Horning Geosciences

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September 13, 2013

Mark Barnes, Planning Director
City of Cannon Beach
P.O. Box 368
Cannon Beach, OR 97110

RE: Evaluation of Geologic Hazards for a 55-acre Site in Tolovana Park, east of Highway 101; Map 4 10 6B, northwest quadrant of Tax Lot 800.

Dear Sir:

This report addresses geologic hazards of the above-referenced property for the purpose of assisting the City of Cannon Beach and a local citizen's group in determining the best site for the location of a proposed new elementary school for the community. Three sites have been proposed on the lot. All are above worst-case tsunami run-up. They are referred to as the North, Central, and South Sites. The North Site is located between the Haystack Heights subdivision and a steep gully that is about 200 ft south of the subdivision. The Central Site lies on gentle ground of an incised terrace, bounded to the north and south by gullies. The South Site is in the southwest corner of the property, just east of a smaller lot that the city owns along Highway 101.

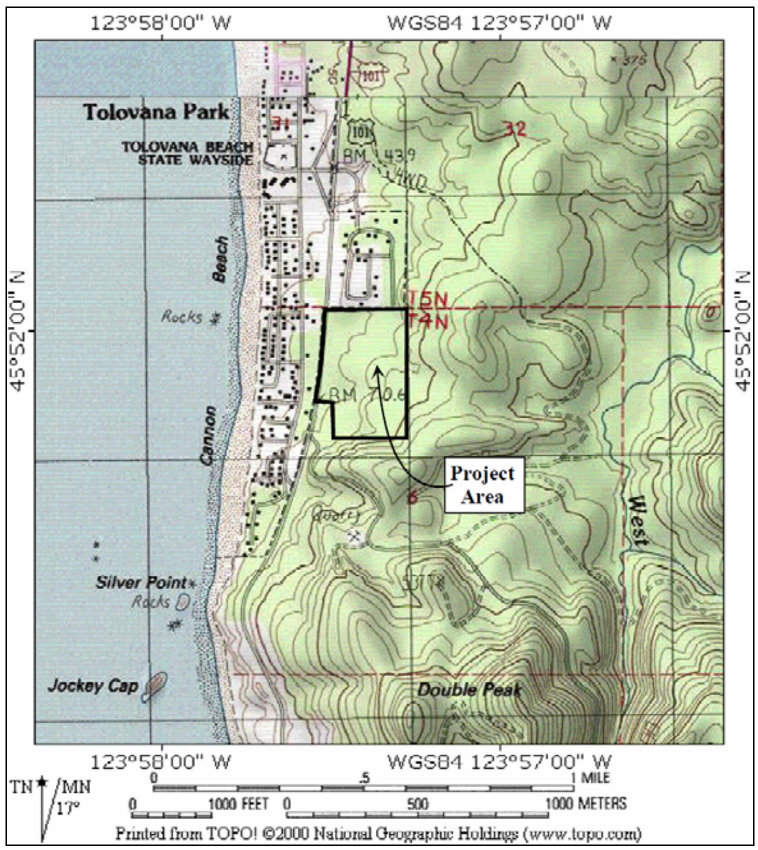


Figure 1: Property location map.

The investigation summarizes hazards and geotechnical challenges for each of the three sites. One or two test pits were excavated at each site on June 27, 2013. The site was mapped in the months of June and July. We have utilized LIDAR imagery from the DOGAMI LIDAR viewer website, and the results have been plotted on a LIDAR-based topographic map provided by David Vonada, AIA. The LIDAR imagery is a powerful tool for identifying landslide-related landforms. Soils were investigated with the test pits, identified by field methods for the Unified Soil Classification System, and compared against soils maps published by the Natural Resources Conservation Service. Bedrock geology was mapped and interpreted using standard field methods and referral to previous maps by Schlicker and others (1972) and Niem and Niem (1985). Tsunami inundation hazards are addressed by maps published by DOGAMI.

General Geology

This property consists of a gently sloping coastal terrace on the west that laps onto more steeply sloping mudstone and (?) basaltic bedrock on the east. Numerous creeks cross the property and have cut gullies as much as 30 ft deep. The gullies are broader and less deep in the terrace sediments, whereas they are narrower and steeper in the mudstone. The broader terrace gullies display scalloped slopes that are interpreted as slumps of various size, the ground failures triggered by low internal strengths of the soils, as well as by saturation, creek erosion, and/or seismic loading. Slumps are less obvious in mudstone, its greater internal strength supporting steeper slopes. Mudstone bedding has been tipped from horizontal to nearly vertical in road cuts between the Central and South Sites of the property. This extreme deviation from its typical orientation has been caused by the injection nearby of a dike of Columbia River Basalt, which apparently pushed the mudstone aside as it invaded the pliable young sediments during Miocene time, about 15 million years ago. The incised coastal terrace most likely formed during the last high-stand of sea level, about 80,000 years ago. The land has been lifted about 40 ft since then, which has allowed the creeks to cut down through the sediments.

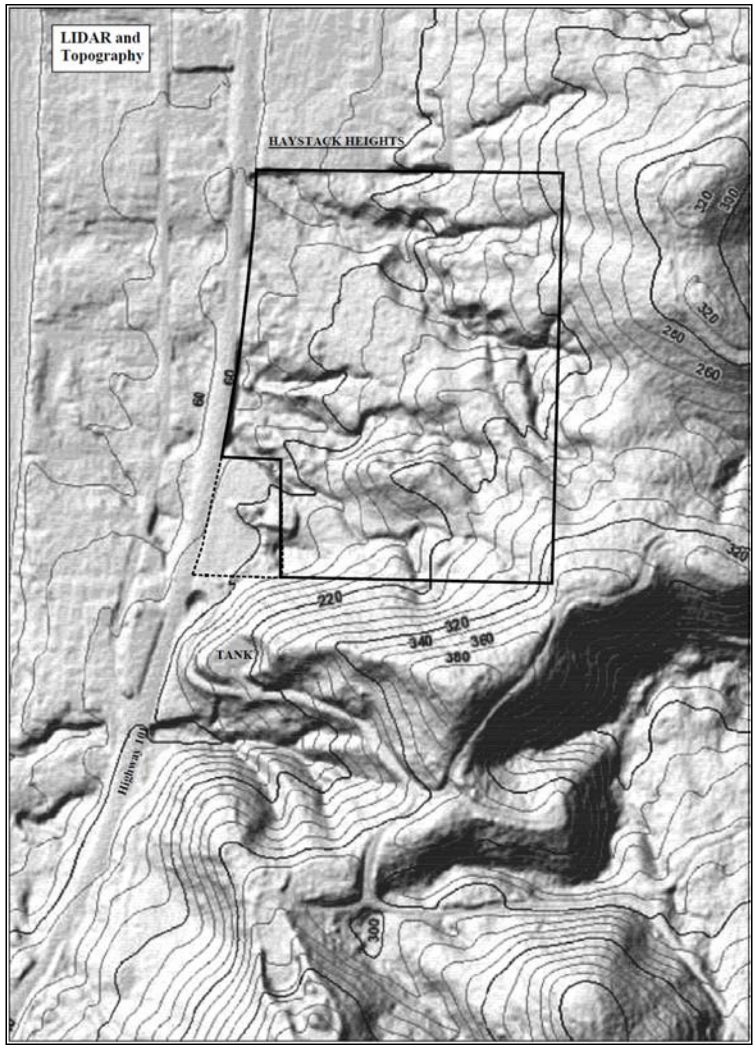


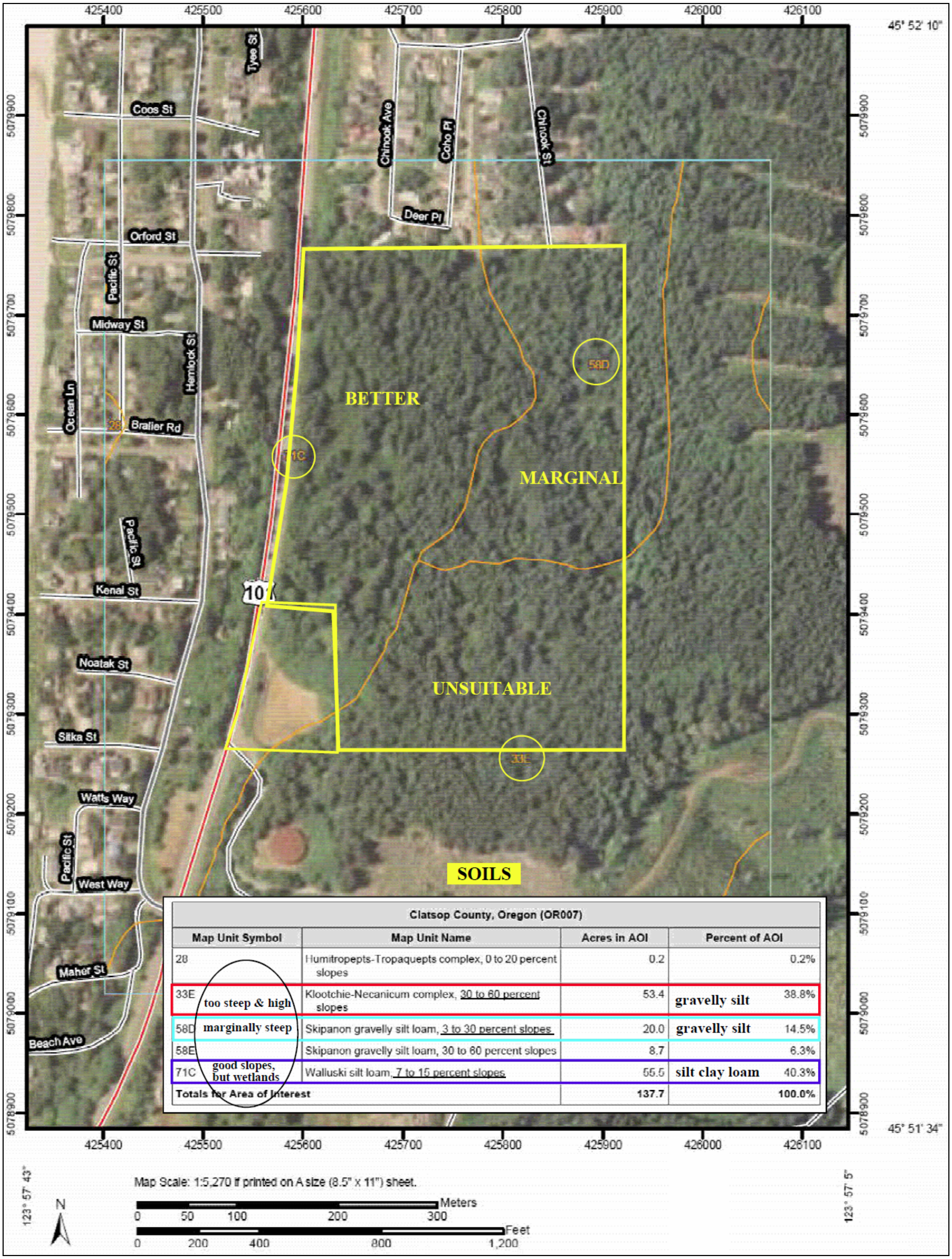
Figure 2: LIDAR shaded-relief topographic map for the southern part of Tolovana Park, the boundary of the subject property shown by dark line.

North Site

Land potentially available for construction at the North Site is about 150 ft wide north-south and about 440 ft long east-west. It slopes to the west at 16 to 21 percent. This is illustrated in Figure 5. The area is limited to the south by the proximity of a gully that is over 30 ft deep in places. Given that most of this gully has been incised into relatively weak bedrock mudstone, it would be appropriate to observe setbacks from the toe of the gully of at least 60 ft, based on a 2 Horizontal to 1 Vertical setback criterion that is commonly used for this type of material. A narrow septum extends farther to the west between the main gully and a smaller one to the north, but the septum is underlain by terrace sediment, which has slumped and produced a recessional escarpment that extends nearly 80 ft back from the gully bottom. Construction on the septum should be avoided. Soils consist of deeply weathered clay-silt with a Very Stiff Consistency that has a presumptive vertical bearing pressure of 1500 psf. The uniform texture of the soil suggests that it is composed of weathered mudstone. The soil is probably less than 12 ft deep. Seismic shaking amplification therefore will be limited. Shallow groundwater was not encountered.

Central Site

Accessed by a single-lane logging road from the south, the Central Site has a minimum construction area of 260 ft by 400 ft, plus additional ground to the northwest and southeast. A narrow gully splits the northwest extension of the buildable area and could be filled in to provide added space. It slopes northwestward at 9 to 12 percent. Additional land lies higher on the hill to the southeast, where the ground is underlain by mudstone with slopes that range from 10 to 38 percent. Gullies have incised this eastern land and have made its development difficult due to potentially unstable slopes. Groundwater was encountered in one of the two test pits that were dug into the terrace sedi-



Clatsop County, Oregon (OR007)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
28	Humitropepts-Tropaquepts complex, 0 to 20 percent slopes	0.2	0.2%
33E	Klootchie-Necanicum complex, 30 to 60 percent slopes	53.4	38.8%
58D	Skipanon gravelly silt loam, 3 to 30 percent slopes	20.0	14.5%
58E	Skipanon gravelly silt loam, 30 to 60 percent slopes	8.7	6.3%
71C	Walluski silt loam, 7 to 15 percent slopes	55.5	40.3%
Totals for Area of Interest		137.7	100.0%

Figure 3: Soils map for the subject area with descriptions and relative ratings for geologic hazards, based on slope inclination. Terrace soils form gentle slopes, whereas bedrock soils form steeper slopes that may host landslides.

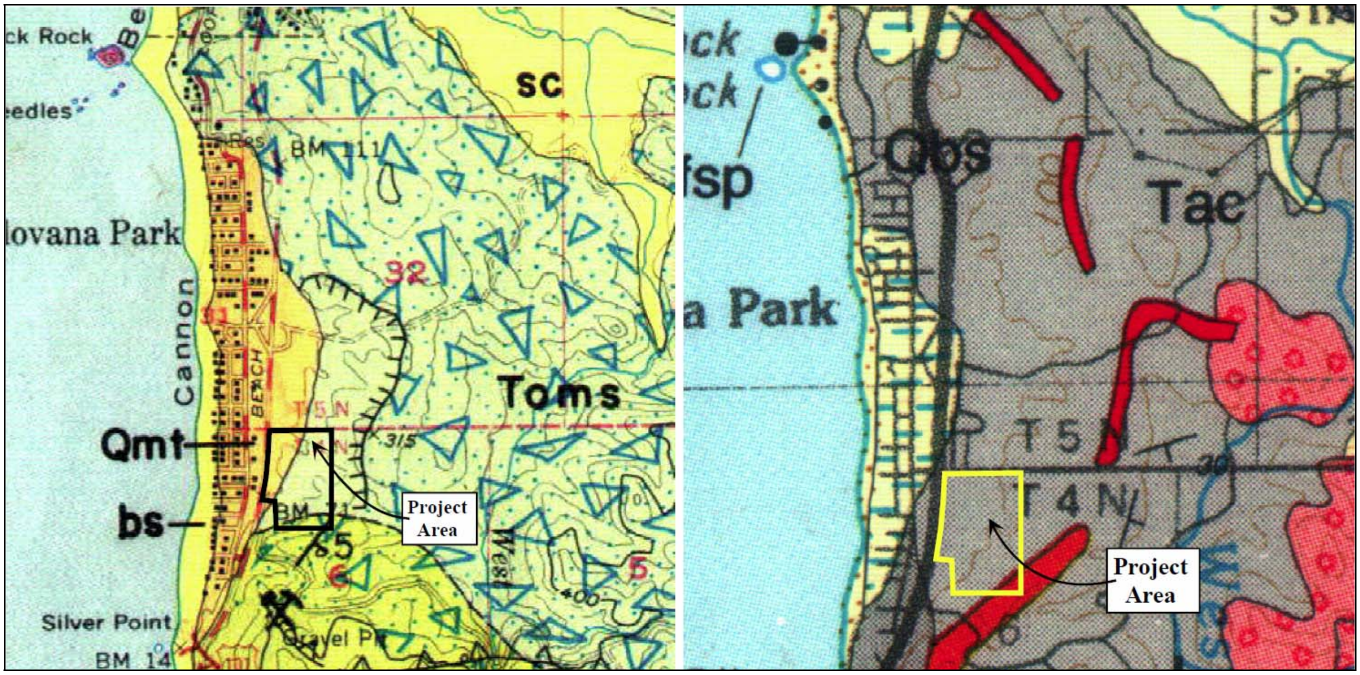


Figure 4: Geologic hazard and bedrock geology maps for the Tolovana Park vicinity; after Schlicker and others (1972) on right, and Niem and Niem (1985) on left. On right, the property lies partly on Pleistocene coastal terrace (Qmt) and partly on Oligocene to Miocene marine sedimentary rock (Toms), part of which forms a landslide on which the lot rests, as indicated by the barbed line. The landslide interpretation is not supported by LIDAR imagery. On right, the property is shown lying entirely on mudstone of the Cannon Beach member of the Miocene Astoria Formation (Tac), except for the extreme southeast corner of the lot, which is underlain by a dike of invasive Columbia River Basalt (red). The map errs by not showing marine terrace (dashed buff color) under the western part of the lot.

ments. The depth of the terrace sediment will be less near the bedrock contact, but will increase farther from it. Test pits exposed clay-rich sediments that may reduce the soil bearing capacity to 1000 psf. This can be mitigated with rock fill. The terrace sediments will tend to amplify seismic shaking, particularly if the depths of sediment approach 100 ft. During test pit excavation, ground waves could be felt by thumping of the machinery, indicating the generally weaker soil types. This will require added shear wall design to structures to mitigate lateral accelerations. Shallow groundwater encountered in test pits will require drainage controls. Foundations should be kept back at least 25 ft from the edges of the gullies to avoid future slumping. Access to the Central Site presumably will be by the route of the logging road presently on the property. It will be necessary to dig out the steeply dipping mudstone knob between the Central and Southern Sites in order to widen the access road and build it on firm ground, although this should not be difficult.

South Site

The South Site is located in a bowl-shaped amphitheater just east of the city storage building on the adjacent lot. The amphitheater aspect of the property is created in part by steep slopes to the south-southeast, where a dike of basalt forms a resistant steep ridge. Slopes in this area range up to 55 percent, an inclination steep enough to shed debris flows from intense soil saturation or seismic loading. An area of about 150 to 215 ft across could be filled in the lower part of the site to create a building pad, although may be likely that foundations may need to be stepped up the hill to offset the steep inclinations. There is some uncertainty as to how far away from the +50 percent slopes any structures should be placed. Test Pit 5 discovered soils that are rich in rock fragments, grits, and sand, apparently shed downslope by the nearby basaltic dike rock. The soils are clearly colluvial (landslide) in origin, but to what degree they formed by creeping soils or by debris flow cannot be determined. There is at least minor risk of debris flows from seismic shaking. When filling this site, it will be necessary to collect all ground water and pipe it away. The site can be filled properly with the appropriate structural aggregate.

Conclusions

The Central Site provides the largest area for a school and playground, plus it has enough space to permit reasonable setbacks from slump-prone gully walls nearby. The soils of the Central Site are thicker and perhaps slightly weaker than the other two sites, but this can be mitigated by strengthening the shear walls and foundations to resist amplified seismic loads.

The North Site is constrained by its proximity to potentially unstable gully walls, but it does extend uphill from its access point at the southeast corner of the Haystack Heights neighborhood. Bedrock and thin soils will resist slope movements.

The South Site is exposed to possible debris flows from 55 percent slopes to its south. This may be mitigated by siting the school as far north on the lot as possible and perhaps by constructing a barrier wall to resist future high-speed landslides.

All sites will have temporary shallow groundwater that necessitates foundation drains. Shallow groundwater will tend to be more commonplace at the Middle Site.

Please feel free to call or write if you have questions.

Thomas S. Horning, CEG
Horning Geosciences

Expires: 6/30/14

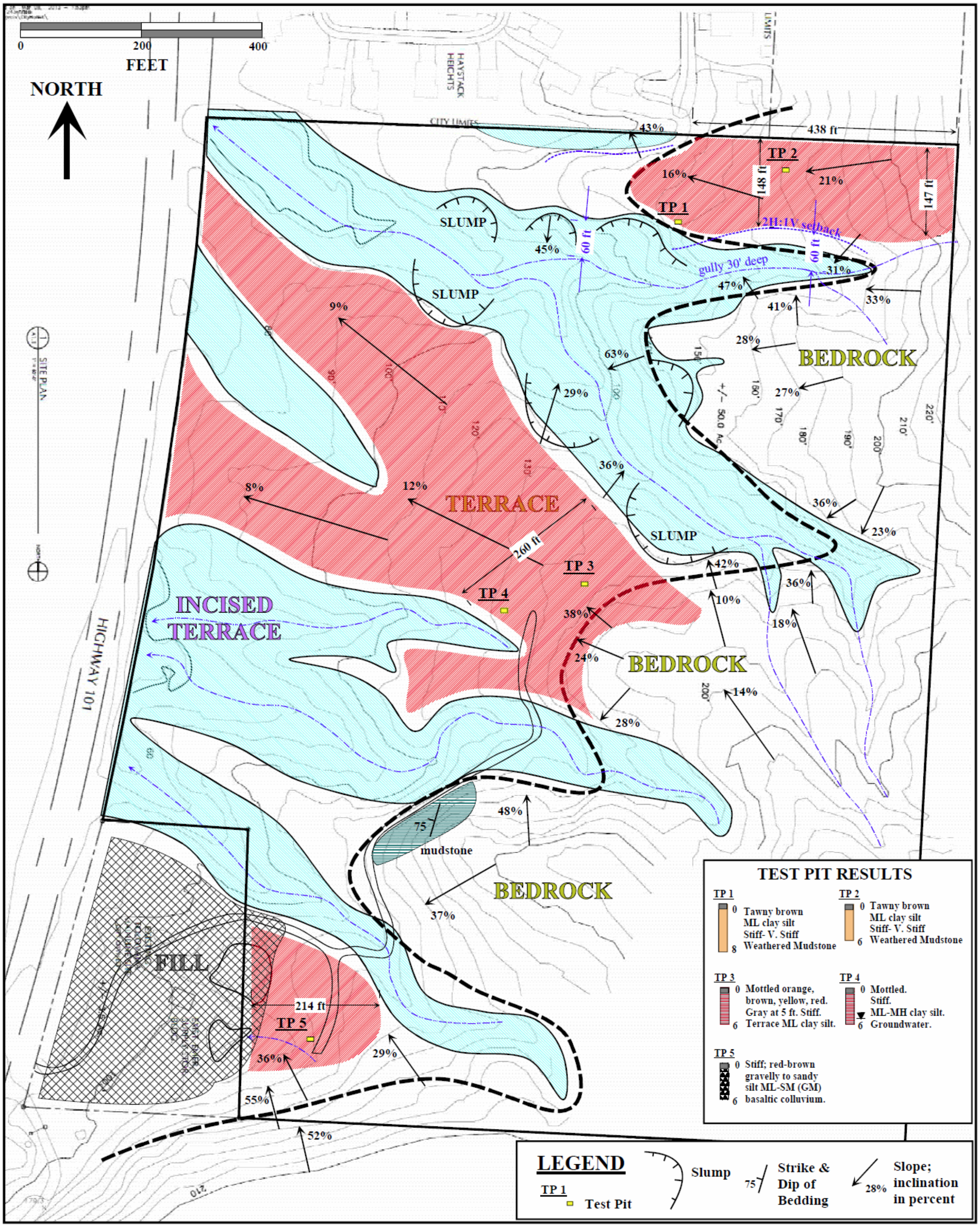


Figure 5: Geologic map with test pit results for the 50-acre lot on which the school may be built. Areas of red hatching (North, Central, and South Sites) are generally suitable for construction, with respect to geologic hazards. Dimensions are provided for the sites. Blue hatched areas are incised gullies with saturated soils. More detailed maps for the three sites are provided in Figures 6, 7, and 8.

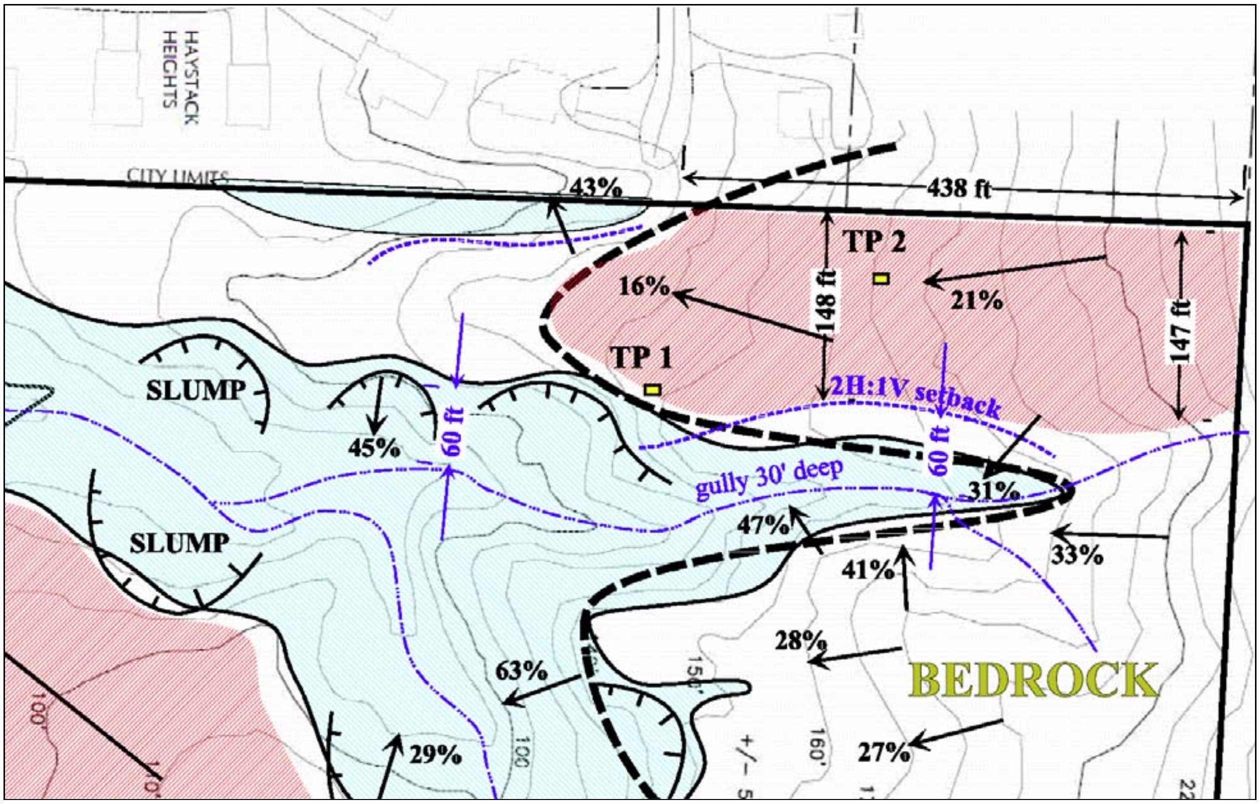


Figure 6: Geology of the North Site.

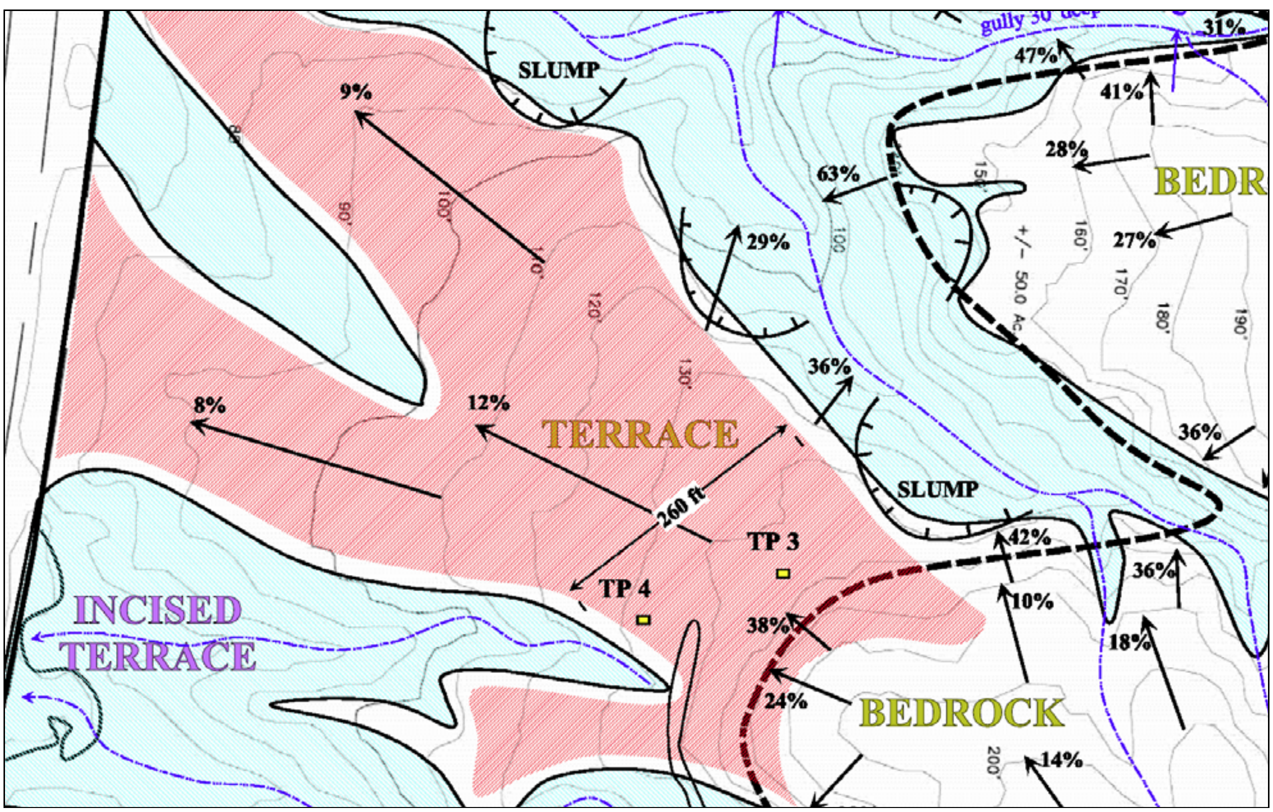


Figure 7: Geology of the Central Site.

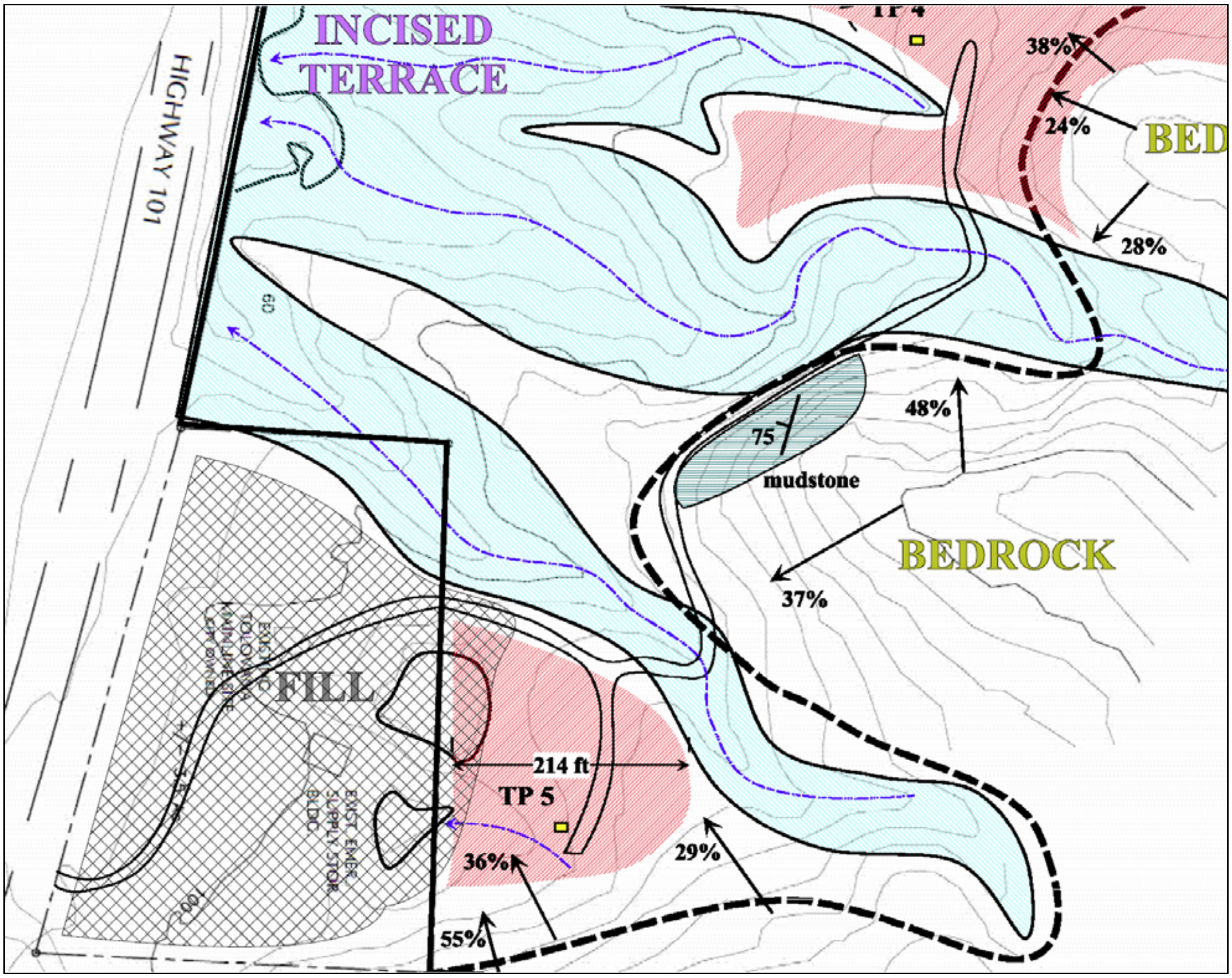


Figure 8: Geology of the South Site.

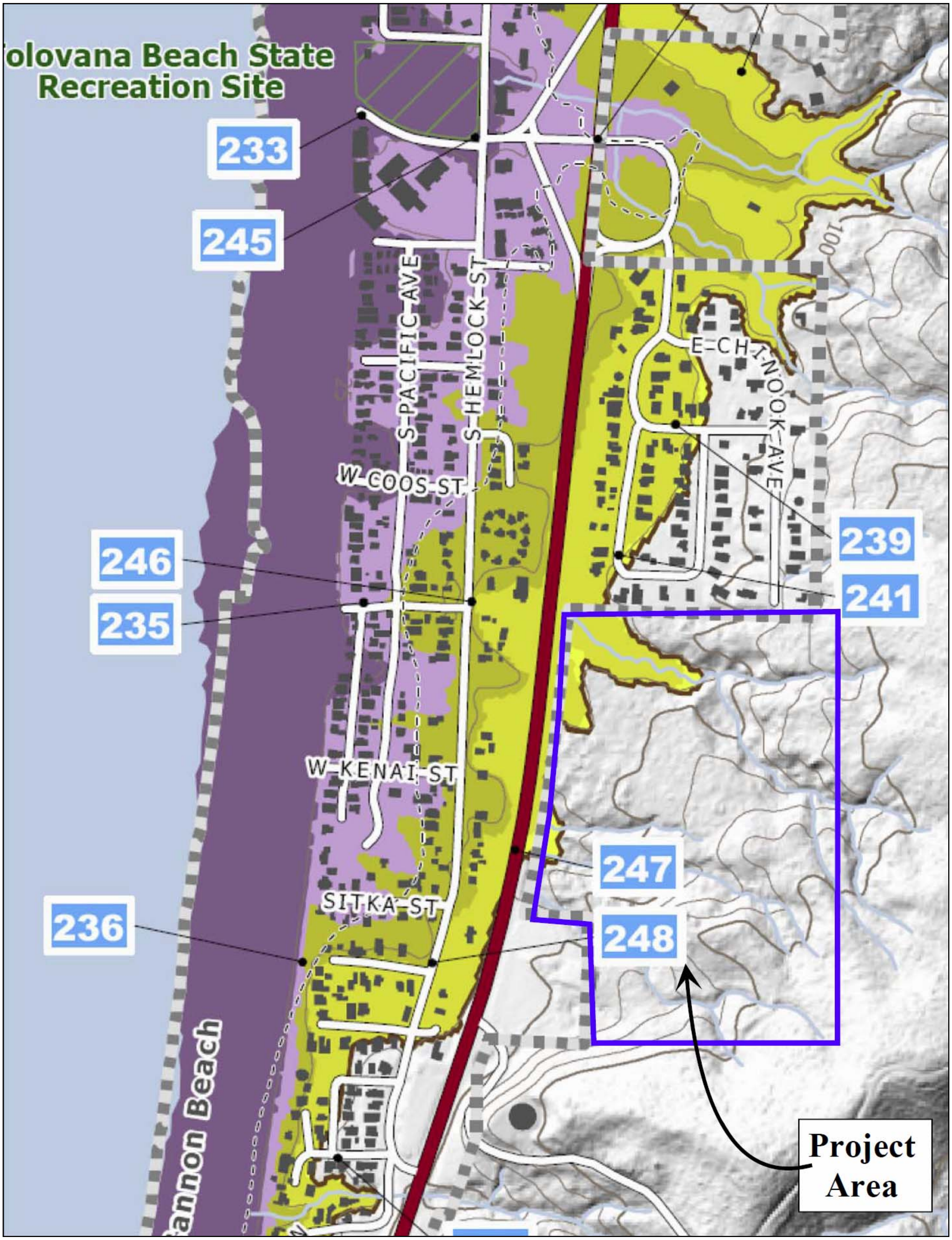


Figure 9: Tsunami run-up projections for Cascadia-sourced seismic sea waves. Minor flooding of the lower gullies may occur in the worst-case modeling scenario.