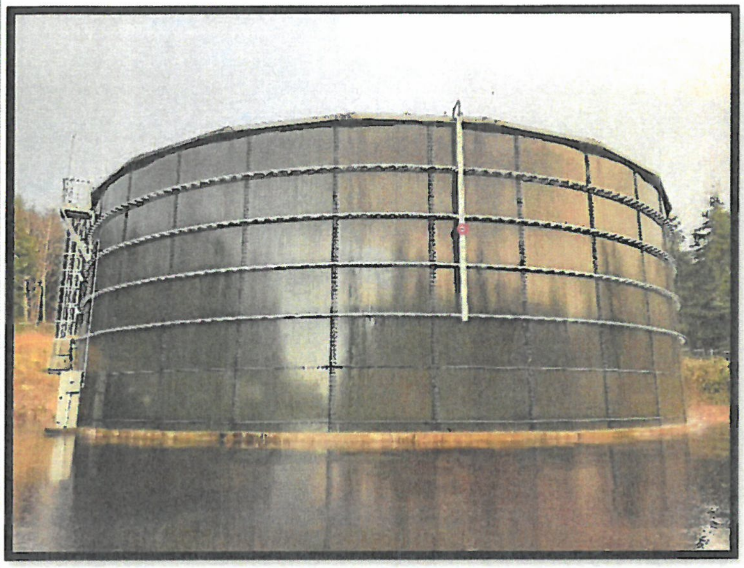
CITY OF GEARHART

CLATSOP COUNTY,
OREGON



Seismic Risk Assessment and Mitigation Plan

September 2022

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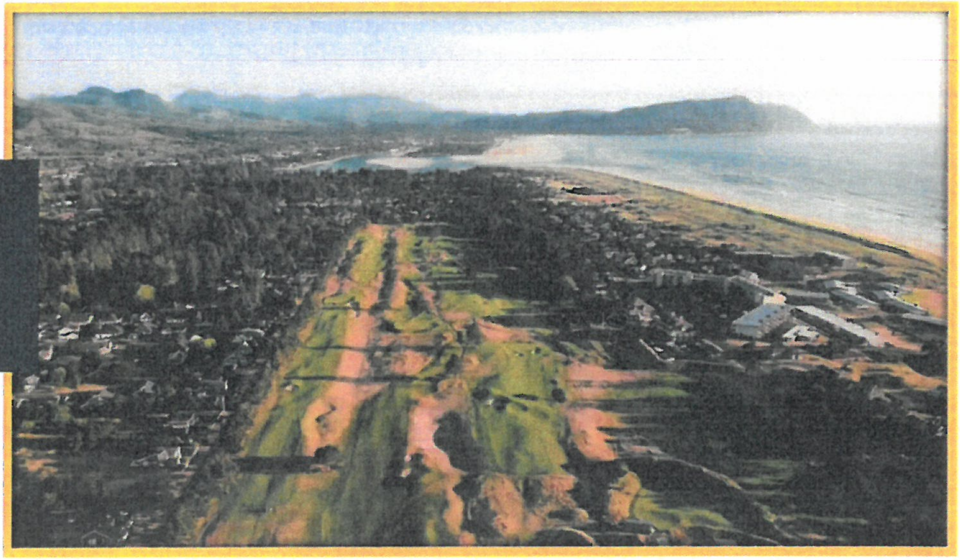

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CLATSOP COUNTY, OREGON

Seismic Risk Assessment and Mitigation Plan

September 2022

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EXPIRES: JUNE 30, 2023

Civil West
Engineering Services, Inc.

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1 EXECUTIVE SUMMARY

1.1 Introduction and Overview

The City of Gearhart (City) operates a public water utility located north of Seaside and the Necanicum River along Highway 101. The City is responsible for supplying water to property owners within the City. Due to seasonal fluctuation, the City serves as few as 1,545 people to as many as 7,000 people. Portland State University (PSU)

Civil West Engineering Services, Inc was commissioned by the City to develop a Seismic Risk Assessment and Mitigation Plan (SRAMP) with the assistance of City staff. This Plan will act as a guide for the City as it prepares for the future. The Plan addresses recommended improvements such as aging pipelines, water storage, and redundancy concerns.

1.2 Purpose and Need

The purpose of this SRAMP is to document findings regarding the City potable water system's seismic resiliency and make improvement recommendations over the next 50-year planning horizon.

The City and Civil West reviewed and assessed fundamental planning elements such as current population, projected population growth, water supply sources, current and projected water demand geographic challenges. The assessment resulted in several recommended improvements (capital improvements) with associated priorities. Figures and supporting data for the information presented in this report have been included as attachments for reference.
This SRAMP includes:

- A review of the fundamental planning elements (design criteria) such as guidelines, immediate impacts of a seismic event, and geotechnical and structural evaluations.
- Different likely seismic scenarios and event process which will affect different aspects of the City's Public Works operations and water service.
- A summary of each water system component, its condition, vulnerability and susceptibility to seismic damage.
- Identification of upgrades and improvements to address potential vulnerabilities and correct deficiencies.
- A summary of recommended capital improvements with prioritization.

2 SEISMIC RISK ASSESSMENT AND MITIGATION PLAN

2.1 Introduction

The City has been identified as a Level VIII on the Oregon Department of Geology and Mineral Industries (DOGAMI) Oregon plate number 7 for earthquake and tsunami damage as shown on Attachment A. Due to the City's proximity to the coast, and in the event of a large (9.0+) Cascadia Subduction Zone (CSZ) event, a large portion of the City would be compromised if not outright destroyed by an earthquake and/or resultant tsunami. (DOGAMI)

Based on the current condition and location of the existing infrastructure, the City is vulnerable to seismic events, including resultant tsunamis, subsidence, landslides, and power outages. Considerable work must be done to update the City's utility infrastructure to ensure it has the most seismically resilient system possible. Modification, replacement, and/or relocation of existing infrastructure is critical to ensure the City can continue to supply water and essential community needs after a major CSZ event.

This SRAMP will address the likely impact a CSZ 9.0 earthquake will have on the City's water utility facilities, changes that can be made to reduce the impact, and ways the City can prepare to reduce system recovery time after such an event. The intent of this SRAMP is to identify, assess, and plan to upgrade or relocate existing critical facilities and infrastructure as necessary to supply the City post-CSZ 9.0 event with:

- Clean Drinking Water
- Fire Suppression
- Health Care and Fire Aid
- Emergency Response

The 2013 Oregon Resilience Plan (ORP) has a 50-year planning goal for cities and special utility districts to attain the capability to restore critical services within a one-week period after an earthquake/tsunami event, and to be able to restore all services within three to six months. This restoration of services will be considerably more difficult for coastal communities due to the compounded effect an earthquake, subsidence, and resultant tsunami are likely to present. Currently, coastal communities are estimated to take up to 3+ years to restore drinking water services after a major seismic event. By focusing planning and capital improvement toward improving seismic resiliency, the recovery period after such an incident can be significantly reduced.

2.1.1 Guidelines

Every community water system with more than 300 connections who submits a water system master plan is required to conduct "a seismic risk assessment and mitigation plan for water systems fully or partially located in areas identified as VII to X, inclusive, for moderate to very heavy damage potential using the Map of Earthquake and Tsunami Damage Potential for a Simulated Magnitude 9 Cascadia Earthquake, Open File Report 0-13-06, Plate 7 published by the State of Oregon, Department of Geology and Mineral Industries (see Figure 2.1).

(i) The seismic risk assessment must identify critical facilities capable of supplying key community needs, including fire suppression, health and emergency response and community drinking water supply points.
(ii) The seismic risk assessment must identify and evaluate the likelihood and consequences of seismic failures for each critical facility.
(iii) The mitigation plan may encompass a 50-year planning horizon and include recommendations to minimize water loss from each critical facility, capital improvements or recommendations for further study or analysis." (OAR 333-061-0060)"

The result of this City Risk Assessment is a list of infrastructure backbone components including supply, treatment, distribution, and storage elements that are needed to continue to supply water for essential community needs immediately after a CSZ earthquake.

The assessment evaluates the likelihood and consequences of seismic failures for the City identified as critical. General information for assessing various facilities by construction date and material is found in the ORP, which also references the American Lifelines Alliance (2001) Seismic Fragility Formulations for Water Systems, www.americanlifelinesalliance.org.

Based on the critical facilities identified to form the backbone, the City Mitigation Plan consists of projects that will be completed over the next 50-year period to upgrade, retrofit, or rebuild these facilities so that they will continue to provide water following a CSZ earthquake. The mitigations include planned capital improvement projects, improvements to minimize water loss from each critical facility, and recommendations for further study or analysis. The Mitigation Plan includes a schedule as to when these mitigation efforts are targeted to be completed within the 50-year planning horizon.

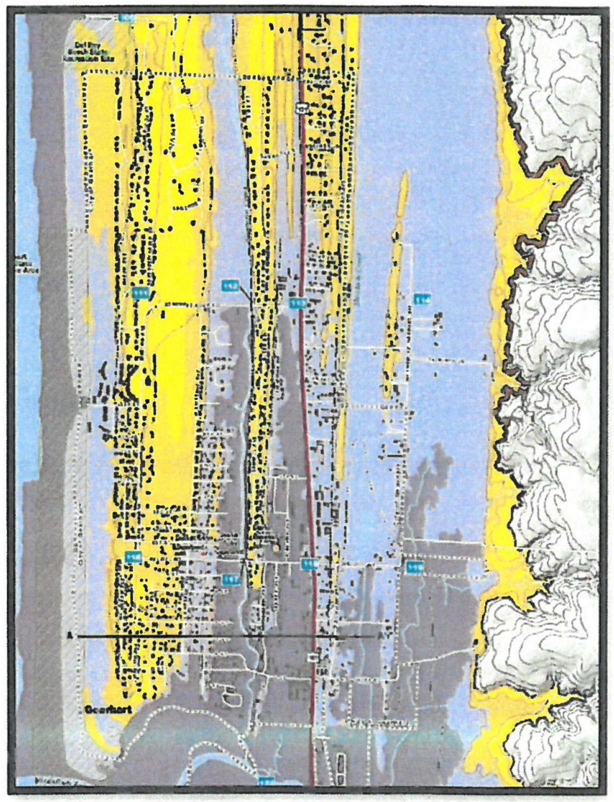
2.1.2 Immediate Impacts of a Seismic Event

Earthquakes in the Pacific Northwest occur in response to active convergence of the Juan de Fuca oceanic plate and the North American continental plate. CSZ megathrust events generate along the boundary between the subducting Juan de Fuca plate and the overriding North American plate. Recent studies indicate that the CSZ can potentially generate large earthquakes with magnitudes ranging from 8.0 to 9.2 depending on the rupture length. A CSZ earthquake of 7.1+ magnitude has an estimated probability of occurrence off the Oregon Coast by 37 percent over the next 50 years. (OEM)

The first notice of an earthquake will be severe shaking for 3 to 5 minutes. It will be very difficult to stand up. If driving, it will be difficult to maintain a position on the roadway. Non-reinforced masonry buildings will receive extensive damage and may collapse. Wooden structures will be significantly damaged. Different geographical areas will react differently; landslides will occur in the mountain range to the east of the City. Roads will split, bridges will fail. In the water system, water storage tanks may shake off their footings, treatment plant structures and pump buildings may be damaged, transmission pipelines may tear apart, and distribution lines may break.

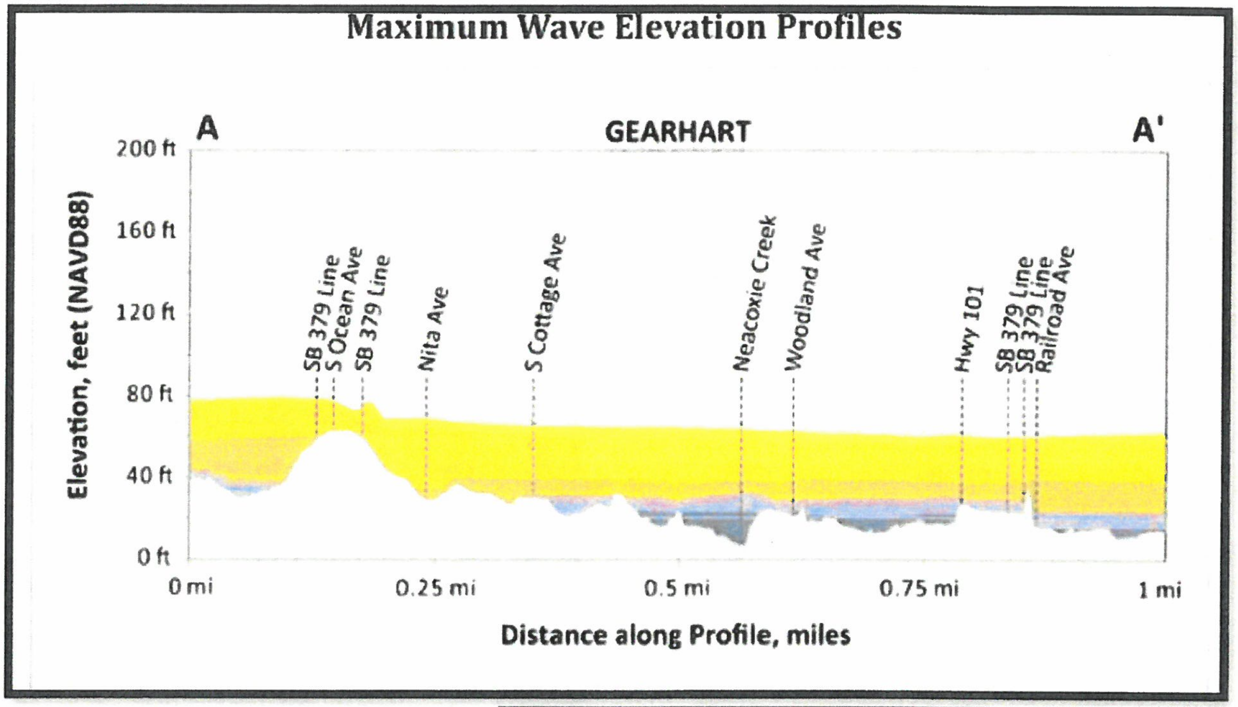
About 20 minutes after the initial shaking, a tsunami will, with high probability, hit the coast and inundate areas. In preparation for a Tsunami event, the City has established the Tsunami Hazard Overlay Zone for preparation of a Large "L" tsunami event as established by DOGAMI. Figure 2-1 shows a focused map of the City. A description of the color coding is shown in Figure 2-2 for the tsunami wave profile which is applicable on Figure 2-1. The larger referenced DOGAMI Map of Seaside-Gearhart can be seen in Attachment B of this report. The prepared inundation limit by the City has been established at 49 feet above sea level. This will affect about 81 percent of the water service customers in the City. It will also affect City facilities within the inundation areas including the City Hall office on Pacific Way, the well field, and the Water Treatment Plant (WTP). (DOGAMI)

FIGURE 2-1: DOGAMI TSUNAMI INNUNDATION MAP



Immediately after the tsunami, few City employees may be available as they themselves will be working to check on the status of family members or otherwise affected personally. Many telephone systems will be down. Cell phones may not be reliable, and if they are working, the service providers will be loaded with calls. Electrical power may be down for some time. Transportation will not be reliable. Portions of US Highway 101 will have been inundated with the tsunami. Sections that are structurally intact will be covered with debris. Landslides will destroy sections of Highways 26, 30, and 101, potentially isolating the City from other communities and the coastal communities from the Willamette Valley. Water leaking from broken pipes will soon empty the system tanks.

FIGURE 2-2: TSUNAMI WAVE PROFILE



Legend

Earthquake Size		Average Slip Range (ft)	Maximum Slip Range (ft)	Time to Accumulate Slip (yrs)	Earthquake Magnitude
	XXL	59 to 72	118 to 144	1,200	~9.1
	XL	56 to 72	115 to 144	1,050 to 1,200	~9.1
	L	36 to 49	72 to 98	650 to 800	~9.0
	M	23 to 30	46 to 62	425 to 525	~8.9
	S	13 to 16	30 to 36	300	~8.7
	XXL Wet/Dry Zone				

2.1.3 **Geotechnical and Structural Seismic Evaluation**

Although there is a general discussion here regarding seismic resilience of various components of the water system, this report does not delve into the actual geological and structural condition of the structures that make up the components. For the City to have a more accurate estimate of areas vulnerable to seismic events, it would need to commission a detailed geotechnical and structural investigation including specific recommendations as to the risks associated with various soil types and geologic features and existing structures.

2.2 Geologic and Seismic Setting

Current research indicates the region is "past due" based on historic and prehistoric recurrence intervals documented in the ocean sediments. In 2013, the State of Oregon developed the ORP 2013 to prepare for the magnitude 9.0 CSZ event. The following are geological activities that can be triggered or intensified by ground shaking and that can damage water system infrastructure.

2.2.1 **Ground Shaking**

Ground shaking is a hazard created by earthquakes. If the vibrations are strong enough, they may cause damage to buildings, roads, or other structures.

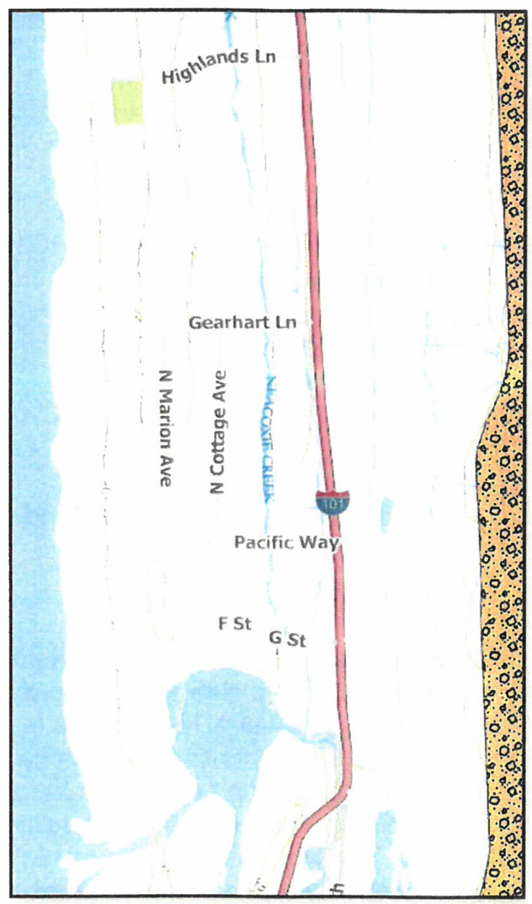
Liquefaction and landslides can be triggered by ground shaking. The rapid and extreme shaking during an earthquake can cause stress and strain in pipelines that can be damaging if the pipe material and joints are not strong enough to withstand the transient ground deformations. Damage from ground shaking occurs even when there is no Peak Ground Displacement (PGD). The intensity of ground shaking can be quantified by measuring the Peak Ground Velocity (PGV) at a site because of an earthquake.

Ground shaking varies depending on the soil, the topography, and the location and orientation of the rupture. Ground shaking is one hazard that causes damage to buried pipes.

2.2.2 **Liquefaction**

Liquefaction is a phenomenon that occurs during ground shaking in areas of loose, saturated, granular soils. The lack of soil stability may cause infrastructure to sink and collapse. The areas in the City that would be prone to liquefaction are in the floodplain areas near Neacoxie Creek, the low-lying areas on the east side of Highway 101 along McCormick Gardens Rd.

FIGURE 2-3: DOGAMI SLIDO MAP



The City recently obtained a geological report from Foundation Engineering Inc. which studied the area around the proposed Police/Fire station. The geology analyzed at the proposed Police/Fire station showed little risk of liquefaction in the elevated areas. Low lying areas where the ground is completely saturated consisting of loose sandy soils pose a higher risk of liquefaction. (James K. Maitland)

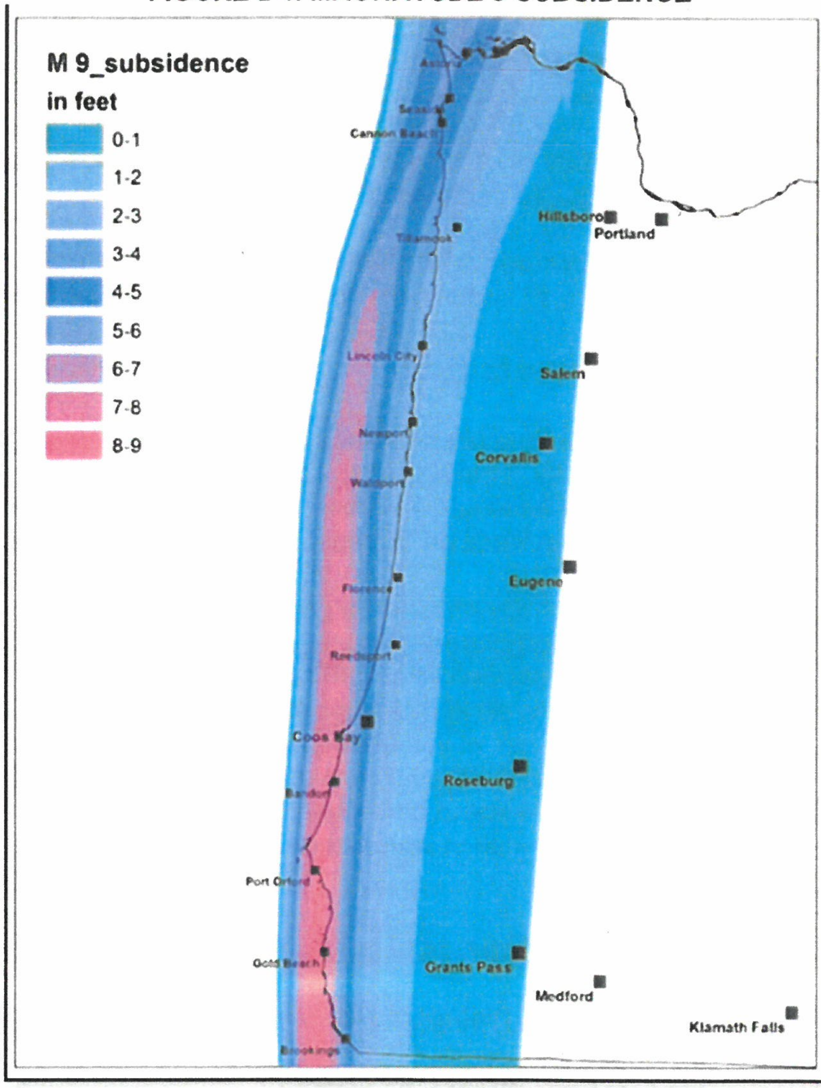
2.2.3 **Landslides**

The Statewide Landslide Information Database for Oregon (SLIDO) shows the City limits outside the historic landslide area (Figure 2-3). The tan hatched section on the east side of the map shows areas susceptible to landslides. Landslides generally occur on steep cliffs or slopes with saturated soils. They are frequently triggered by additional rain, uprooted trees, slope disturbance from construction, and ground shaking. Earthquake-induced landslides can occur on slopes when inertial forces from an earthquake add dynamic loading to an already unstable slope. Saturation of soils will further exacerbate the potential for landslides if the earthquake should happen during the wet season. The ground movement caused by landslides can be extremely large and damaging to pipelines, tanks, and other facilities. DOGAMI publishes maps of landslide prone areas.

2.2.4 **Lateral Spread**

During earthquake shaking, the ground may move laterally causing blocks of land to move in the same direction. Generally, this occurs near a slope but can occur anywhere there are soils underlain with a weak foundation. Lateral spreading will crack and stretch the ground surface. The area of the City may not be prone to lateral spread.

FIGURE 2-4: MAGNATUDE 9 SUBSIDENCE



2.2.5 **Subsidence**

Subsidence causes the ground to drop in an area quite literally. Indicated on Figure 2-4 from ORP states the City has the potential for a subsidence of 4-5 feet during a Magnitude 9 seismic event. This subsidence will further exacerbate the effect of the resultant tsunami by creating a 3-foot permanent “storm surge” prior to the tsunami arrival. Anywhere in the City that is susceptible to tsunami runup will be negatively affected by subsidence. There is a higher probability of land movement for properties adjacent to waterbodies, wetlands and drainages such as Neacoxie Creek and Neawanna Creek, which may suffer from the compounded effects of subsidence and liquefaction due to saturated soils.

2.2.6 **Tsunami**

When an earthquake occurs under the ocean, the elevation of the ocean floor suddenly changes. The relative change causes a wave to propagate away from the site of the displacement. The wave, known as a tsunami, can travel thousands of miles. As it nears the shore, the wave height rises and can cause severe damage as it runs up on shore. Smaller waves will follow over a period of several hours. Attachment C contains the local Tsunami Evacuation Maps encompassing the City, showing inundation of nearly the entire service area of the City. The map shows optional high ground tsunami evacuation assembly areas only if you are unable to make it out of the hazard area before the first wave comes. The optional high ground areas will be able to endure a “L” tsunami up to 49 ft above mean sea level. Most structures will not survive the impact of the debris-laden waves. As the tsunami waves withdraw, they will cause erosion of the soil. Within the tsunami zone, damage will be much worse than that from the shaking alone.

The impact on City infrastructure in the tsunami zones will vary. Some fire hydrants may be jarred loose because of the impact with debris in the waves. In some places, pipes may be exposed or broken because of erosion of the surrounding and underlying soil. Some places might have soil accumulation, making it difficult to find valves.

2.2.7 Aftermath

Due to the nature of the shaking, the unpredictable actions of landslides, and unknown weaknesses, it is impossible to predict where and to what extent damage to the system will occur. Advance preparation can reduce the chances of impact to selected areas. After the shaking and flooding stop, the City staff and officers will make an assessment to see where the damage occurred and take actions to save as much water as possible from draining through broken pipes.

Electrical power to the City is provided by Pacific Power. Although Pacific Power has received recognition for having redundancy built into their system, there may not be any electrical power available for a time. The City will need to rely on the City-owned localized generators, which will also have a limited useful time because of unavailability of fuel.

The highway access for delivery of fuel, repair parts, supplies, etc. will also pose a problem for restoring service. To that end, the City should develop a list of materials that should be stockpiled in order to resume basic production and distribution of treated water.

2.3 Seismic Risk Assessment and Mitigation

The goal of the risk assessment recommendations is to create a disaster resilient water system infrastructure backbone involving each of the water system components:

- Water Supply / Sources (Wells, Pipelines, Pumps)
- Water Treatment
- Water Storage
- Water Distribution

The backbone system consists of key supply, treatment, transmission, storage, and distribution components that, over the 50-year timeframe, will have been upgraded, retrofitted, or rebuilt to withstand a Cascadia Subduction Zone earthquake. The backbone water system would be capable of supplying key community needs, including fire suppression, health and emergency response, and community drinking water distribution points, while damage to the larger (non-backbone) system is being addressed.

This Mitigation Plan is an effort to reduce loss of life and property by lessening the impact of a seismic disaster. To be effective, mitigation must address difficult realities, and invest in long-term goals. Acting prior to an event will ensure the City will be safer, financially secure, and self-resilient. The City has a Tsunami Overlay Zone Code adopted in July 2019. The City has a policy to prohibit the development of certain essential facilities and special occupancy structures within the "L" tsunami inundation zone, see Figure 2-2 or Attachment B. (City of Gearhart)

The cost of complete seismic mitigation to the City's entire water infrastructure would exceed the City's resources. Therefore, as outlined in Section 2.4, a phased approach to system recovery improvements is recommended.

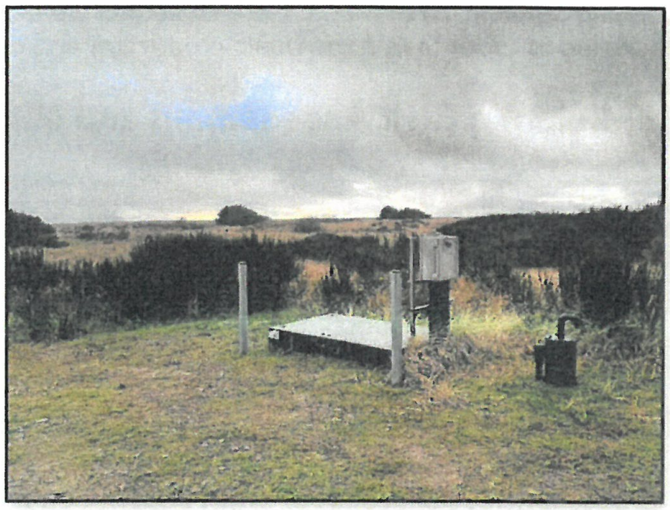
The next paragraphs will analyze the water system components individually for likely points of failure because of a CSZ -9 earthquake and subsequent tsunami. Possible actions to harden the facilities will be discussed and recommendations made to accomplish the resiliency goals.

2.3.1 Water Supply / Sources

Groundwater Source

As noted in Section 3.1 in the Water System Master Plan, the City's groundwater wells are along the west side of the City in line with the State Park boundary, See Attachment D for locations of the wells. The City has 8 wells drilled with approval of potentially 16 wells in the well field area. Eight wells are implemented within the system with pumping equipment. (Chris R. Hyatt, RG, LHG,) The most likely disruption of water supply would be the wellheads being destroyed or inaccessible. This would likely occur during a subsidence or tsunami event. Inundation from salt water may also damage a well or make the source water unpotable. Shown in Figure 2-5 is the typical above ground features of a well including well head, valve vault, and electrical control panel.

FIGURE 2-5: GROUNDWATER SOURCES



Due to the potential inaccessibility of the well field and the imprecise ability to predict earthquakes, there is not much that can be done to prevent impacts to the well field from a tsunami. The above ground features of the wellheads and control panel are vulnerable from a tsunami. Although the initial wave from inundation may not impact the wells, the drawback of debris and saltwater inundation after the initial surcharge may damage the wells. If the wells are operable afterward, they will need to be purged and tested before being reimplemented into the system. Fortunately, the City has an intertie with the City of Warrenton and the City of Seaside for supplemental water. If the wells were out of commission for a while after a tsunami, the system could potentially still operate.

Warrenton Inter-Tie

There are three water distribution interties with the City of Warrenton. The inter-ties are located on McCormick Garden Road (East), Dawson Road (Northeast), and Pinehurst Road (Northwest). The Pinehurst Road inter-tie is a one-way connection through a pressure reduction valve for fire suppression within the Warrenton distribution system of the Pinehurst Subdivision. The Pinehurst inter-tie cannot supply the City of Gearhart. A transmission line leading to the east inter-tie is approximately a quarter mile long coming into the City from the east, see Attachment D for location of the intertie. The main potential disruptions of the intertie due to an earthquake would be a subsidence event causing separation of the pipe within the quarter mile transmission alignment through the susceptible subsidence region to the east. The transmission piping is presumed to be welded steel. The shaking from a CSZ quake may damage the intertie transmission piping. It is doubly important that the staff monitor the intertie. Staff from Warrenton or Gearhart should be engaged to check the alignment for both seeps as well as slide potential along the route. Further geotechnical analysis should be conducted to investigate risk associated from any potential slide or subsidence event along the alignment.

Seaside Inter-Tie

There is a water distribution intertie with the City of Seaside along the Oregon Coast Hwy. The line leading to the intertie is within the City of Seaside's distribution network. Interruption to the intertie is not expected to occur without City of Seaside's distribution system going offline. The connection to the system is through a normally closed valve. Coordination with the City of Seaside would be required in case of emergency and verification of Seaside's system being able to produce and convey potable water.

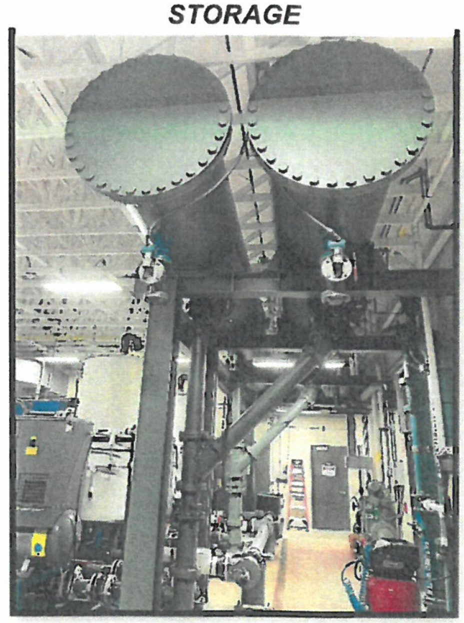
Ground Water Transmission Pipelines

Section 3.7 of the Water System Master Plan indicates the City has one 8-in PVC ground water transmission pipe from the well field to the WTP. (Milton Dean Larson) The condition of the transmission line is of unknown condition. It is recommended all polyvinyl chloride (PVC) transmission lines should be changed to high density polyethylene (HDPE) pipe or restrained joint C900 PVC within the next 20-50 years, or as resources become available.

Raw Water Conveyance

All the City's ground water is pumped by individual submersible pumps in each well. The pumps and wells are in the tsunami evacuation area and would likely be seriously damaged because of the effects of a CSZ-9 earthquake. Fortunately, the City is not completely dependent on the wells. As such, when taken out of service and while receiving water from Warrenton and/or Seaside, the City's water facilities, such as the WTP, can be assessed and repaired. The raw water pumping conveyance system is considered a key backbone element.

FIGURE 2-6: RAW WATER STORAGE



Ground Water Storage

There are two recently installed ductile iron storage pipes elevated at the WTP shown in Figure 2-6. Although these tanks were installed to current seismic building code requirements, it is recommended a structural engineer analyze these elevated pipes and give any recommendations for additional seismic resiliency.

2.3.2 Water Treatment Plant

The City has a water treatment plant constructed in 2012. The treatment plant appears to be away from slide-prone areas but is within of the tsunami zone. The most probable cause of damage to the water treatment plant during a major earthquake would be due to a tsunami. Second probable cause would be from shaking, potentially damaging both the building and the machinery/equipment. The plant was built after the latest State's building code for seismic standards were upgraded. The City's one-half million-gallon concrete clearwell is situated on the west side of the water treatment plant under public tennis courts. It is recommended the City hire a structural engineer to review the construction plans and the codes that were applied at the time of construction to assess what retrofits may be necessary to get the facility up to current code. The engineer should also look at the placement of motors, pumps, storage tanks, and other appurtenances at the plant to assure they are properly braced to prevent failure in a seismic event.

The next most probable cause of disruption of service to the plant would be lack of electricity. The plant is serviced by Pacific Power, which has redundancy in its feed lines to the area. However, in case of outage, the water treatment plant has a generator of adequate size to supply the needs to keep the plant operating for a limited period.

The third area of vulnerability to the treatment plant after a major earthquake will be materials and supplies, including fuel to run the generator, treatment chemicals, lab supplies, repair parts, etc. There will be major disruptions to vehicle traffic and confusion in the distribution of supplies throughout the north coast. There is not a lot the City can do to improve accessibility for these supplies, so the staff must analyze how much material and supplies they need to keep in reserve. The water treatment plant is considered part of the "backbone" system.

2.3.3 **Water Storage**

The City currently has one treated steel water storage tank, see Section 3.7.3.2 of the Water System Master Plan. The tank was built in 2012. The 1 million gallon (MG) tank is considered part of the "backbone" system. It is presumed due to the date of construction that the tank was designed to current seismic standards. The tank is above the tsunami inundation zone, at 177 feet. However, the tank appears to be in an active landslide zone, although the area around the tank is relatively clear and the hillside slopes have been laid back a considerable distance from the tank site. A landslide could affect the access route to the tank. The cause of damage to this tank will most likely be due to shaking. The inertial forces of the ground shaking, and water sloshing will tend to cause a tank to either slide off its foundation or rip the walls apart. The shaking can also cause differential movement between the tank and the surrounding ground. If the pipes connecting the tank to the water system are not flexible, they can break.

In case of an emergency, it is recommended to isolate the tank to preserve treated water and provide a location for residents to get water, it is recommended a seismic valve be installed next to the existing valve vault to isolate the tank if the distribution system is damaged and prevent the tank from draining.

2.3.4 **Water Distribution**

Distribution System

The distribution system has hydrants, water meters, various types of valves, and several types of pipes. A map of the City's distribution pipe network is shown as Attachment D to this report. Pipe materials used within the City distribution system include Asbestos Cement (AC) Pipe, multiple classes and manufacturers of PVC Pipe, and HDPE Pipe. See Section 3.9 of the Water System Master Plan for detailed description of the distribution system. These elements of the water distribution system are most vulnerable. It is here the "backbone" system is most important.

Different types of pipes have different abilities to withstand seismic events. AC pipe is considered a "rigid" pipe and very susceptible to breaking during a seismic event. Rigid pipes are better able to handle loading without deformation, but do not have the capability to flex during ground movement. PVC, while considered a flexible pipe, is generally installed with non-restrained joints, meaning it is susceptible to pulling apart during ground movement. The use of restrained joints can make PVC pipe an acceptable material for seismic resiliency. HDPE is the most flexible pipe material commonly used for water transmission and distribution, and is generally welded together, meaning it is fully restrained pipe. HDPE is widely recognized as the most resilient to ground movement.

As pipelines break, storage will be depleted. The principle behind a backbone is that the key pipelines will be built to be most resistant to the effects of an earthquake. Valves at key locations can be used to isolate smaller service neighborhoods until those portions of the network can be systematically repaired and restored to service. Hydrants with customer use adaptors or faucets at key locations can be part of the backbone so customers can fill water containers for their home use.

The recommendations made in Section 5.1.5 of the Water System Master Plan specifically mention the replacement of certain AC pipe with PVC pipe (WSMP Table 5.2). Although PVC pipe is a step in the right direction, PVC should be installed with restrained joints or HDPE pipe. As these improvement projects are constructed, the use of HDPE pipe will make the City less susceptible to adverse consequences. Through the course of this seismic assessment, it is apparent the City could struggle in a seismic event if the pipeline system isn't improved.

The hydrants are above ground and possibly subject to impact with debris in the tsunami inundation zone. As replacement or new hydrants are installed, it is recommended they be break-away hydrants to minimize water loss and damage to underlying pipes in case of such an impact.

Treated Water Pumps

The treated water pumps include three booster pumps and two high demand pumps. They are installed within the WTP. The booster pumps operate off reservoir level in the 1 MG storage tank and the high demand pumps operate based on low pressure readings from remote pressure monitoring stations. (Gearhart Water Treatment and Supply Facilities, Operations and Maintenance Manual DRAFT) As this could be called on to supplement fire flow into all areas of the City, it is critical and should be considered part of the "backbone" system. These treated water pumps are within the tsunami inundation zone and could be subject to flooding and debris damage.

Electrical panels could also be submerged. They are most vulnerable to tsunami flooding and shaking during a CSZ-9 earthquake. It is also vulnerable to availability of electrical power; thus, the existing on-site generator will provide power only for a limited time. Operation precautions should be made so that the emergency generators do not transfer till after the tsunami event has completely ended so the generators are not submerged while running. Approximately 81% of homes within the service area are in the tsunami zone and would likely not survive a CSZ-9 earthquake and tsunami event. Due to the estimated lack of demand after a CSZ-9, it is recommended that the City isolate their source water intake, water treatment system, and direct connection with the storage tank for providing potable water at one location for the public during the recovery phase. An ideal location for potable water public access would be at the water storage tank where the City's emergency caches are located, and potential short wave radio communications are available.

2.4 Summary Recommendations

There are several improvements the City can do in phases over the next 50-years to make the water system more resistant to damage and more resilient to be returned to service in the case of an earthquake and/or tsunami. The City should actively seek to replace the ridged and brittle AC pipe with the flexible, more resilient HDPE pipe or joint restrained PVC pipe. These improvements, if done, will increase the ability of the system to withstand the impacts of an earthquake.

In summary, seismic-related recommendations include:

1. Expert evaluations and analysis of specific water system components:

    a. An engineering geologist should be engaged to check the tank site and Warrenton intertie alignment. Coordinate with City of Warrenton on condition of transmission line.
    b. An inspection of the settling basins and clearwell should be conducted every five years.
    c. A structural engineer should evaluate the water treatment building as well as look at the placement of motors, pumps, storage tanks, and other appurtenances at the plant to assure they are properly braced to prevent failure in a seismic event.

2. Have tools and equipment necessary to repair large sections of pipeline and many small breaks. It is suggested to stock approximately 3% of the total system pipeline, which is approximately 3,600 LF of various sized pipe for the City. The pipeline stock can be coordinated with annual pipe replacement projects, so the supply pool is rotated. Pipe material should be stored out of the sun.

3. Keep a supply of various sized repair bands and fittings to facilitate repair of a minimum of 10 breaks.

4. Store vehicles, parts, materials above tsunami zone. The buildings where these items are stored should be reviewed for construction to the latest earthquake standards. City should evaluate sites to consider the best location for equipment storage.

5. Emergency cache at the 1 MG storage tank should be inspected annually. Training on emergency equipment should be conducted by public works staff on a regular basis. Consider hosting an earthquake preparedness drill for City staff.

6. Train City staff/volunteers on using ham radios and coordinate with local ham radio club for emergency equipment usage.

7. Install a seismic valve at the 1 MG storage tank to conserve water when breaks occur, and the water storage needs to be isolated.

8. GPS locate all valves and meters. If such are covered with debris and dirt, GPS coordinates of valves can be used to find the valve to shut down a section of pipe if necessary. Purchase handheld GPS unit or obtain mobile ArcMap Application for public works cell phones. Once phone services are reestablished recovery of the City distribution system can commence.

9. The existing Emergency Operations Plan should be periodically reviewed and updated to assure the plan is current.

10. Annually set aside funding for sections of existing pipe to be replaced with resilient HDPE for transmission line segments or C900 for smaller distribution segments with restrained joints, starting with the backbone of the system: from the well heads to treatment plant and from the treatment plant to the storage tank.

11. Seismically restrain all equipment within the WTP.

12. Be a participant in ORWARN. Oregon Water/Wastewater Agency Response Network (ORWARN) is a mutual aid association for water systems. In the event of a major impact to water systems, crews can be recruited from less-damaged areas of the state, and even out of state, to help with repairs.

2.5 Conclusion and Next Steps

The water system improvements recommended in this SRAMP, and current water master plan are a significant undertaking. Projects of this magnitude will require strong public support and financial assistance. This SRAMP provides sufficient technical and financial information to prospective funding agencies for their initial review and consideration.

The City should consider necessary water system improvements to create a more seismically resilient system. Some initial next steps may include:

1. Public outreach regarding overall water system improvements.

2. A One-Stop meeting with Business Oregon, USDA Rural Development, and other funding agencies to work through and consider options. With COVID-related economic impacts and other natural disasters that have impacted the state, there is an influx of funding available for upgrades to water systems like Gearhart. It is recommended the City aggressively pursue funding for needed projects and compete for funds that could be very advantageous. To make improvement projects manageable, grant and loan-forgiveness money are important and there could be some great opportunities.

Map of Earthquake and Tsunami Damage Potential for a Simulated Magnitude 9 Cascadia Earthquake

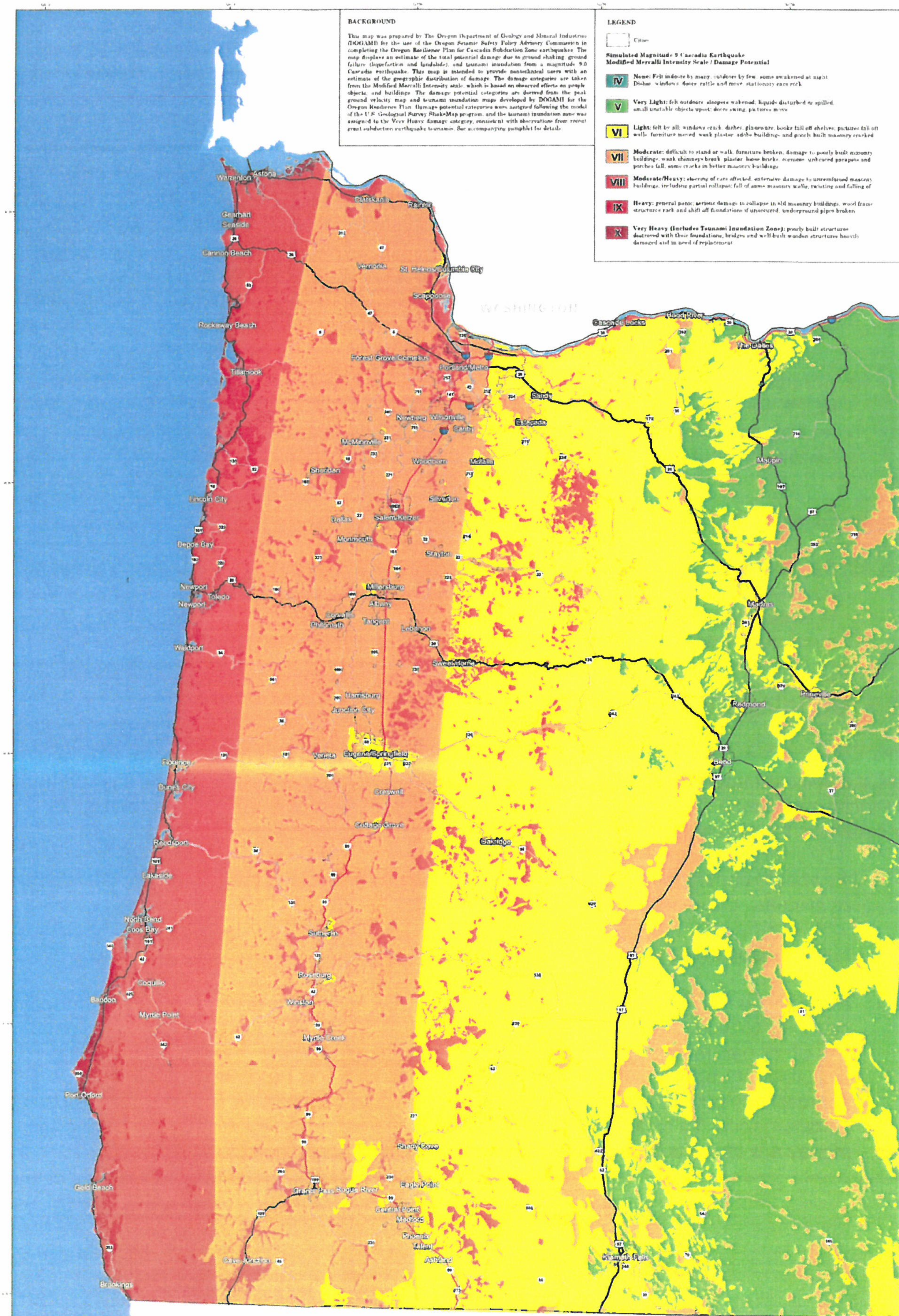
2013

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

OPEN-FILE REPORT O-13-06

Ground Motion and Ground Deformation Data and Maps for the 2013 Oregon Resilience Plan for Cascadia Subduction Zone Earthquakes

PLATE 7



BACKGROUND

This map was prepared by The Oregon Department of Geology and Mineral Industries (DOGAMI) for the use of the Oregon Seismic Safety Policy Advisory Commission in completing the Oregon Resilience Plan for Cascadia Subduction Zone earthquakes. The map displays an estimate of the total potential damage due to ground shaking, ground failure (liquefaction and landslide), and tsunami inundation from a magnitude 9.0 Cascadia earthquake. This map is intended to provide nontechnical users with an estimate of the geographic distribution of damage. The damage categories are taken from the Modified Mercalli Intensity scale, which is based on observed effects on people, objects, and buildings. The damage potential categories are derived from the peak ground velocity map and tsunami inundation maps developed by DOGAMI for the Oregon Resilience Plan. Damage potential categories were assigned following the model of the U.S. Geological Survey ShakeMap program, and the tsunami inundation zone was assigned to the Very Heavy damage category, consistent with observations from recent great subduction earthquake tsunamis. See accompanying pamphlet for details.

LEGEND

Cities

Simulated Magnitude 9 Cascadia Earthquake
Modified Merralli Intensity Scale / Damage Potential

- IV — **None:** Felt indoors by many, outdoors by few, some awakened at night. Dishes, windows, doors rattle and move, stationary cars rock.
- V — **Very Light:** felt outdoors, sleepers wakened, liquids disturbed or spilled, small unstable objects upset; doors swing, pictures move.
- VI — **Light:** felt by all; windows crack, dishes, glassware, books fall off shelves; pictures fall off walls, furniture moved, weak plaster, adobe buildings and poorly built masonry cracked.
- VII — **Moderate:** difficult to stand or walk, furniture broken, damage to poorly built masonry buildings, weak chimneys break, plaster, loose bricks, cornices, unbraced parapets and porches fall, some cracks in better masonry buildings.
- VIII — **Moderate/Heavy:** steering of cars affected, extensive damage to unreinforced masonry buildings, including partial collapse; fall of some masonry walls, twisting and falling of
- IX — **Heavy:** general panic; serious damage to collapse in old masonry buildings, wood frame structures rack and shift off foundations if unsecured, underground pipes broken.
- X — **Very Heavy (Includes Tsunami Inundation Zone):** poorly built structures destroyed with their foundations, bridges and well-built wooden structures heavily damaged and in need of replacement.

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

Local Source (Cascadia Subduction Zone) Tsunami Inundation Map
Gearhart - Seaside, Oregon

2013

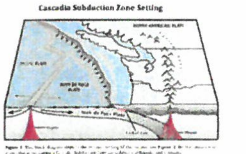
Tsunami Inundation Map Clat-08

Plate 1

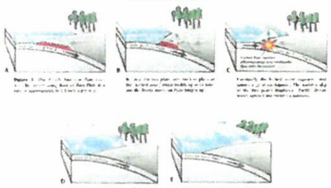
Introduction

Map Explanation

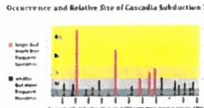
Cascadia Subduction Zone Setting



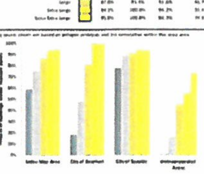
How Tsunamis Occur



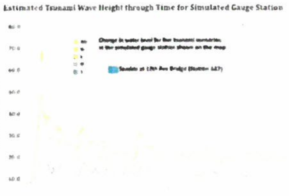
Occurrence and Relative Size of Cascadia Subduction Zone Megathrust Earthquakes



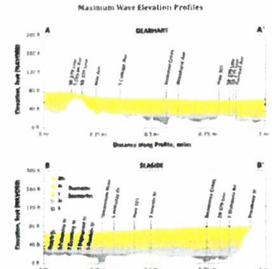
Buildings within Tsunami Inundation Zones

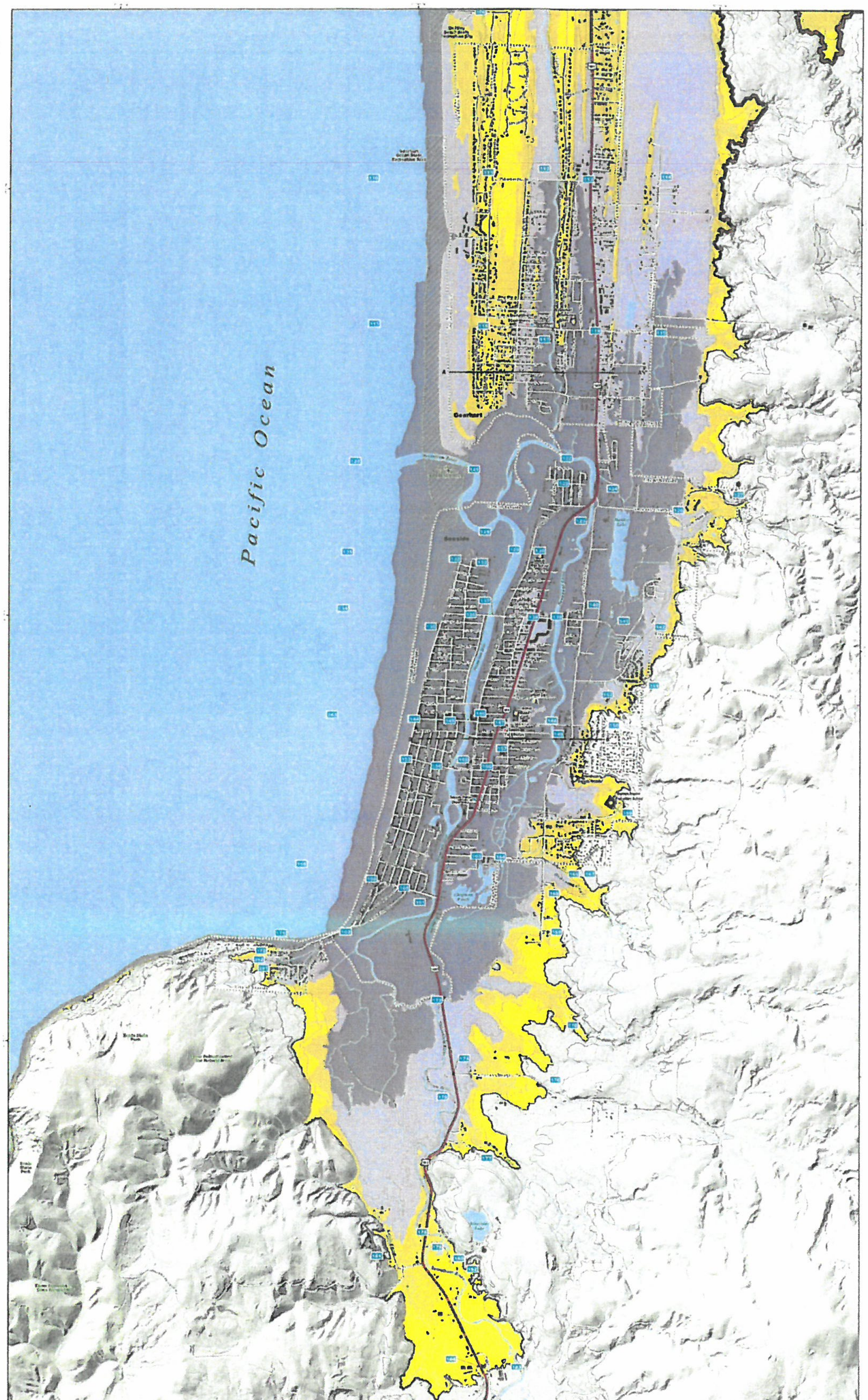


Estimated Tsunami Wave Height through Time for Simulated Gauge Station



Maximum Wave Elevation Profiles

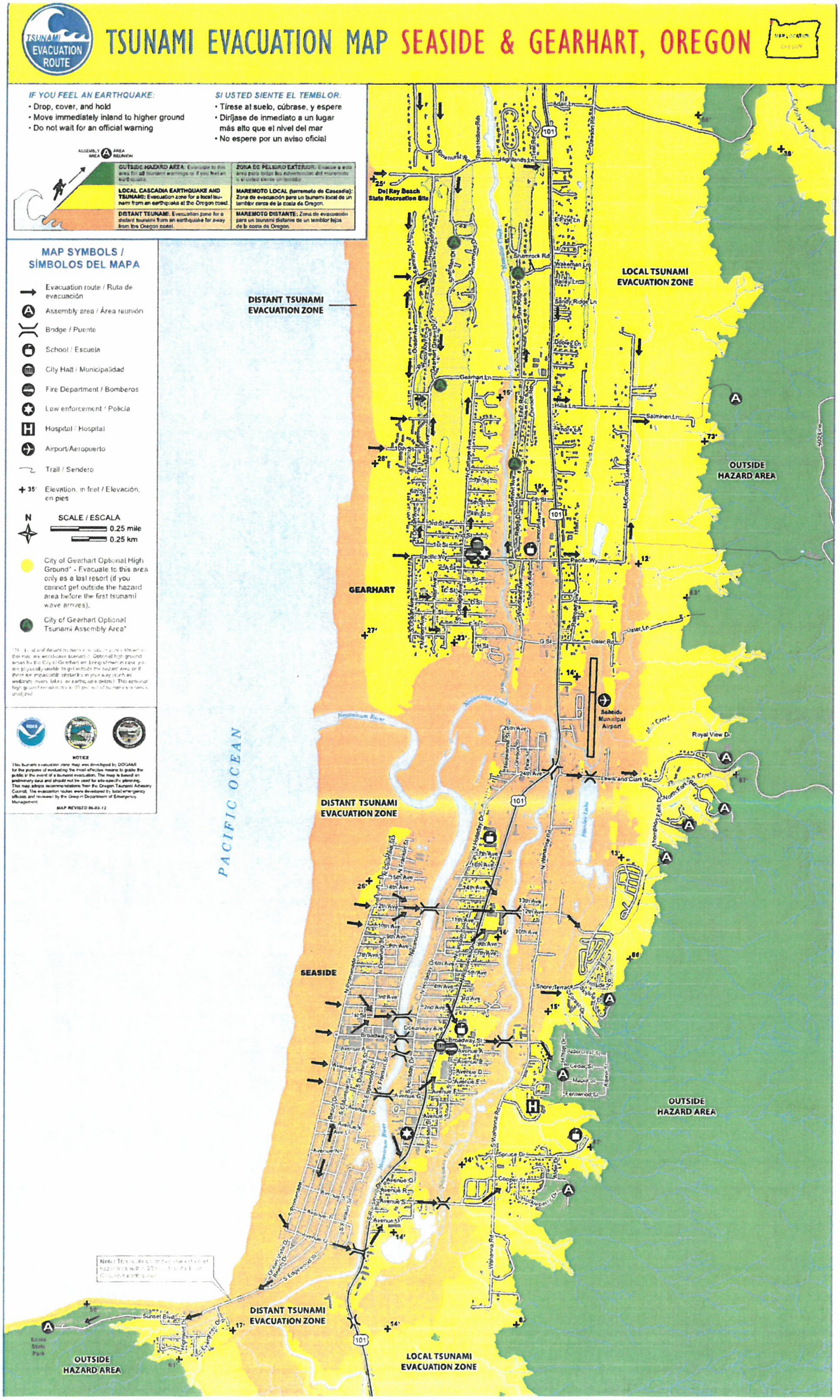




Legend

Tsunami Inundation Map Index

Data References


TSUNAMI EVACUATION ROUTE
TSUNAMI EVACUATION MAP SEASIDE & GEARHART, OREGON
IF YOU FEEL AN EARTHQUAKE:
• Drop, cover, and hold
• Move immediately inland to higher ground
• Do not wait for an official warning
SI USTED SIENTE EL TEMBLOR:
• Tírese al suelo, cúbrase, y espere
• Diríjase de inmediato a un lugar más alto que el nivel del mar
• No espere por un aviso oficial
ASSEMBLY AREA / ÁREA REUNIÓN
LOCAL CASCADIA EARTHQUAKE AND TSUNAMI: Evacuation zone for a local tsunami from an earthquake at the Oregon coast.
MAREMOTO LOCAL (terremoto de Cascadia): Zona de evacuación para un tsunami local de un temblor cerca de la costa de Oregon.
DISTANT TSUNAMI: Evacuation zone for a distant tsunami from an earthquake far away from the Oregon coast.
MAREMOTO DISTANTE: Zona de evacuación para un tsunami distante de un temblor lejos de la costa de Oregon.
MAP SYMBOLS / SÍMBOLOS DEL MAPA
Evacuation route / Ruta de evacuación
Assembly area / Área reunión
Bridge / Puente
School / Escuela
City Hall / Municipalidad
Fire Department / Bomberos
Law enforcement / Policía
Hospital / Hospital
Airport/Aeropuerto
Trail / Sendero
Elevation, in feet / Elevación, en pies
SCALE / ESCALA
0.25 mile
0.25 km
City of Gearhart Optional High Ground* - Evacuate to this area only as a last resort (if you cannot get outside the hazard area before the first tsunami wave arrives).
City of Gearhart Optional Tsunami Assembly Area*
DISTANT TSUNAMI EVACUATION ZONE
LOCAL TSUNAMI EVACUATION ZONE
OUTSIDE HAZARD AREA
PACIFIC OCEAN
GEARHART
SEASIDE
Del Rey Beach State Recreation Site
Seaside Municipal Airport
Ecola State Park
MAP REVISED 06-03-13

If you feel an earthquake, a tsunami may be coming…

WHAT TO DO

- DROP, COVER, HOLD until the earthquake is over; protect yourself
- MOVE IMMEDIATELY INLAND to high ground and away from low-lying coastal areas
- FOLLOW EVACUATION ROUTE SIGNS
- DO NOT WAIT for an official warning
- GO ON FOOT if at all possible
- DO NOT PACK or delay
- DO NOT RETURN to the beach – large waves may continue to come onshore for several hours
- WAIT for an "all clear" from local emergency officials before returning to low-lying areas

TSUNAMI EVACUATION ROUTE

www.OregonTsunami.org

CONTACTS

City of Seaside
989 Broadway Street
Seaside, OR 97138
(503) 738-5511
(503) 738-6311 non-business hours
www.cityofseaside.us

Gearhart Fire Department
670 Pacific Way
Gearhart, OR 97138
(503) 738-7838
www.gearhartfire.com

City of Gearhart
698 Pacific Way
Gearhart, OR 97138
(503) 738-5501
www.cityofgearhart.com

Clatsop County Emergency Management
800 Exchange Street, Suite 400
Astoria, OR 97103
(503) 325-8645
www.co.clatsop.or.us

Oregon Emergency Management
3225 State Street, Salem, OR 97301
P.O. Box 14370, Salem, OR 97309-5062
(503) 378-2911
http://www.oregon.gov/OMD/OEM/

Oregon Department of Geology and Mineral Industries
800 NE Oregon Street #28, Suite 965
Portland, OR 97232
(971) 673-1555
http://www.oregongeology.org

Nature of the Northwest Information Center
800 NE Oregon Street #28, Suite 965
Portland, OR 97232
(971) 673-2331
http://www.naturenw.org

International Tsunami Information Center
737 Bishop Street, Suite 2200
Honolulu, HI 96813
(808) 532-6422
http://itic.ioc-unesco.org

Seaside & Gearhart

TSUNAMI EVACUATION ROUTE

OREGON

This information could save your life — Please read it and share it with your family and friends

EVACUATION MAP ON REVERSE

BE PREPARED!

Assemble **emergency kits** with at least a 3-day supply for each family member:

- Local map showing safe evacuation routes to high ground
- First-aid supplies, prescriptions and non-prescription medication
- Water bottle and filtration or treatment supplies capable of providing 1 gallon per person per day
- Non-perishable food (ready-to-eat meals, canned food, baby food, energy bars)
- Cooking and eating utensils, can opener, Sterno® or other heat source
- Matches in water-proof container or lighter
- Shelter (tent), sleeping bags, blankets
- Portable radio, NOAA weather radio, flashlight, and extra batteries
- Rain gear, sturdy footwear, extra clothing
- Personal hygiene items (toilet paper, soap, toothbrush)
- Tools and supplies (pocket knife, shut-off wrench, duct tape, gloves, whistles, plastic bags)
- Cash

How to help with tsunami awareness in your community

- Start a tsunami buddy system
- Make and distribute emergency packs
- Initiate or participate in a local preparedness program

Visit **OregonTsunami.org** to find more great resources!

Climb to Assembly Area

Look for these hazard zone signs and be ready to leave the area by following evacuation route signs.

WHAT TO DO for both local and distant tsunamis

TSUNAMI EVACUATION ROUTE

1. Evacuate on foot, if at all possible. Follow evacuation signs and arrows to an Assembly Area.*
2. If you need help evacuating, tie something **white** (sheet or towel) to the front door knob. Make it large enough to be visible from the street. If the emergency is a distant tsunami, then help may arrive. In the event of a local tsunami, it is unlikely that anyone will help you, so make a plan and be prepared!
3. Stay away from potentially hazardous areas until you receive an ALL CLEAR from local officials. Tsunamis often follow river channels, and dangerous waves can persist for several hours. Local officials must inspect all flooded or earthquake-damaged structures before anyone can go back into them.
4. After evacuation, check with local emergency officials if you think you have special skills and can help, or if you need assistance locating lost family members.

*Assembly areas Ⓐ are shown on the map. Do not confuse Assembly Areas with Evacuation Centers, which are short-term help centers set up *after* a disaster occurs.

Local tsunamis

A ***local tsunami*** can come onshore within 15 to 20 minutes after the earthquake — before there is time for an official warning from the national warning system. Ground shaking from the earthquake may be the only warning you have. Evacuate quickly!

WHAT TO KNOW about tsunamis

A ***tsunami*** is a series of sea waves, usually caused by a displacement of the ocean floor by an undersea earthquake. As tsunamis enter shallow water near land, they increase in height and can cause great loss of life and property damage.

Recent research suggests that tsunamis have struck the Oregon coast on a regular basis. They can occur any time, day or night. Typical wave heights from tsunamis occurring in the Pacific Ocean over the last 500 years have been 20–65 feet at the shoreline. However, because of local conditions a few waves may have been much higher — as much as 100 feet.

We distinguish between a tsunami caused by an undersea earthquake near the Oregon coast (a **local** tsunami) and an undersea earthquake far away from the coast (a **distant** tsunami).

Distant tsunamis

A ***distant tsunami*** will take 4 hours or more to come ashore. You will feel no earthquake, and the tsunami will generally be smaller than that from a local earthquake. Typically, there is time for an official warning and evacuation to safety.

Evacuation for a distant tsunami will generally be indicated by a **3-minute siren blast** (if your area has sirens) and an announcement over NOAA weather radio that the local area has been put into an official TSUNAMI WARNING.

In isolated areas along beaches and bays you may not hear a warning siren. Here, a **sudden change of sea level** should prompt you to move immediately to high ground. If you hear the 3-minute blast or see a sudden sea level change, first evacuate away from shoreline areas, then turn on your local broadcast media or NOAA weather radio for more information.

Gearhart Water District Service Area