An aerial photograph of a river valley. The river is a vibrant blue, winding through a lush green landscape. The hills are covered in dense vegetation, and the terrain appears to be a mix of forested areas and open fields. The sky is a clear, pale blue. The text is overlaid on the center of the image.

Predicted Effects of the Cascadia Earthquake Clallam County

by
Jim Buck

INFORMATION ORIGIN

Clallam County Emergency Management Requested My Help

Study Conducted by the Department of Homeland Security's Homeland Infrastructure Simulation and Analysis Center (HITRAC)

Based on the Cascadia Regional Earthquake Workgroup 9.0 Earthquake

FEMA's HAZUS – MH 2 Multi Hazard Loss Estimation Program

Washington National Guard Contingency Plans to Meet the Emergency

US Government Contingency Plans to Meet the Emergency

http://www.washingtonepin.org/external/content/document/5163/2454186/1/Cascadia_Rising_2016_Exercise_Scenario_Document_Low_Res.pdf

<https://www.youtube.com/watch?v=oiALmpnfN10>

CASCADIA SUBDUCTION ZONE

Plate Tectonic Setting

Subduction zone: Juan de Fuca and Gorda plate subducting beneath North American plate
Rate: ~3 cm/year
Dip of interface: ~12°

PACIFIC PLATE

JUAN DE FUCA PLATE

NORTH AMERICAN PLATE

GORDA PLATE

Most Recent Great Earthquake

Date: January 26, 1700
Magnitude: ~9.0
Rupture length: ~1000 km
Rupture width: ~80 km
Recurrence interval: 500 years

1000 km

PACIFIC PLATE

Tsunami Characteristics

(rough estimate from Native American oral history and written records in Japan)
Peak tsunami height in the near-source area: ~60 ft at mouth of Redwood Creek, Northern California (from Yurok stories)
Peak tsunami height in Japan (9 hours travel time and 3900 miles away): ~15 ft

THE 9.2 QUAKE

Location: 130 miles off coast

Length of Rupture: 600 miles

Width of Rupture: 50 miles

Duration: 6.5 minutes

Magnitude at rupture: 9.2

PGA on Oly Pen: 25 to 50% G

PGA near I-5: 30 to 40% G

Law Enforcement

Area of Operation	Damage State			
	None	Low	Medium	High
Coastal	0%	5%	38%	57%
I-5 corridor	8%	49%	6%	37%
East	100%	0%	0%	0%
Summary of damage description	Facility is fully functional.	Facility is structurally sound and able to be occupied, though damage to interior contents may make immediate use more difficult.	Facility is damaged and may need repair before full occupation.	Facility is not accessible.

HIGHWAYS

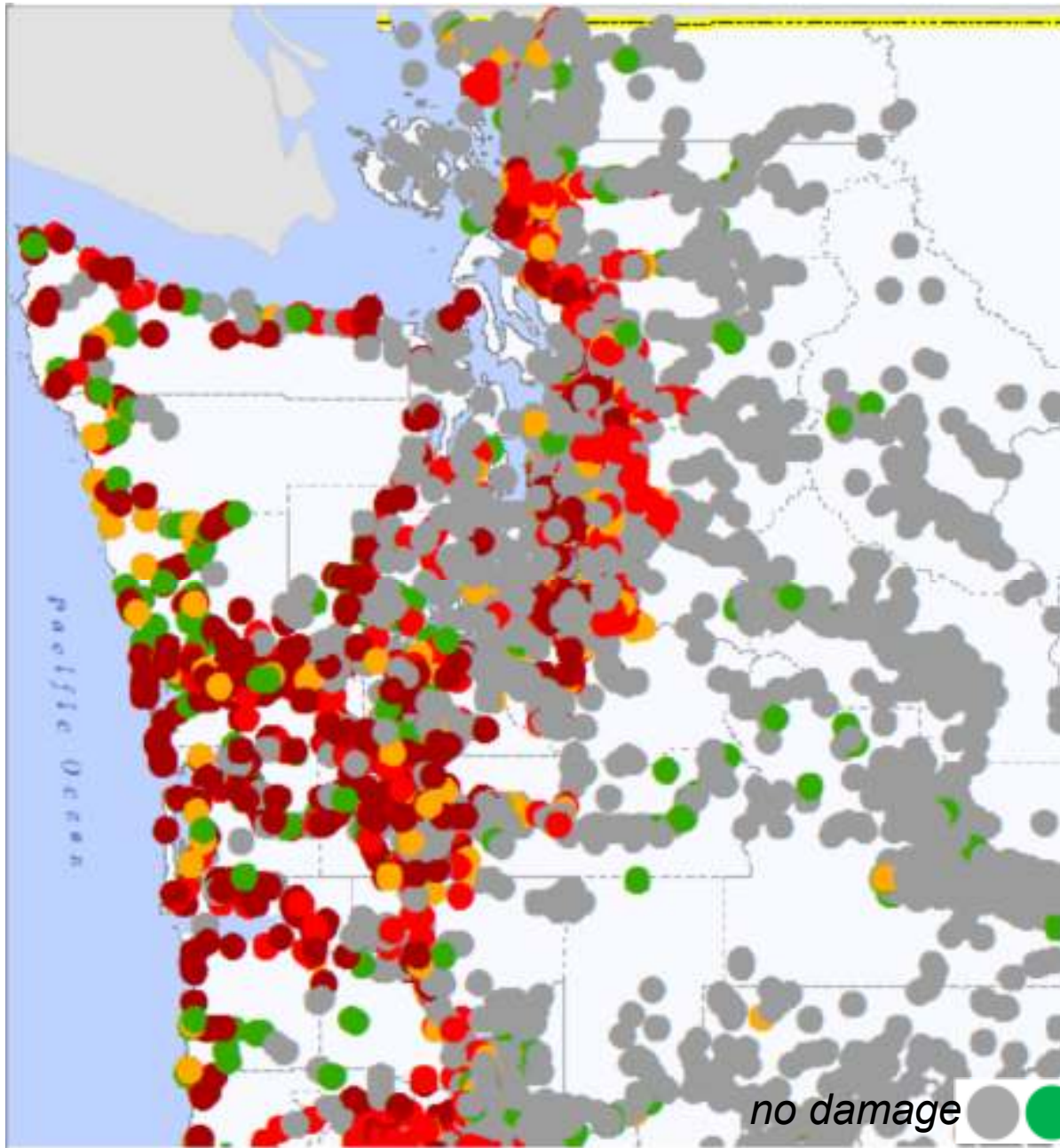


The highway system will suffer the most damage in the vicinity of the coast from both earthquake and tsunami damage.

There are no surviving ground routes to the coastal region.

no damage ● *completely destroyed*

BRIDGES



23% of coastal area bridges will be out of service for days.

50 % of Coastal bridges will be damaged and unusable.

The lack of suitable bridges will be a factor in rescue/recovery efforts and timelines.

no damage      completely destroyed

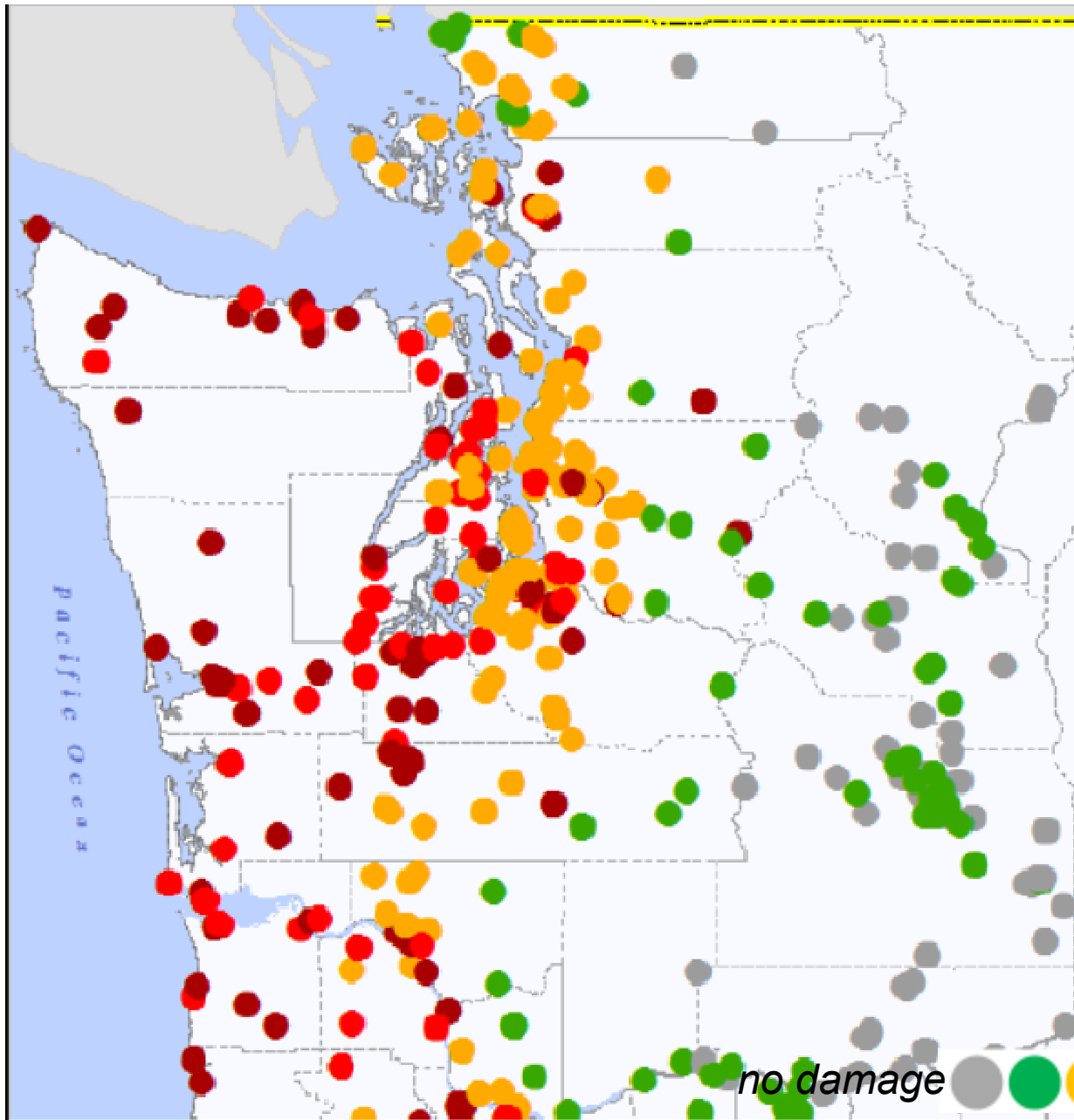
Area of Operation	None	Low	Medium	High
Coastal	14%	6%	5%	75%
I-5 corridor	65%	5%	8%	22%
East	33%	66%	0%	0%
Summary of damage description	No damage.	1 - 3 inches ground displacement. Slight cracking or movement. No interruption of traffic.	3 - 12 inches ground displacement. Moderate to extensive cracking or movement of pavement surface but not failure of subsurface soils.	Over 12 inches ground displacement. Roadway pavement and subsurface soils fail. Roadway surface requires replacement.

Roads

Road Bridges

Area of Operation	None	Low	Medium	High
Coastal	16%	12%	23%	50%
I-5 corridor	53%	7%	27%	13%
East	100%	0%	0%	0%
Summary of damage description	No damage.	Slight damage requiring only minor, cosmetic repairs, but the bridges can support traffic even before these repairs are made.	Moderate damage requiring repairs before use, but not requiring demolition of bridges. Bridges may not support heavy loads and will likely require engineering assessments before deemed safe for traffic.	Bridge collapse or damages so severe as to require demolition and complete replacement of the entire bridge. Bridge likely impassable to traffic.

COMMUNICATIONS



After the CSZ, the entire region will experience phone, cell phone, internet, radio and TV outages for extended periods.

It may take days or weeks to restore 33% of coastal communications facilities.

67% may need to be replaced.

no damage

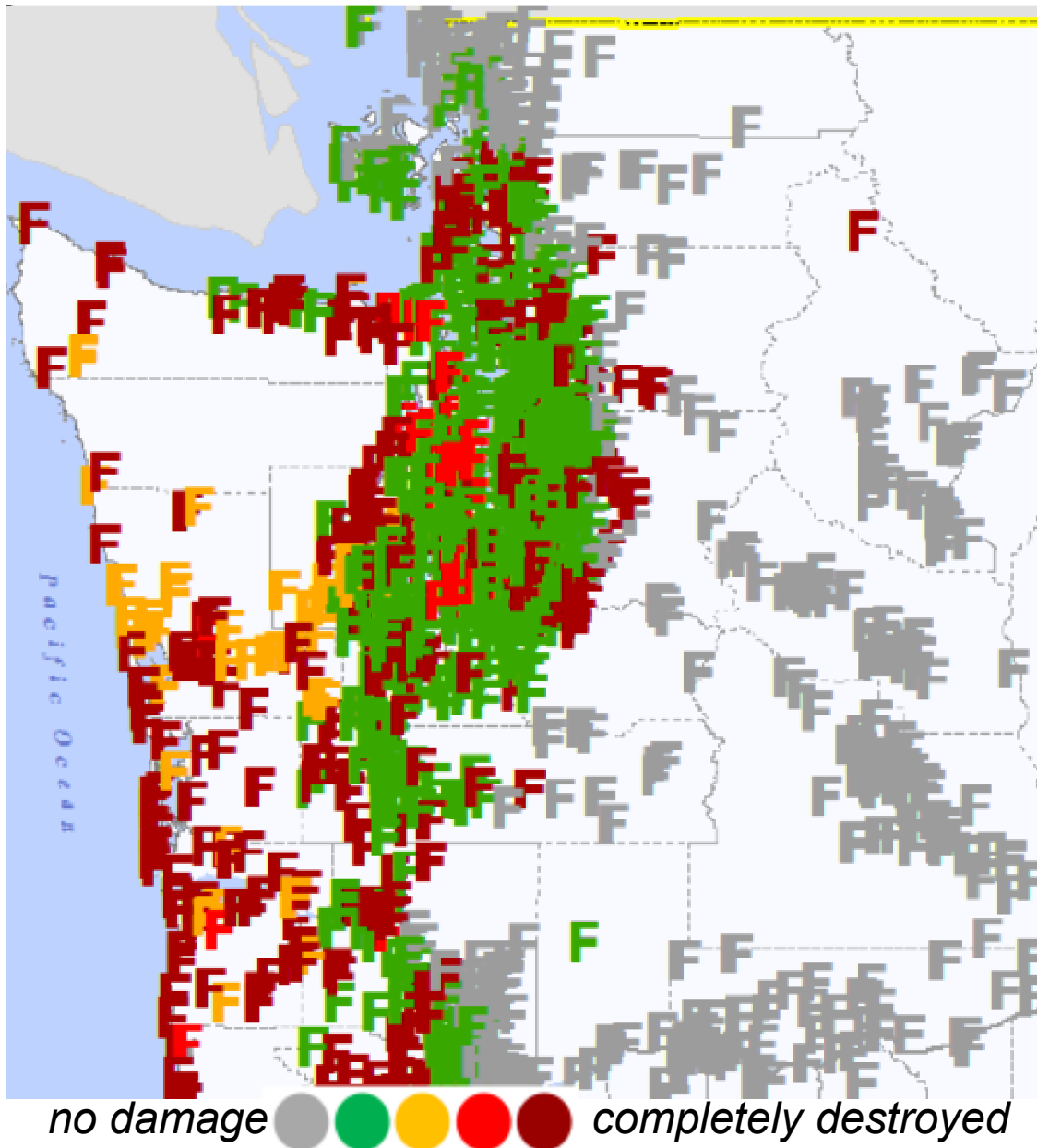


completely destroyed

Communications

Area of Operation	None	Low	Medium	High
Coastal	0%	0%	33%	67%
I-5 corridor	5%	19%	55%	21%
East	95%	5%	0%	0%
Summary of damage description	No damage to facility building or equipment. Antennae misalignment may temporarily disrupt service.	Slight damage to the communication facility building, or loss of the center's ability to provide services for up to a few days due to loss of electric power and backup power. The facility may be functional with minor repairs.	Moderate to severe damage to communication facility buildings, many digital switching boards dislodged, resulting in malfunction. The central office may be without service for a few days due to loss of electric power or loss of backup power, typically due to overload.	Severe to complete damage to the communication facility building, with most switching boards dislodged, resulting in malfunction. The damage to digital switching boards may be beyond repair.

FIRE STATIONS

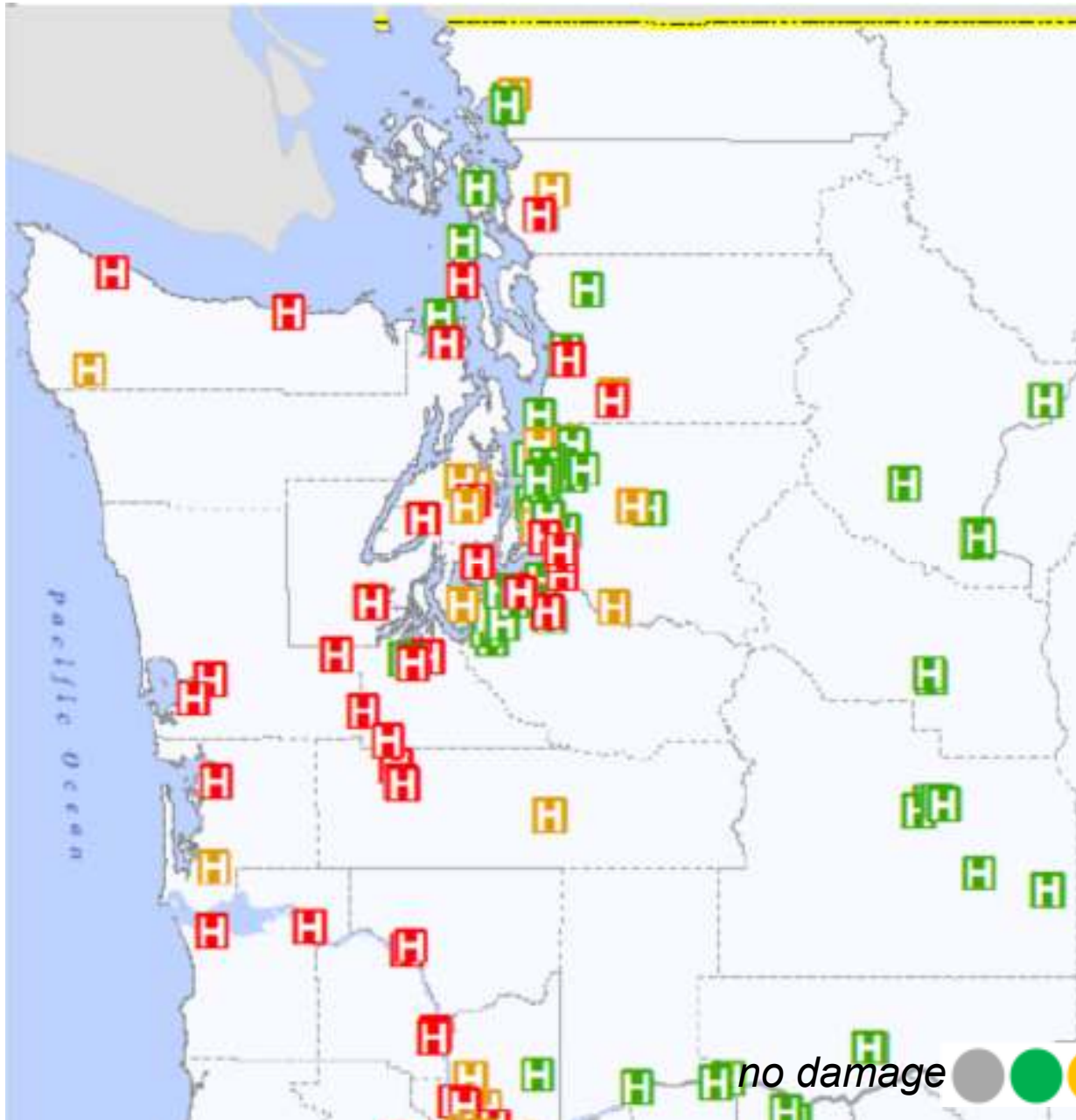


Total reduction is assumed to be 33% of Fire Response capability in Washington.

The facilities nearer to the epicenter suffer most significant damage resulting in significantly reduced capability west of Shelton.

This reduction plus damage to highways, bridges, and communications renders mutual aid agreements impractical.

HOSPITALS



The facilities nearest the epicenter suffer most significant damage resulting in **virtually no Hospital capacity west of the I-5 corridor.**

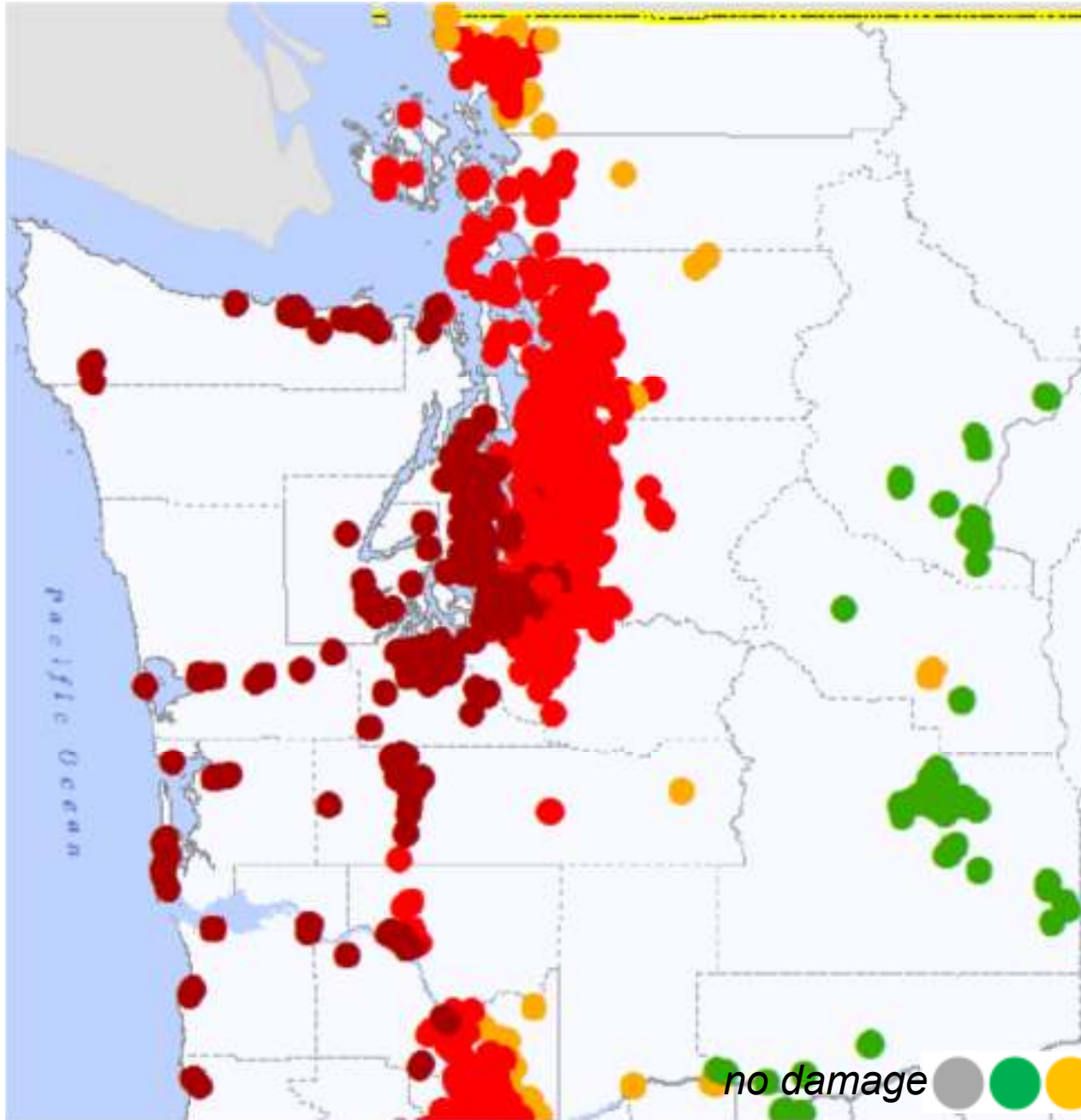
Total western Washington hospital capacity is assumed to be reduced by 45% of total hospital capacity.

no damage grey green yellow red dark red completely destroyed

Hospitals

Area of Operation	None	Low	Medium	High
Coastal	0%	7%	43%	50%
I-5 corridor	7%	42%	28%	24%
East	100%	0%	0%	0%
Summary of damage description	Hospital is fully functional.	Hospital is structurally sound and able to be occupied, though damage to interior contents may make immediate use more difficult.	Hospital is extensively damaged and operating at limited capacity. Partial evacuation may be required.	Hospital is severely damaged. Full evacuation may be required.

SENIOR LIVING FACILITIES

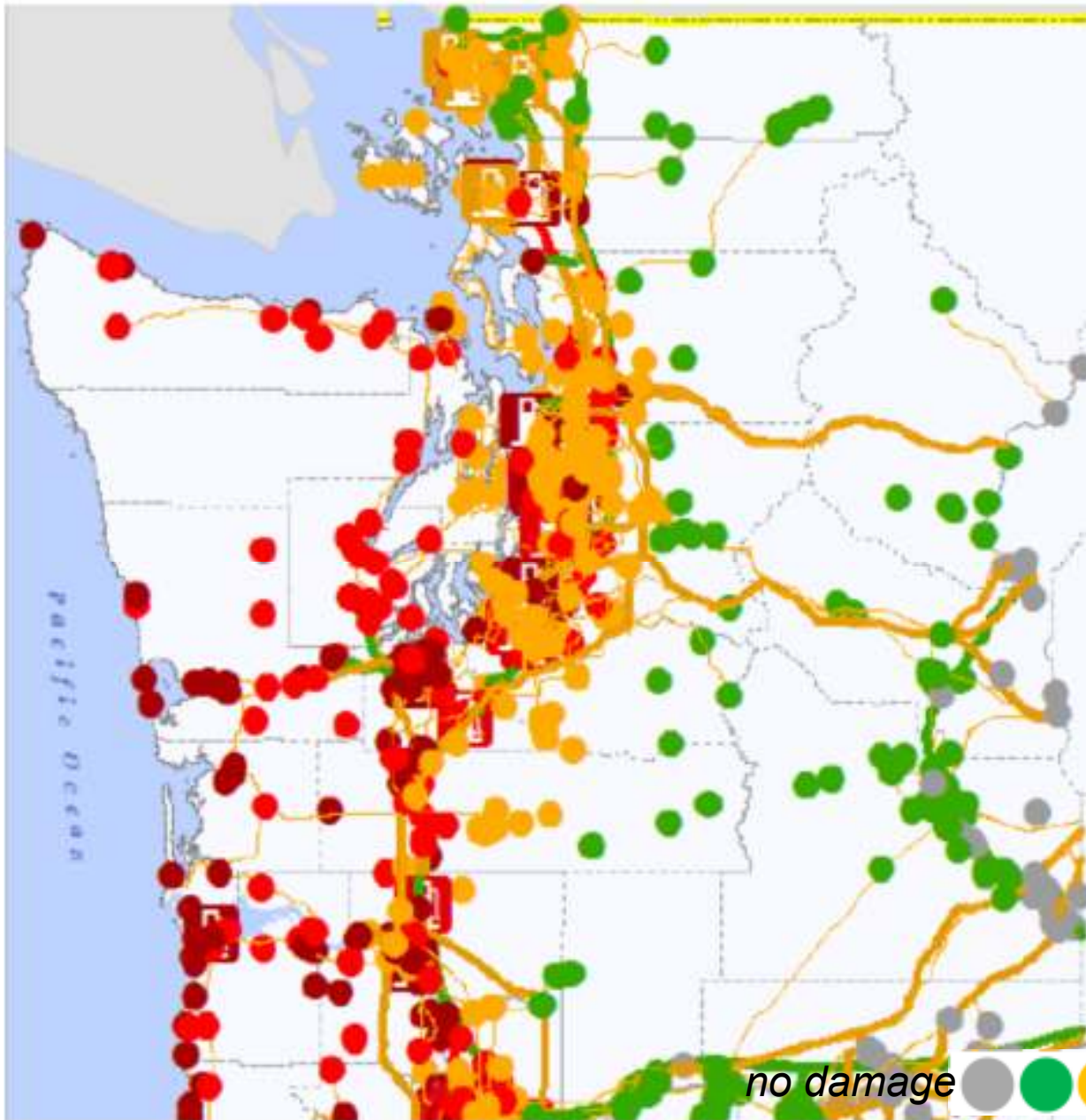


The facilities nearest the epicenter suffer most significant damage.

Virtually no senior/DD living facility capacity remains west of the I-5 corridor.

no damage      completely destroyed

UTILITIES



Electrical, water and sewer systems will be out-of-service until significant repairs can be made.

Broken sewer lines have been a serious public health issue in other earthquake events.

no damage      completely destroyed

Electricity

Area of Operation	None	Low	Medium	High
Coastal	0%	0%	60%	40%
I-5 corridor	0%	22%	66%	12%
East	31%	69%	0%	0%
Summary of damage description	No damage to distribution systems and substations.	Light damage to generation plants, substation equipment, and buildings. No transformer damage. Repairs completed in a few hours to days. Temporary outage period, if any.	Considerable damage to generation plants, substation equipment, and buildings. Repairs are needed to regain functionality. Restoring power to meet 90% of demand may take weeks to months.	Extensive damage to generation plants, substations, and buildings. Repairs are needed to regain functionality. Restoring power to meet 90% of demand may take months to one year.

Area of Operation	None	Low	Medium	High
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Wastewater Facilities

Coastal	0%	0%	44%	56%
I-5 corridor	0%	12%	57%	12%
East	21%	79%	0%	0%

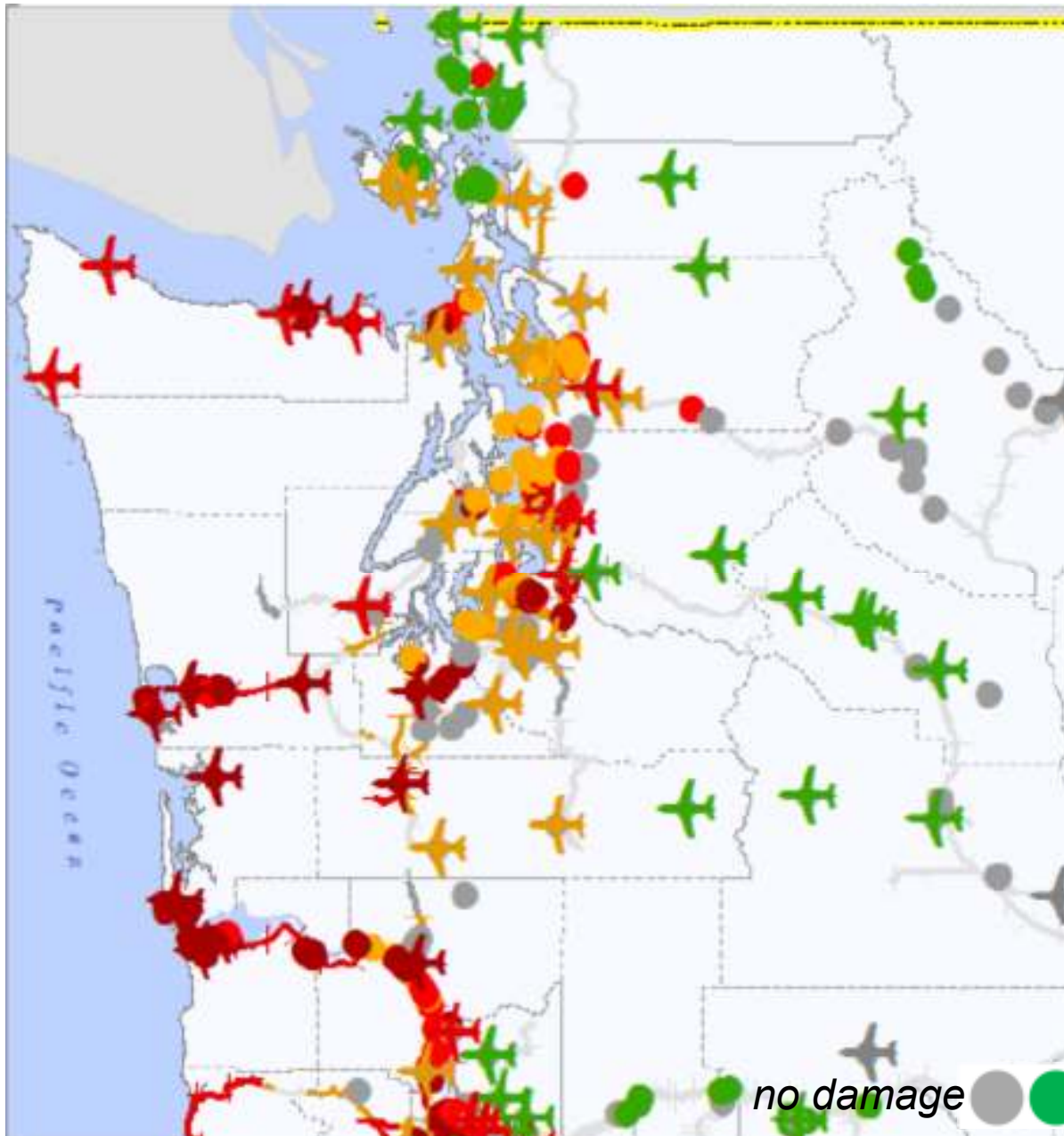
Potable Water Facilities

Coastal	0%	0%	67%	33%
I-5 corridor	0%	11%	86%	3%
East	0%	100%	0%	0%

Water and Sewer

Summary of damage description	None	Low	Medium	High
No structural damage to water and wastewater treatment plant, lift-stations, pumping plants and water storage tanks.	Loss of electric power and backup power, resulting in temporary malfunction for less than three days. Loss of water quality may occur. Minor water storage tank damage without loss of functionality.	Loss of electric power and backup power, resulting in malfunction for about a week. Loss of water quality is likely. Damaged pipes connecting to basins and chemical units, which may result in a shutdown of treatment plant. Damage to pumps and lift-stations may be beyond repair. Considerable to severe damage to water storage tanks, resulting in loss of content.	Complete failure of pipings, or extensive damage to the filter gallery at treatment plant. Pumping plant or lift-station building collapse. Water storage tank collapse and loss all of content.	

AIR TRANSPORTATION



Most airports west of the I-5 corridor suffer complete to severe damage.

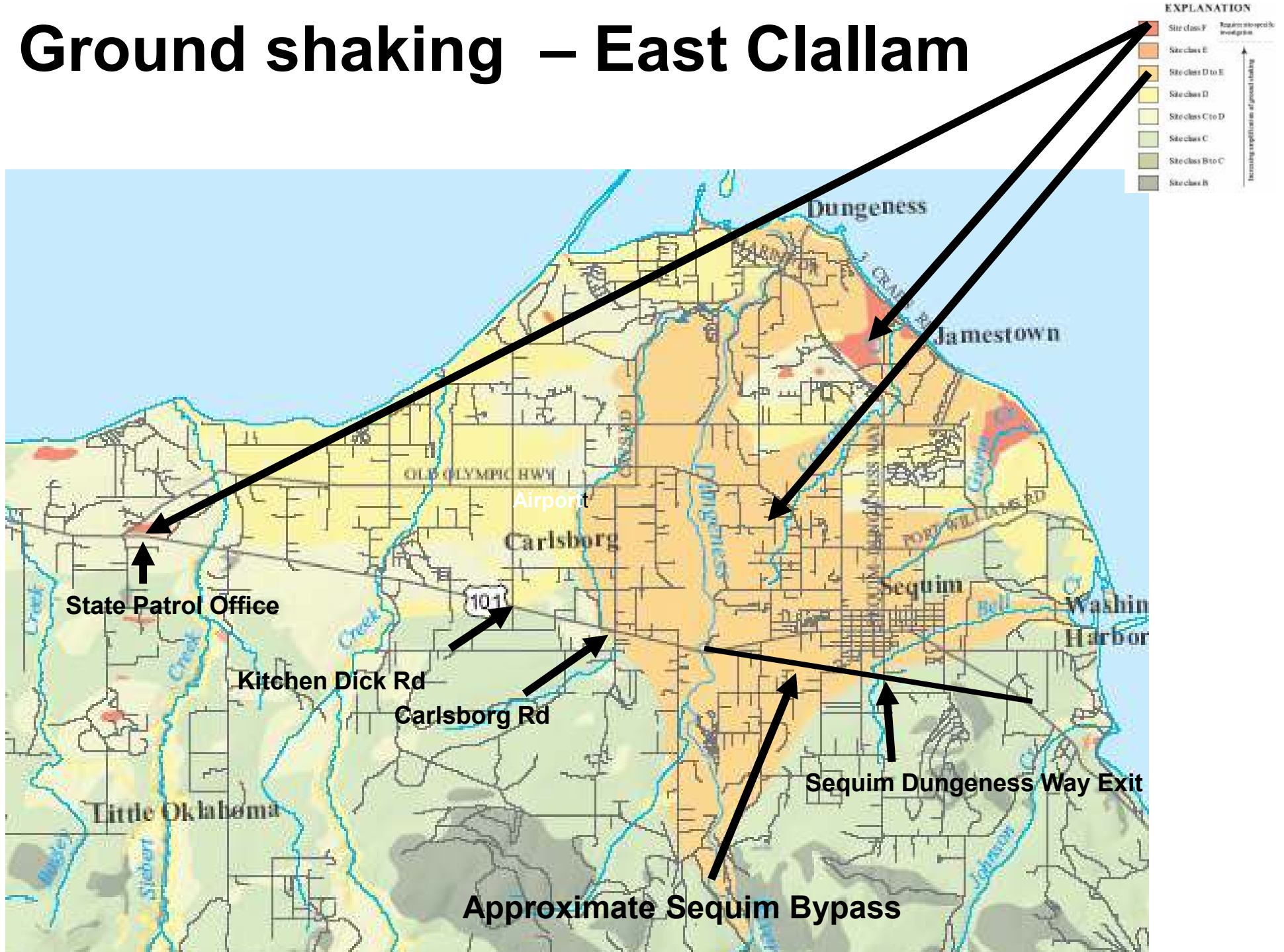
Most airports along the I-5 corridor suffer severe to moderate damage.

no damage      completely destroyed

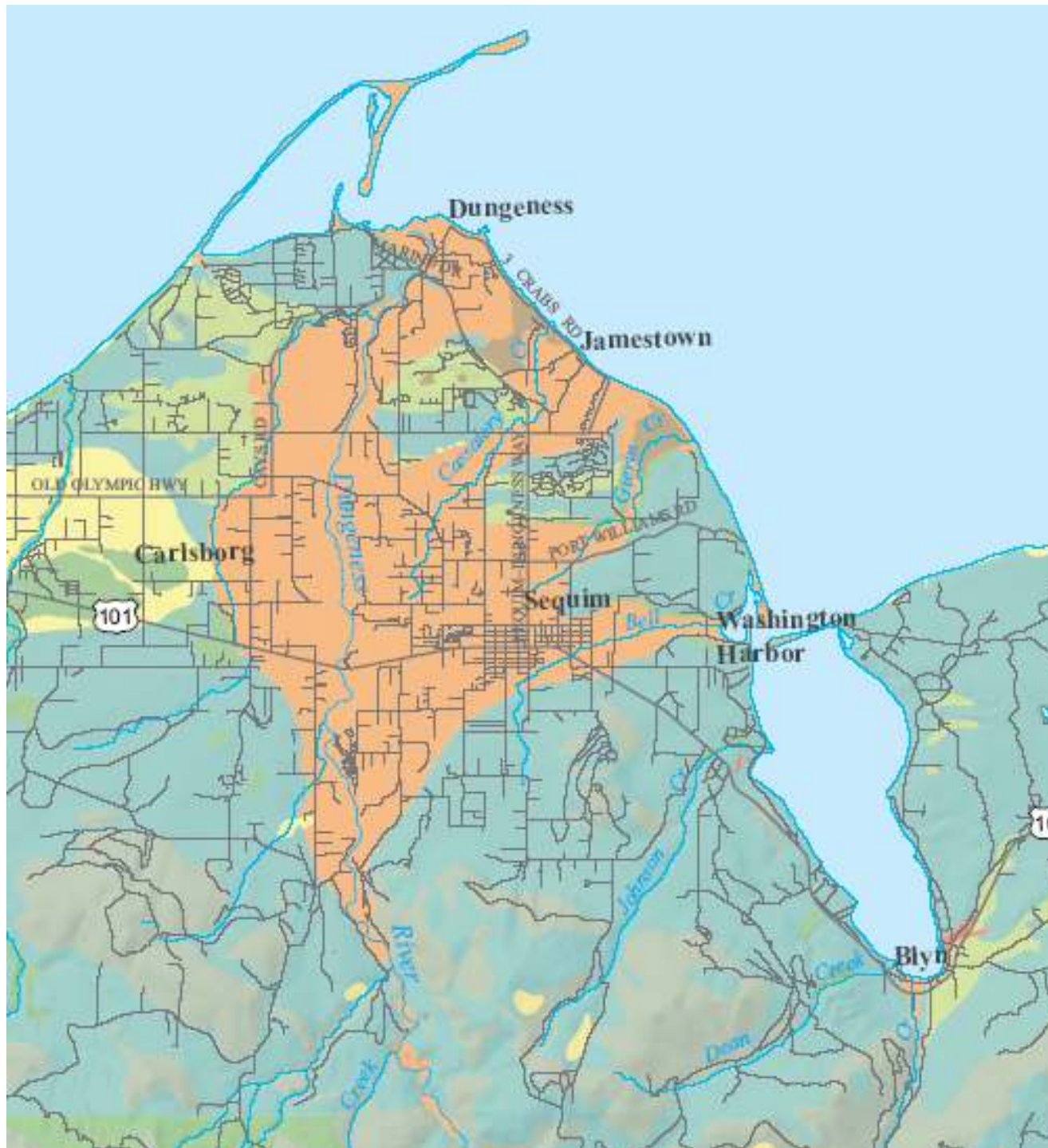


Communities become micro-islands.

Ground shaking – East Clallam



Liquefaction – East Clallam

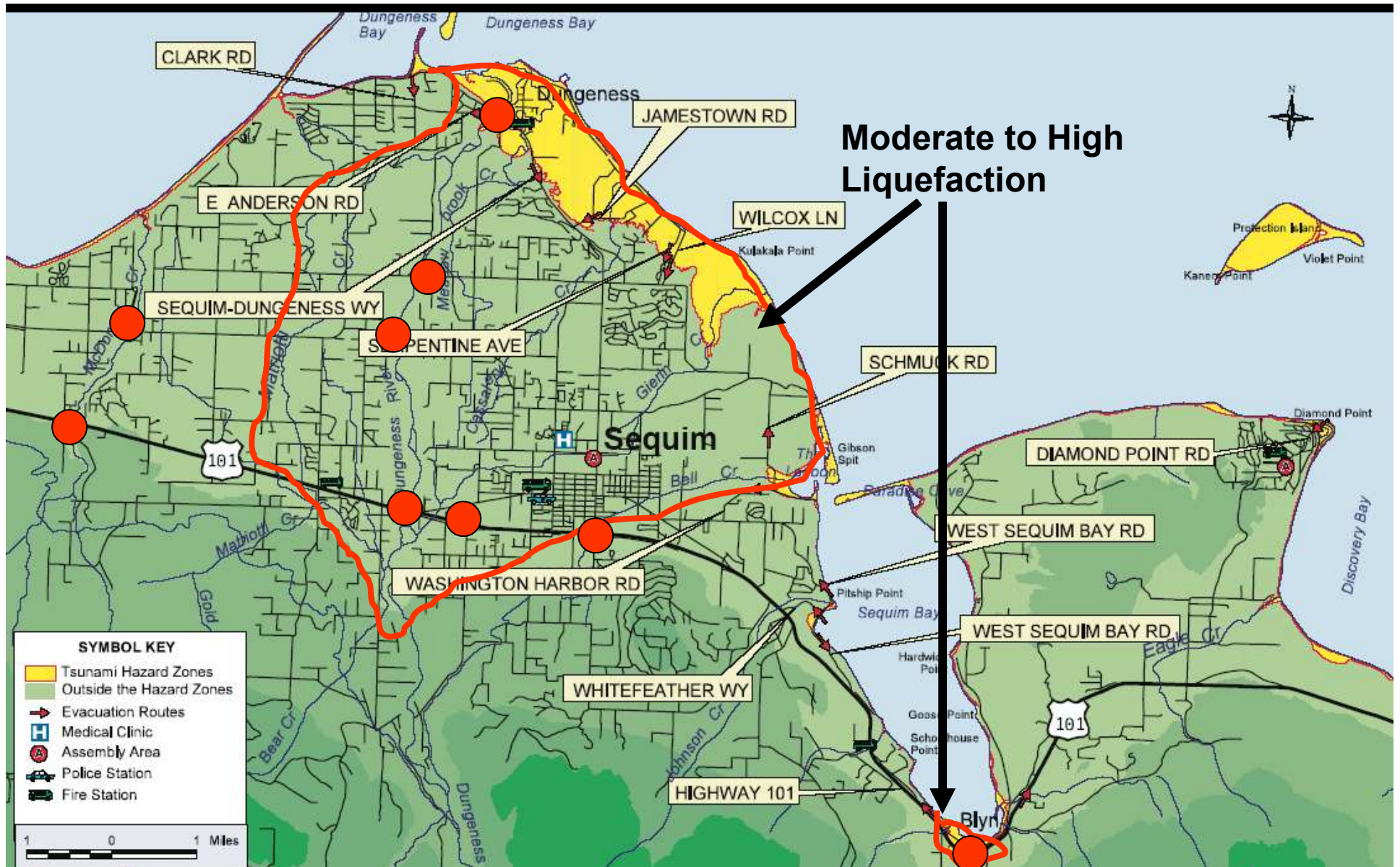


EXPLANATION

- Liquefaction susceptibility: HIGH
- Liquefaction susceptibility: MODERATE to HIGH
- Liquefaction susceptibility: MODERATE
- Liquefaction susceptibility: LOW to MODERATE
- Liquefaction susceptibility: LOW
- Liquefaction susceptibility: VERY LOW to LOW
- Liquefaction susceptibility: VERY LOW
- Bedrock
- Peat deposit

Peat is not susceptible to liquefaction but may undergo lateral displacement or loss of strength as a result of earthquake shaking.

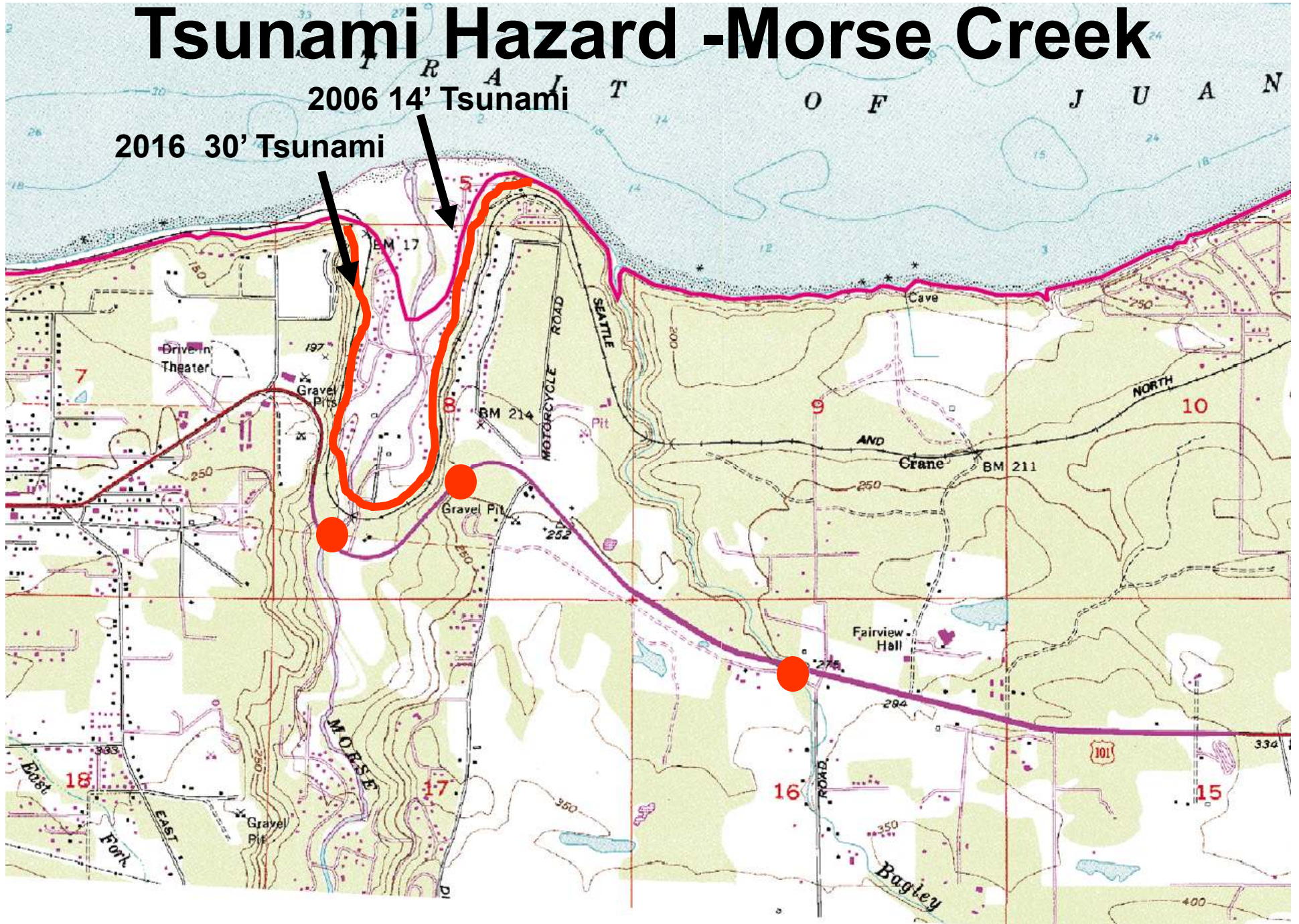
Damage Summary – East Clallam



Tsunami Hazard -Morse Creek

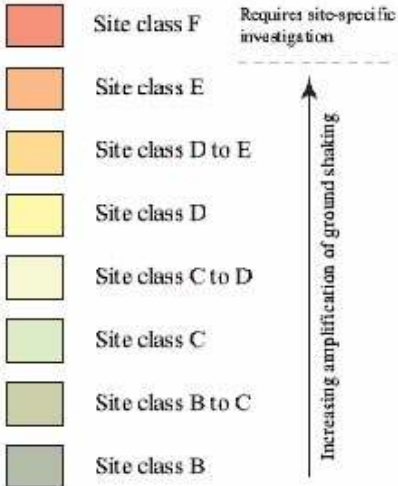
2006 14' Tsunami

2016 30' Tsunami

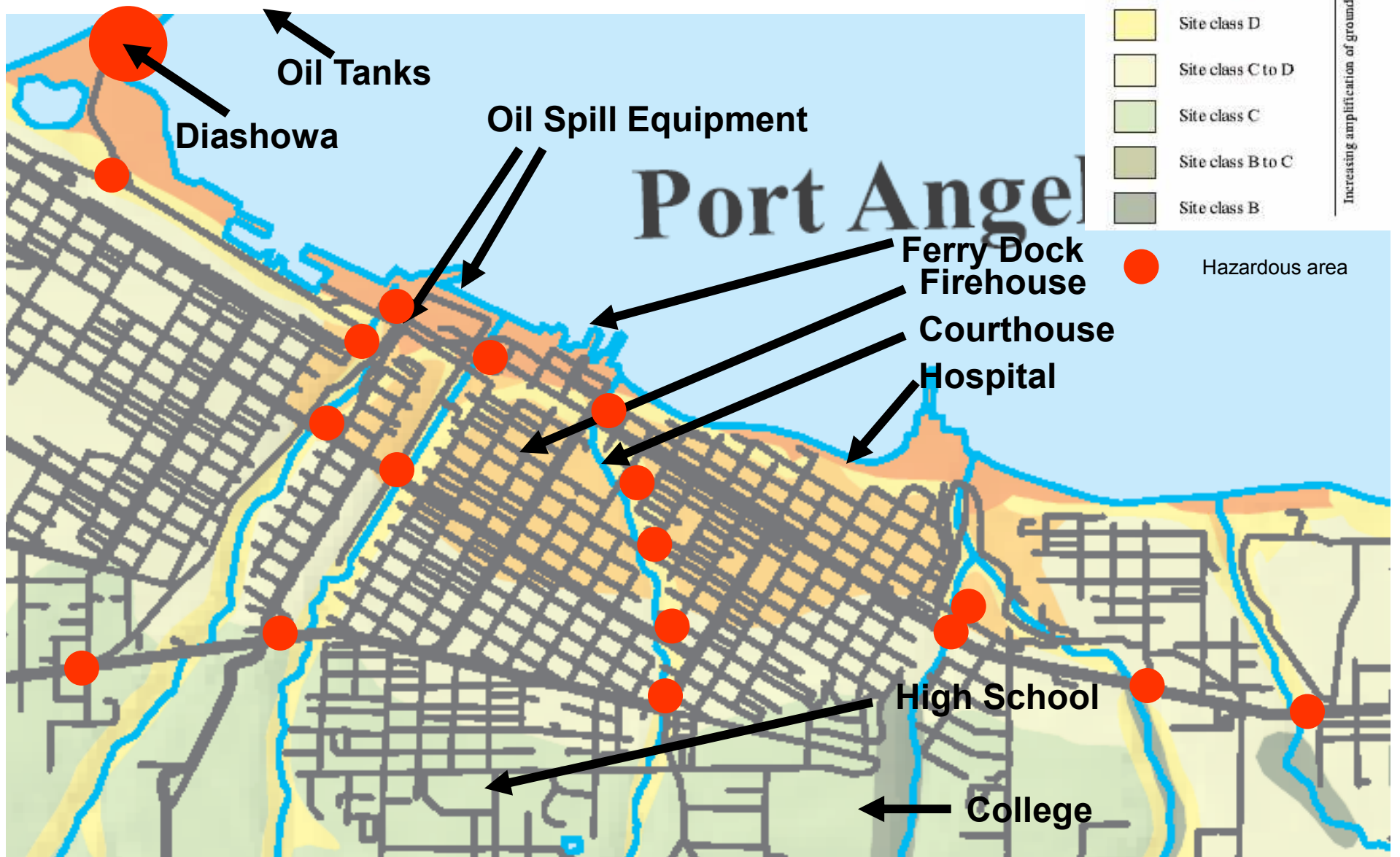


Ground Shaking – PA Vicinity

EXPLANATION



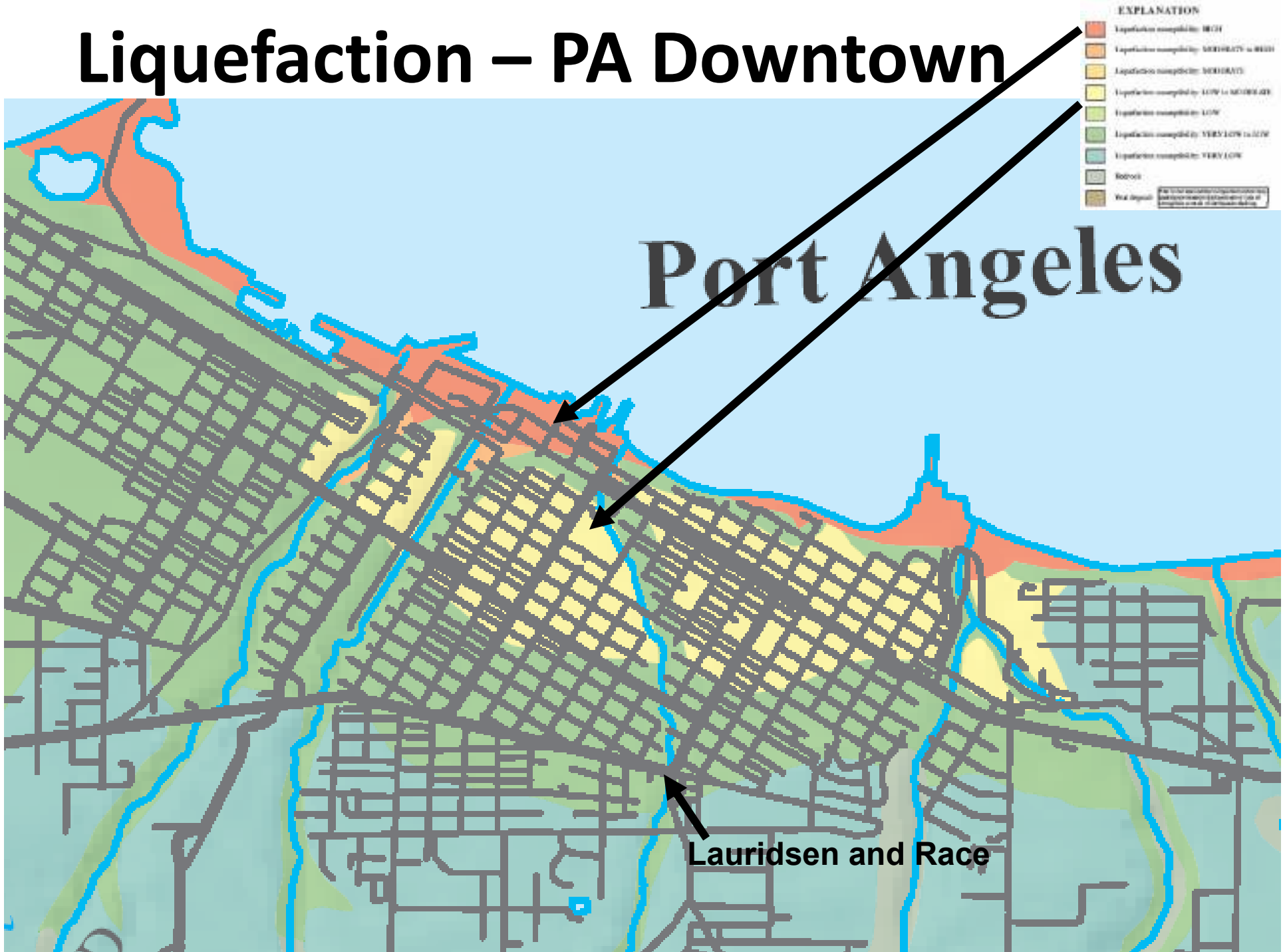
Ground Shaking - PA Downtown



Liquefaction – PA Vicinity



Liquefaction – PA Downtown



Tsunami Hazard – Port Angeles

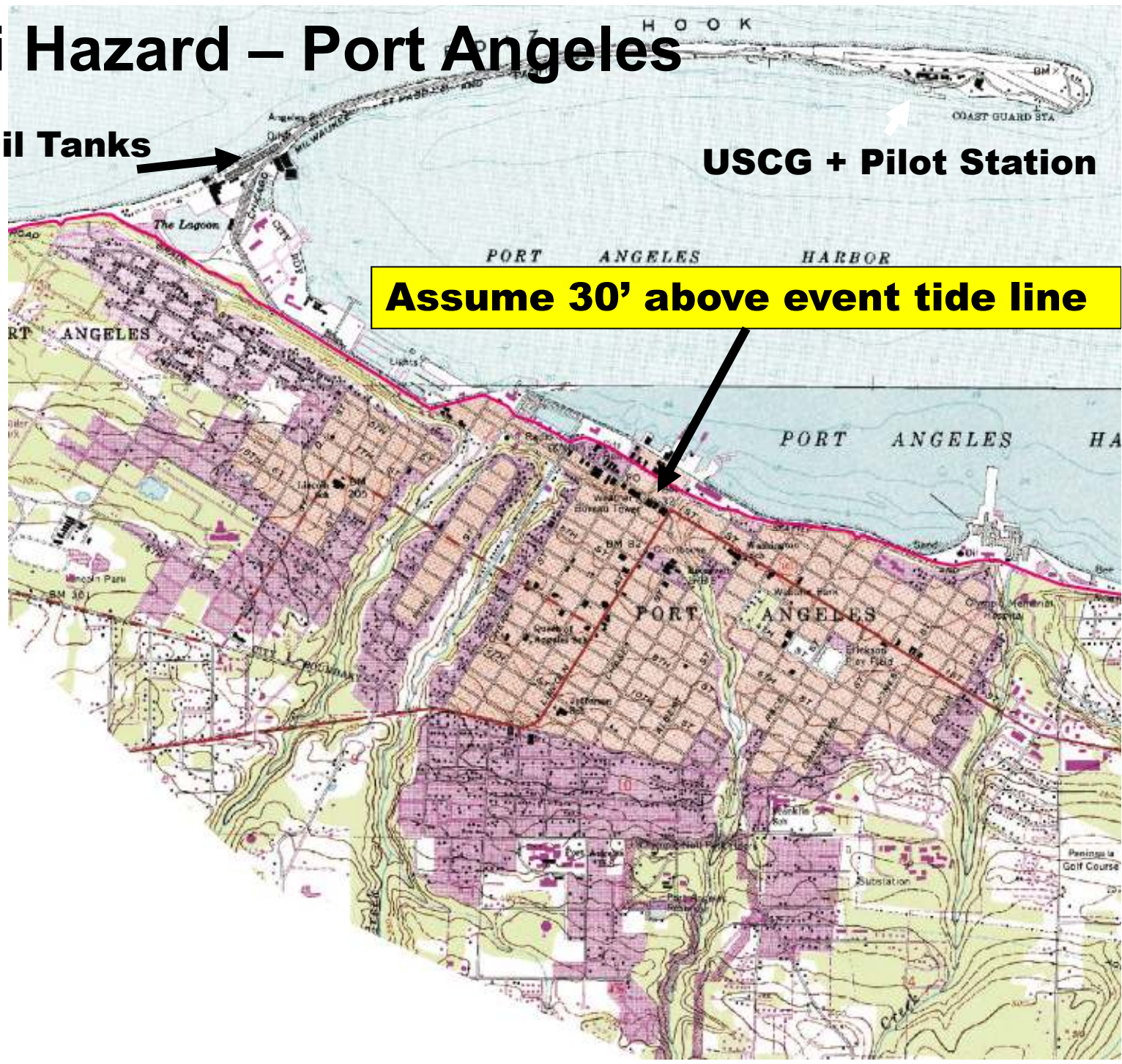
Diashowa + Oil Tanks



USCG + Pilot Station



Assume 30' above event tide line



Tsunami Timing - Port Angeles

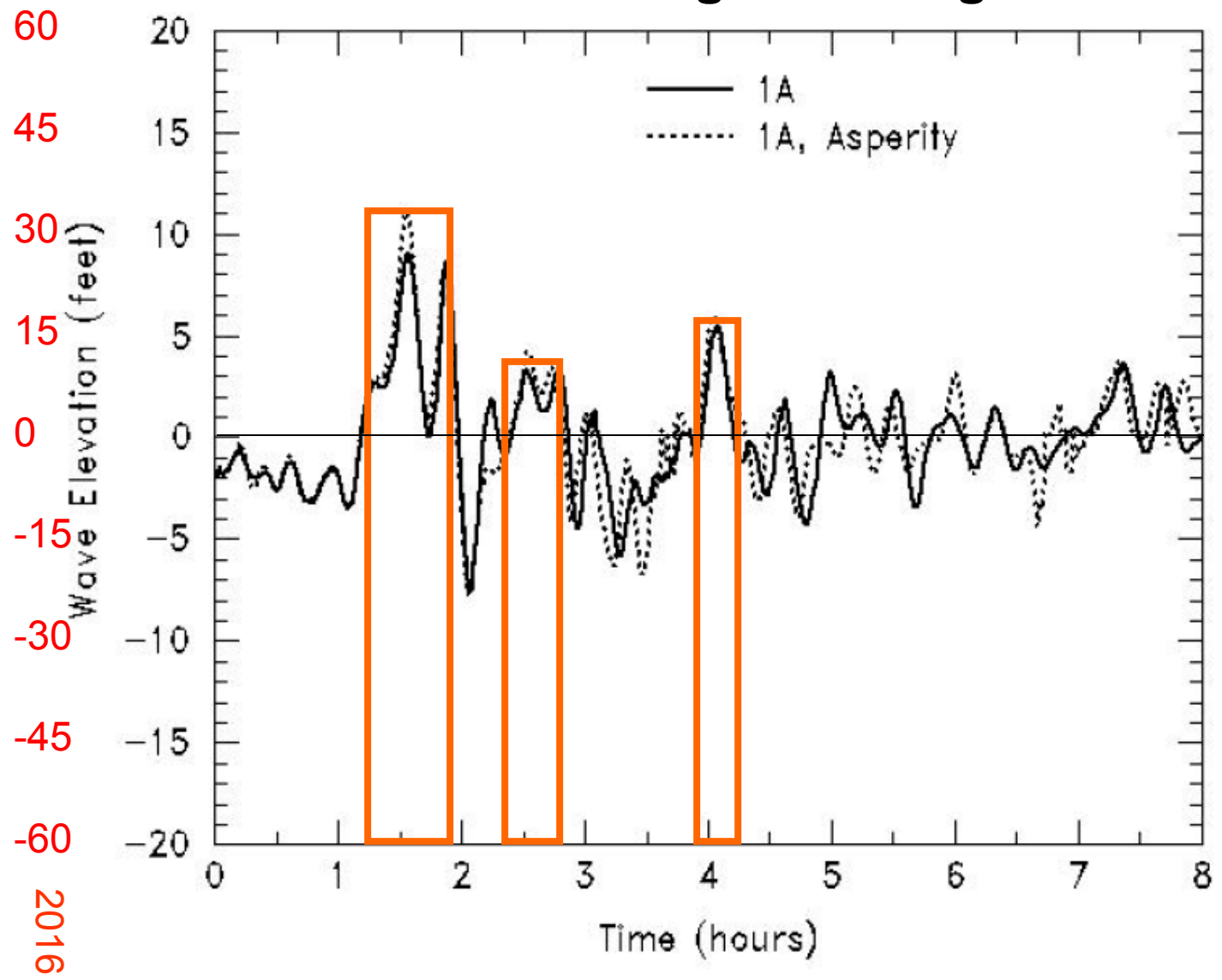
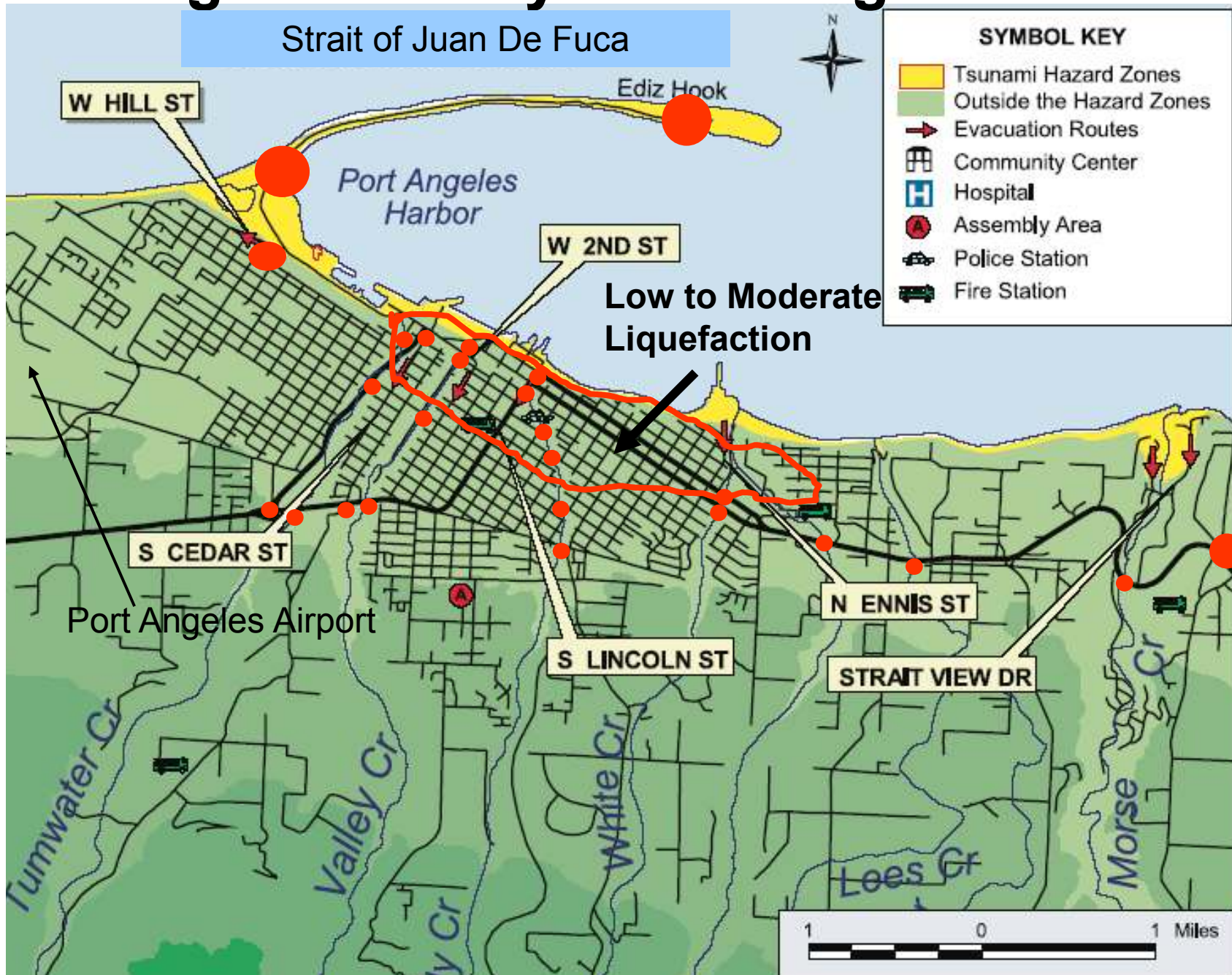
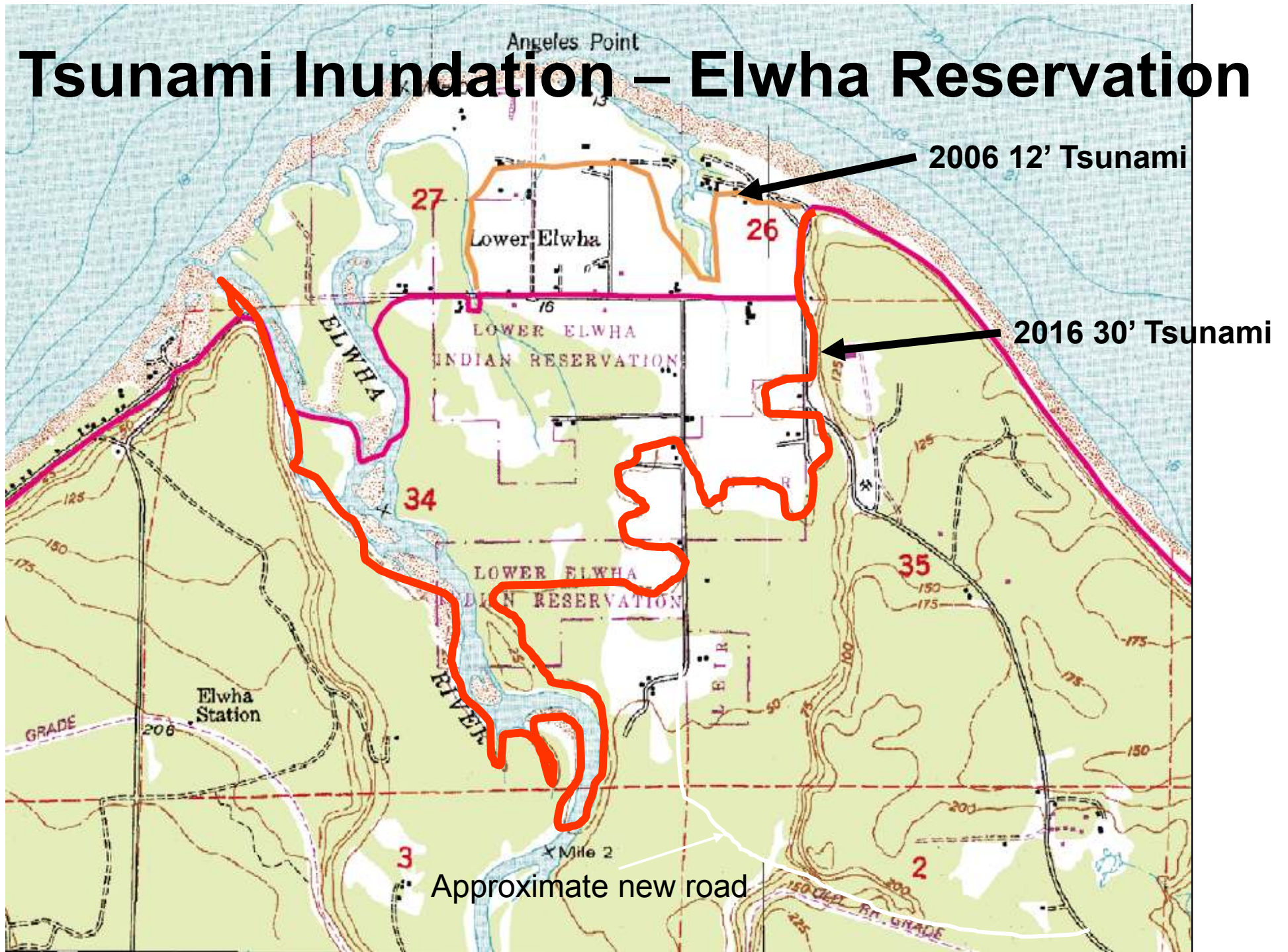


Figure 3. Elevation time history of tsunami waves in open water near Ediz Hook. Negative numbers indicate water moving out and positive numbers are water moving in

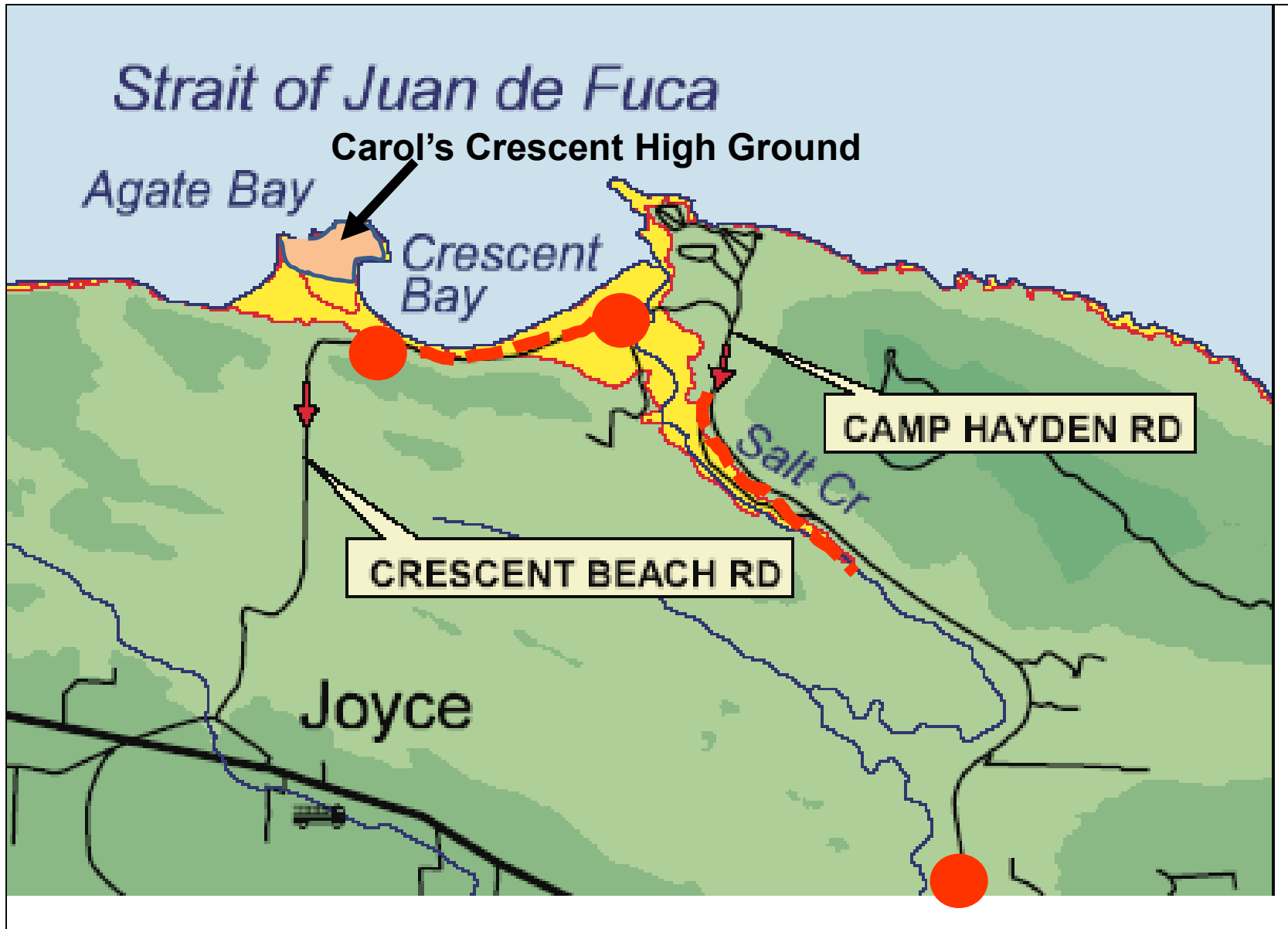
Damage Summary – Port Angeles



Tsunami Inundation – Elwha Reservation

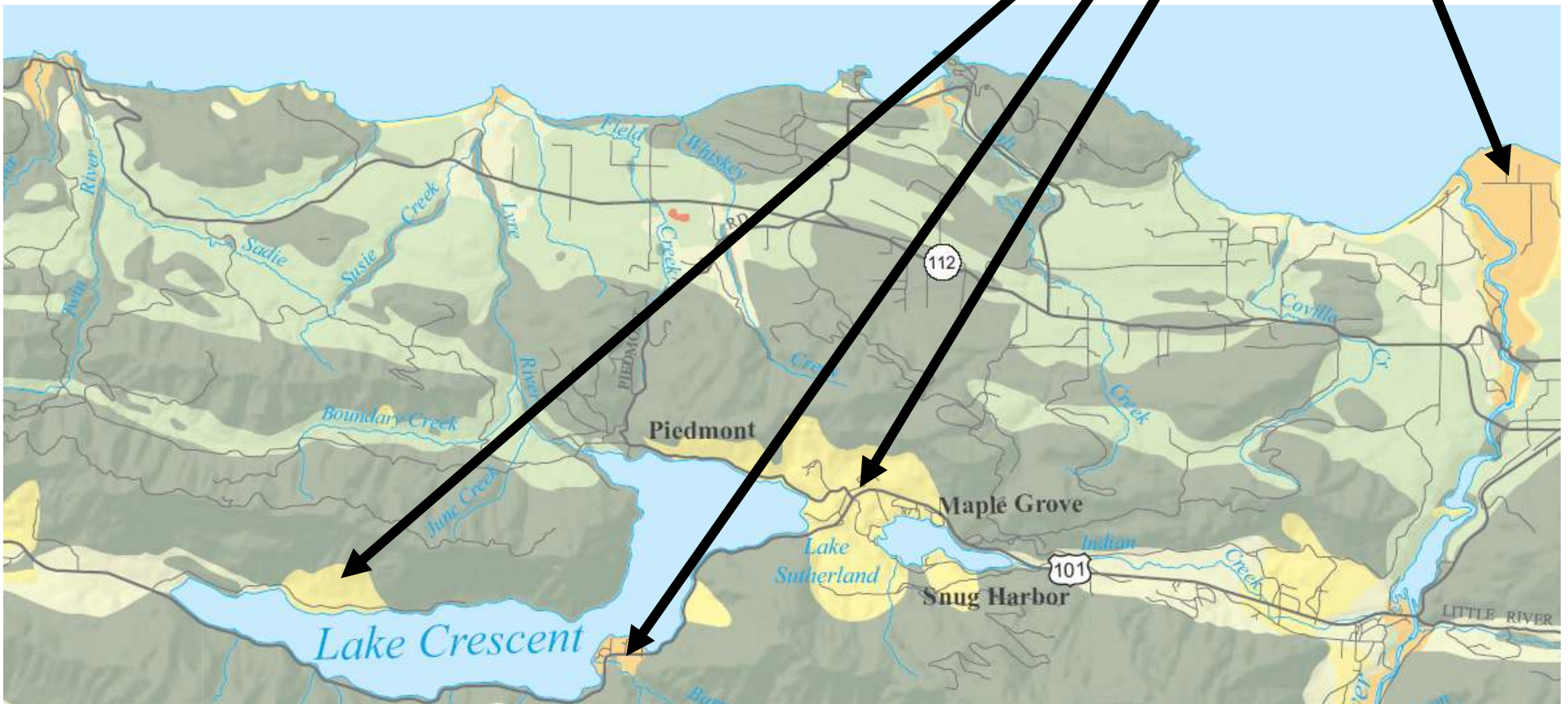
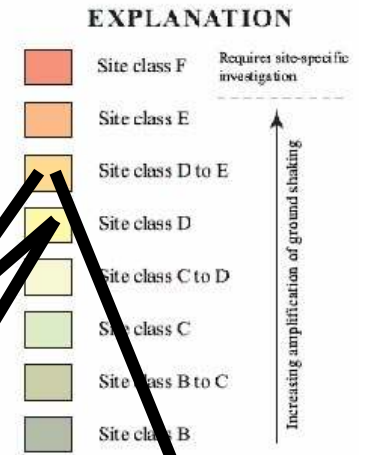


Damage Summary – Salt Creek

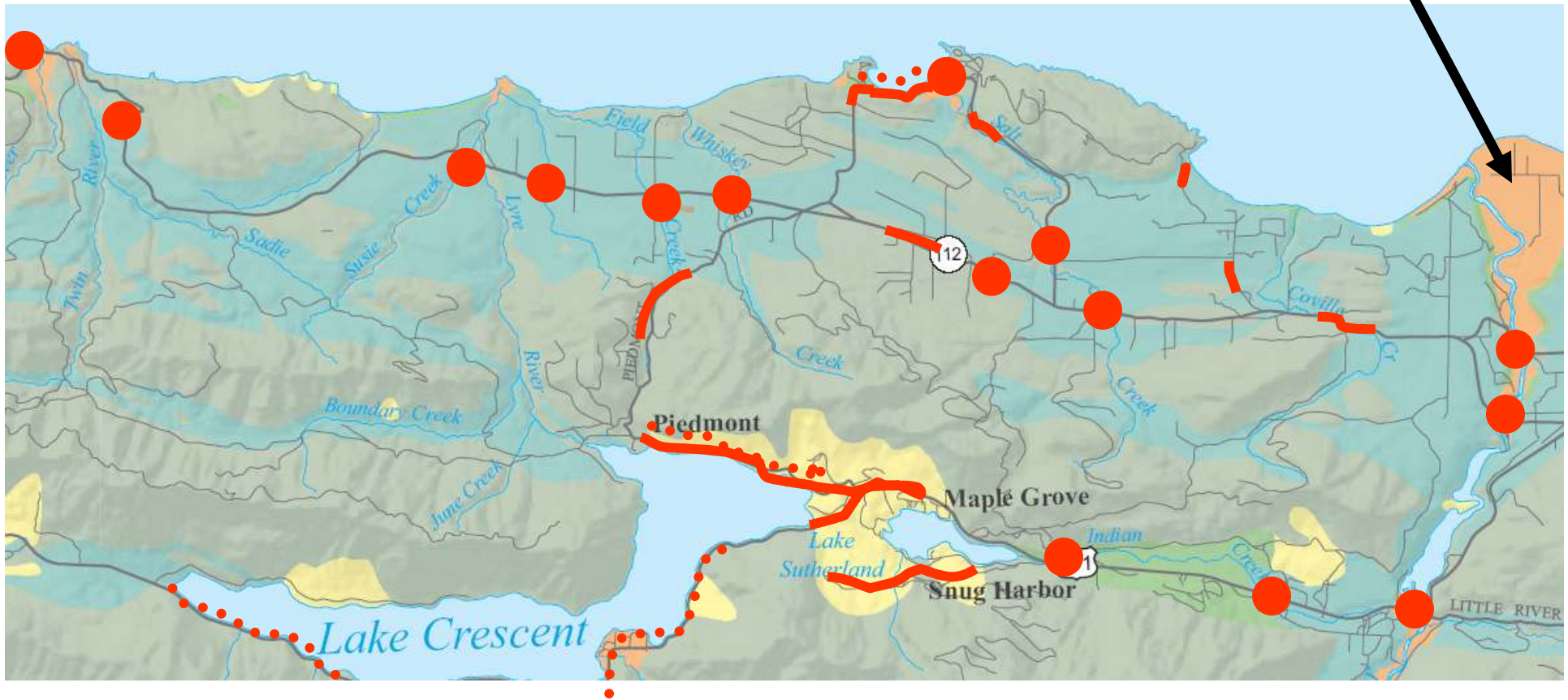
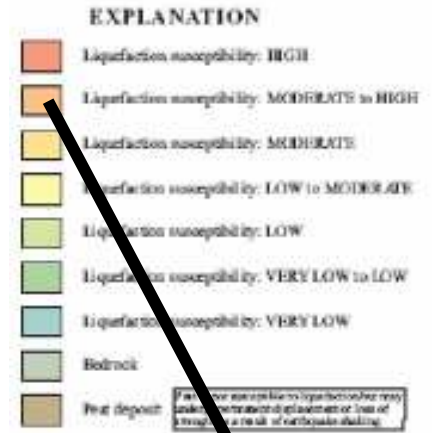


Ground Shaking – Elwha to Twin

Note the Seiche Potential on Lakes Crescent and Sutherland



Damage Summary – Elwha to Twin



Ground Shaking – Pysht Valley

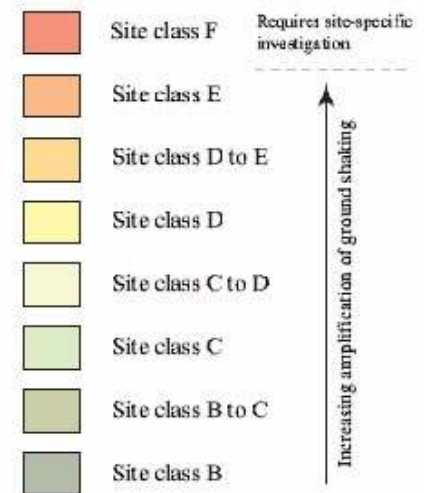


EXPLANATION

- Site class F Requires site-specific investigation
 - Site class E
 - Site class D to E
 - Site class D
 - Site class C to D
 - Site class C
 - Site class B to C
 - Site class B
- ↑ Increasing amplification of ground shaking

Ground Shaking – Sekiu/Clallam Bay

EXPLANATION











Summary of Damage Pysht/Clallam Bay/Sekiu



Ground Shaking – Neah Bay












EXPLANATION

- | | | |
|---|-------------------|--------------------------------------|
|  | Site class F | Requires site-specific investigation |
|  | Site class E | |
|  | Site class D to E | |
|  | Site class D | |
|  | Site class C to D | |
|  | Site class C | |
|  | Site class B to C | |
|  | Site class B | |
- ↑
Increasing amplification of ground shaking

Liquefaction – Neah Bay

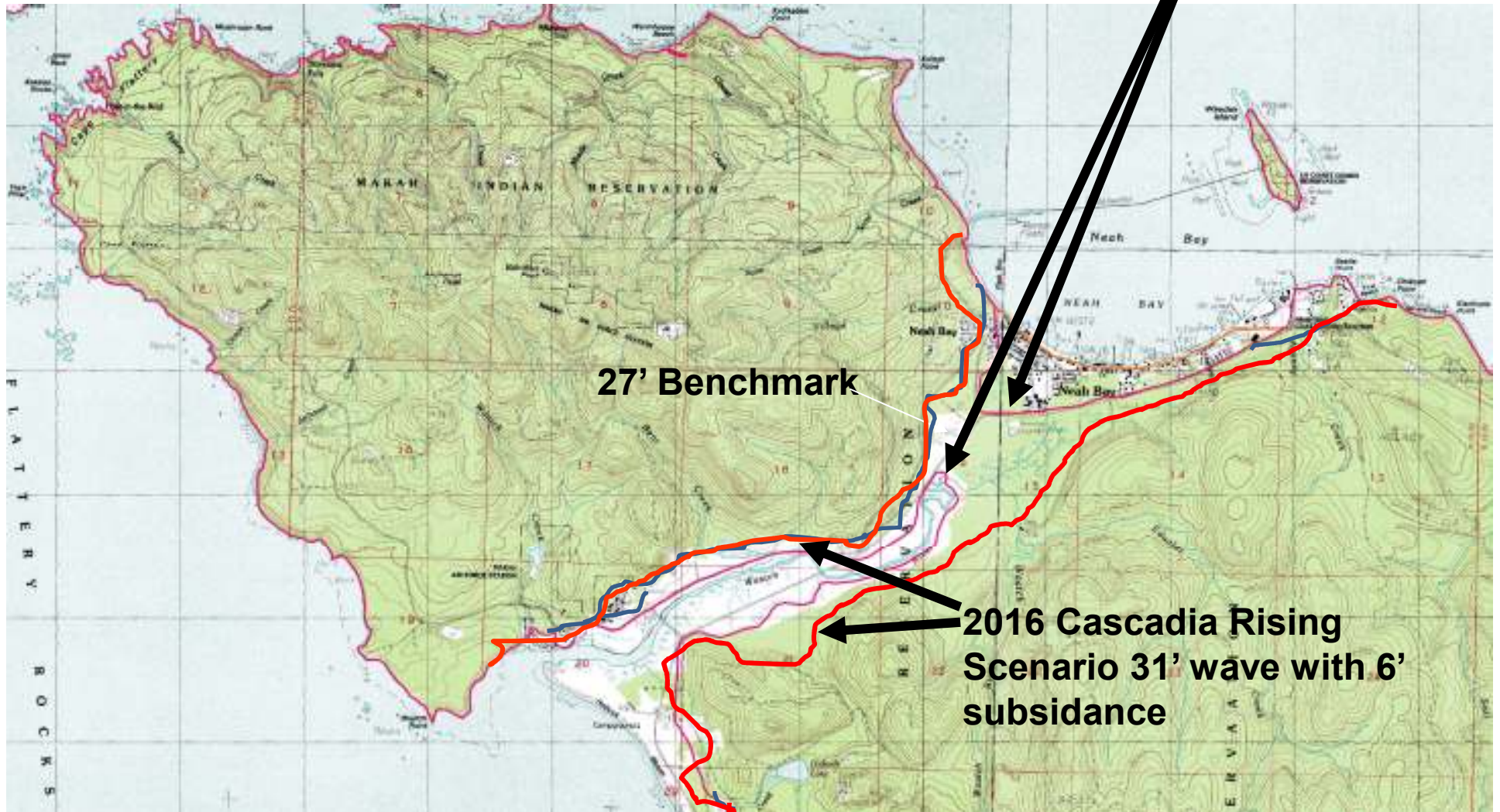


EXPLANATION

-  Liquefaction susceptibility: HIGH
-  Liquefaction susceptibility: MODERATE to HIGH
-  Liquefaction susceptibility: MODERATE
-  Liquefaction susceptibility: LOW to MODERATE
-  Liquefaction susceptibility: LOW
-  Liquefaction susceptibility: VERY LOW to LOW
-  Liquefaction susceptibility: VERY LOW
-  Bedrock
-  Peat deposit: Peat is not susceptible to liquefaction but may undergo lateral displacement or loss of strength as a result of earthquake shaking.

Tsunami Hazard – Neah Bay

2006 Animation of Predicted 10' tsunami and wave runup



27' Benchmark

2016 Cascadia Rising Scenario 31' wave with 6' subsidence

Tsunami Timing - Neah Bay

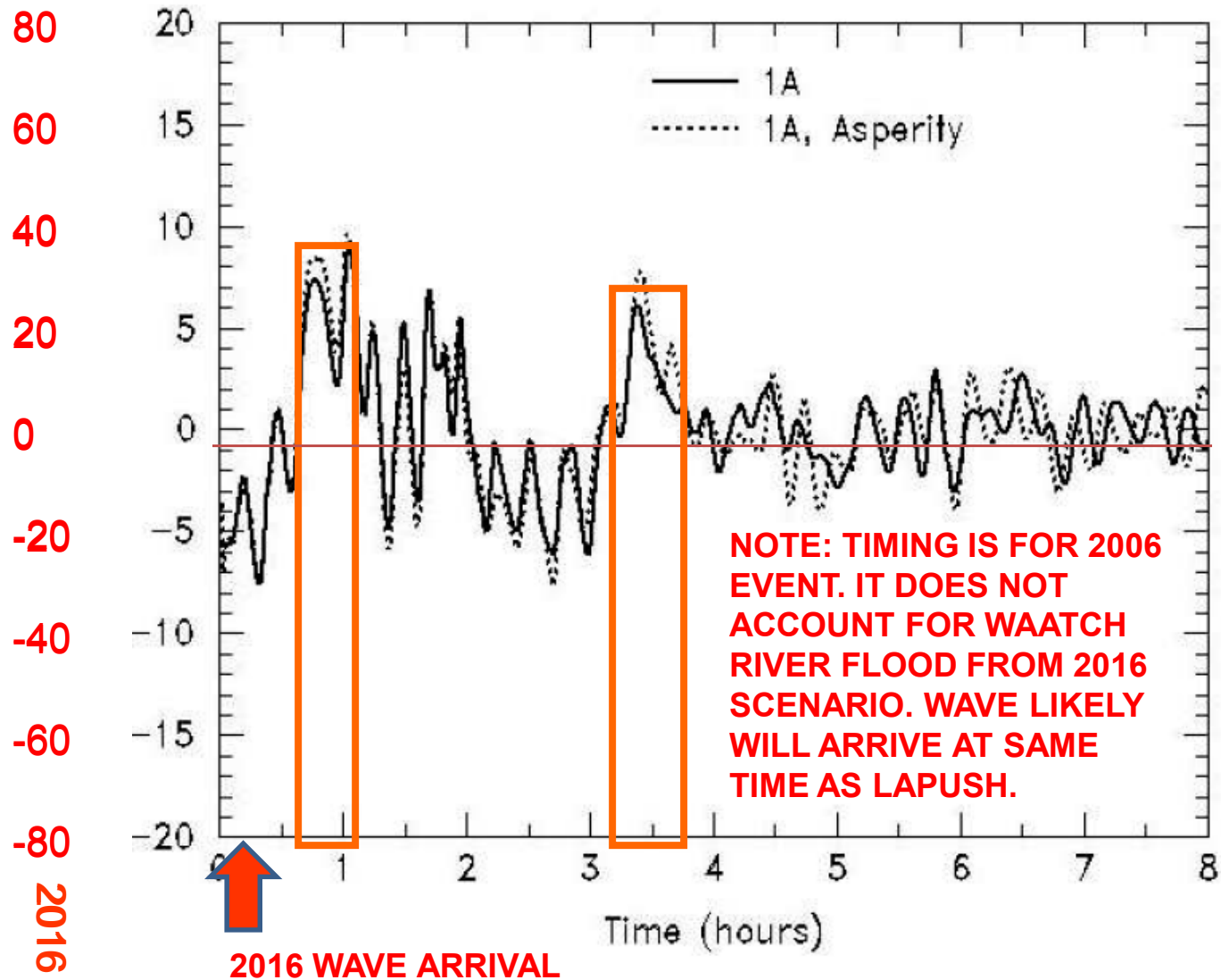


Figure 3. Elevation time history of tsunami waves in open water near Neah Bay. Negative numbers indicate water moving out and positive numbers indicate water moving in.



Summary of Damage Neah Bay

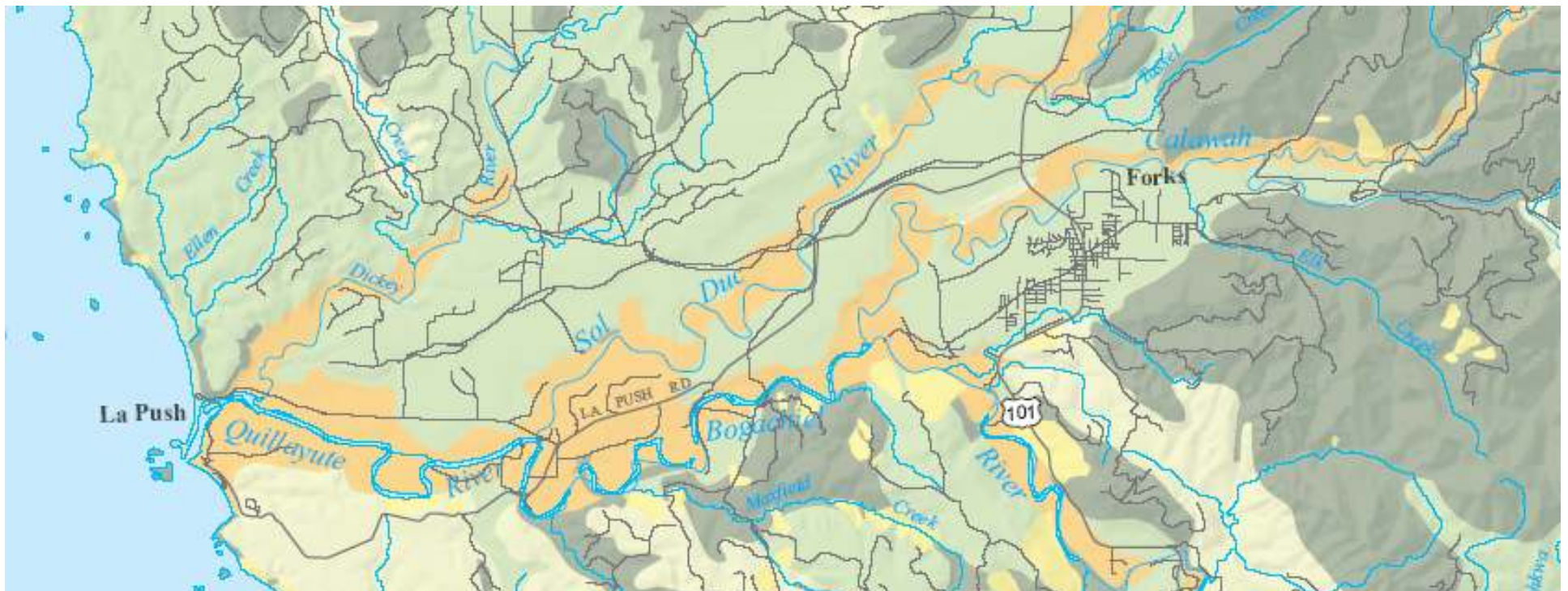
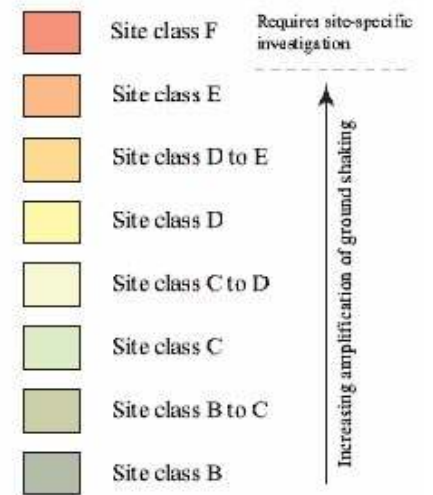
Highway 112 Impassible to Sekiu River due to slide and tsunami Debris

2016 Tsunami Scenario

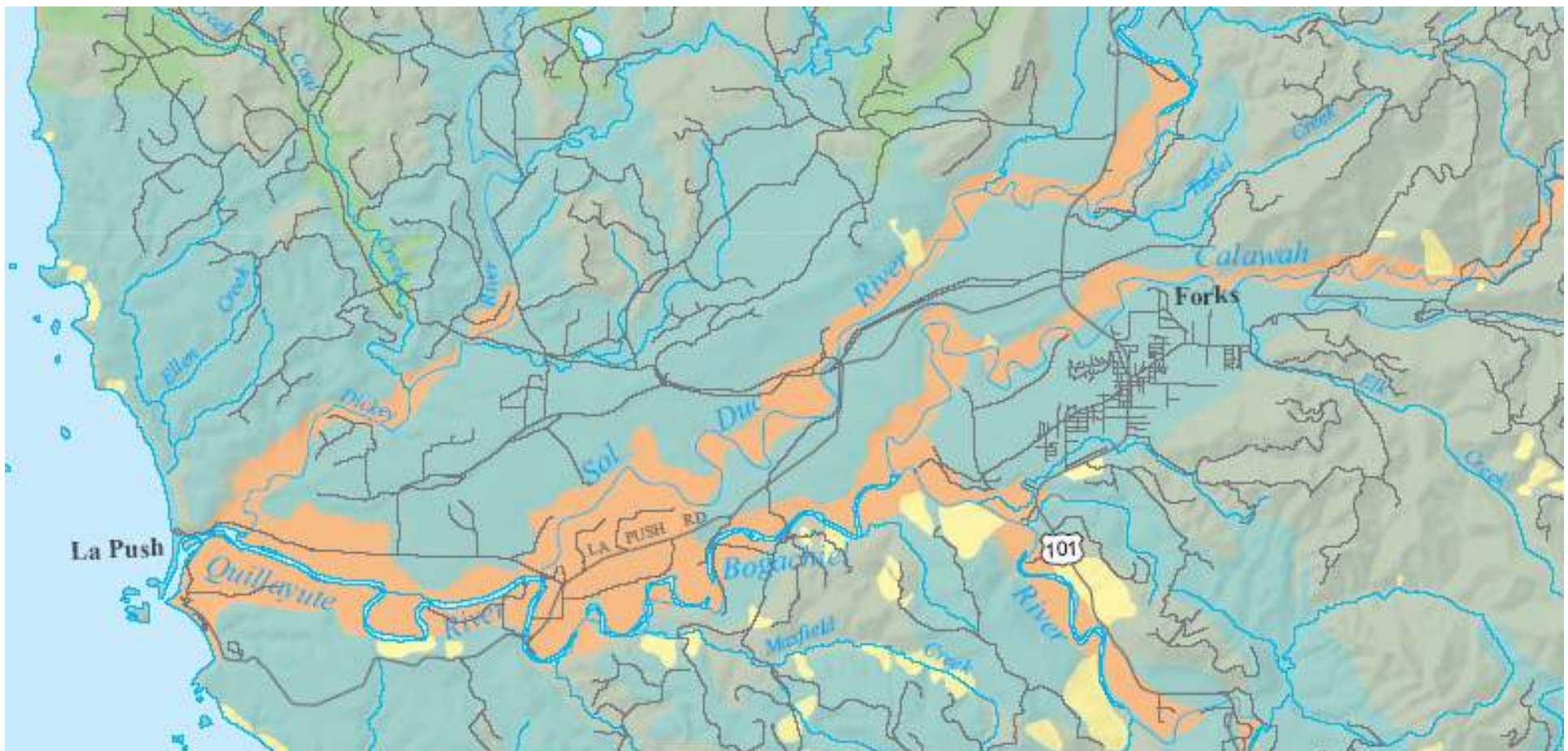
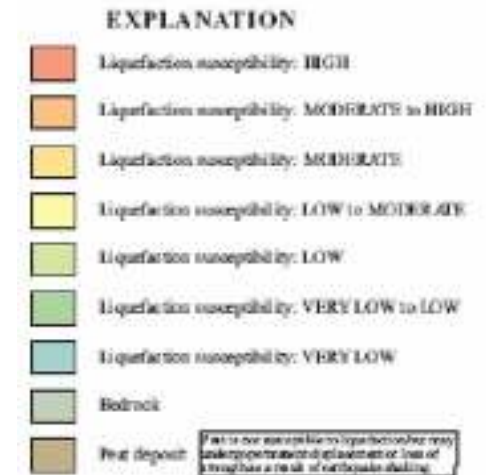
2006 Tsunami Scenario

Ground Shaking – Forks/La Push

EXPLANATION



Liquefaction – Forks/La Push

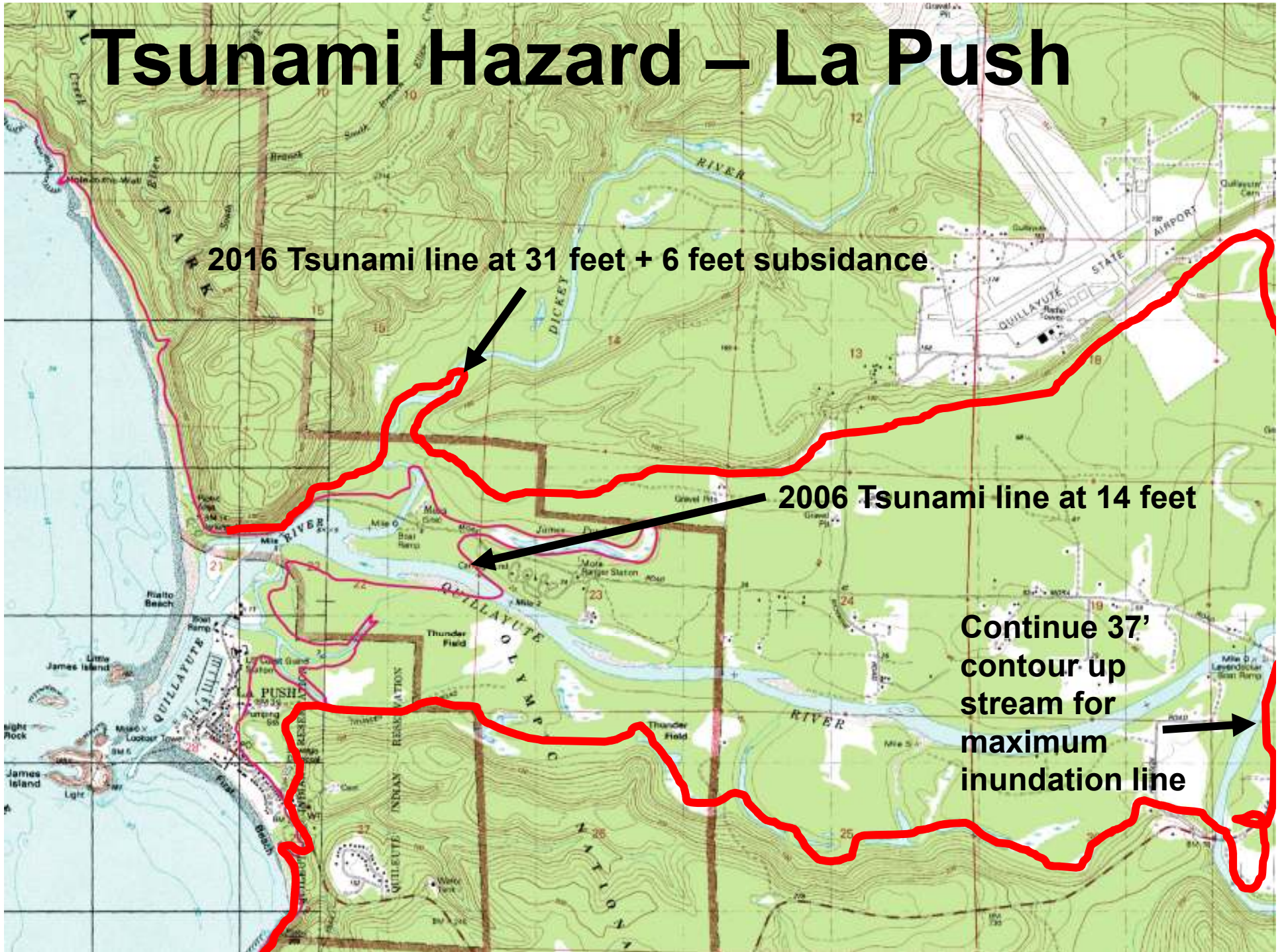


Tsunami Hazard – La Push

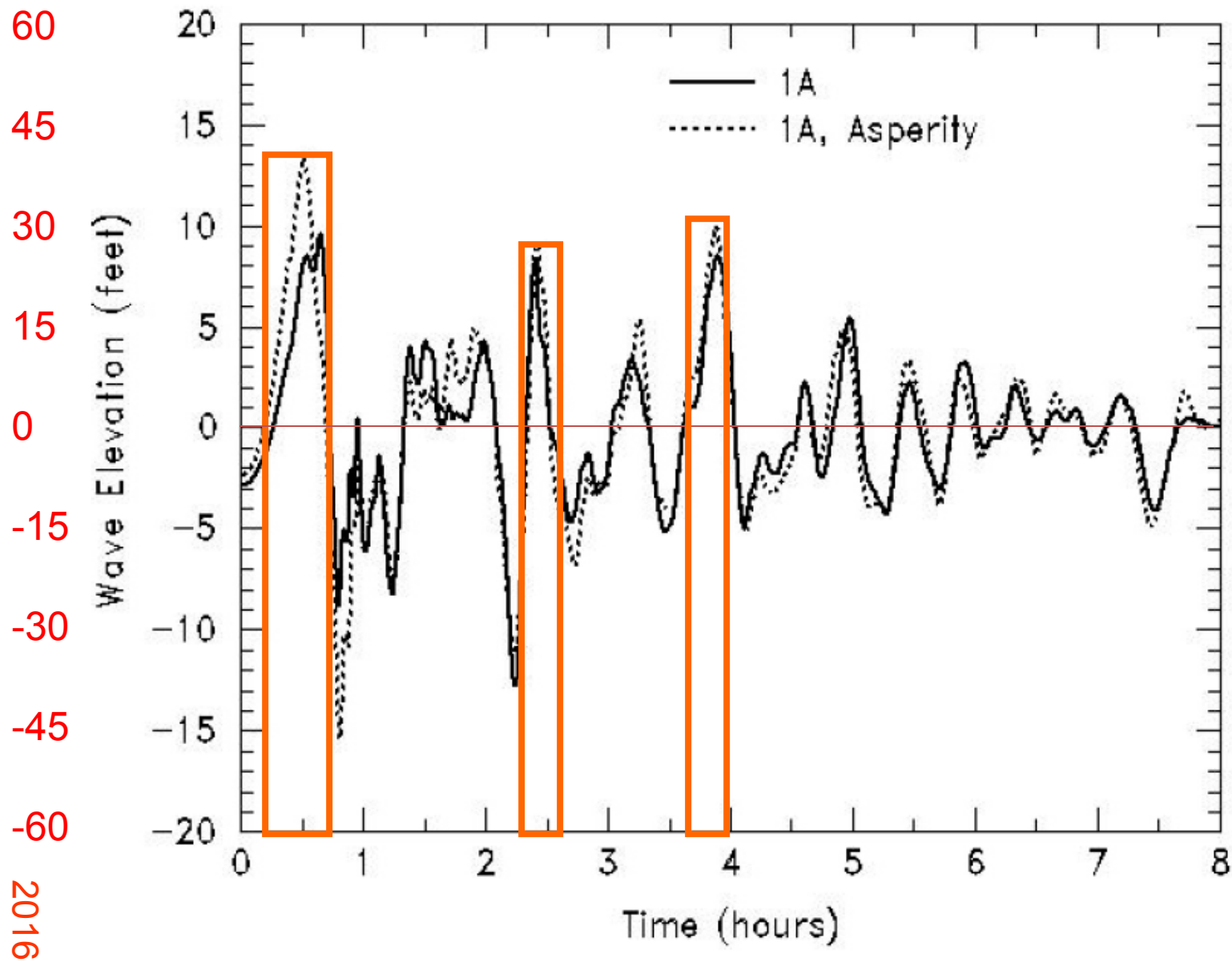
2016 Tsunami line at 31 feet + 6 feet subsidence

2006 Tsunami line at 14 feet

Continue 37'
contour up
stream for
maximum
inundation line



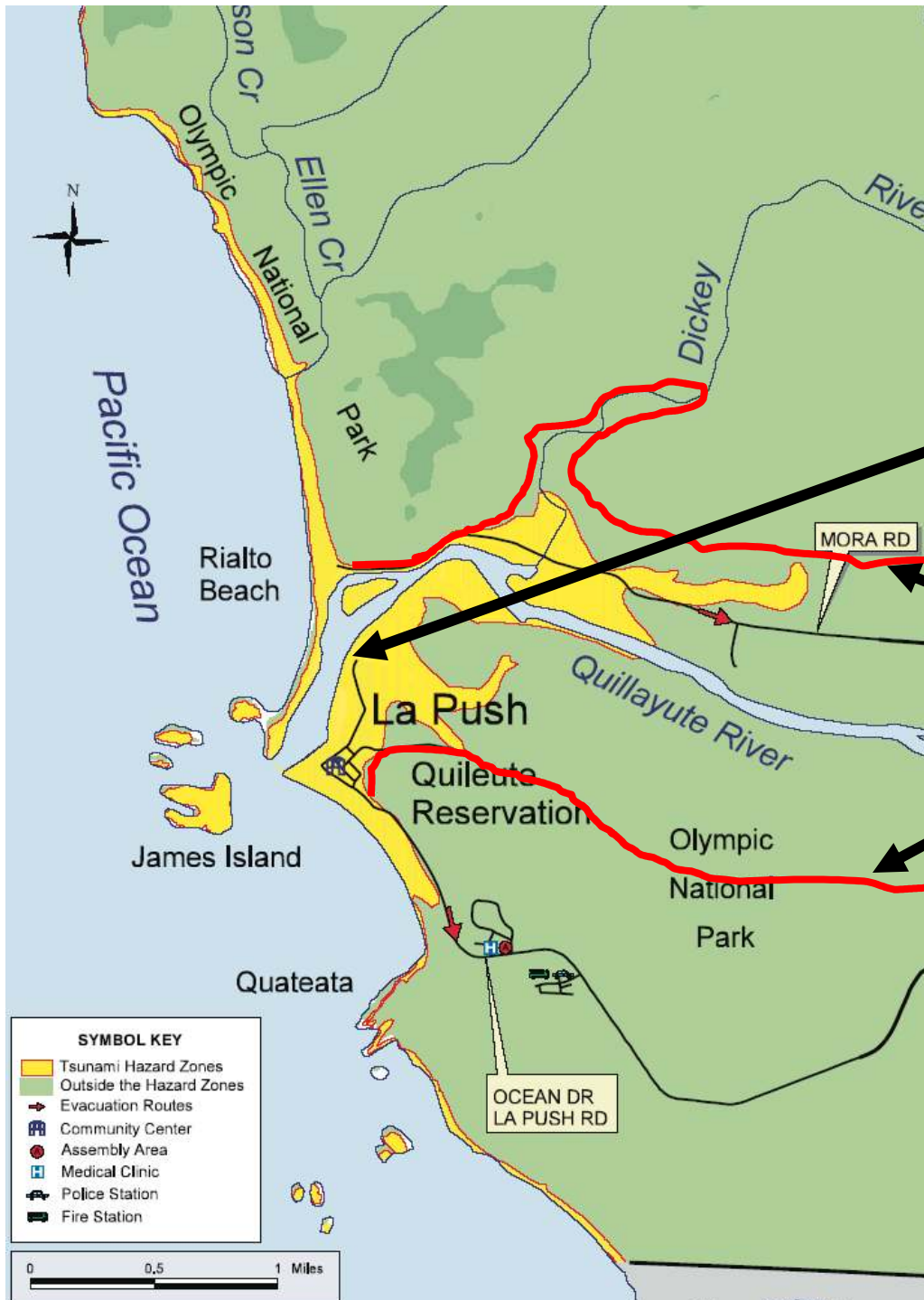
Tsunami Timing - La Push



2016

Figure 3. Elevation time history of tsunami waves in open water off the Quileute Reservation. Negative numbers indicate water moving out and positive numbers

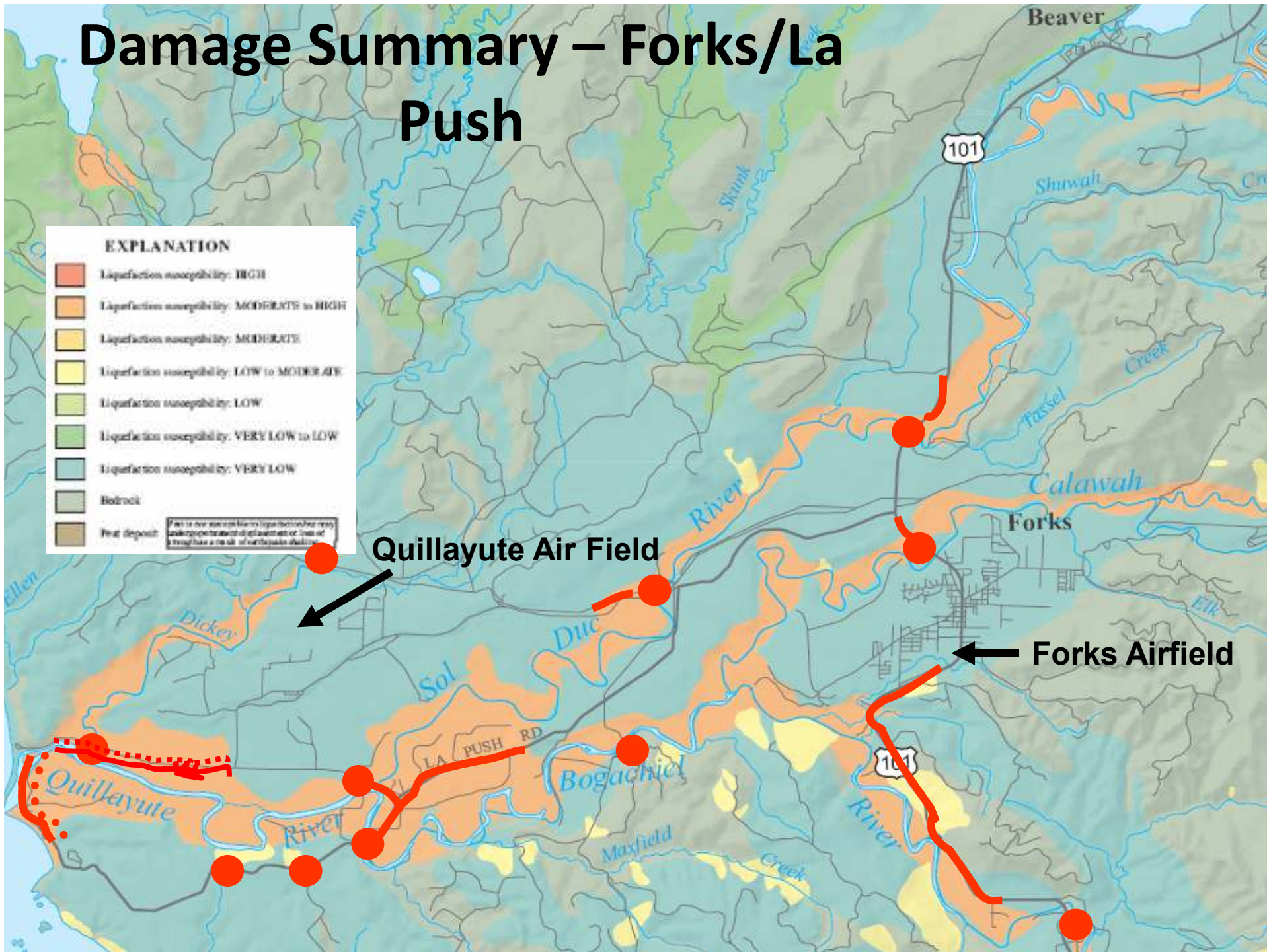
Evacuation routes for La Push



2006 14' Tsunami

2016 31' Tsunami with 6' subsidence

Damage Summary – Forks/La Push



Cascadia Rising

National CSZ Contingency Planning Event

4 Day Functional Exercise, June 6, 2016

**EOCs at all levels of government/private sector in
Washington and Oregon**

FEMA and major military commands nationwide

Clallam County is training to participate

DRAFT CLALLAM COUNTY MISSION

Clallam County Emergency Management is to coordinate rescue and shelter of as many people as possible until help arrives. (A meaningful volume of assistance for 75,000 people will not arrive until 2 to 3 weeks after the event.)

We plan to:

- **Restore Public Safety Radio Network (PSRN) as soon as possible. Use ARES as necessary.**
- **Coordinate city/county rescue/recovery operations as soon as possible.**
- **Establish an Emergency Operations Center within 4 hours**
- **Establish communications with Camp Murray within 6 hours. Use ARES as necessary.**
- **Coordinate city/county/state/contractor efforts to re-establish routes to the micro-islands as soon as possible.**
- **Coordinate city/county/state/contractor efforts to re-open the runway and a route to the airport within 48 hours. Assist US Army in establishing Cat 3 Airheads in Port Angeles and Quillayute.**
- **Establish Responder Basecamp and refugee evacuation facilities at airport and fairgrounds.**
- **Coordinate city/county/state/contractor efforts to re-open a route to the harbor as soon as possible.**
- **Coordinate county program to shelter the population in place as long as needed.**
- **Coordinate waste disposal and community points of distribution (CPODS) for water and supplies as available.**

Things to Consider for Clallam County

Security of food, fuel, pharmaceuticals and survivors. Security of courthouse.

Staffing operations/facilities with limited manpower. (WANG estimates only 40% turnout.)

Coordination with ARES/contractors to re-establish emergency communications.

Coordination of rescue/recovery efforts in micro-islands.

Coordination with City of Port Angeles for clearance of emergency routes, power, water, sewer and fuel to the hospital, airfield and micro-islands.

How to rescue and shelter 75,000 people for 3 weeks with resources on hand.

How to efficiently deliver those resources.

Coordination with mortuary affairs between rescuers, coroner and mortuary unit.

Procedures for dealing with substance abusers, criminal and mental health issues.