

Tsunami Evacuation Plan for the Hatfield Marine Science Center – Newport, OR



12 December 2011

Submitted By: Dr. Hunter-Zaworski's Intelligent Transportation Systems Class

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1.0 Introduction

The Hatfield Marine Science Center (HMSC) was originally established in 1965 as a marine laboratory for Oregon State University (OSU). In 1983, it was named after the long-serving U.S. Senator from Oregon, Mark Hatfield. The HMSC is located on the South Beach Peninsula of Newport, OR, at Yaquina Bay. Since its inception, the HMSC and its many partners have grown to encompass a 49-acre site. Figure 1 shows the location of the HMSC. The HMSC's mission is to provide "research, education, and outreach through collaborative partnerships" [1][2].

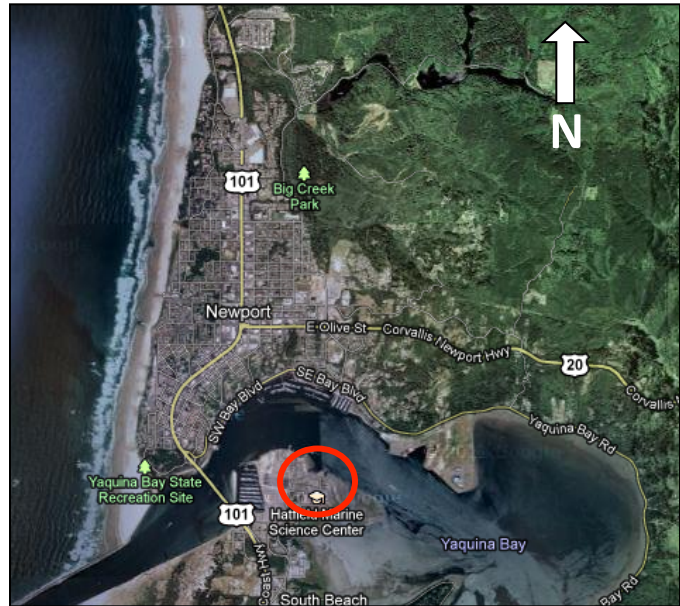


Figure 1: HMSC Location in Newport, OR (Image provided by Google Maps)

1.1 Partnerships & Research

Research partners from within OSU include members of the College of Agricultural Sciences, College of Science (Zoology, Math and Science Education, Microbiology, Botany and Plant Pathology), College of Oceanic and Atmospheric Sciences, College of Veterinary Medicine, College of Pharmacy, College of Engineering, and the College of Forestry. Additionally, the HMSC is partnered with the Coastal Oregon Marine Experiment Station (COMES), Cooperative Institute for Marine Resources Studies (CIMRS), OSU Marine Mammal Institute, and the Northwest National Marine Renewable Energy Center [1].

The HMSC is also involved with research partnerships with the following agencies: Environmental Protection Agency (EPA), Oregon Department of Fish and Wildlife (ODFW), U.S Fish and Wildlife Services (FWS), the National Oceanic and Atmospheric Administration (NOAA), and United States Geological Survey (USGS). The EPA, ODFW, FWS, and NOAA each own one or more buildings on the site [1].

Areas of research at the HMSC include marine ecology, oceanography, marine mammal ecology, marine chemistry, marine geology, population genetics, marine acoustics, fish disease and microbiology, among many others [1].

1.2 Education

The HMSC provides a variety of education opportunities for students of all ages and backgrounds. The HMSC visitor center serves as a source of informal learning opportunities for

its 150,000 visitors each year. Additionally, more formal educational opportunities exist in the form of K-12 programs, family programs, scouting programs, day camps, and other programs [2].

Higher education opportunities also exist at the HMSC. OSU offers graduate and undergraduate classes that utilize the facilities located at the HMSC. Classes may visit the HMSC for weekend field trips or may be taught entirely at the HMSC. During the course of their studies, some students may reside in housing located at the HMSC [2].

1.3 Community Partners

Community partners of the HMSC include the Yaquina Bay Economic Foundation, the local fishing industry, the Oregon Coast Community College, the Oregon Youth Conservation Corps, the Friends of the Hatfield Marine Science Center, local schools, and the Oregon Coast Aquarium [1]. The Oregon Coast Aquarium has its own facilities located on the peninsula and hosts many visitors each year.

2.0 Threat Assessment

There are a variety of dangers associated with any facility. Fire, terrorism, and severe weather events can be expected at almost any location. The location of the HMSC on Yaquina Bay exposes the HMSC to additional threats, which are described in the following sections.

2.1 Subduction Earthquake

Oregon is located near the Cascadia Subduction Zone. In this zone, the Juan de Fuca tectonic plate is being pushed under the North American Plate causing a buildup of forces along the interface of the two plates. This situation can lead to a megathrust earthquake as the fault releases energy and the Juan de Fuca plate slips under the North American Plate. The magnitude of a subduction earthquake can be 9.0 or higher on the Richter scale [3]. This would be similar in magnitude to the 2011 Tōhoku earthquake in Japan. There is approximately a 10% chance of a megathrust earthquake in the next 50 years and a subduction zone earthquake such as this would almost certainly result in a tsunami [3].

2.2 Tsunamis

Tsunamis are a system of large waves which are produced by the displacement of large volumes of water. Tsunamis can be generated in a variety of ways including landslides, volcanic eruptions, and earthquakes.

Depending on the origin of a tsunami, it may be considered a distant or local tsunami [3]. For example, the 2011 Tōhoku tsunami was a local tsunami for Japan and a distant tsunami for the HMSC. In the event of a distant tsunami, there is ample time for a calm and orderly evacuation.

However, a local tsunami, as would be generated by a subduction earthquake in the Cascadia Subduction Zone relative to the HMSC, would allow only minutes to evacuate. Current estimates project that a local tsunami would hit the HMSC in as little as 15 minutes from the time of the initial earthquake [4].

3.0 Current Tsunami Evacuation Plan

The current tsunami evacuation plan for the HMSC has two distinct responses, one for a distant tsunami and a different response for a local tsunami. The plan for a local tsunami will be of greatest concern due to the short time for evacuation.

3.1 Distant Tsunami

It is assumed that the response for a distant tsunami follows that of the HMSC Inclement Weather Emergency Closure Policy and Procedures [5]. This plan indicates the campus' closure via the HMSC's central switchboard as well as through the OSU Department of Public Safety Information and the OSU Alert System. A notification email would be sent out to the HMSC community list. Lastly, a notification will be given to the following radio stations [5]:

- Yaquina Bay Communications (KCRF, KYTE, KNPT, etc.)
- KPPT (Boss Radio 100.7FM) and KCUP (1230AM)
- KSHL (97.5FM)
- KLCC / KLCO (90.5 FM OPB/NPR)
- KOAC 550AM (Corvallis OPB affiliate)

It is expected that this evacuation will be relatively calm and orderly. For an example of an evacuation of this type, one need only look back to the successful evacuation of the HMSC due to the 2011 Tōhoku tsunami.

3.2 Local Tsunami

The evacuation plan for a local tsunami is time-critical. It is expected that there will be only a 15-minute window for evacuation [4]. The 15-minute response includes the use of evacuation routes from HMSC to Safe Haven Hill located southeast of the main campus. Figure 2 shows the evacuation route and photographs along the route. The evacuation routes are designed for pedestrian movement. Information provided by George Boehlert, the Director of HMSC, indicated that the NOAA facility located at the end of peninsula has a vehicle on standby to transport wheelchair-bound individuals to Safe Haven Hill from the NOAA facility. However, the ability of this vehicle to traverse the evacuation route after a local subduction earthquake is in question due to the expectation of severely altered terrain.

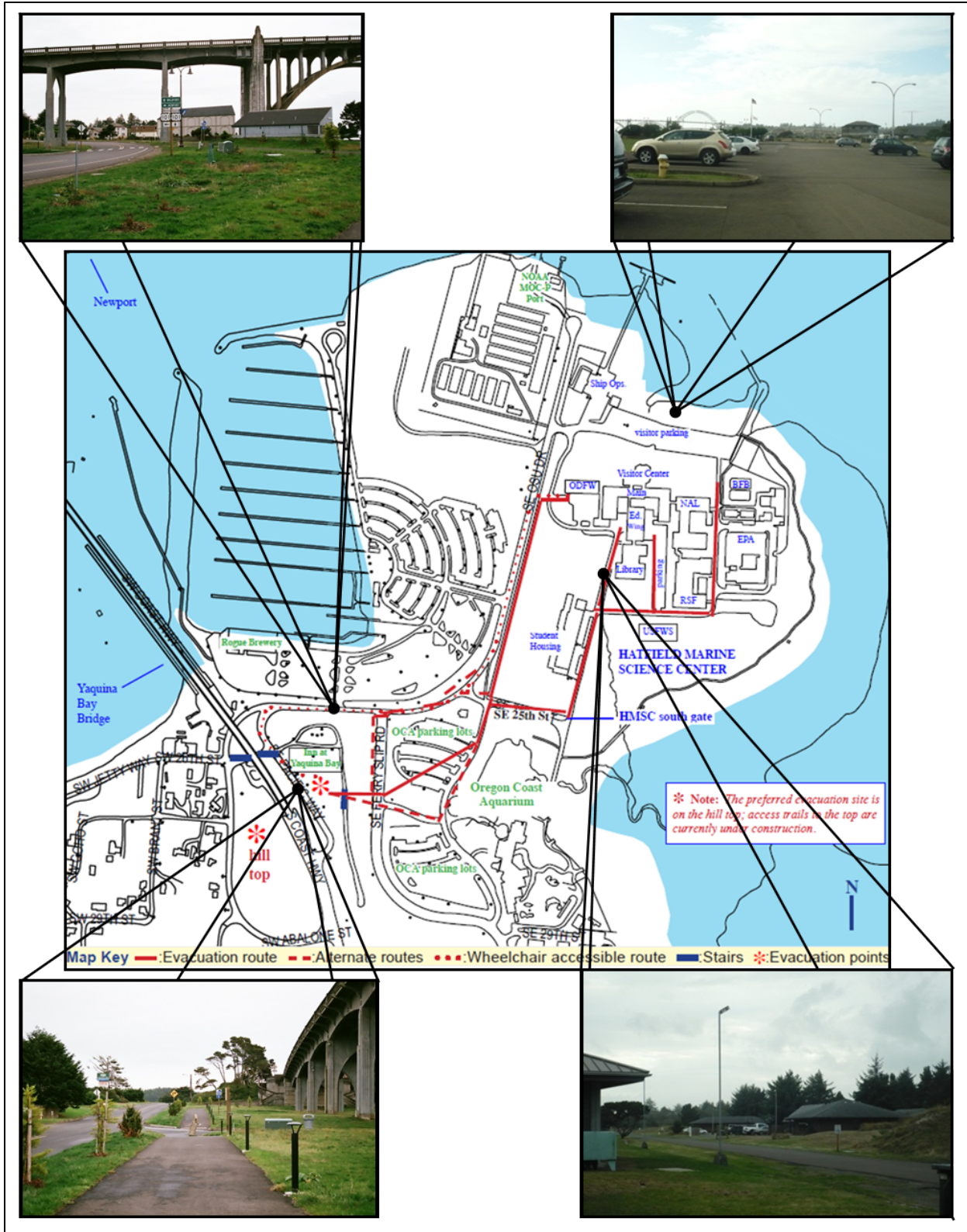


Figure 2: HMSC Earthquake and Tsunami Evacuation Routes with Images of Existing Conditions (Photos by L. Bornasal, November 2011)

For a local tsunami, there is no official warning signal system. The only warning for individuals to evacuate to Safe Haven Hill is the severe ground-shaking of an earthquake lasting 20 seconds or more [6]. At this time, every staff member, visitor, and resident who is on the HMSC campus is expected to evacuate. According to Boehlert, there are a number of emergency supply buckets that should be grabbed before evacuating. Additionally, some departments and agencies have invested in emergency back packs.

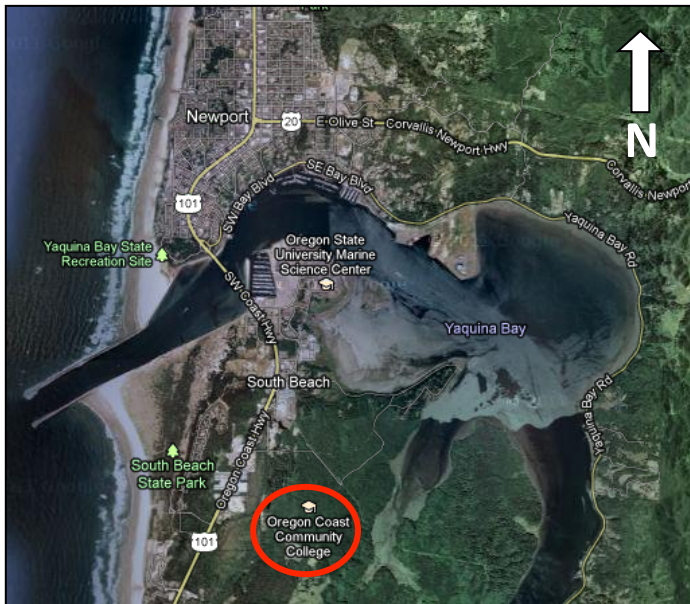


Figure 3: Oregon Coast Community College Location (Image provided by Google Maps)

After the initial tsunami wave reaches shore, individuals who have taken refuge on Safe Haven Hill will need to stay there until an “all clear” signal is given. This may not be given until up to 24 hours after the initial event. After the “all clear” signal, individuals on the hill must travel by foot to the nearest zone of safety, the Oregon Coast Community College, located approximately two miles south of the HMSC. Figure 3 shows the location of the Oregon Coast Community College.

The American Red Cross and other relevant emergency response units will be stationed at this location after a severe natural disaster. This campus is reachable in approximately twenty minutes walking “at a fast clip” [7].

3.3 Existing Communications

An evaluation of the communication infrastructure with regard to the evacuation procedures of HMSC revealed a severe lack of integration between the communications and warning systems of the 19 buildings located on the peninsula. This is in large part due to the fact that the buildings are separately owned and operated by OSU, NOAA, ODFW, USFW, and the EPA. Each building and organization has its own policies, procedures, and infrastructure [1].

As an alternative form of emergency warning, individuals are encouraged to join the Lincoln County Emergency Alert Program, a Reverse 911 program, which alerts individuals via cell phone texts, emails, and home phone calls of emergency situations within the county. The October 2011 HMSC Safety Committee Meeting minutes indicate that this system was tested during an evacuation drill and was able to send out 2,600 Reverse 911 messages within five minutes of initiation [1].

In a disaster scenario, cellular phone towers will likely be incapacitated. The only long range disaster communication system currently in place at the HMSC is that of volunteer HAM radio operators [1].

3.4 Evacuation Route Infrastructure

The infrastructure in place for evacuation has been developed for the past several years. The existing evacuation route (shown in Figure 2) to Safe Haven Hill is currently marked with posted signs. Unfortunately, these signs are sometimes targeted for theft. Figure 4 shows an example of one of these signs. Additionally, there are streetlights and paved sidewalks along a majority of the evacuation route to Safe Haven Hill.



Figure 4: Example of Tsunami Evacuation Route Sign (Photo by L. Bornasal, November 2011)

The actual Safe Haven Hill is much less developed. Currently, there are no defined routes up the hill. Figure 5 shows the existing conditions along the proposed evacuation trail along the hill. It is composed of sand, and there is heavy tree cover along the hill. A gate indicating ownership by the Oregon Department of Transportation is the only manmade structure on the hill.

3.5 Number of Evacuees

The number of individuals at the HMSC varies daily and is not tracked on a day-to-day basis. The HMSC website lists a staff directory of 343 persons associated with the HMSC [2]. The same website indicates that the housing units have a maximum capacity of 100 individuals. According to Maryann Bozza, the program manager of the HMSC, on a typical summer day they estimate that there will be 250 staff, 250 visitors, and 70 residents, all of whom would need to evacuate in the event of an emergency. On a typical winter day, the number of visitors and students drop to 50 and 15, respectively. A newspaper article reporting on the most recent evacuation drill for the HMSC indicates that nearly 200 individuals and several pets trekked up to the summit of Safe Haven Hill during the drill [8].

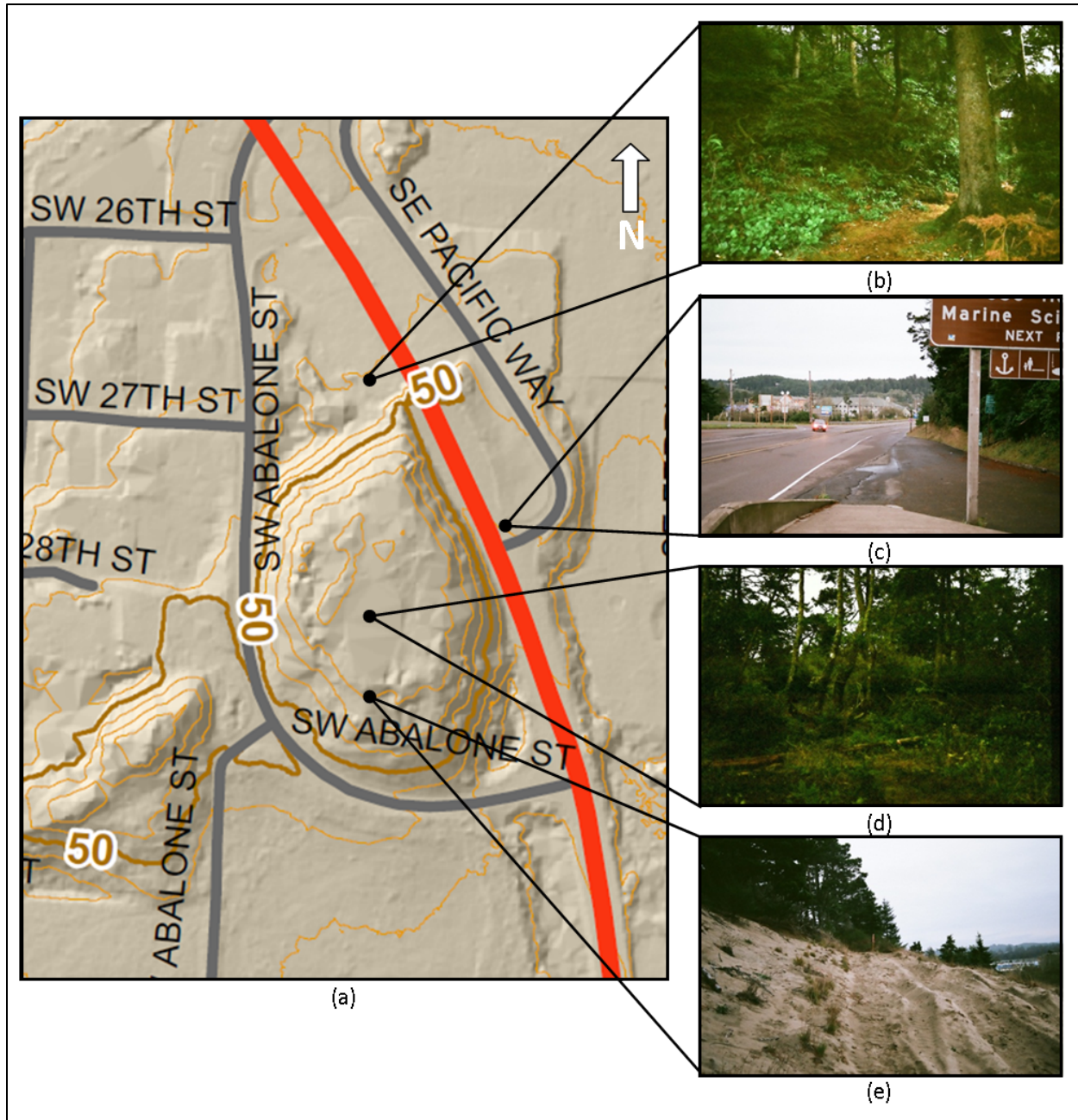


Figure 5: Existing Conditions on Safe Haven Hill:
 (a) LiDAR imaging of Safe Haven Hill with approximate contour lines (provided by ODOT-GIS Unit and “Newport South Beach Tsunami Safe Haven Concept Plan” provided by Sera GreenWorks) (b) Existing condition at beginning of proposed northern footpath (c) View from beginning of Bridge looking south along Highway 101 (d) Existing condition at the peak of hill (e) Existing condition along proposed shared-use path located on southern face of hill (Photos by L. Bornasal, November 2011)

It is important to understand that the HMSC is not the only source of refugees that may seek to use Safe Haven Hill. Other evacuees could include people from the Oregon Coast Aquarium, the Rouge Brewery, and residents of the surrounding area. According to Maryann Bozza, the total number of people seeking to use Safe Haven Hill could be as high as 1,500.

3.6 Concerns

There are several concerns regarding the existing plan, infrastructure, and warning systems for an evacuation due to a local tsunami:

- Safe Haven Hill has not been developed to properly accommodate the number of individuals that may have to utilize it during an emergency event.
- There is limited space on the highest point of the hill due to excessive tree cover.
- The hill is not accessible to wheelchair-bound individuals and other disabled persons.
- There may be a lack of supplies for everyone staying on the hill for the recommended 24 hours.
- The supply buckets currently in use are difficult to carry
- There are limited communications between buildings.
- Post-disaster communications will also be limited.
- The existing evacuation path between the HMSC campus and Safe Haven Hill is marked only with signs, which are easily stolen.

4.0 Planned Improvements to Safe Haven Hill

Fortunately, the City of Newport is already planning some improvements to Safe Haven Hill in anticipation of the possible local tsunami. They plan to remove some of the trees in order to make room for the nearly 1,500 people who are expected to evacuate to Safe Haven Hill. They also have plans to improve the existing trails and build new ones so that people can access the hill from multiple directions, as shown in Figure 6. Finally, they plan to build a storage shed to keep emergency supplies such as food and water, which they will give out to the evacuees on the hill [9].

These improvements are essential because this hill needs to hold a large number of evacuees and space is limited. Currently, there is no path for a person in a wheelchair to make it up the hill. The development of newer trails may improve, but not eliminate, this problem. The supplies that will be stored in the shed will be essential to the survivors. Even if some of the staff of the HMSC come prepared with food and water, visitors, local residents, and some staff may not.

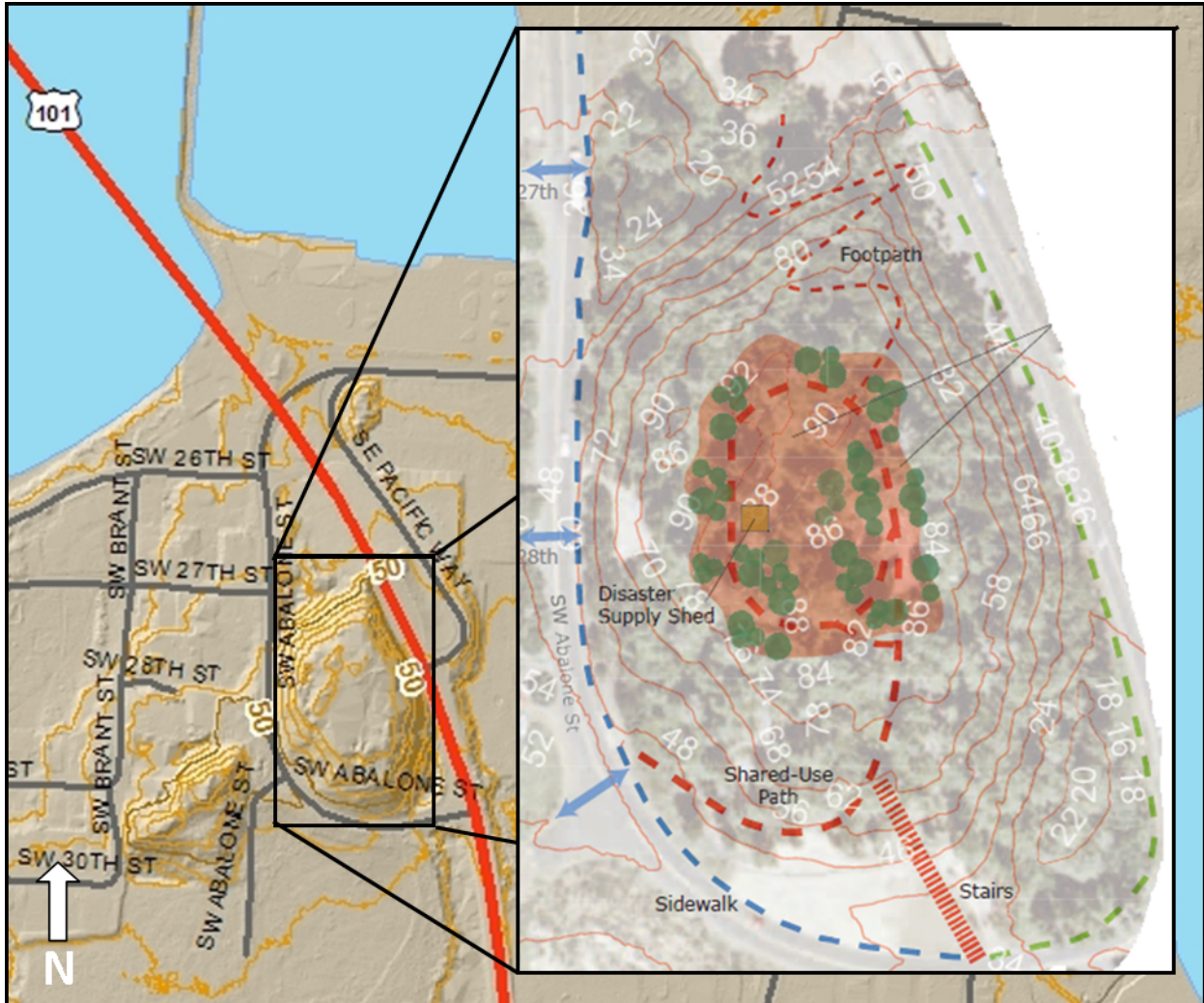


Figure 6: Location of Proposed Developments to Safe Haven Hill

5.0 Additional Improvement Alternatives

While the planned improvements will no doubt increase the survivability of a local tsunami, there are still many more improvements that can be made. The following sections describe some of the additional alternatives.

5.1 Pavement Markings

Currently, the only means of indicating the emergency pedestrian route from the HMSC is with posted signs. These signs can be stolen before a disaster or knocked down during an earthquake. Pavement markings would be nearly impossible to steal and should be easily identifiable even in a post-earthquake landscape. Additionally, these pavement markings could provide a redundant form of communication during an emergency.

The most current edition of the Manual on Uniform Traffic Control Devices (MUTCD) does not include any standards associated with tsunami escape route pavement markings. The Oregon Supplement to the MUTCD only includes standards for posted signs and does not mention pavement markings pertaining to tsunami escape routes.

Figure 7, shown below, gives examples of pavement markings utilized in other countries faced with the threat of tsunamis. Some of the graphics were taken from Dr. Rizzo’s “Tsunami Evacuation and Route Planning” presentation [3]. The concepts illustrated can be applied to the evacuation route for the HMSC.



Figure 7: Tsunami Evacuation Route Pavement Markings

5.2 Vertical Evacuation

An alternative to evacuating to Safe Haven Hill would be to construct a vertical evacuation site. This would most likely take the form a new building on the peninsula. A vertical evacuation site would reduce the distance that evacuees would need to travel during the 15 minute evacuation window.

This type of building would need to follow FEMA’s “Guidelines for Design of Structures for Vertical Evacuation from Tsunamis”. The minimum height for this type of building is the estimated maximum tsunami run up, plus 30%, plus 10 ft. [16]. At the HMSC a vertical evacuation building would need to reach at least 90 to 100 ft. in elevation. Considering the elevation of the peninsula, this would require a building of at least six stories [15]. The minimum recommended square footage of a building used as a short term tsunami refuge is 10 sq. ft. per person. For the current 570 estimated evacuees this would require a football field size evacuation area.

This cost associated with this type of building would be substantial. It would not be practical to design a building of this magnitude solely as an evacuation site [15]. A vertical evacuation building would need to fill some other need at the HMSC and also act as a vertical evacuation

site. The cost to include vertical evacuation would still be significant, on the order of millions of dollars, but could be justified due to the threat [15].

A vertical evacuation site would not be risk free. During a tsunami buoyant objects can be carried by waves and turned into waterborne missiles [16]. Boats from the dock located next to the Rouge Ale house, cars in the parking lots, and even the NOAA fleet could be turned into waterborne missiles during a tsunami. These missiles would cause devastating effects if they struck the vertical evacuation building [16].

5.3 Communications Technologies

There are a variety of communication technologies that can be used in an emergency scenario. Some of these are already in use by different agencies and individuals at the HMSC.

5.3.1 OSU Alert System

The OSU Emergency Alert System, OSUEAS, was developed in 2009 after the shooting at Virginia Tech, which forced an overhaul of alert systems implemented throughout the nation. At the beginning of the overhaul of OSUEAS, OSU was involved in a strong working relationship with the City of Corvallis and Benton County fire and police departments to develop a reliable system that works for everyone. Though OSUEAS is for OSU emergencies, alerts are sent out to the Corvallis police and fire agencies to inform them of what is going on at OSU [10].

The OSUEAS is managed by Blackboard Connect Ed. Blackboard Connect Ed is a

"leading provider of multimodal alert notification services for school districts, institutions of higher learning, local government, state and Federal agencies, as well as the U.S. armed forces. The Connect platform supports the usage of outbound communications via voice, email, SMS text messaging, web alerts, and networked digital signage" [11].

The OSUEAS is provided automatically for OSU Network Identification (ONID) accounts. All ONID email accounts users can add up to six phone numbers, including one text messaging number, and two email addresses to the alert profile. ONID accounts are only available to admitted and registered students (including dual-enrolled students through Central Oregon Community College), all employees of the University, official OSU Associates, and emeriti, adjunct, or courtesy faculty; however, the ability to add additional phone numbers and email addresses to an ONID alert profile is one way to address interagency connectivity. Non-ONID account users may be able to add their contact information to the alert profile on an ONID account user [10].

"It takes approximately 10-30 minutes to activate the OSUEAS and the total response time for the system is approximately 10-35 minutes. This allows time

for the six people who are allowed to activate the alert system to check the facts and to develop the message that will be sent out" [10].

Once the message is developed and the system is activated, it takes about 1-2 minutes for phone calls or text messages to be received and a bit longer for email communication. This delay is due to "trunking within the network, sending out ~59,000 emails" [10]. Also, specific groups of ONID accounts can be targeted to receive alerts that are specific to that group depending on location or activity [10]. This time delay may make this system inadequate to warn people of a local tsunami since they will only have 15 minutes from the time the ground starts shaking until they need to be at Safe Haven Hill.

During the 2011 Tōhoku tsunami, the OSUEAS broadcasted a warning message to all ONID accounts aimed to prevent people from going to the coast and to inform people to start moving away from the tsunami inundation zone. OSU employees at the HMSC got the message through their ONID email address [10].

The barriers that HMSC will face if they try to implement their own alert notification service are money, infrastructure, and additional labor. Along with a startup equipment cost of "tens of thousands of dollars" and an annual service fee, an additional work is required [12]. With the implementation of an alert system, someone will need to manage and implement the service. This would require a community "officer" that would be in charge of safety for the HMSC community.

5.3.2 Family Service Radios

The Family Radio Service (FRS) is an improved walkie-talkie radio system designed for personal use. It applies frequencies in the ultrahigh frequency (UHF) band. Instead of using amplitude modulation (AM), FRS technology uses frequency modulation (FM). The range of these radios varies widely; in normal conditions with line-of-sight blocked by fixed objects, these walkie-talkies have an effective range of 1/3 to 1 mile [13]. Figure 8 shows an example of a family service radio.

For evacuees at Safe Haven Hill, there would be some improvement of this range. After the earthquake and tsunami, there will be fewer standing obstructions to block the radio signal. Also, evacuees will have to occupy areas of high ground, further improving range. Under perfect conditions (hilltop to hilltop with no obstructions), these devices can communicate at ranges over 30 miles, however manufacturers usually advertise a range of approximately two miles [13].



Figure 8: Family Service Radio

These radios are very reasonably priced; a pair of such devices can cost less than \$30 at retail. These radios could provide vital short range communication immediately after a disaster and may have some potential as a medium range form of communication.

5.3.3 HAM Radios



Figure 9: Handheld UHF/VHF Transceiver

Amateur, or HAM, radios contain the necessary equipment to communicate with another similar station. A handheld package usually integrates a transceiver with an antenna and a battery, which is a fairly light assembly and thus, portable. Most handheld transceivers are designed for operation on the VHF or UHF amateur radio bands and most often are capable of only FM voice communications transmissions. To conserve battery power, they have limited transmitter power, often below 1 Watt, to cover a local range, typically a few kilometers or miles [14].

The price of a handheld HAM radio ranges from \$72 to \$500 depending on the type of accessories included, e.g., GPS Antenna Unit, GPS Adapter, Lithium-Ion Battery Pack, and Battery Rapid Charger. Figure 9 shows an example of a HAM radio.

A license is needed to operate a HAM radio. Licenses are issued by the Federal Communications Commission (FCC) and require an individual to pass an exam [14]. According to George Boehlert, ham licensure cannot be required of employees and must be done on a volunteer basis.

5.3.4 Handheld Mobile Satellite Communication

Handheld satellite telephone systems, also known as Satellite Phones or “Satphones,” have a high potential in post-disaster situations. Unlike the common cellular phones, these phones do not require any terrestrial cell sites; rather they connect to orbiting satellites.

These systems provide access through very small, cell phone-sized devices, as well as pagers and in-vehicle units. Figure 10 shows two examples of Satellite Phones. These phones are priced ranging from \$400 to \$2,000. It would not be practical to



Figure 10: Handheld Satellite Communication Devices

equip all employees with this technology, however owning a few of these satellite phones for emergency purposes could be useful.

5.4 Warning Systems

These systems, which include detectors and sirens, can provide rapid dissemination of emergency information. There are currently no warning systems of this type in place at the HMSC.

5.4.1 Tsunami Siren

Tsunami sirens are intended to be used as a warning when a distant tsunami approaches the shoreline. In the case of a local tsunami, where the first wave will reach the coast in as little as 15 minutes, evacuation should occur immediately after the ground stops shaking [19].

A tsunami generated by a distant earthquake may take several hours to reach the Oregon Coast, and the tsunami sirens are intended to be used as a warning when a distant tsunami approaches the shoreline. An outdoor tsunami warning system, developed by American Signal Corporation, is powered by the CompuLert™ control system from a central location, communicating with all the sirens throughout a coastal area. These sirens are radio controlled and some new sirens are solar powered [20]. Figure 11 shows one of these sirens.



Figure 11: Tsunami Warning Siren

The alert tone of the siren system can be used to indicate different messages during an emergency situation. The type of tone that is used as the real-time evacuation blast is known as a wail tone. Evacuation for a distant tsunami will generally be indicated by a siren blast and an announcement over the NOAA weather radio that the local area has been put into an official tsunami warning. The wail tone varies from a low to high warble sound [19].

5.4.2 Earthquake Alarms

The most recent innovation in earthquake detection allows a small window of time to trigger an automatic siren [21]. This brief time window can allow people to duck and cover before the shockwave of an earthquake hits. These systems can also be used to shut down a potentially hazardous utility service, such as a gas line. An example of such technology is QuakeGuard™ [18].

QuakeGuard™ is a system that can detect and warn of an imminent earthquake, providing 1-40 seconds of warning before the onset of damaging earthquakes of magnitude 5.0 and

greater. The system is capable of eliminating false triggers from environmental vibrations and filters out smaller non-damaging quakes. It can be connected to an external audible alarm/siren, or visual alerts and lights [18].

An earthquake warning system would be expected to raise the level of safety at the HMSC. Any steps that can be taken immediately before an earthquake or a resulting tsunami will reduce the damage and panic experienced after the event. A few seconds of warning before an earthquake could greatly reduce the amount of injuries and casualties due to the earthquake.

6.0 Recommendations

Due to the risks associated with the location of the HMSC and the difficulty mitigating these threats, new policies and procedures will be the most effective tool in combating the dangers associated with a subduction zone tsunami. Additionally, several investments in technology and infrastructure will help mitigate damages in the event of a tsunami.

6.1 Reduction of Personnel on Peninsula

The best way to reduce the risk to people on the peninsula is to get them off of the peninsula. This can be done by moving non-essential personnel, stopping construction on the peninsula, and relocating the student housing.

Although the location of the HMSC provides many opportunities for research, not all of the work being done at the HMSC requires accesses to the bay. Work that can be accomplished at a site other than the HMSC should take place at a location outside of the tsunami danger zone. Non-essential tasks and personnel should be gradually transitioned to sites that are located away from the tsunami inundation zone.

A moratorium on new buildings should be implemented for the HMSC peninsula. The current buildings could be allowed to renovate and improve to allow for expansion of laboratories and research facilities. This policy will force a reduction in non-essential personnel in the area of greatest danger while still allowing for the expansion of research facilities.

As convenient as it may be to have student housing located at the HMSC, it greatly increases the risk for those students. An employee who lives away from the site risks exposure to a tsunami for one third to half of each workday. Students living at the HMSC are exposed to the risk of a tsunami for the entire day. The simplest way to reduce the risk for these students is to reduce the time they spend on the peninsula.

6.2 Safe Haven Hill and Evacuation Route Improvements

There are lingering concerns about Safe Haven Hill. The preliminary geotechnical report says that it is basically a sand hill. Although the site is not ideal, it seems to be the best of the

currently available options. At this time, it is the only high ground that most people can be reasonably expected to reach given the time restraints. Some people may make a personal choice to evacuate to Oregon Coast Community College, but a consistent message to evacuate to Safe Haven Hill should be presented in order to reduce confusion during a disaster.

The currently planned physical improvements to Safe Haven Hill, as listed in section 4 of this report, will address some the concerns that people may have about the hill. The addition of the storage shed will allow for emergency supplies to be stored on Safe Haven Hill. Improvements and stabilization of the trail will improve accessibility for people with and without disabilities. The removal of trees from the hill will allow for maximum occupancy of Safe Haven Hill.

In addition to the currently planned improvement, pavement markings should be added to mark the evacuation route. These markings will provide a redundant form of communication. Pavement markings have two major advantages over signs: they cannot be stolen and they may be easier to find even in the case of significant damage from an earthquake.

6.3 Vertical Evacuation

A vertical evacuation site would need to be 90-100 ft. in height. With the base elevation of the HMSC this would be a six story build. A total area the size of a football field would be needed to accommodate the current number of evacuees.

The location of the HMSC is not an ideal site for a vertical evacuation building. The large number of boats and cars located on the peninsula would be turned into waterborne missiles during a tsunami. These could damage or destroy the vertical evacuation building during a tsunami.

The cost to build a standalone vertical evacuation site would be prohibitive. A vertical evacuation site would need to be incorporated into a planned development. If a new building must be located on the peninsula, it should serve as a vertical evacuation site. However, it would be safer, simpler, and cheaper to build at a different site.

6.4 Communications

Developing an alert system for the HMSC similar to the OSU Emergency Alert System could serve as a redundant system for warning of distant tsunami. However, the current evacuation plan adequately addresses evacuation during a distant tsunami. This style of system would provide no benefits during a local tsunami. The money required to implement and operate this style of system would be better spent elsewhere.

For a minor investment, \$30 per pair at retail, family radio service devices should be purchased in bulk. These walkie-talkie type radios have a short range, typical less than a mile typically, and will provide immediate close range communications during an emergency. Additionally, under

conditions after an earthquake and tsunami, with less standing obstructions, range will improve.

A form of longer range communication should be considered as well. An investment in a few satellite phones or volunteer HAM radio operators will allow for wider range communication. This will be vital after the evacuation is complete in order to communicate with offsite rescue and relief teams.

6.5 Invest in Cooperation

In order to reduce confusion during a disaster, a cooperative spirit must be established before an emergency. To this end, informal and formal meetings should be established between the different agencies on the peninsula.

An informal summer BBQ could be held in one of the large grassy areas on site. This would allow for people to get to know their neighbors and increase general goodwill among different agencies.

A more formal meeting of liaisons from each agency should be used to coordinate agency cooperation. This meeting would allow for more detailed discussions. Example topics could include the feasibility of a peninsula-wide alarm system, how agencies will communicate during an emergency, and any special concerns of individual groups.

6.6 Sirens and Warning Systems

A tsunami siren is unneeded at the HMSC. It would provide no added benefits during a local tsunami, and warning of distant tsunamis is already adequately addressed by the current system.

An earthquake warning system could provide 1-40 seconds warning of an earthquake. This brief warning could allow people to duck and cover before an earthquake hits, greatly improving survivability. As to date, we have been unable to locate a price for this type of system, so this system cannot fully recommend at this time.

7.0 Conclusion

The HMSC is a unique institution providing a collaborative environment for many different partners to work together. Its location on Yaquina Bay allows for research and education opportunities that a different site simply would not. Along with these opportunities come risks. While these risks can never fully be eliminated, there are steps that can be taken to mitigate them.

Moving people who do not need access to the bay away from the danger zone is will greatly reduce the potential dangers. For those who must be in the danger zone, preparedness is vital. Investment should be made into infrastructure, cooperation, and communications. In the end, what risks can be mitigated should be and what risk cannot must be accepted.

8.0 References

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