Tax Lot 440, Map 5S-11-35DA
Tillamook County, Oregon

H.G. Schlicker & Associates, Inc.

Figure 1



B-1

= Approximate location of boring

A A'

= Approximate trend of profile line

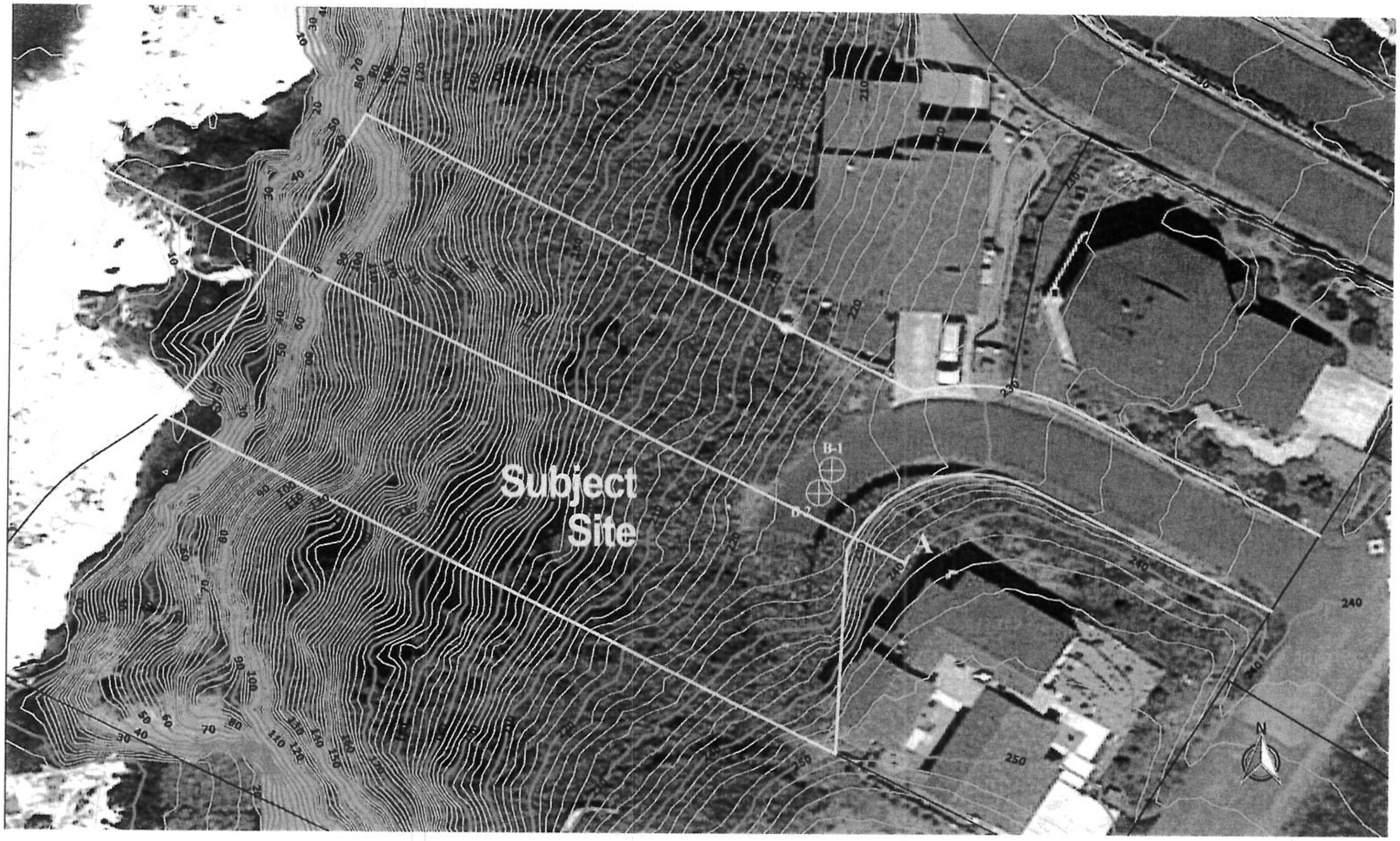
Modified from Plat Map 05S11W35DA.
All locations and dimensions are approximate.

Date: 12/06/2017	Project #Y174044	Prepared by: AML
Scale: 1" = 50'		Approved by: JDG

Site Map
Tax Lot 440, Map 5S-11-35DA
Tillamook County, Oregon

H.G. Schlicker & Associates, Inc.

Figure 2



B-1 ⊕ = Approximate location of boring

A ⊢—⊣ A' = Approximate trend of profile line

Imagery from Google. Topographic data derived from 2009_OLC_North Coast lidar data provided byDOGAMI.
Elevation Vertical Datum is NAVD 88.
All locations and dimensions are approximate.

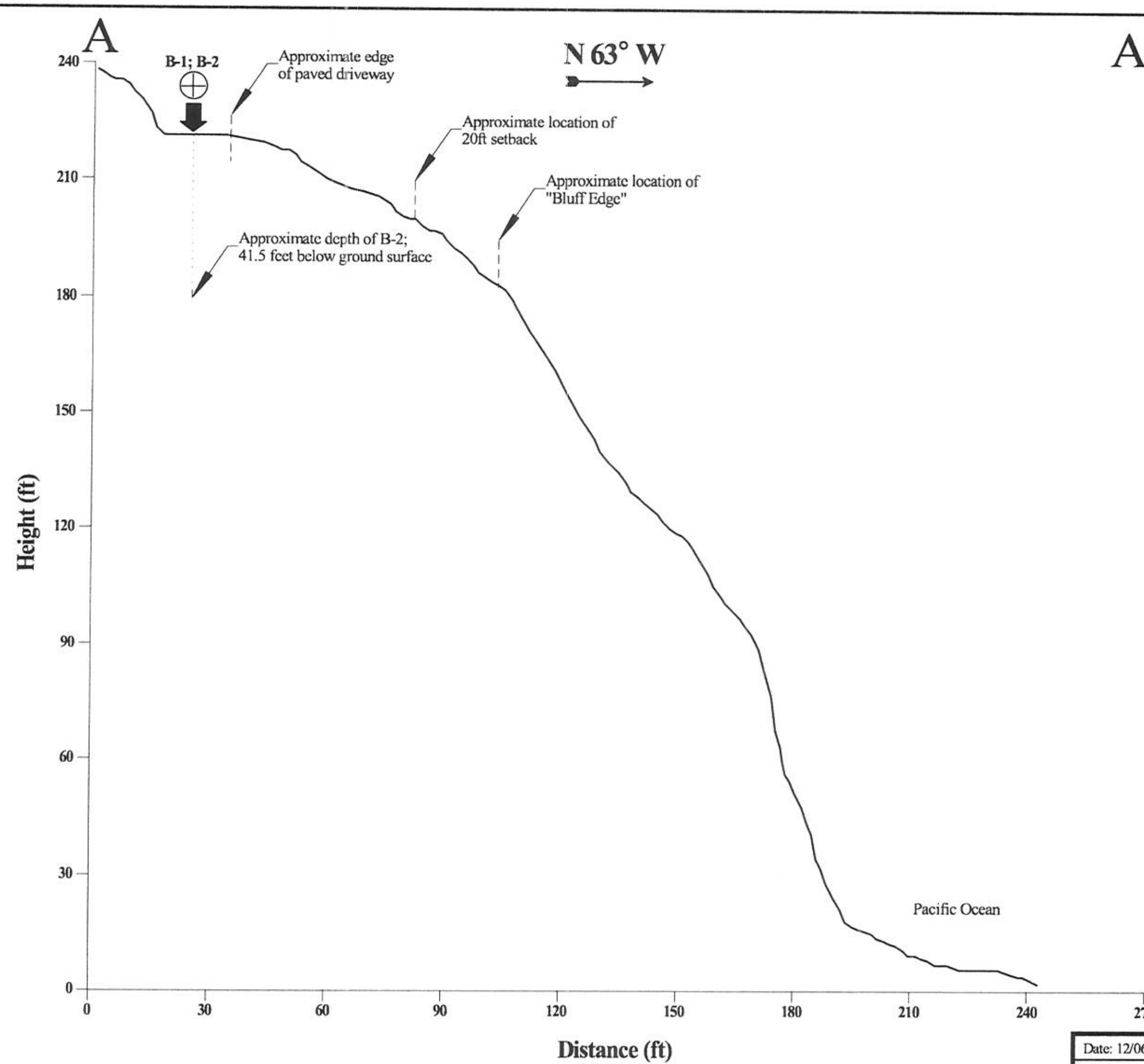
30 0 30 60 ft

Date: 12/06/2017	Project #Y174044	Prepared by: AML
Scale: 1" = 30		Approved by: JDG

Site Topographic Map
Tax Lot 440, Map 5S-11-35DA
Tillamook County, Oregon

H.G. Schlicker & Associates, Inc.

Figure 3



B-1 = Approximate location of boring

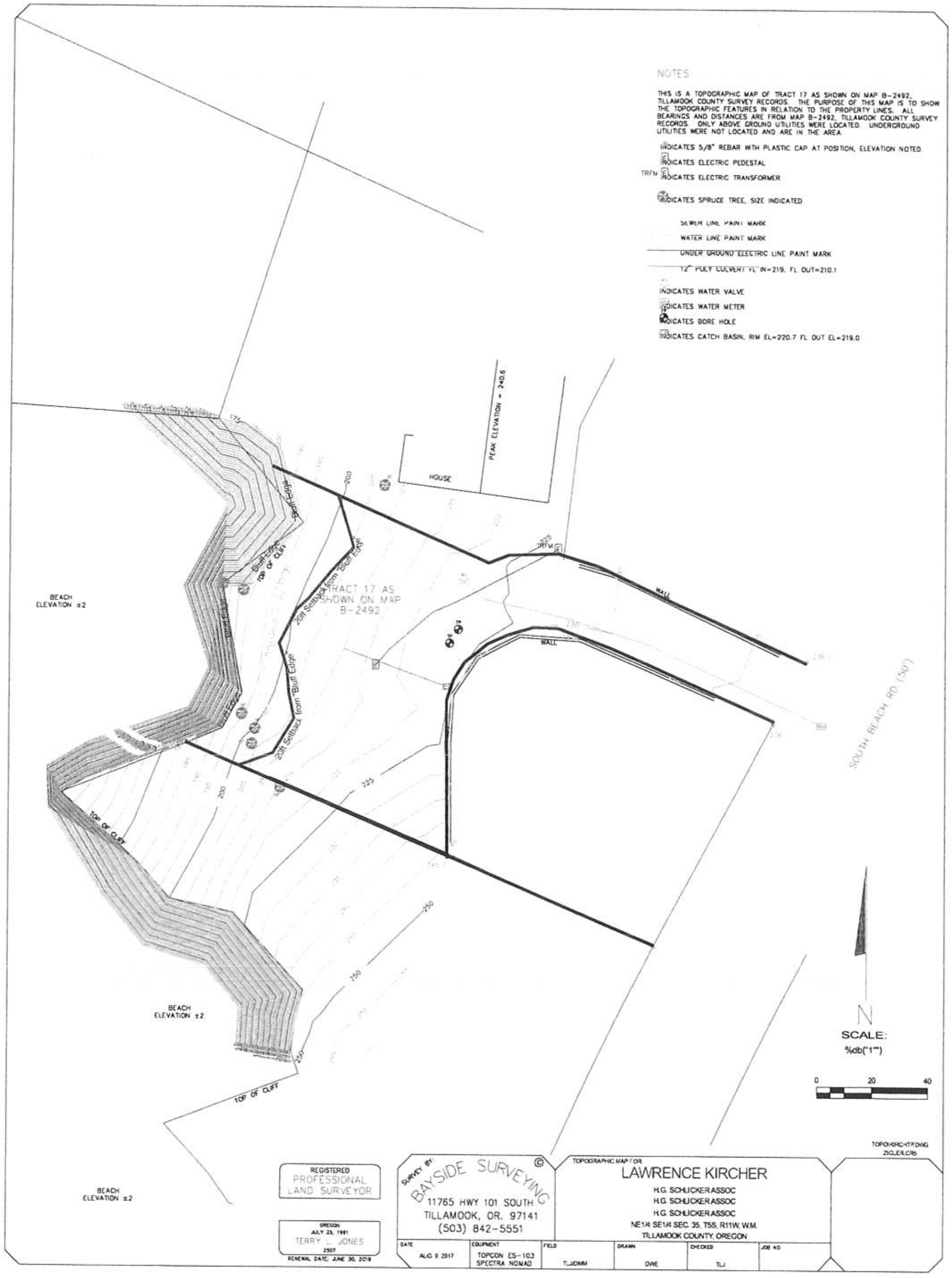
All dimensions and locations are approximate.
Heights derived from 2009 OLC North Coast lidar data from DOGAMI.

Date: 12/06/2017	Project #Y174044	Prepared by: AML
Scale: 1" = 30'		Approved by: JDG

Slope Profile, A-A'
Tax Lot 440, Map 5S-11-35DA
Tillamook County, Oregon

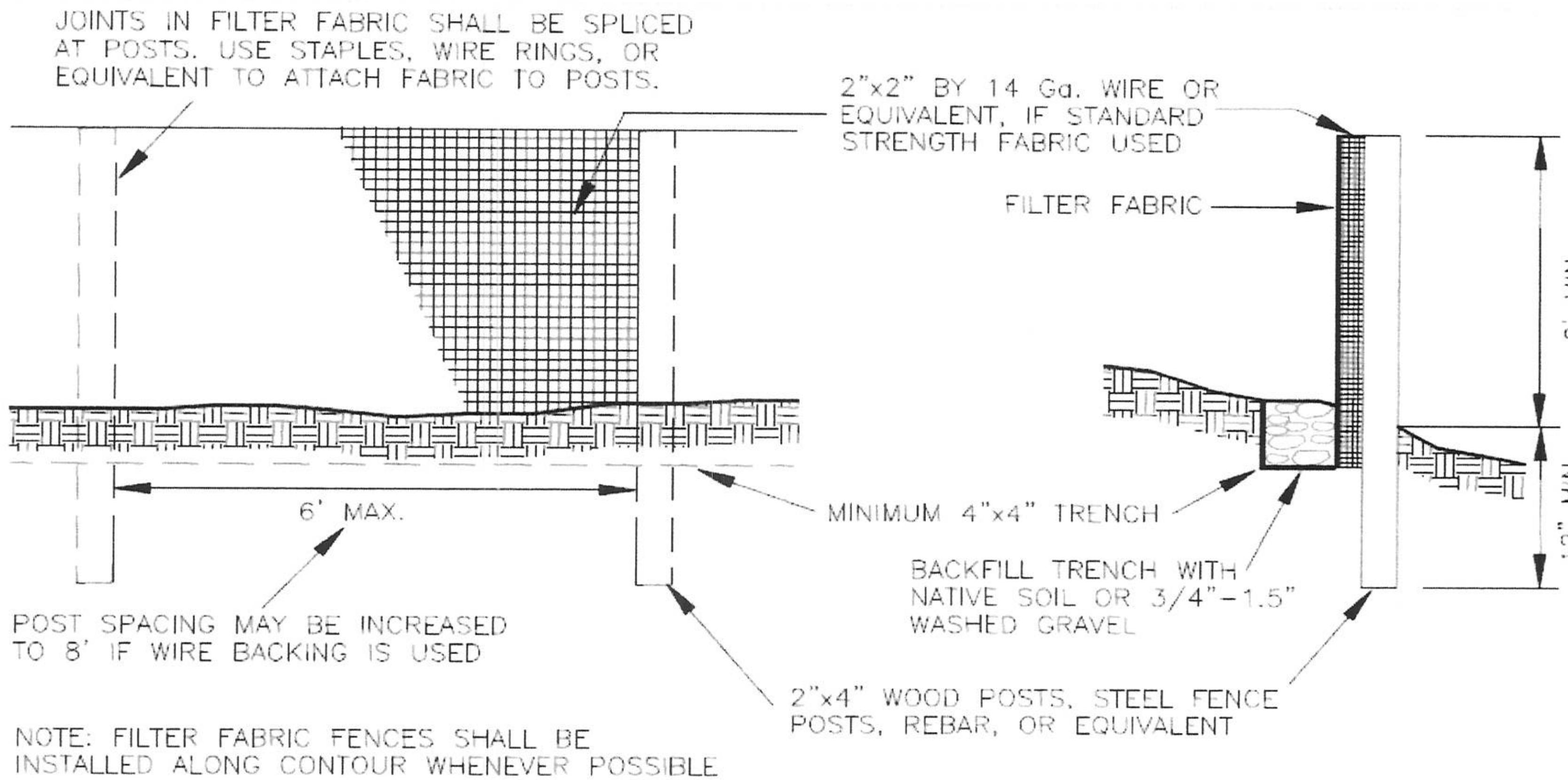
H.G. Schlicker & Associates, Inc.

Figure 4



Modified from drawing provided by Bayside Surveying.
All locations and dimensions are approximate.

Date: 12/06/2017	**Project #Y174044**	Prepared by: AML
Scale: 1" = 40'		Approved by: JDG
	Site Topographic Survey Tax Lot 440, Map 5S-11-35DA Tillamook County, Oregon	
	H.G. Schlicker & Associates, Inc.	**Figure 5**



Date: 12/06/2017	Project #Y174044	Prepared by: AML Approved by: JDG
	Sediment Fence Detail Tax Lot 440, Map 5S-11-35DA Tillamook County, Oregon	
H.G. Schlicker & Associates, Inc.		**Figure 6**

Appendix A
- Site Photographs -

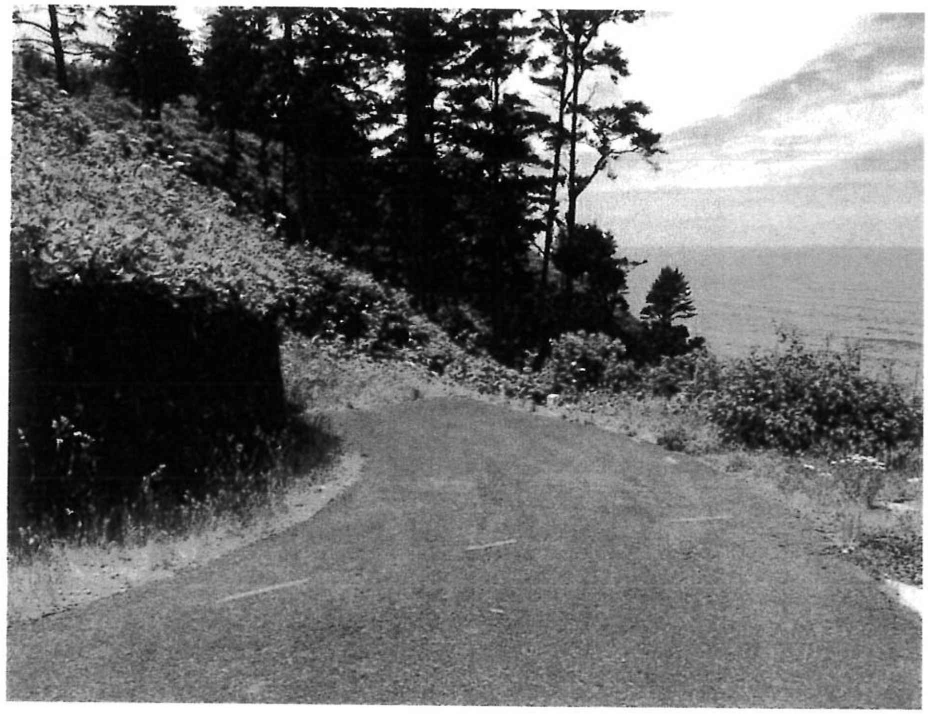


Photo 1 - Southerly view of the driveway leading to the site.

Photo 2 - View of the vegetation on the site.

Photo 3 - Oblique aerial photograph of the site, nearby lots and the Pacific Ocean to the west.

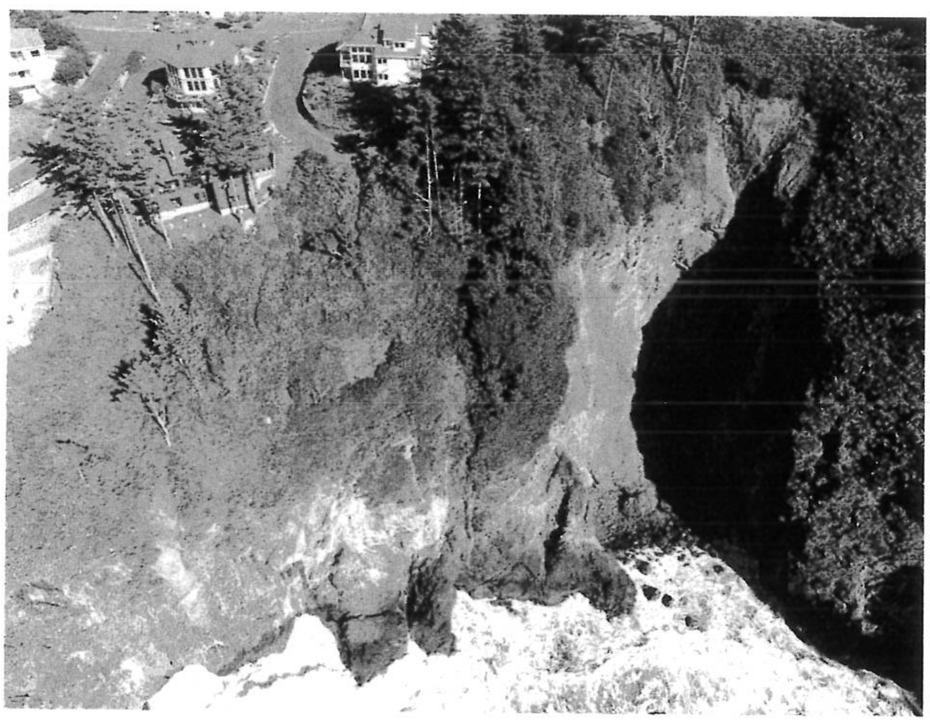


Photo 4 - Oblique aerial photograph of the bluff in the area of the site.

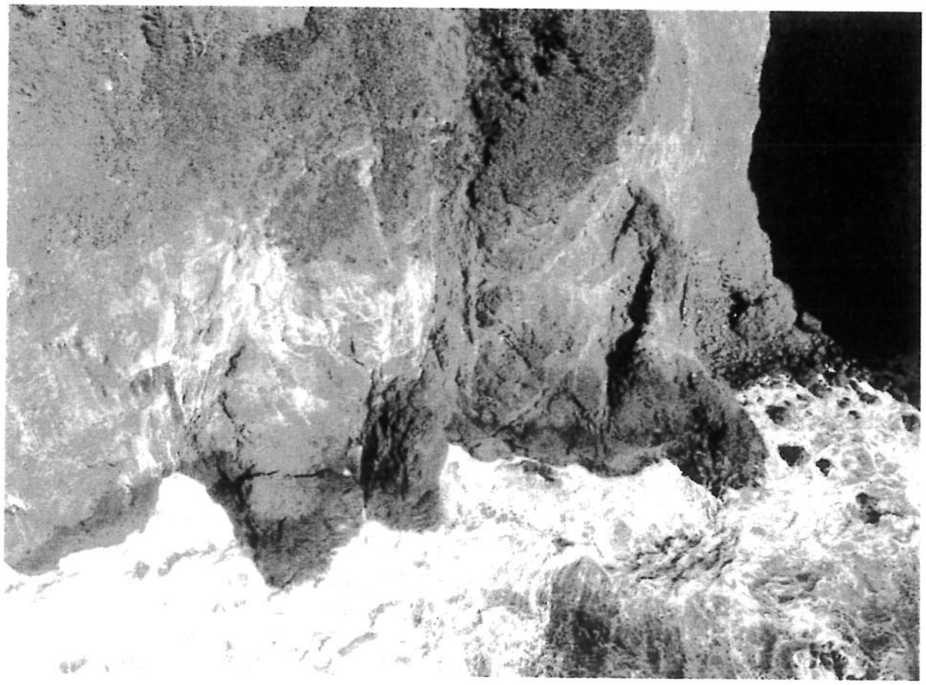


Photo 5 - Oblique aerial photograph of the base of the bluff below the site.

Photo 6 - Close-up view of basalt breccia exposed upslope to the east of the site.

Photo 7 - Close-up view of rock core samples from boring B-2 recovered from approximately 10 to 19.5 feet below ground surface.

Appendix B
- Boring Logs -

Location: Neskowin, OR	**Job Name: Kircher**	**Project** #Y174044
Drilling Co.: Hardcore Driller: Sam Drill Rig: Truck #102, CME 75 Mud rotary with HQ core		**Boring #:** 1 Sheet 1 of 1
Field Personnel: Adam Large		Ground Elevation: ~220

Water Level	Depth (ft.)	Time	Date	Start	Finish
NONE ENCOUNTERED				Time: 10:30 am	Time: 3:30 pm
				Date: 6/30/2017	Date: 6/30/2017

Attempt. Sample Length (ft.)	Core Recovery (ft.)	Sum >4" (ft.)	RQD	Depth (ft.)	Description
				0	Asphalt surface approximately 6" thick.
					Approximately 6" of gravel road base.
					SILTY SANDY GRAVEL/WEATHERED BASALT BRECCIA - Brown/gray, with extensively weathered/altered basalt breccia
				2.5	
				5	SPT at 5-6.5' : 16, 22, 52, sandy with highly weathered basalt gravel. Slightly cemented, Red/Brown.
				7.5	
					CLAYEY SAND WITH GRAVEL/WEATHERED BASALT BRECCIA - Blue-gray, moist, dense to very dense, coarse sand and gravel with extensively weathered/altered basalt breccia
				10	SPT at 10': 50 blows for 4" inches then refusal. BASALT BRECCIA
1.00	1.00	1.00	100		Core from 10.5' to 11.5', BASALT/BASALT BRECCIA, slightly vesiculated at top of core, zeolite infilling in fractures and vesicles. RQD: 100%, RMQ: Fresh Rock
5.00	4.75	4.75	95		Core from 11.5' to 16.5', BASALT/BASALT BRECCIA. Zeolite infilling in fractures. RQD: 95%, RMQ: Fresh Rock
				12.5	
				15	
					HQ core locked up downhole - breaking saver sub.
					Boring terminated at 16.5' in fresh basalt/basalt breccia
				17.5	

H.G. Schlicker & Associates, Inc.

Location: Neskowin, OR	**Job Name: Kircher**	**Project #**Y174044
Drilling Co.: Hardcore Driller: Sam Drill Rig: Truck #102, CME 75 Mud rotary with HQ core		**Boring #:** 2 Sheet 1 of 3
Field Personnel: Adam Large		Ground Elevation: ~220

Water Level	Depth (ft.)	Time	Date	Start	Finish
NONE ENCOUNTERED				Time: 9:45 am	Time: 6:30 pm
				Date: 7/10/2017	Date: 7/10/2017

Attempt. Sample Length (ft.)	Core Recovery (ft.)	Sum >4" (ft.)	RQD	Depth (ft.)	Description
				0	Asphalt surface approximately 6" thick.
					Approximately 6" of gravel road base.
					SILTY SANDY GRAVEL/WEATHERED BASALT BRECCIA - Brown/gray, with extensively weathered/altered basalt breccia
				2.5	No SPT. Used Tri-cone bit to get down to hard rock faster. See Boring log 1 for first 10'
				5	
				7.5	
				10	
2.00	1.68	1.67	84		Core from 10' to 12', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 84%, RMQ: Hard Rock
1.00	1.00	.67	67	12.5	Core from 12' to 13', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 67%, RMQ: Moderately Weathered Rock
2.00	1.83	1.83	92		Core from 13' to 15', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 92%, RMQ: Fresh Rock
3.00	3.00	2.42	81	15	Core from 15' to 18', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 81%, RMQ: Hard Rock
				17.5	

Location: Neskowin, OR	Job Name: Kircher	Project #Y174044
Drilling Co.: Hardcore Driller: Sam Drill Rig: Truck #102, CME 75 Mud rotary with HQ core		Boring #: 2 Sheet 2 of 3
Field Personnel: Adam Large		Ground Elevation: ~220

Water Level	Depth (ft.)	Time	Date	Start	Finish
NONE ENCOUNTERED				Time: 9:45 am	Time: 6:30 pm
				Date: 7/10/2017	Date: 7/10/2017

Attempt. Sample Length (ft.)	Core Recovery (ft.)	Sum >4" (ft.)	RQD	Depth (ft.)	Description
3.00	3.00	2.16	72	18	Core from 18' to 21', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 72%, RMQ: Moderately Weathered Rock
				20.5	
4.00	3.50	2.83	71		Core from 21' to 25', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 71%, RMQ: Moderately Weathered Rock
				22.5	
1.25	1.25	0.75	60	25	Core from 25' to ~26', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 60%, RMQ: Moderately Weathered Rock
2.75	2.63	2.38	87		Core from ~26' to 29', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 87%, RMQ: Hard Rock
				27.5	
2.50	2.50	2.25	90	30	Core from 29' to 31.5', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 90%, RMQ: Hard Rock
5.00	5.00	2.54	51		Core from 31.5' to 36.5', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 51%, RMQ: Moderately Weathered Rock
				32.5	
				35	

Location: Neskowin, OR	**Job Name: Kircher**	**Project** #Y174044
Drilling Co.: Hardcore Driller: Sam Drill Rig: Truck #102, CME 75 Mud rotary with HQ core		**Boring #:** 2 Sheet 3 of 3
Field Personnel: Adam Large		Ground Elevation: ~220

Water Level	**Depth (ft.)**	**Time**	**Date**	**Start**	**Finish**
NONE ENCOUNTERED				Time: 9:45 am	Time: 6:30 pm
				Date: 7/10/2017	Date: 7/10/2017

Attempt. Sample Length (ft.)	Core Recovery (ft.)	Sum >4" (ft.)	RQD	Depth (ft.)	Description
				36	
5.00	5.00	1.16	23		Core from 36.5' to 41.5', BASALT/BASALT BRECCIA, zeolite infilling in fractures and vesicles. RQD: 23%, RMQ: Completely Weathered Rock
				38.5	
				40	
					Boring terminated at 41.5' in weathered fractured basalt
				42.5	

H.G. Schlicker & Associates, Inc.

Appendix C

- Unconfined Compressive Strength of Rock Cores -

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc
9120 SW Pioneer Court, Suite B, Wilsonville, Oregon 97070 | ph: 503.682.1880 fax: 503.682.2753 | www.nwgeotech.com

TECHNICAL REPORT

Report To:	Mr. J. Douglas Gless, R.G., C.E.G. H. G. Schlicker & Associates, Inc. 607 Main Street Oregon City, Oregon 97045	**Date:** **Lab No.:**	7/28/17 17-152
Project:	Laboratory Testing Project No. Y174044	**Project No.:**	1824.1.1

Report of: Compressive strength of rock

Sample Identification

NTI completed compressive strength of rock testing on samples delivered to our laboratory on July 26, 2017. Testing was performed in accordance with the standards indicated. Our laboratory test results are summarized on the attached pages.

Attachments: Laboratory Test Results

Copies: Addressee

 BKA

 REVIEWED BY: Bridgett Adame

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.

9120 SW Pioneer Court, Suite B, Wilsonville, Oregon 97070 | ph: 503.682.1880 fax: 503.682.2753 | www.nwgeotech.com

TECHNICAL REPORT

Report To: Mr. J. Douglas Gless, R.G., C.E.G.
H. G. Schlicker & Associates, Inc.
607 Main Street
Oregon City, Oregon 97045

Date: 7/28/17

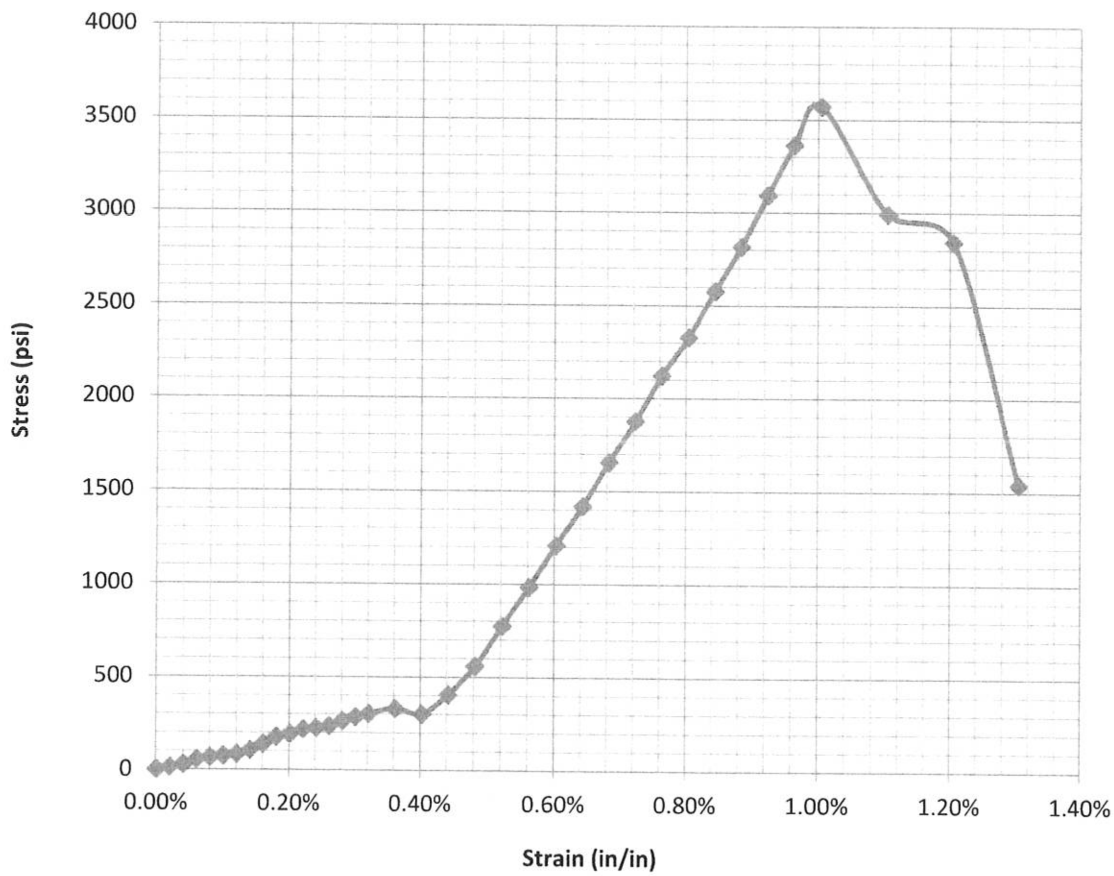
Lab No.: 17-152

Project: Laboratory Testing
Project No. Y174044

Project No.: 1824.1.1

Laboratory Testing

Compressive Strength of Intact Rock Core Specimens (ASTM D 7012 Method C)				
Sample ID	**Diameter (inches)**	**Height (inches)**	**Rate of Loading (lbs/s)**	**Uniaxial Compressive Strength (psi)**
B-1 @ 11.5 ft.	2.39	4.98	50	3571



REVIEWED BY: Bridgett Adame

Northwest Testing, Inc.
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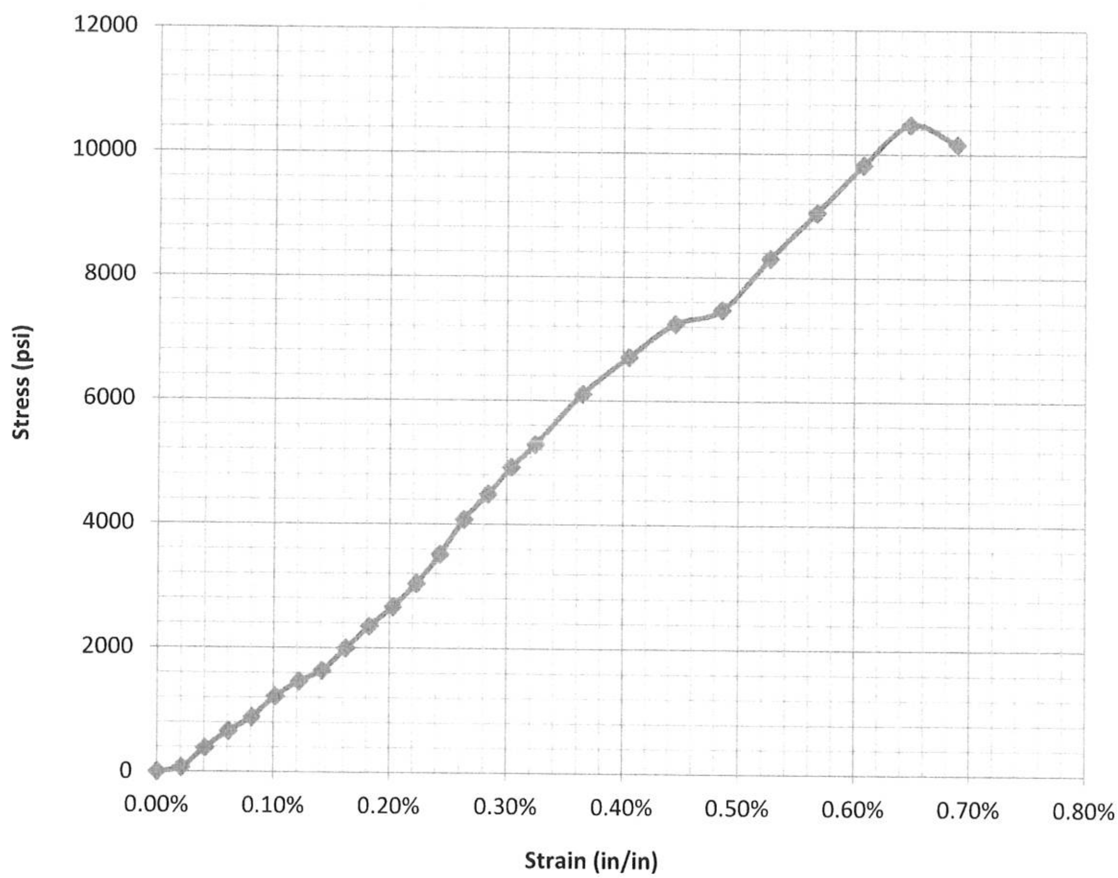
9120 SW Pioneer Court, Suite B, Wilsonville, Oregon 97070 | ph: 503.682.1880 fax: 503.682.2753 | www.nwgeotech.com

TECHNICAL REPORT

Report To:	Mr. J. Douglas Gless, R.G., C.E.G. H. G. Schlicker & Associates, Inc. 607 Main Street Oregon City, Oregon 97045	**Date:** **Lab No.:**	7/28/17 17-152
Project:	Laboratory Testing Project No. Y174044	**Project No.:**	1824.1.1

Laboratory Testing

Compressive Strength of Intact Rock Core Specimens (ASTM D 7012 Method C)				
Sample ID	**Diameter (inches)**	**Height (inches)**	**Rate of Loading (lbs/s)**	**Uniaxial Compressive Strength (psi)**
B-2 @ 27.5 ft.	2.38	4.94	100	10,474



REVIEWED BY: Bridgett Adame

Appendix D

- Checklist of Recommended Additional Work, Plan Reviews and Site Observations -

Project #Y174044

APPENDIX D
Checklist of Recommended Additional Work, Plan Reviews and Site Observations To Be Completed by a Representative of H.G. Schlicker & Associates, Inc.

Item No.	Date Done	Procedure	Timing
1*		Review site development, foundation, drainage, grading and erosion control plans.	Prior to construction.
2*		Observe foundation excavations and setbacks.	Following excavation of foundations, and prior to placing fill, and forming and pouring concrete.**
3*		Review Proctor (ASTM D1557) and density test results for all fills placed at the site.	Following compaction, and prior to forming and pouring.

* There will be additional charges for these services.

** Please provide us with at least 5 days notice prior to all site observations.