

September 5, 2022

Dear Gearhart City Hall:

Following are my comments on the Seismic Resiliency and Mitigation Plan to be discussed at the September 7 City Council meeting. I've commented only in areas where I have expertise, which relate to the tsunami inundation and evacuation maps and their interpretation, and the City's tsunami hazard overlay zone and related ordinances.

There are several basic errors in this document, relating to the elevations of tsunami inundation in Gearhart and the content of Gearhart's ordinance relating to the Tsunami Hazard Overlay Zone. These are easily verified by reference to the DOGAMI inundation maps and the Gearhart's ordinance text.

I believe that the document should not be approved until these errors are corrected. Approval without correction makes Gearhart's City Council and staff look like it does not know the content of its own city ordinance, the elevation of its own optional assembly areas, or how to read and interpret its own tsunami inundation map.

Following are detailed comments referenced to the page of the document.

Sincerely,  
Stewart Schultz  
140 NW 20<sup>th</sup>  
Rockaway Beach, OR

== Schultz comments follow

The text and legend in Figure 2-1 are not readable because the resolution is too low. Figures need to be re-inserted in full resolution in order to have any information value to the reader.

p. 7 *"CSZ megathrust events generated along the boundary between the subducting Juan de Fuca plate and the overriding North American plate."*

This is not a sentence.

p. 8 *"The potential for a CSZ earthquake has an estimated probability of occurrence off the Oregon Coast on the order of 16 to 22 percent over the next 50 years."*

This statement is incorrect, as it does not include the probability of a southern event (including southern Oregon coast), which brings the total probability up to over 35 percent. Also "on the order of" is incorrect, as it means mathematically within an order of magnitude, a concept inapplicable here. Also, the word "potential" is meaningless.

The statement should be corrected to read *"A full-rupture CSZ earthquake has an estimated probability of occurrence of 16 to 22 percent over the next 50 years."*

p. 8 *“The prepared inundation limit by the City has been established at 49 feet above sea level.”*

This is incorrect and confused. Nowhere in city ordinances has an elevation of 49 feet been established or stated as any kind of flood limit or standard. Gearhart has a Tsunami Hazard Overlay Zone which is equivalent to the DOGAMI Tsunami Hazard Zone which extends up to 80 feet elevation at the oceanfront of Gearhart, and up to 60 feet elevation inland. This is clear in Figure 2-3 in the document.

Gearhart additionally has a Prohibited Uses clause in Section 3.1450 of the city ordinance which restricts certain uses below the inundation of the “L” event scenario as mapped in the Tsunami Inundation Map Series. *“In areas identified as subject to inundation from the “L” magnitude local source tsunami event as set forth on the Tsunami Inundation Map Series (TIMs), the following uses are prohibited:”* (THO-3, Gearhart city ordinance)

The prohibited use limit is therefore not defined by any elevation, rather it is defined by the limits of the “L” flood event, which has a different elevation in different areas of the city, and nowhere is it 49 feet. At the oceanfront it ranges from 59 to 62 feet, and inland from 36-40 feet depending on the location. This is clear from the inundation map, and from Figure 2-3 in the document, which shows the “L” event (dark mustard color) as flooding to 60 feet at the oceanfront, and 40 feet inland.

Therefore the statement should be corrected to read *“The prohibited use limit by the City has been established at the L inundation scenario”* or something similar and any references to “49” feet should be eliminated as this elevation does not exist in Gearhart city ordinance or in any “L” flood limit in any DOGAMI analysis of Gearhart.

p. 9 *“Current research indicates the region is “past due” based on historic and prehistoric recurrence intervals documented in the ocean sediments.”*

This is an incorrect statement. First, the purpose of this document is to prepare for a magnitude 9 or full-rupture CSZ earthquake. The recurrence interval for a full-rupture earthquake is roughly 500 years. The last full rupture event was in 1700, therefore if the recurrence interval is the average of 500 years, the next would be predicted to occur in 2200. An earthquake predicted to occur in 2200 is not “past due,” it is due in roughly another 200 years.

Second, even if we consider a partial (southern) rupture event, the statement is still not true. This is because an earthquake is “due” at the 50% probability level. A partial rupture event has a probability of 35% in the next 50 years. Therefore, a partial rupture event is “due,” statistically, in over 50 years. An event due in over 50 years is not “past due.”

To understand this better, consider a different context: we do not say that an 80-year-old woman is “past due for death” even though the average female longevity when she was born was less than 80 years. The average 80-year-old woman in the US lives for another 9 years; i.e. the probability of death in 9 years is 50%. She is not “due” for death, statistically, for another 9 years. Similarly, the probability of another CSZ event in 50 years is 35%, indicating that another CSZ event is not due, statistically, for more than 50 years. Or, stated differently, the probability of death, conditional on being alive and female at age 80, is 50% in nine years. And, the probability of a partial rupture CSZ earthquake, conditional on being quiescent for the 322 years since 1700, is 35% in 50 years.

Therefore, for the earthquake considered in this document, we are not “past due” in any sense of the word. I realize that some people in the popular media have stated that we are “past due” or “11 months

pregnant” but these people are not statisticians and do not understand the concept of conditional probability.

The correct sentence should read *“Current research indicates the region is due for another event in approximately 50 to 200 years”*.

p. 10. Why does this report reference the “proposed Police/Fire station” in the Highlands in its discussion of liquefaction? This site is outside Gearhart city limits, outside the legal boundaries of the area covered in this document. Further, there have been many “proposed” locations of the station, within city limits, with liquefaction risk already estimated for them in submitted City geologic reports. Why not refer to those, rather than a location outside city limits? Further, there was no analysis done in that geotechnical report to conclude there was no liquefaction risk at that site; the author simply stated that in his experience the ground surface of a site such as this is rarely if ever water saturated, and more detailed study is necessary to know for certain at this particular location, including wells monitored during the winter rainy season. There are many hardpan areas just below the surface at this site that cause standing water into the summer season.

p. 11 It is not true that “Subsidence” is an issue additional to the tsunami inundation maps. The maps take the estimated subsidence into account in calculating the flood elevations. All the issues in section 2.2.5 have already been taken into account in the DOGAMI tsunami inundation maps.

p. 11 *“The optional high ground areas will be able to endure a “L” tsunami up to 49 ft above mean sea level.”*

This statement is wrong and incoherent. The datum in all the maps is the 0 foot level, not mean sea level. The elevation of the “L” tsunami is different in different areas in Gearhart, roughly 60 feet at the oceanfront and 40 feet inland. And the areas dry in an “L” tsunami are above this elevation not “up to” the elevation. The correct statement should be: *“The optional high ground areas will be able to endure an “L” tsunami, which floods to approximately 60 feet above the 0 datum at the oceanfront and 40 feet inland from the first dune ridge”*. Nowhere in Gearhart does the “L” tsunami flood to 49 feet, and nowhere in City ordinance is an elevation of 49 feet mentioned. Also worth pointing out that this is the estimated mean tsunami height in theoretical models. The tsunami from a real “L” earthquake could be anywhere from 20 feet to over 100 feet in wave height.

Also, the optional assembly areas in Gearhart are not above 49 feet elevation as stated here. The City GIS shows the LIDAR elevations of each assembly area. The LIDAR elevations of the four optional assembly areas in Gearhart are 46, 41, 41, and 46 feet elevation above 0, clockwise from Gearhart Lane. None of the optional assembly areas are above 49 feet elevation. They of course do not need to be above 49 feet to be above the “L” tsunami, because the “L” tsunami floods only to about 36 to 40 feet over most of Gearhart, as can be easily seen from the DOGAMI inundation map.

The corrected statement should be *“The optional high ground areas are all above the mean predicted tsunami from an “L” scenario, and range in elevation from 41 to 46 feet.”*