## SCOPE OF SERVICES

Our scope of services was limited to addressing the minimum information required for a City of Lincoln City and Lincoln County-required geo-hazard assessment. No geotechnical engineering recommendations are included in our scope of work (i.e. the report identifies geologic hazards that could impact the property, and broadly presents mitigation options and/or recommendations for additional investigation), nor was subsurface investigation, surveying, or producing topographic site plans or erosion control drawings. Based on our understanding, the project does not include expansion of the building footprint on the west (ocean bluff-facing) side of the property. We have also provided an explanation of the published erosion rates for this part of Lincoln County.

## SITE LOCATION

The 0.22-acre property located at 866 Southwest 8th Street, Lincoln City, Lincoln County, Oregon includes a 3-story single family residence. The tax lot, 07-11-15-DB-09100-00 is bounded to the north, east, and south by existing residential properties, and to the west by an approximate 120-foot-tall bluff facing the Pacific Ocean. The beach is accessed at Canyon Drive Park, approximately 500 feet south of the property.

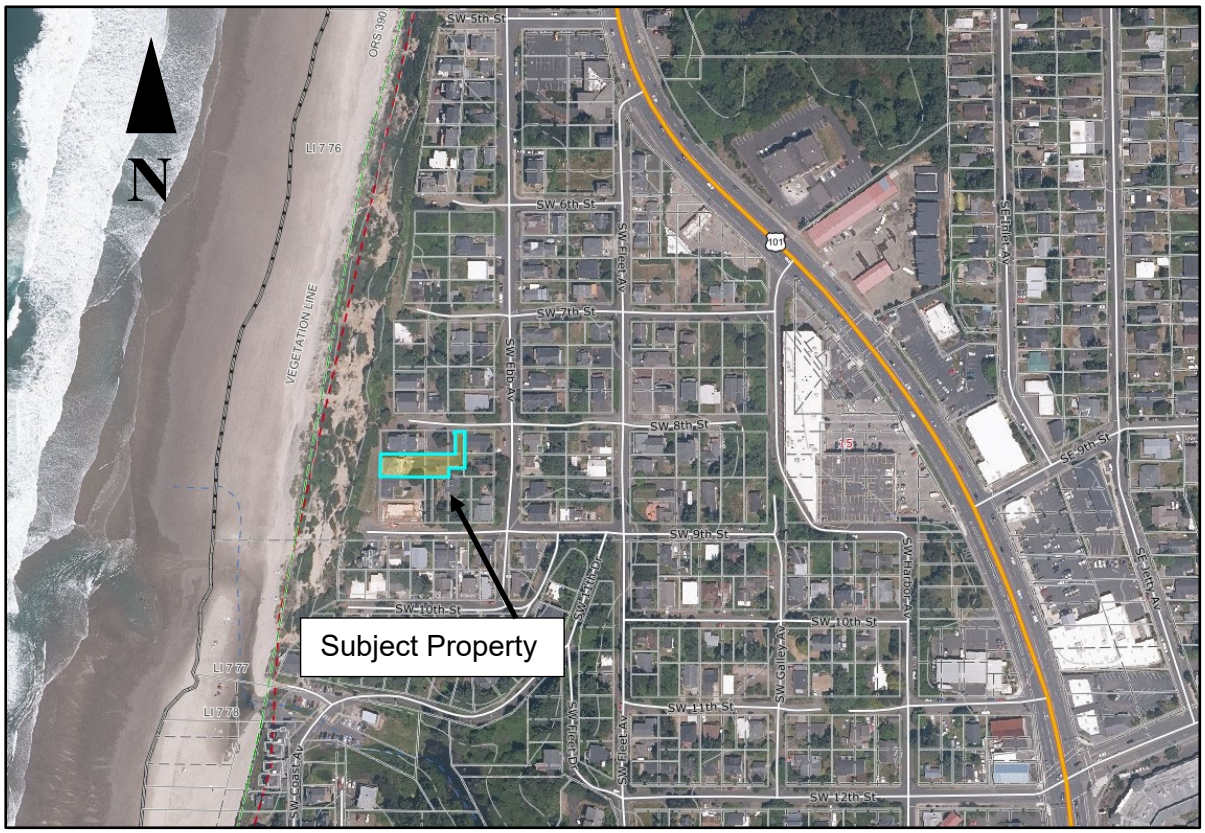


**Figure 1**: Site map showing tax lot location (blue border, yellow fill).

## MAPPED SOILS, GEOLOGY AND GEOLOGICAL HAZARDS

In the vicinity of the subject property, the underlying geology is mapped as Qtc - Quaternary marine terrace deposits composed of semi-consolidated beach sand overlain with fine-grain dune deposits.

The United States Department of Agriculture (USDA) Soil Survey provides geographical information of the soils in Lincoln County as well as summarizing various properties of the soils. Within the planned building addition areas on the property, the soil is mapped as 35E-Lint silt loam, 5 to 25 percent slopes. These soils form on marine terraces with the parent material consisting of alluvial and aeolian deposits derived from mixed sources, and is a well-drained soil, with low shrink-swell potential.

According to the USGS Quaternary Fault and Fold Database (http://earthquake.usgs.gov/hazards/faults/), there are no known faults located underneath the property or adjacent properties. The nearest mapped fault that has been active during the Quaternary is the Cascadia fold and fault belt, located approximately 6 miles to northwest. As such, we consider the fault rupture hazard for the site to be low. Note that it is possible for faults to be present at or near the property that are not currently mapped.

The Oregon Department of Geology and Mineral Industries (DOGAMI) Statewide Geohazards Viewer, HazVu (https://gis.dogami.oregon.gov/maps/hazvu/) produces geological hazard maps for the state. The following hazards were noted:

- Seaward side of the property (western side) is within a low to moderate high coastal erosion zone (Figure 3).
- Severe Cascadia earthquake shaking (Figure 4).
- Borders tsunami evacuation zone (Figure 5).
- Violent shaking from crustal fault earthquake (Figure 6).
- Low liquefaction hazard (Figure 7)
- Moderate landslide risk on landward side of the property, with high landslide risk along the seaward (western) bluff (Figure 8).
- Historic landslide deposits 0.5 miles to east of property, presumed landslide deposits at base of seaward bluff on western side of property (Figure 9).

HazVu indicates that the property is within the Coastal Erosion Hazard zone. The erosion hazard ranges from moderate to high (active) on the western side of the lot, to low hazard on the eastern side nearest to Southwest Ebb Ave (Figure 3). The very high (active) zone is defined as being actively eroded by waves and mass movement caused by wave energy. Allan and Priest (2001) define this area as potentially being affected by active erosion within the next 60 to 100 years.

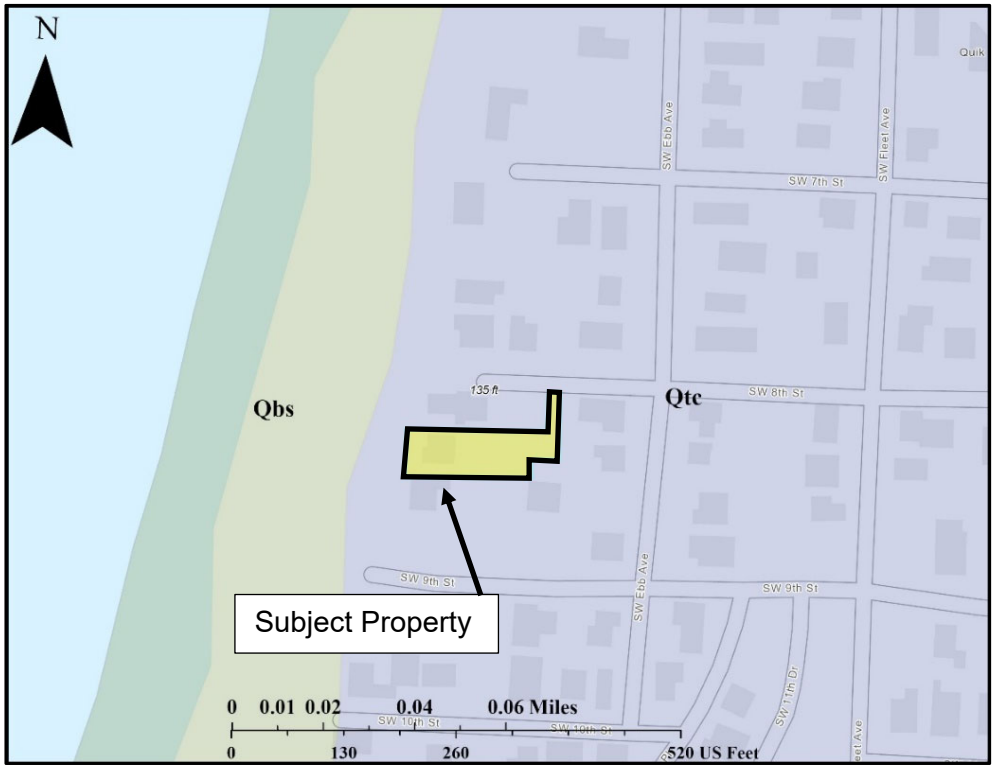


**Figure 2:** Geologic map of site. Site notated in yellow polygon with blue border; Qtc: Quaternary coastal terrace deposits; Qbs: Quaternary beach sand.

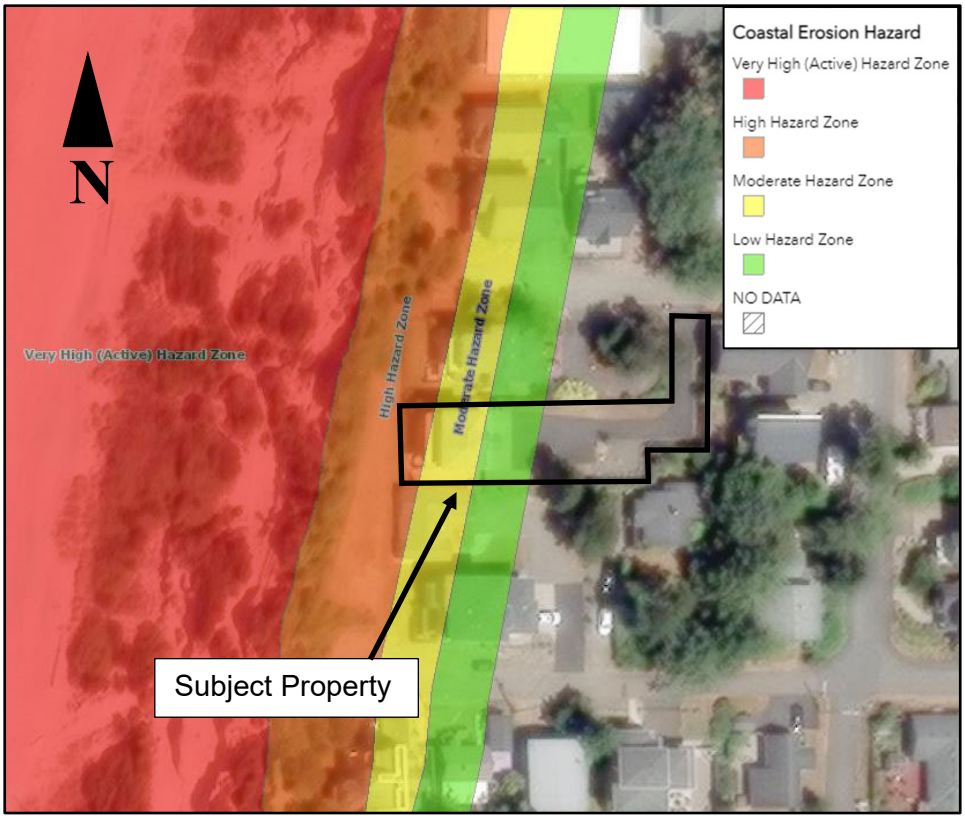


**Figure 3**: Site location within the Coastal Erosion Hazard Zone.

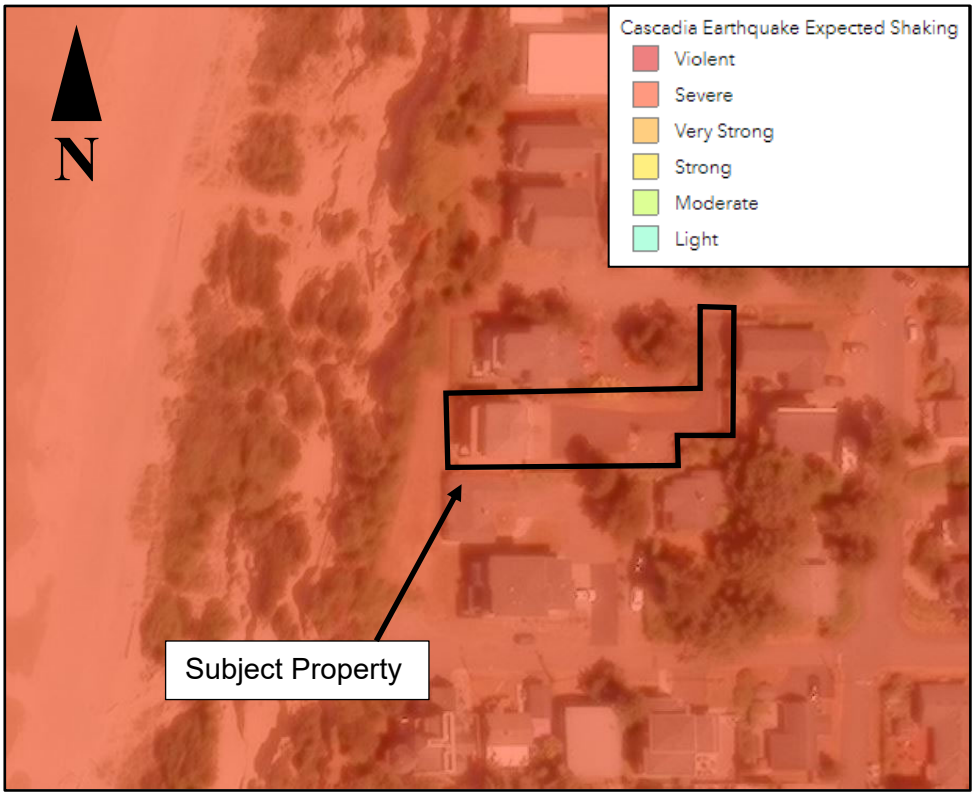


**Figure 4:** Cascadia earthquake shaking hazard map of site.

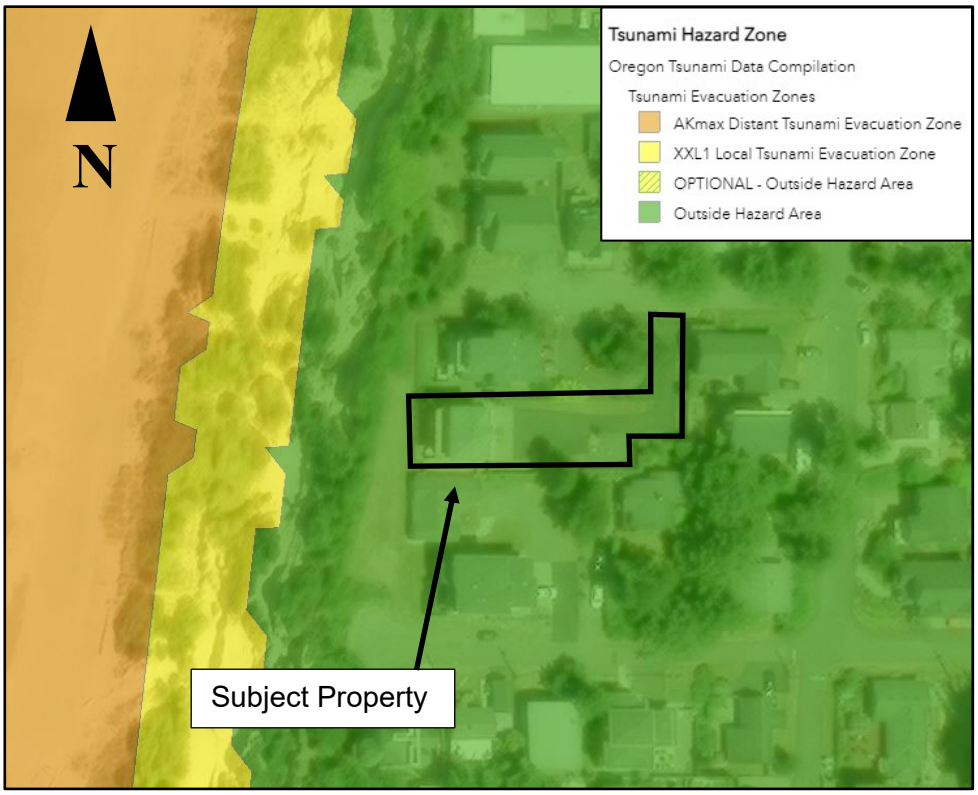


**Figure 5:** Tsunami inundation hazard map of site location.

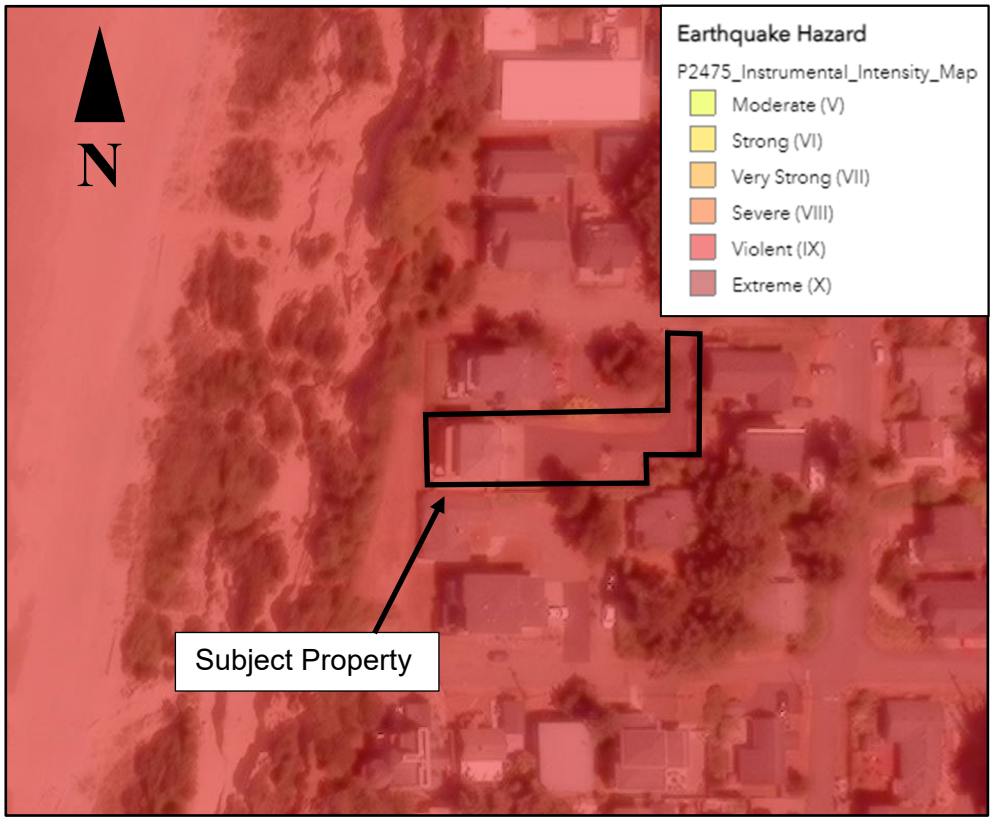


**Figure 6:** Crustal fault earthquake shaking hazard of site location.

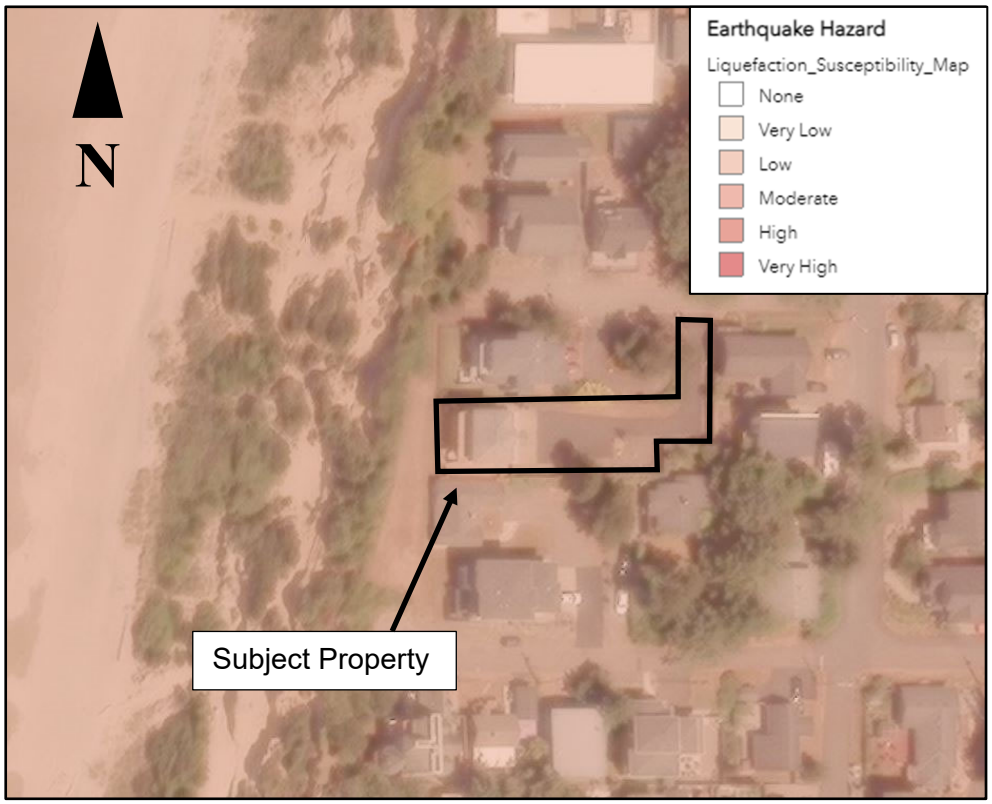


**Figure 7:** Liquefaction hazard map of site location.

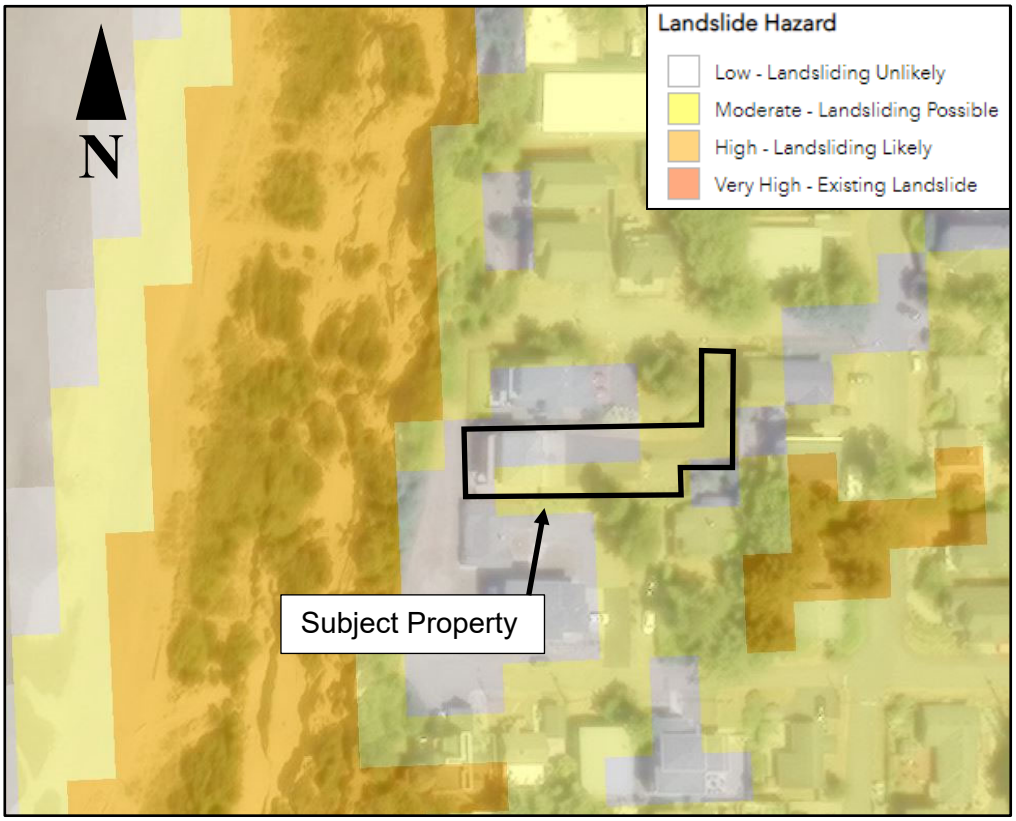


**Figure 8:** Landslide hazard map of site location.


**Figure 9:** Landslide inventory of site region.

## SITE OBSERVATIONS AND CONCLUSIONS

The following is a summary of our visual reconnaissance performed by Senior Engineering Geologist Jake Munsey, R.G., C.E.G. from our firm on March 19, 2024. Approximately 90 minutes were spent walking the residential lot and observing the site slopes from the beach. The following is a summary of our observations:


**Photo 1:** View of residence from rear porch, looking southwest from west side of house.

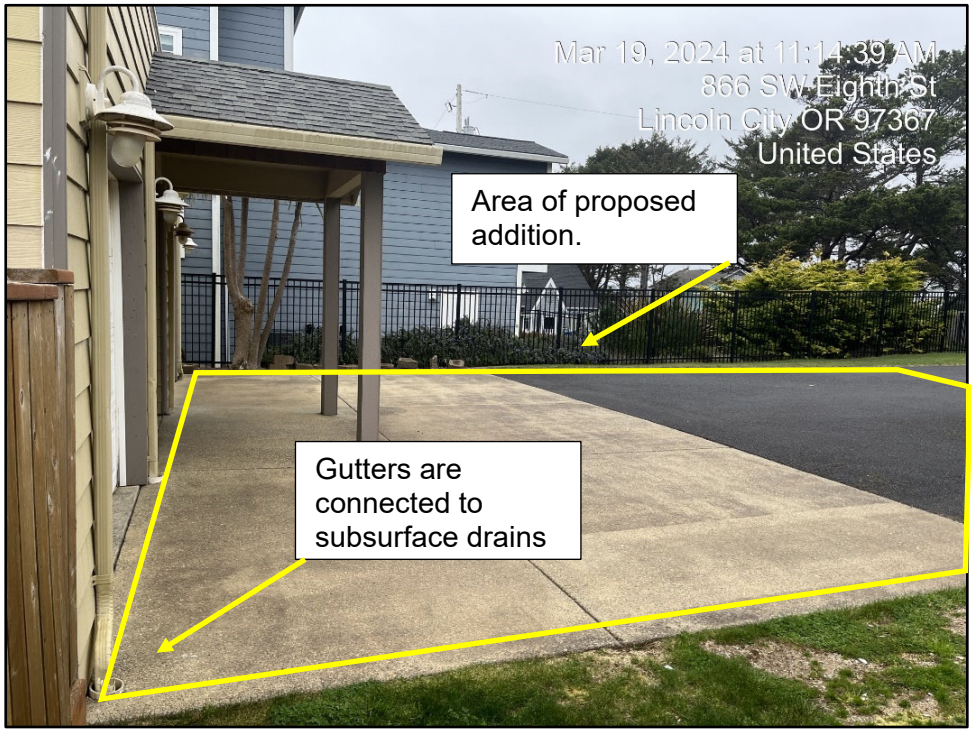


**Photo 2:** View of east side of residence looking northeast toward the area of the proposed house addition. Note that the entire area is currently covered in impermeable surfaces of either asphalt or concrete. Furthermore, note that all gutter downspouts were connected to subsurface drains.


**Photo 2:** View of bluff on western side of the site, viewed to the north east.


**Photo 3:** View of property looking up from the beach (tan house, right side), looking towards the east.


**Photo 5:** Backyard of property, looking towards the north.


**Photo 6:** View of the sandstone bluff on western edge of property, with notable landslide warning sign at the base of the bluff.

General Site Observations:

1. The majority of the parcel generally consists of flat topography (including beyond the western edge of the property for approximately 25 feet before the edge of the bluff as shown in Figure 1). The bluff generally descends at an approximate 1.25Horizontal:1Vertical (1.25H:1V) slope as shown in the below Figure 10. Elevations provided by DOGAMI LiDAR (https://pubs.oregon.gov/dogami/ldq/LDQ-45124A1.zip) show the relatively flat property at an elevation of approximately 136 feet and the base of the bluff at an elevation of approximately 20 feet feet (NAVD 88).

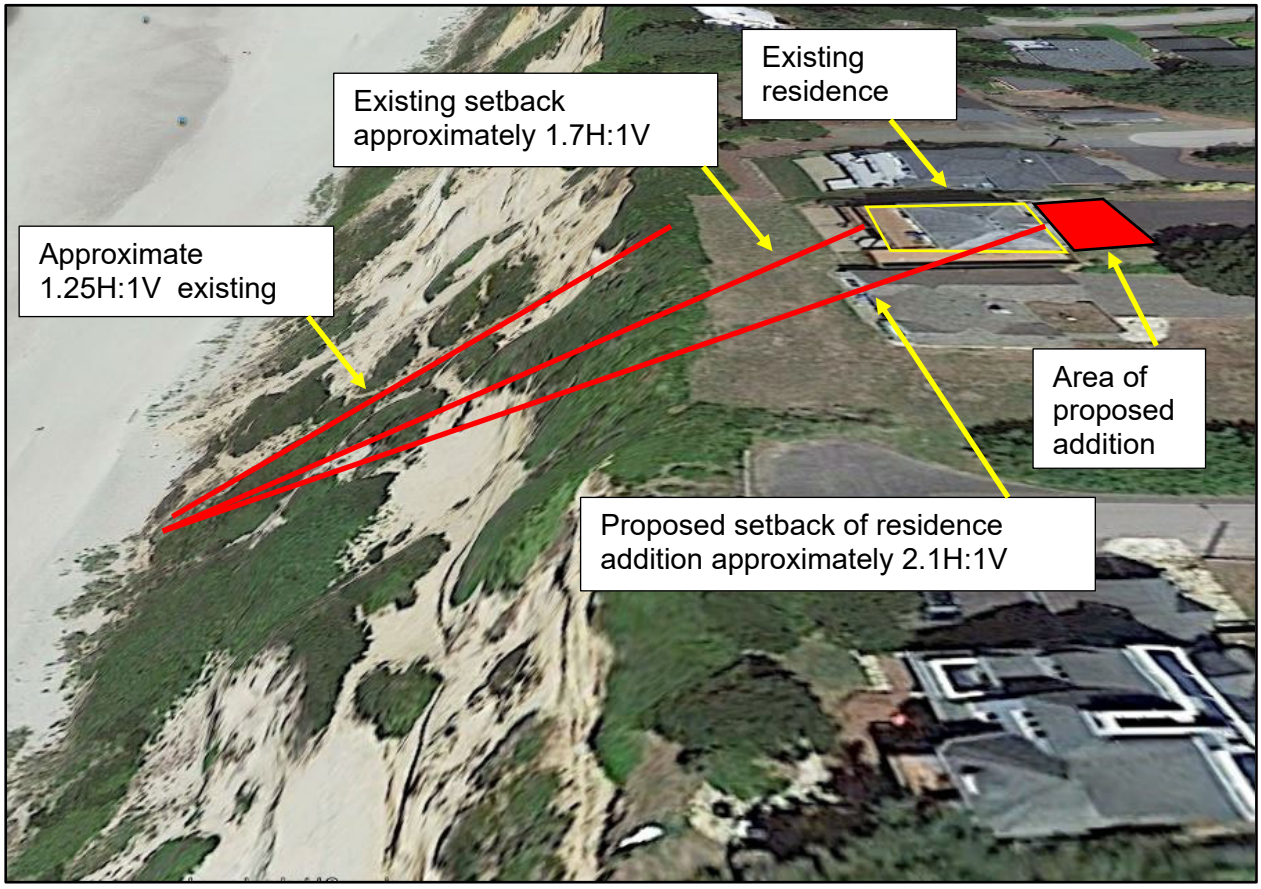


**Figure 10:** Showing the site with oblique view to indicate observed slopes, existing setback, and proposed setback of proposed residence addition.

2. There is no SPS at the base of the bluff, and there is notable signage (Photo 6) warning of potential landslide risks.

3. The bluff is vegetated with grass and small shrubs, typical of most adjacent buffs to the north and south. The bluff slopes are sparsely vegetated with large shrubs near the top of the slope and beach grasses and shrubs at the base of the slope.

4. The beach was composed of typical beach sand. A review of geological data from Peterson and Kingen, 2021 indicate the mean grain size of 0.276-mm for Lincoln City (closest to the site) (https://pdxscholar.library.pdx.edu/geology_data/1/).

5. As previously stated, the proposed development plan includes the building of an addition on the east side of the existing residence. Because of this, we do not expect the redevelopment activities will affect the existing site vegetation, the stability of existing slopes, site erosion, or geologic hazards to surrounding properties. The setback of the proposed addition (2.1H:1V) will not change the current susceptibility of the upland portion of this property to coastal erosion, and does not change the resistance of the property to wave attack. Furthermore, the area of the proposed addition is currently either paved with asphalt or concrete, which would produce surface runoff during rain events, therefore

there is no additional proposed impermeable surfaces. If possible, we recommend that the proposed addition should have gutters and downspouts connected to subsurface drains that will transport runoff from impervious surfaces to a storm sewer. Because of this, we recommend that the proposed addition should have no negative impact on bluff stability or erosion, and stormwater management on the property will not include additional discharge of concentrated stormwater onto the west side of the lot as a result of the improvements.

## GEOLOGIC HAZARD SUMMARY FINDINGS

Because the site is located within the coast erosion hazard zone defined by Priest and Allan, 2004, we are providing this section of our report to facilitate the review of the anticipated building permit of the site. The following section of Lincoln City Code, Chapter 17.47 (Natural Hazards, Beaches, and Dunes) and Section 17.47.020 are addressed below. Note that all of the Site Description items (1.a. through 1.k.) have been previously addressed in the report text, or (if not previously addressed) are not applicable or pertinent to this property or review. Items 2 through 5 are discussed below.

### *17.47.020 Development in Identified Hazard Areas*

### 2. Description of the Fronting Beach

a. Average Summer and Winter Beach Widths
Based on aerial photos between 1994 and 2019 provided on Google Earth, the beach adjacent the subject property site varies in width from approximately 250 to 450 feet wide in the summer, and approximately 100 to 250 feet wide in the winter.

b. Median Beach Sediment Grain Size
The median beach sediment grain size is fine- to medium-grained sand. Peterson and Kingen (2021) indicate a mean grain size of 0.183-mm for the Road's End area.

c. Summer and Winter Beach Elevations and Average Slopes
The typical beach slopes at this location vary from approximately 2 to 3 degrees westward based on elevations (NAV 88) derived from DOGAMI LiDAR. As typical of the Oregon Coast, the conditions are dynamic and can change substantially is a relatively short period of time, particularly during El Nino and La Nina events.

d. Elevations Above Mean Sea Level of the Beach at the Seaward Edge of the Property During Summer and Winter
Elevations provided by DOGAMI LiDAR show the contact between the beach and the toe of the bluff (approximately 195 feet west of the west property boundary) between 17- and 18-feet elevation (NAVD 88). The property is set back from the edge of the bluff at an elevation of approximately 136 feet (NAVD 88)

e. Rip currents and Embayments
Rip currents are common on this part of the Oregon Coast, and rip embayments regularly set up and form in the Lincoln City area. The effects of rip embayments have been particularly severe in areas south of Lincoln City, with historical impacts of property and structural loss the Salishan Spit. Based on our review of available GoogleEarth satellite imagery (period ranging from 1994 and 2019), we did not observe a prevalence of rip embayments in the vicinity of the subject site on the images from this period.

f. Rock Outcrops and Sea Stacks
Rock outcrops do exist at beach level, and appear to consist of metamorphosed basalt. No sea stacks were observed at or near the site location.

g. Depth of Beach Sand to Bedrock
Bedrock was not observed at the time our visual reconnaissance. Based on our experience in the vicinity of the subject property, it is anticipated that depth to bedrock could be from approximately 0 to 10 feet below observed beach level.

**3. Analyses of Erosion and Flooding Potential**

a. DOGAMI Beach Monitoring Data
We reviewed available DOGAMI beach monitoring data (Allan and Hart, 2005) pertinent to this location. In the vicinity of the subject property, there was relative consistency in beach elevation for the years monitored (1997, 1998, and 2002).

b. Human Activities Affecting Shoreline Erosion
While there is no shoreline protection structure to prevent bluff erosion. Signage has been placed to keep people from climbing onto the bluffs. At the time of our site visit, it appears that the signs do little to prevent people from climbing the bluffs as evidenced by carvings onto the soft rock relatively high on the bluff.

c. Mass Wasting, Weathering, Landsliding, and Slumping
As previously discussed in this report, the site is not mapped on a known landslide and the site is not oversteepened and is essentially flat.

d. Wave Runup Beyond Mean Water Elevation
We generally observed large pieces of drift wood deposited by waves at the base of the bluff indicating that wave runup currently makes it to at least that point (an elevation of 17 to 18 feet (NAVD 88)). The nearest water level data obtained from DOGAMI is located at the very north end of the Siletz Spit (approximately 2.5 miles south of the property). The data we reviewed suggest a Mean Low Low Water (MLLW) elevation of approximately -1 feet (NAVD 88) and a Mean High High Water (MHHW) of

approximately 7 feet (NAVD 88), therefore, we would expect the wave run up beyond mean water elevation to be approximately 14 to 15 feet (NAVD 88).

e. Frequency of Erosion-Inducing Processes
DOGAMI (Priest, 2024) indicates that he average erosion rate is for Lincoln City ranges between 0.30 and 0.31 feet/year (0.19 and 0.37 feet/year, factoring range of uncertainty). We do not anticipate that construction will increase these processes, assuming construction is limited to the eastern portion of the site.

f. Dune-Backed Shoreline Erosion
Not applicable for this site.

g. Bluff-Backed Shoreline Erosion
As mentioned previously, we generally observed large pieces of drift wood deposited by waves at the base of the bluff indicating that wave runup currently makes it to at least that point and causes eroision; however, we did not see any drift wood above the base of the slope. Based on aerial images from 1994 to 2019, it does not appear that there have been any major changes to the position or general shape of the bluff toe in the last 25 years. As such, while we anticipate that while wave action is actively eroding the toe, it is relatively slow and gradual at this time.

h. Potential of Sea Level Rise
A review of NOAA data for South Beach and Garibaldi monitoring stations in Oregon (https://tidesandcurrents.noaa.gov/) show sea-level rise between 1.78 and 2.52 mm per year for data collected between 1967 through 2023. This rise translates to 0.58 to 0.83 feet of sea level rise per 100 years.

i. Estimation of Annual Erosion Rate
Because the bluff is not protected by an SPS, the published estimated annual erosion rate at this location is between 0.30-0.31 feet/year, or 0.19 to 0.37 feet/year factoring range of uncertainty (Priest, 2004). Based on our review of aerial photos, it does not appear that the bluff has eroded substantially in the past 25 years. However, based on the published erosion rates, the bluff would have theoretically eroded 8 feet in 25 years. This indicates that the real erosion rate may be on the lower end of uncertainty (or lower). In reality, the bluff most likely erodes in blocks or chunks that break off during prolonged or extreme climactic events.

**4. Assessment of Potential Reactions to Erosion Episodes**

a. Legal Restrictions of Shoreline Protective Structures
As described above the subject property is not protected by a SPS. According to the online Oregon Coast Atlas, the subject property is not Goal 18 eligible either (i.e. the property was developed after January 1, 1977). Therefore, subject to permit rules of

the municipality and the Oregon Parks and Recreation Department (OPRD) Ocean Shores program, constructing a SPS is not permissible under current rules.

b. Potential Reactions to Erosion Events and Future Erosion Control
Based on the geologic hazard conditions at the subject property, potential reactions to erosion events and future erosion control may include vegetation maintenance/management. Additional measures to protect the existing structures could include retrofit of the existing foundations with deep foundation elements, and/or construction of retaining walls or a seawall.

c. Annual Erosion Rate
As previously noted, the published average erosion rate is for Lincoln City ranges between 0.30 and 0.31 feet/year with uncertainty range of 0.19 to 0.37 feet/year (Priest, 2004).

## 5. Recommendations

a. Safety and Compliance of all Local Requirements
In general, based on our reconnaissance, review of geologic hazard conditions associated with the subject property, and our understanding of the project, we recommend that the proposed project can be performed at an acceptable level of safety and in compliance with local requirements. As noted previously, the proposed project does not include a reduction in the existing setback of structures.

b. Preservation of Vegetation and Within Setback Area
We understand that the project includes no changes to the existing grade on or adjacent the subject site, and that vegetation will not be impacted (and further, will be preserved and protected during project implementation).

c. Consideration of Local Variance Process to Reduce Building Setback
As noted previously, the proposed property improvements do not include changes to the existing setback, and therefore we recommend that consideration of a setback variance is not applicable to this project.

d. Control and Direction of Stormwater Drainage Away From the Ocean
We understand that the project includes the addition of an impermeable surface area (roofline); however, the area of the proposed addition is currently paved with either concrete or asphalt. Therefore, the impermeable surface area will be the same after development as existing. If possible, we recommend that surface water should be collected from the roofline area and diverted from building foundations and walls, to approved disposal points on the eastern portion of the property, or discharged to a municipal storm sewer (if present). Regardless, the water should be diverted in such a way so as to not cause erosion or visual impacts. For new perimeter footings, subsurface drainage of the building perimeter using footing drains is recommended

and the water should be discharged in the same manner as the surface water described above.

## LIMITATIONS

Geologic hazard evaluations can take the form of simplistic visual observations, or they can involve detailed investigations with borings, inclinometer installations, laboratory testing, and slope stability modeling. Visual observation evaluations tend to translate to more risk and less cost for the client than a detailed investigation. However, no matter what method of landslide hazard evaluation is selected, there is always some risk to the client that earthquake shaking, coastal erosion or a landslide could occur in the future. Our evaluation is not a guarantee that some form of coastal erosion or landsliding will never occur on this property in the future. It is merely an evaluation of the risk based on our observations.

The geologic hazard recommendations presented in this report are based on the available project information described in this report. If any of the noted information is incorrect, please inform EE in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. EE will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

This report has been prepared for the exclusive use Chad Ruhoff of East Avenue Design+Build, for the specific application to the proposed development of a property at 866 Southwest 8th Street, Lincoln City, Lincoln County, Oregon. EE does not authorize the use of the advice herein nor the reliance upon the report by third parties without prior written authorization by EE.

We appreciate the opportunity to perform this geologic hazard assessment. If you have any questions pertaining to this report, or if we may be of further service, please contact Jake Munsey at 360-567-1806 (office) or 360-210-9406 (cell).

Sincerely,

**Earth Engineers, Inc.**


Jake Munsey, R.G., C.E.G.
Senior Engineering Geologist

Rachel Sweeten, M.Sc.
Engineering Geology Associate