Primer on Geological Hazards in Oregon

Introduction to Seismic Hazards

Oregon is at risk from several different types of seismic events: earthquake, tsunami, and volcanoes.

- **Earthquakes** occur when rock underground suddenly breaks along a fault. This sudden release of energy causes the seismic waves that make the ground shake. Oregon lies at a convergent continental boundary where two tectonic plates are colliding. The **Cascadia Subduction Zone** is actually a 600 mile long earthquake fault stretching from offshore northern California to southern British Columbia. This fault builds up stress for hundreds of years as the Juan de Fuca and North America Plates push against each other. Eventually, the two plates rip apart, creating some of the largest earthquakes and tsunamis on earth. Where the Juan de Fuca oceanic plate and the North American continental plate meet is called a subduction zone, because the denser Juan de Fuca Plate is being pulled under North America. The Juan de Fuca Plate is moving to the northeast at about an inch a year as the North American Plate moves west. The Oregon coastline is actually bulging upward from the two plates pushing against each other.
- There are over 1000 earthquakes over magnitude 1.0 in Washington and Oregon every year, with at least two dozen being large enough to be felt. Approximately 17 people have lost their lives due to earthquakes in the Pacific Northwest. Since 1872, there have been 20 damaging earthquakes in Washington and Oregon. The Pacific coast poses special risk from tsunamis associated with a Cascadia Subduction Zone earthquake. In addition to Subduction zone earthquakes, Oregon is also susceptible to crustal earthquakes. The two largest earthquakes in recent years in Oregon, Scotts Mills, (magnitude 5.6) and the Klamath Falls, main shocks (magnitude 5.9 and magnitude 6.0) of 1993 were crustal earthquakes.

- **Tsunamis** are generated when geologic events cause large, rapid movements in the sea floor that displace the water column above. These destructive waves can be caused by coastal or submarine landslides or volcanism, but they are most commonly caused by large submarine earthquakes. The Pacific Coast is at risk both from locally and distantly generated tsunamis.
- **Volcanic eruptions** occur only in certain places and do not occur randomly. Mount St. Helens is typical of more than 80 percent of the volcanoes that have formed on land. Known as *subduction zone* volcanoes, they occur along the edges of continents where one plate dives, or subducts, beneath a second plate. In the Cascade volcanic chain that extends from Lassen Peak in northern California to Meager Mountain in British Columbia, over 3,000 large and small volcanoes have erupted during the past five million years.

Tsunami

What is a Tsunami?

A tsunami:

- is a *series* of waves caused by a sudden, large displacement of water most often caused by earthquakes, but also by landslides; volcanic eruptions; and comet or meteorite impacts in the ocean
- is like a fast rising flood tide, storm surge or an advancing wall of water and strikes with devastating force.
- Moves faster than you can run.
- **The first wave is not the largest nor the most dangerous**, and surges may arrive 10 hours or more after the initial wave.

Who is at Risk?

All U.S. coasts can be impacted by tsunamis, though based on proximity to tsunami sources and seafloor configurations, some areas are at much greater risk than others. Within the last 150 years, destructive and deadly tsunamis have struck Hawaii, Alaska, California, Oregon, Washington, American Samoa, Puerto Rico, and the U.S. Virgin Islands.

How are Tsunamis Generated?

Tsunamis are generated when geologic events cause large, rapid movements in the sea floor that displace the water column above. This swift change creates a series of high energy waves that radiate outward from the source. Locations nearest to the source, such as a large earthquake, will be impacted within minutes. Locations farther away may not see impacts for hours. All coasts can be impacted by tsunamis. Some areas are at a much greater risk than others due to the proximity to tsunami sources and sea floor configurations. For example, the Pacific Northwest coast (Vancouver Island to Cape Mendocino) is right on top of the Cascadia subduction zone (CSZ), so tsunamis from the CSZ strike the coast 10-30 minutes after a CSZ earthquake. Impacts also vary widely from site to site depending on the shape of the seafloor and coastline.

Why are Tsunamis Dangerous?

As the tsunami crosses the deep ocean, it may be only a few feet or less in height. Unlike wind-generated waves that affect the surface of the ocean, tsunamis move the entire water column. As the waves move toward shore, the wave energy is compressed in a smaller water column, and the tsunami grows in height and current strength. There is usually little time to

forecast the severity of a tsunami after one is generated and entire coastlines can be inundated by a large tsunami.

Two Ways to Find out a Tsunami is Coming

Natural Warning (local tsunami)

Strong ground shaking, a loud roar from the ocean, or the water receding unusually far and exposing the sea floor or surging in faster than a normal tide, are all Nature's warning signs that a tsunami may be coming. If you observe any of these signs, immediately move to higher ground or inland. A dangerous tsunami may arrive within minutes. Stay away from low areas until told by officials that the danger has passed. Waves may impact the coast at irregular intervals for ten hours or longer and other hazards like fires or hazardous spills may be present.

Official Warning(distant tsunami)

You may learn that a Tsunami Warning has been issued by listening to TV and radio stations, alerts from NOAA Weather Radio, or in some cases by announcements from emergency officials, airplanes, or outdoor sirens. Move away from beaches or harbor areas (if possible to higher ground) and seek more information without using a phone. Tune into local radio or television stations for more information. Follow instructions of emergency personnel.

Both Natural and Official Warnings are equally important. Respond to whatever you hear or observe first!

Tsunami Warning Centers in the U.S.

When an earthquake that might generate a tsunami for the U.S. coast is detected, the West Coast/Alaska Tsunami Warning Center and Pacific Tsunami Warning Center calculate the danger for coastal locations within their respective areas of responsibility. The West Coast/Alaska Tsunami Warning Center in Palmer, Alaska is responsible for providing tsunami warnings, advisories, watches, and information statements for Alaska, the U.S. west, east, and Gulf of Mexico coasts, Puerto Rico, the U.S. Virgin Islands, and Canada. The Pacific Tsunami Warning Center in Ewa Beach, Hawaii is responsible for providing tsunami warnings, advisories, watches, and information statements for Hawaii, U.S. Pacific Territories, Pacific Ocean, Indian Ocean, and Caribbean Sea nations.

Tsunami Warning Flow Chart

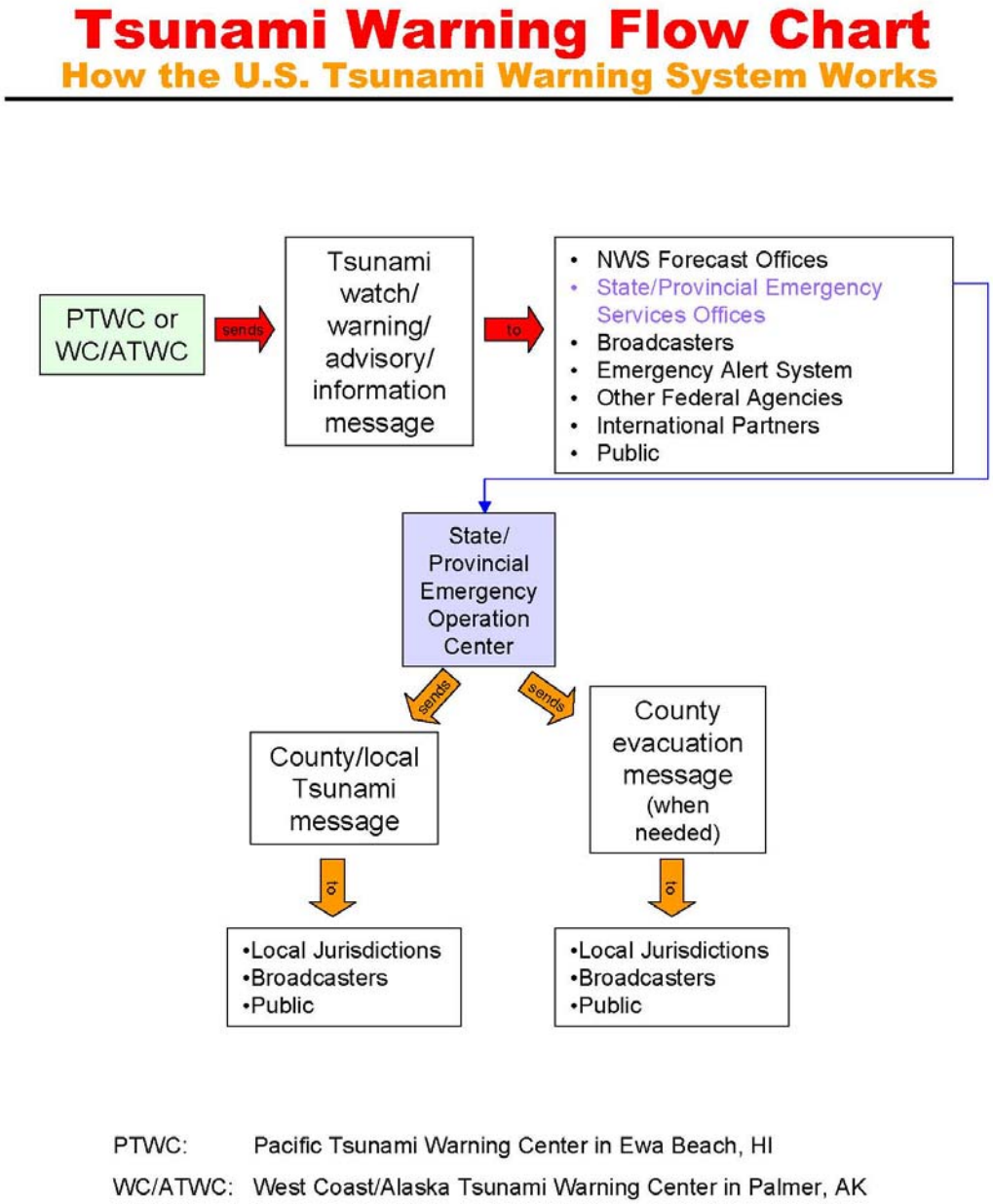

Figure 1. Tsunami Warning System Message Flow Chart. (Credit: NOAA/NWS)

Levels of Tsunami Alert

Warning: A tsunami warning is issued when a potential tsunami with significant widespread inundation is imminent or expected. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after the arrival of the initial wave. Appropriate actions to be taken by local officials may include the evacuation of low-lying areas. People in the warned areas need to move to higher ground or inland and stay in a safe area until local officials give the 'all-clear."

Advisory: A tsunami advisory is issued due to the threat of a potential tsunami that may produce strong currents or waves dangerous to those in or near the water. The threat may continue for several hours after the arrival of the initial wave, but significant widespread inundation is not expected for areas under the advisory. Appropriate actions to be taken by local officials may include the closing of beaches and the evacuation of harbors and marinas. People in the advisory area should heed local official's instructions to leave affected areas until given the "all-clear".

Watch: A tsunami watch is issued when a potentially dangerous, distant seismic event has occurred which may later impact the watch area with a tsunami. Be ready to take action if a tsunami warning or advisory is later issued

Information Statement: A tsunami information statement is issued when an earthquake has occurred or a tsunami warning, advisory, or watch has been issued for another part of the ocean. In most cases, tsunami information statements are issued to indicate there is not threat of a destructive tsunami for the area.

Tsunami Warning Centers –

Once an earthquake or tsunami is detected and the information is received at the Tsunami Warning Center, an earthquake and tsunami investigation begins:

- Locate and size the earthquake (automated);
- Analyze the earthquake or tsunami data;
- Analyze historical data for the same epicentral area and similar magnitudes;
- Analyze the sea-level data to verify the existence of a tsunami and to calibrate models;
- Send the appropriate warning, advisory, watch, or information messages. Typically more than a single message for a tsunami warning will be issued. It is a series of messages culminating in a cancellation, which itself can proceed slowly from breakpoint to breakpoint until final cancellation.

If the source of the earthquake is under or near the ocean, not too deep within the earth, and if the magnitude is sufficiently large, then a tsunami may have been generated. On the basis of this seismic evidence, the appropriate Tsunami Warning Center issues a tsunami warning, advisory, or watch to threatened areas near the epicenter. This is important for EMs because there can be misunderstandings due to message streams from the two TWCs. The warning, advisory, or watch may be extended to areas located further from the epicenter if the magnitude of the earthquake is so large there is a possibility of a long-range destructive tsunami. All remaining areas will be notified that an event has occurred.

SIDEBAR: The West Coast and Alaska Tsunami Warning Center is responsible for tsunami bulletins in Oregon.

Tsunami bulletins are initially issued based solely on earthquake parameters – magnitude, location, and depth. Initial messages are issued as soon as this information has been determined.

After the initial message has been issued, the Tsunami Warning Center monitors the nearest tide gauges and DARTs to confirm the existence or nonexistence of a tsunami and its degree of severity, and issues supplementary information or cancels the initial message. Tsunami history, forecast models, and observed tsunami amplitudes are taken into account when determining the extent of danger for the area of responsibility.

The time it takes for a Center to issue an alert is dependent on the seismic network density and distribution around the epicenter. In regions of high seismic network density, Centers can provide alerts within 5 minutes. In areas of lower seismic network density, response time increases to 10-15 minutes. Initial, automated estimates of earthquake size are often smaller than the actual size, so they can be

misleading in the short time frame for response to a local tsunami. Estimates both earthquake and tsunami size are constantly refined and become more and more accurate as the tsunami travels across the ocean.

If a potentially destructive, long-range tsunami is detected, the Tsunami Warning Center will issue an ocean-wide tsunami warning to advise designated national authorities. Such a warning alerts all warning system participants to the approach of a potentially destructive tsunami and provides estimated tsunami arrival times for key locations. Tsunami forecasts or estimated wave heights may be included if there is enough data and the model results are judged by Tsunami Warning Center staff to be reasonable.

Typically, during a tsunami, bulletins containing updated information are issued at least hourly, until the tsunami has crossed the entire ocean or additional data is received to indicate there is no further threat. Tsunami warnings are canceled when the Tsunami Warning Center judges that the tsunami is no longer dangerous. However, even when the warning is canceled, that does not mean it is safe for the public to return to any evacuated coastline areas. Due to structural damage, debris, and other safety concerns, the “all-clear” may not be issued by the local authorities for hours or even days after the event. In the case of the Tohoku event, there were distinct and dangerous wave packet arrivals many hours later. Probably due to reflections from distant coastlines (although not yet fully explained for this event!)

When an earthquake that might generate a tsunami for the U.S. coast is detected, the West Coast/Alaska Tsunami Warning Center and Pacific Tsunami Warning Center calculate the danger for coastal locations within their respective areas of responsibility.

Areas of Responsibility

The West Coast/Alaska Tsunami Warning Center in Palmer, Alaska is responsible for providing tsunami warnings, advisories, watches, and information statements for Alaska, the U.S. West, East, and Gulf of Mexico coasts, Puerto Rico, the U.S. Virgin Islands, and Canada.

The Pacific Tsunami Warning Center in Ewa Beach, Hawaii is responsible for providing tsunami warnings, advisories, watches, and information statements for Hawaii, U.S. Pacific Territories, Pacific Ocean, Indian Ocean, and Caribbean Sea nations.

Figure 2. Areas of Responsibility for Tsunami Warning Centers

Levels of Tsunami Alert

Tsunami Warning		
Information Statement	Minor waves at most or event in another ocean basin	No action suggested
Watch	Danger level not yet known	Stay alert for more info
Advisory	Strong currents likely	Stay away from the shore
Warning	Inundating wave possible	Full evacuation suggested

Warning: (WEAK51/TSUAK1): When earthquakes occur within the WC/ATWC's area of responsibility (AOR), Tsunami Warnings are issued under the following circumstances:

- If the initial magnitudes are greater than 7.0, but less than or equal to 7.5, WC/ATWC issues a tsunami warning if the tsunami is within two-hour's wave travel time from the coast. Warnings or Advisories called between breakpoints at or just beyond 250 km from epicenter for the Pacific AOR. No watch.

- If the initial magnitudes greater than 7.5, WC/ATWC issues a tsunami warning if the tsunami is within three-hour's wave travel time from the coast. Warnings are updated half-hourly until cancellation or until a Final Supplemental Bulletin is issued.

- For Mw 7.6 - 7.8, warning called between BPs within 500 km and advisory between BPs at 500 to 1000 km from epicenter. No Watch.

- A tsunami warning is issued when a potential tsunami with significant widespread inundation is imminent or expected. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after the arrival of the initial wave. Appropriate actions to be taken by local officials may include the evacuation of low-lying areas. People in the warned areas need to move to higher ground or inland and stay in a safe area until local officials give the ‘all-clear.” A “Warning” is the most

urgent announcement of an imminent tsunami and advises coastal locations in the warned area to prepare for flooding.

Advisory: (TIBWCA, WEPA43):

When earthquakes occur with initial magnitudes greater than 7.5, and the epicenter is more than six-hour's travel time away from any part of the WC/ATWC's AOR, the WC/ATWC will issue a Tsunami Advisory Bulletin. The intent of the Advisory Bulletin is to inform participants within the WC/ATWC AOR that a significant earthquake has occurred, but there is not a threat of a tsunami for the west coast of the United States. The Tsunami Advisory states the Pacific Tsunami Warning Center (PTWC) at Honolulu has issued a tsunami warning for parts of the Pacific Ocean, however, the warning is not for the Pacific coast, from Alaska to southern California.

A Tsunami Advisory can be updated by the WC/ATWC hourly until:

- A Tsunami Warning or Watch becomes necessary within the WC/ATWC AOR,
- All Tsunami Warnings and Watches issued by PTWC are cancelled, or
- A Final Supplemental Bulletin is issued.

A Tsunami Advisory can be issued when the earthquake's magnitude is greater than 7.5 and the tsunami is within six-hour's travel time to the WC/ATWC AOR, but there is no danger of the tsunami causing damage within the WC/ATWC area of responsibility.

A tsunami advisory is issued due to the threat of a potential tsunami that may produce strong currents or waves dangerous to those in or near the water. The threat may continue for several hours after the arrival of the initial wave, but significant widespread inundation is not expected for areas under the advisory. Appropriate actions to be taken by local officials may include the closing of beaches and the evacuation of harbors and marinas. People in the advisory area should heed local official's instructions to leave affected areas until given the "all-clear".

Watch: (TSUWCA, WEPA41):

When earthquakes occur within WC/ATWC's AOR, Tsunami Watches are issued under the following circumstances:

- If the initial magnitudes are greater than 7.0 but less than or equal to 7.5, WC/ATWC issues a tsunami watch if the tsunami is between two-hour's and three hour's wave travel time from the coast.

- If the initial magnitudes are greater than 7.5, WC/ATWC issues a tsunami watch if the tsunami is between three-hour's and six-hour's wave travel time from the coast. Tsunami Watches may be included in a Tsunami Warning bulletin. Watches are updated half-hourly until cancellation or until a Final Supplemental Bulletin is issued.

- A tsunami watch is issued when a potentially dangerous, distant seismic event has occurred which may later impact the watch area with a tsunami. Be ready to take action if a tsunami warning or advisory is later issued. A “Watch” is an alert issued to areas outside the areas issued a Warning and is essentially a notification to monitor the situation.

Information Statement: (WEAK53/TIBAK1):

When earthquakes occur within the WC/ATWC AOR, and the initial magnitudes are from 6.5 to 7.0, WC/ATWC will issue a Tsunami Information Bulletin. The bulletin will state that a sizable earthquake has occurred, but a tsunami was not generated. The WC/ATWC will also issue a Tsunami information bulletin for earthquakes occurring outside its AOR with initially determined magnitudes of 6.5 to 7.5.

WEPA43: This is the so-called “high level TIS”. There is also the SEUS71 product, which is for lower magnitudes (Ml 4 to M 6.4) that are considered to be non-tsunamigenic.

A tsunami information statement is issued when an earthquake has occurred or a tsunami warning, advisory, or watch has been issued for another part of the ocean. In most cases, tsunami information statements are issued to indicate there is not threat of a destructive tsunami for the area. “Information Bulletins or Messages” are issued when the earthquake is less than 6.5 in Magnitude and not likely to trigger a tsunami that would result in significant impacts.

How Tsunami impacts are forecast

Tsunami Warning Centers utilize Tsunami Forecast Models to provide wave height, arrival time, and inundation forecasts for coastal areas potentially impacted by the tsunami. These models utilize the seismic and sea-level data provided by detection networks to forecast impacts at specific locations throughout the ocean basin.

These forecasts help scientists at the Tsunami Warning Centers determine the level of alert (warning, advisory, information statement, or watch) to issue for specific areas of the coast. The forecasts assist local emergency management to determine whether or not to issue evacuation orders during an event.

This determination is critical as emergency managers not only want to ensure that communities who will experience destruction during a tsunami are evacuated, but also to ensure that communities that are not threatened during a tsunami event do not have to undergo needless evacuation.

Who is at Risk?

All U.S. coasts can be impacted by tsunamis, though based on proximity to tsunami sources and sea floor configurations, some areas are at much greater risk than others. Within the last 150 years, destructive and deadly tsunamis have struck Hawaii, Alaska, California, Oregon, Washington, American Samoa, Puerto Rico, and the U.S. Virgin Islands.

World-wide, tsunamis have been recorded over 100 feet high in coastal zones near the source earthquake; however history of the Oregon coast has recorded few significant damaging incidents from distant events. The most damaging distant tsunami observed so far was from the magnitude 9.2 Prince William Sound Earthquake in 1964. Runup at the open coast reached up to ~20 feet and 10-15 feet in estuaries and bays. Other distant tsunamis have been documented as causing lesser damage to docks, boats and near shore structures. Again, it needs to be stressed that a local tsunami is a far more damaging, and deadly, event, up to 5 times larger than the largest distant tsunamis.

Damage from a tsunami could range from minor to major property loss and death. Damage to roadways, communication systems, public services and infrastructure, along with emergency response and medical service can be expected.

Consequential damage could include electrical equipment such as well pumps near coastal areas being flooded, in turn resulting in a shock hazard:, streams, river crossings and bridges may be washed out:, sewage systems could be flooded resulting in possible overflow conditions and a disruption of normal water supplies to the public.

Potential damage from a significant tsunami is not confined to the immediate shoreline. Tsunamis have traveled up to two miles upstream from the shoreline with resulting life loss, injury and damage. Low lying areas along streams and rivers that empty into the ocean or bays are at risk of high water surge and inundation.

The areas most at risk from tsunami impact are those coastal communities, recreation and developed areas below 50 to 100 feet above mean sea level. Areas not protected by bluffs, wide beaches, dunes, large manmade structures, distance or other barriers to the tsunami surge and rising water levels are most at risk.

No detailed study of distant tsunami vulnerability is available, but vulnerability to a tsunami averaging ~25-35 feet at the open coast (similar to a worst-case distant tsunami) is 90,772 in Oregon (unpublished USGS estimate in 2012 by Nathan Wood based on update of USGS Scientific Investigations Report 2007-5283 with census data from 2000). This figure includes 53,714 average daily State park visitors.

How Tsunamis are Detected and Observed

NOAA's Tsunami Warning Centers monitor the earth 24x7 through a tsunami detection system consisting of seismic, coastal sea-level, and Deep Ocean Assessment and Reporting of Tsunamis (DART) networks.

Seismic Networks –

Most damaging tsunamis are caused by earthquakes. Seismic data are collected at hundreds of seismic sensors, called **seismometers**, around the world. The scientists at the Tsunami Warning Centers use seismic data to determine the location and magnitude of earthquakes. The location and magnitude of an earthquake determine whether or not scientists will issue a tsunami warning, advisory, or watch.

Coastal Sea-Level Networks –

These networks consist of coastal sea-level gauges that measure the ocean height at specific coastal locations. When a tsunami arrives at a gauge, the water level will vary from its normal tide cycle. The scientists use data from these gauges to both detect a tsunami and estimate its impact at the coast.

DART Network –

DART stations sense water level changes in the deep ocean resulting from the formation and propagation of tsunamis. A DART station consists of a pressure sensor, located on the sea floor, and a data transmission buoy, located on the surface. As a tsunami passes, the depth of the water changes as does the pressure on the sensor. This pressure change is transmitted acoustically to the surface buoy and then via satellite to the Tsunami Warning Centers.

Tsunami Warning Centers –

Once an earthquake or tsunami is detected and the information is received at the Tsunami Warning Center, an earthquake and tsunami investigation begins:

- locate and size the earthquake (automated);
- analyze the earthquake or tsunami data;
- analyze the sea-level data to verify the existence of a tsunami and to calibrate models;
- send the appropriate warning, watch, advisory or information message.

If the source of the earthquake is under or near the ocean, not too deep within the earth, and if the magnitude is sufficiently large, then a tsunami may have been generated. On the basis of this seismic evidence, the appropriate Tsunami Warning Center issues a tsunami warning,

advisory, or watch (see Tab 3) to threatened areas near the epicenter. The warning, advisory, or watch may be extended to areas located further from the epicenter if the magnitude of the earthquake is so large there is a possibility of a long-range destructive tsunami. All remaining areas will be notified that an event has occurred.

Tsunami bulletins are initially issued based solely on earthquake parameters – magnitude, location, and depth. Initial messages are issued as soon as this information has been determined.

After the initial message has been issued, the Tsunami Warning Center monitors the nearest tide gauges and DARTs to confirm the existence or nonexistence of a tsunami and its degree of severity, and issues supplementary information or cancels the initial message. Tsunami history, forecast models, and observed tsunami amplitudes are taken into account when determining the extent of danger for the area of responsibility.

The time it takes for a Center to issue an alert is dependent on the seismic network density and distribution around the epicenter. In regions of high seismic network density, Centers can provide alerts within 5 minutes. In areas of lower seismic network density, response time increases to 10-15 minutes.

If a potentially destructive, long-range tsunami is detected, the Tsunami Warning Center will issue an ocean-wide tsunami warning to advise designated national authorities. Such a warning alerts all warning system participants to the approach of a potentially destructive tsunami and provides estimated tsunami arrival times for key locations. Tsunami forecasts or estimated wave heights may be included if there is enough data and the model results are judged by Tsunami Warning Center staff to be reasonable.

Typically, during a tsunami, bulletins containing updated information are issued at least hourly, until the tsunami has crossed the entire ocean or additional data is received to indicate there is no further threat. Tsunami warnings are canceled when the Tsunami Warning Center judges that the tsunami is no longer dangerous. However, even when the warning is canceled, that does not mean it is safe for the public to return to any evacuated coastline areas. Due to

structural damage, debris, and other safety concerns, the “all-clear” may not be issued by the local authorities for hours or even days after the event.

How Tsunamis are Forecast

Forecasting Impacts

Tsunami Warning Centers utilize Tsunami Forecast Models to provide wave height, arrival time, and inundation forecasts for coastal areas potentially impacted by the tsunami. These models utilize the seismic and sea-level data provided by detection networks to forecast impacts at specific locations throughout the ocean basin.

These forecasts help scientists at the Tsunami Warning Centers determine the level of alert (warning, advisory, information statement, or watch) to issue for specific areas of the coast. The forecasts assist local emergency management determines whether or not to issue evacuation orders during an event.

This determination is critical as emergency managers not only want to ensure that communities who will experience destruction during a tsunami are evacuated, but also to ensure that communities that are not threatened during a tsunami event do not have to undergo needless evacuation.

Distant Tsunami Decision Tree

Trigger Event - A Tsunami Product is issued by the West Coast and Alaska Tsunami Warning Center

Information Statement - No community action required

Tsunami Watch - Recommend monitoring situation

Tsunami Advisory - Action required to protect life and property.

Tsunami Warning - Action required to protect life and property.

Page One: Critical Information

Critical information for initial decision making

- Is the earthquake over 7.0 Mw?
- Is the tsunami travel time less than 4 hours away?
- What are the tidal conditions?
- What are the weather conditions?

Page Two: Information Statement

Information Statement is issued by West Coast and Alaska Tsunami Warning Center (WCATWC)

OBJECTIVES: Assess whether the seismic event can lead to a response activation.

QUESTION: Is it over 7.0 Mw?

- NO- **NO** ACTION REQUIRED
- Yes - ACTION **IS** REQUIRED
    - Under-ocean earthquakes that are over 7.0 Mw can be tsunami-genic.
    - Monitor for upgrading to Watch/Advisory/Warning.
    - Review distant tsunami response plans
    - Make initial contacts with point of contact for response support agencies
        - List of recommended agencies in Appendix

QUESTION: Are you activating?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - Choose the level and protocols you will use to activate
    - Identify how you plan to disseminate information, actual procedures

QUESTION: Does the WCATWC upgrade the bulletin to a Watch?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - See Page # X

QUESTION: Does the WCATWC upgrade the bulletin to an Advisory?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - See Page # X

QUESTION: Does the WCATWC upgrade the bulletin to a Warning?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - See Page # X

Page Three: Tsunami Watch

Tsunami Watch is issued by West Coast and Alaska Tsunami Warning Center

OBJECTIVES:

- Assess whether the seismic event can lead to a response activation.
- Pre-staging for response

QUESTION: Is this an update on a previous Tsunami Information Statement?

- NO- ACTION **IS** REQUIRED
  - Under-ocean earthquakes that are over 7.0 Mw can be tsunami-genic.
  - Monitor for upgrading to Advisory/Warning.
  - Review distant tsunami response plans
  - Make initial contacts with point of contact for response support agencies
    - List of recommended agencies in Appendix
- YES - ACTION **IS** REQUIRED
  - Inform point of contact for response support agencies that the Tsunami Watch has been issued.
  - Consider increasing activation level.

QUESTION: Are you activating an emergency operations center (EOC)?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
  - Choose the level and protocols you will use to activate
  - Identify how you plan to disseminate information, actual procedures
    - Begin notification of Public Safety agencies
    - Begin to notify personnel that event may occur
    - Define staffing patterns early to ensure continuity for duration of event

QUESTION: Do you need additional staff?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
  - Increase EOC level

QUESTION: Is there an increase in public request for information about the tsunami event?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
  - Develop public information statement about the tsunami event
  - Disseminate through your public information channels
    - EAS
    - Public Warning
    - Rapid notification systems

QUESTION: Does the WCATWC upgrade the bulletin to an Advisory?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
  - See Page # X

QUESTION: Does the WCATWC upgrade the bulletin to a Warning?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - See Page # X

Page Four: Tsunami Advisory

Tsunami Advisory is issued by West Coast and Alaska Tsunami Warning Center

QUESTION: Is this an update on a previous Tsunami Bulletin?

- NO- ACTION **IS** REQUIRED
    - Under-ocean earthquakes that are over 7.0 Mw can be tsunami-genic.
    - Monitor for upgrading to Warning.
    - Review distant tsunami response plans
    - Make initial contacts with point of contact for response support agencies
        - List of recommended agencies in Appendix
- YES - ACTION **IS** REQUIRED
    - Inform point of contact for response support agencies that the Tsunami Advisory has been issued.
    - Consider increasing activation level.

QUESTION: Are you activating an emergency operations center (EOC)?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - Choose the level and protocols you will use to activate
    - Identify how you plan to disseminate information, actual procedures
        - Begin notification of Public Safety agencies
        - Begin to notify personnel that event may occur
        - Define staffing patterns early to ensure continuity for duration of event

QUESTION: Do you need additional staff?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - Increase EOC level

QUESTION: Is there an increase in public request for information about the tsunami event?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - Develop public information statement about the tsunami event
    - Disseminate through your public information channels
        - EAS
        - Public Warning
        - Rapid notification systems

QUESTION: Is the Tsunami Advisory Cancelled by the WCATWC?

- NO- **NO** ACTION REQUIRED

- YES - ACTION **IS** REQUIRED
    - De-mobilize and monitor for 24 hours (or full tidal cycle…)

Page Five: Tsunami Warning

Tsunami Warning is issued by West Coast and Alaska Tsunami Warning Center

QUESTION: Is this an update on a previous Tsunami Bulletin?

- NO- ACTION **IS** REQUIRED
    - Under-ocean earthquakes that are over 7.0 Mw can be tsunami-genic.
    - Review distant tsunami response plans
    - Make initial contacts with point of contact for response support agencies
        - List of recommended agencies in Appendix
- YES - ACTION **IS** REQUIRED
    - Inform point of contact for response support agencies that the Tsunami Watch has been issued.
    - Consider increasing activation level.

QUESTION: Are you activating an emergency operations center (EOC)?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - Choose the level and protocols you will use to activate
    - Identify how you plan to disseminate information, actual procedures
        - Begin notification of Public Safety agencies
        - Begin to notify personnel that event may occur
        - Define staffing patterns early to ensure continuity for duration of event

QUESTION: Do you need additional staff?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - Increase EOC level

QUESTION: Is there an increase in public request for information about the tsunami event?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - Develop public information statement about the tsunami event
    - Disseminate through your public information channels
        - EAS
        - Public Warning
        - Rapid notification systems

QUESTION: Is the Tsunami Warning Cancelled by the WCATWC?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
    - De-mobilize and monitor for 24 hours (or full tidal cycle…)

Page Six: Cancellation of Tsunami Advisory/Warning after damage occurs

OBJECTIVES:

- Deem area safe for responders, then public, to re-enter
- Begin recovery process, if necessary

QUESTION: Was there damage to property or personal injury/loss of life due to tsunami?

- NO- ACTION **IS** REQUIRED
  - De-mobilize and monitor for 24 hours (or full tidal cycle…)
  - Allow Cautionary Re-entry and ensure public safety
- YES - ACTION **IS** REQUIRED

QUESTION: Was there any marked tsunami inundation?

- NO- ACTION **IS** REQUIRED
  - De-mobilize and monitor for 24 hours (or full tidal cycle…)
  - Allow Cautionary Re-entry and ensure public safety
- YES - ACTION **IS** REQUIRED
  - Assess beach/shore/bay safety
  - Allow Cautionary re-entry as you assess damage and ensure public safety
  - Conduct Initial damage assessment
  - Identify what the public needs
    - Do shelters need to continue?
      - NO- ACTION **IS** REQUIRED
        - Stand down Shelters according to response plan
      - YES - ACTION **IS** REQUIRED
        - Refer to Red Cross Long Term Shelter Plan
  - Does a disaster declaration need to be done?
    - NO- **NO** ACTION REQUIRED
    - YES - ACTION **IS** REQUIRED
      - Transition to IDA/PDA process

QUESTION: Is the call volume from the public still high?

- NO- **NO** ACTION REQUIRED
- YES - ACTION **IS** REQUIRED
  - Continue managing information
    - Phone bank
    - Call-line with pre-recorded message