Turkey Earthquake and Cascadia Rising 22 Observations and Lessons Learned

Briefing to the House Innovation, Community & Economic Development, and Veterans Committee

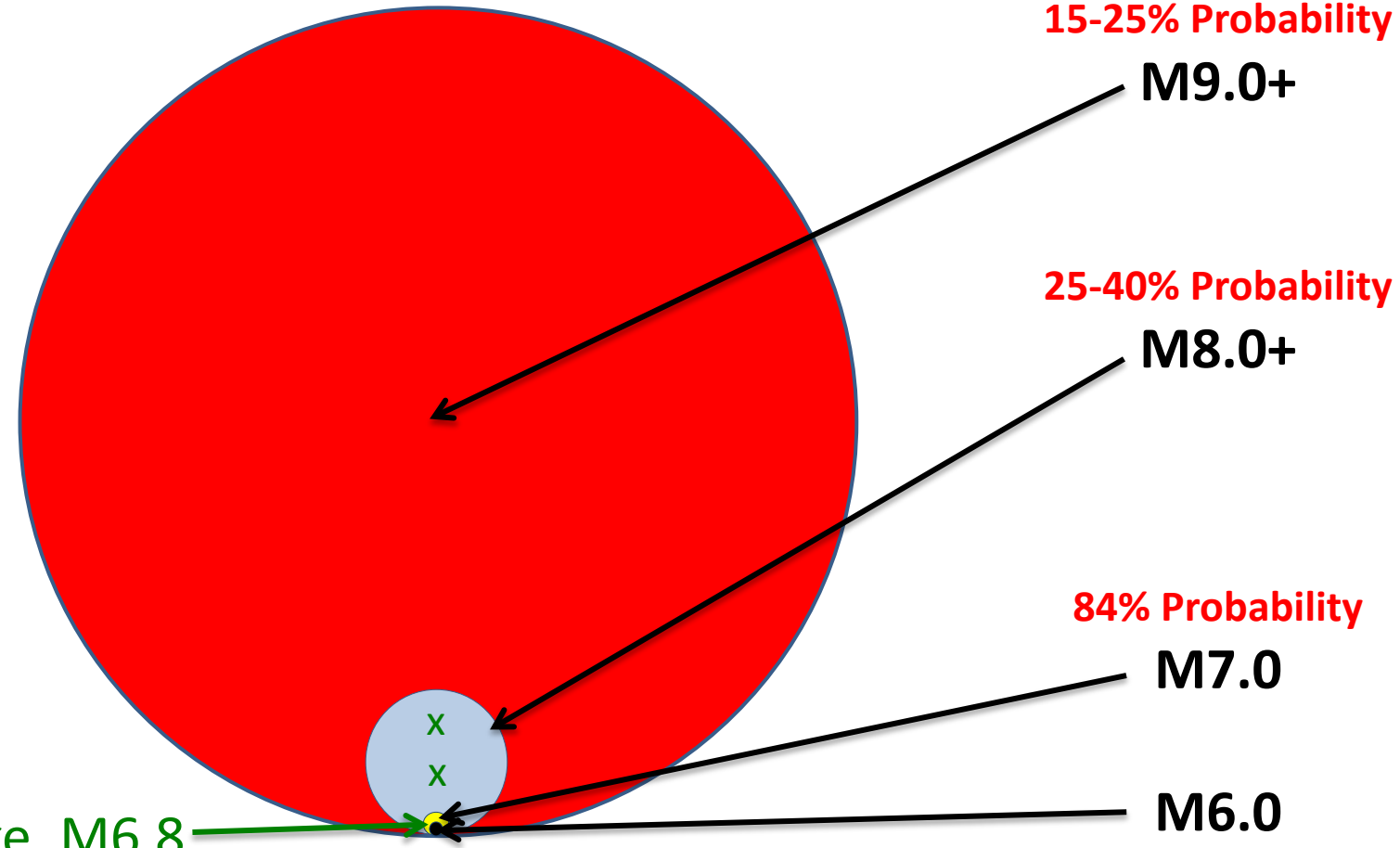
March 21, 2023

Robert Ezelle
Director, Emergency Management Division
Washington Military Department

Washington's Probability of an Earthquake in the Next 50 Years – *Get Prepared Now*

An increase of 1 in magnitude results in 32x more energy released by an earthquake. Thus, an M7.0 releases 32x more energy than a M6.0, and an M8.0 releases 1024x the energy of an M6.0!

Area of circles to the right represent relative energy release for M 6, 7, 8, and 9 earthquakes



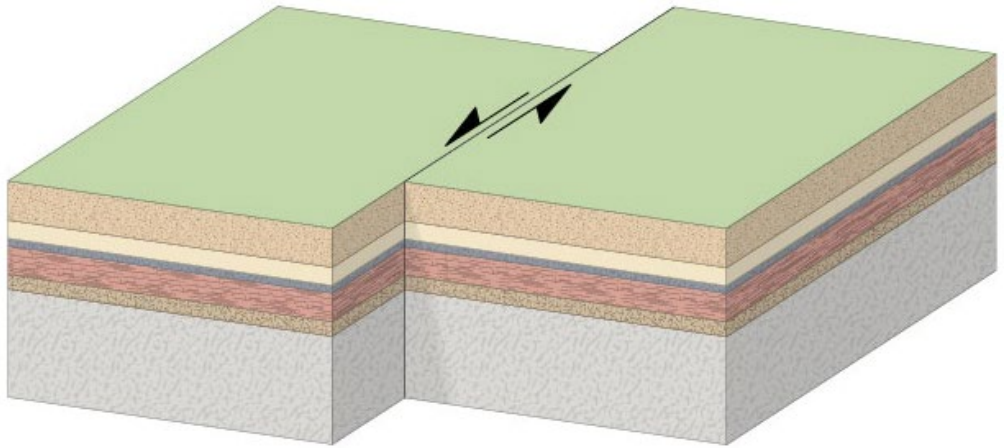
Modified Mercalli Intensity Scale

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

M7.8 and M7.5 earthquakes in Turkey (Türkiye)

The magnitude 7.8 earthquake rupture had one of the longest inland crustal strike-slip ruptures in the world—comparable to the 1906 San Francisco earthquake which ruptured along the San Andreas Fault. Parts of the fault shifted 10 to over 30 feet. These fault ruptures are visible in satellite and radar imagery. There have been thousands of aftershocks, which will continue for years.





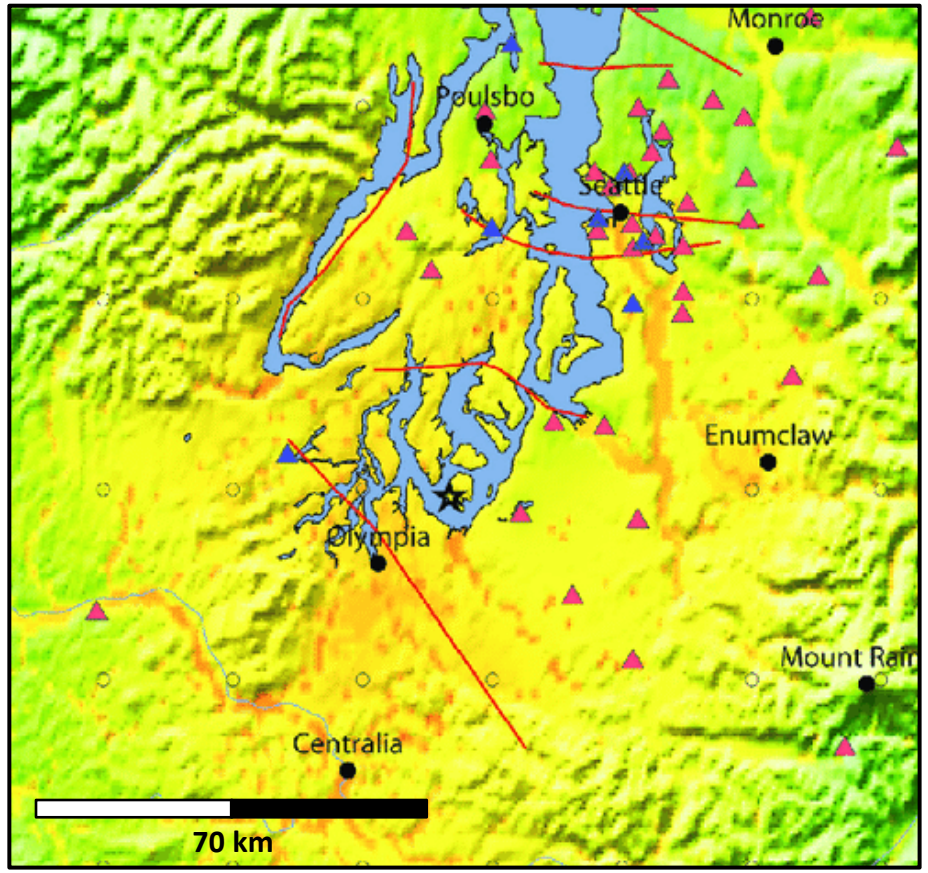
STRIKE-SLIP

Image Source: https://theconversation.com/turkey-syria-earthquakes-shallow-depth-of-main-shocks-is-a-key-reason-why-theyve-been-so-devastating-199540

Comparison with 2001 Nisqually Quake

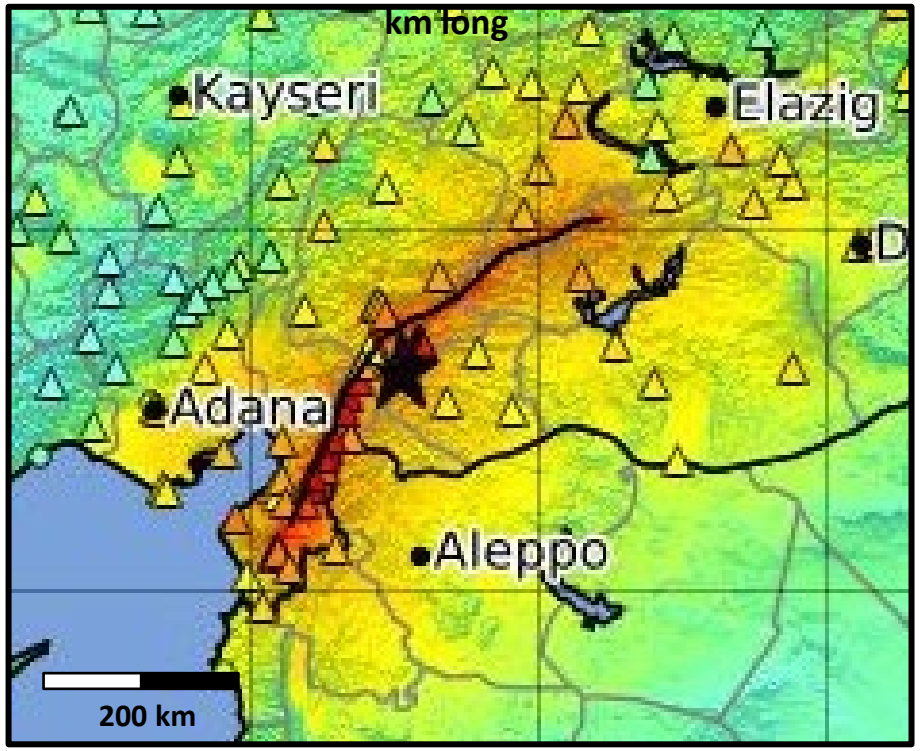
- **Nisqually M6.8**, 2/28/2001 – 54 km (33 miles) deep
  - Maximum Mercalli Intensity of VIII (Severe)
  - 45 seconds of ground shaking
  - >$2 Billion in damages
- **First Turkey Quake M7.8** – 2/6/2023 – 10 km (~6 miles) deep
  - Maximum Mercalli Intensity IX (Violent)
  - Longer duration (1-2 minutes of Shaking)
  - Approximately 32X the energy release of Nisqually
- **Second Turkey Quake M7.5** – 2/6/2023 – 15 km (~9 miles) deep
  - Maximum Mercalli Intensity IX (Violent)
  - Longer duration (1-2 minutes of shaking)
  - Approximately 11X the energy release of Nisqually Earthquake

Nisqually Earthquake M 6.8 – Depth: 51.8 km



Macroseismic Intensity Map USGS
ShakeMap: 26 km ENE of Nurdağı, Gaziantep, TR
Feb 06, 2023 01:17:34 UTC M7.8 N37.23 E37.02 Depth: 10.0km ID:us6000jllz

Scale: Fault (red, high-intensity line) Approximately 400 km long



Modified Mercalli Intensity Scale (for both maps)

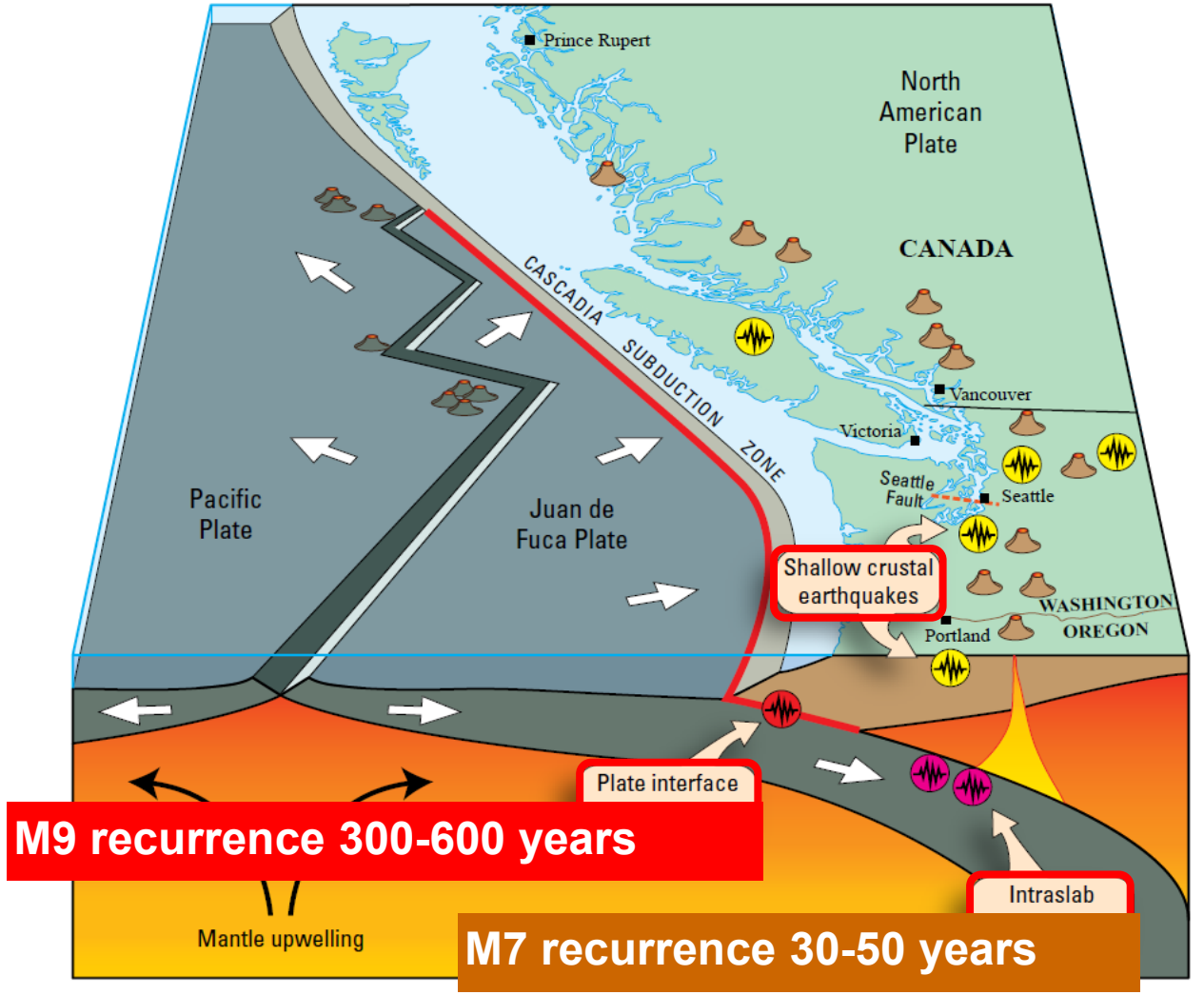
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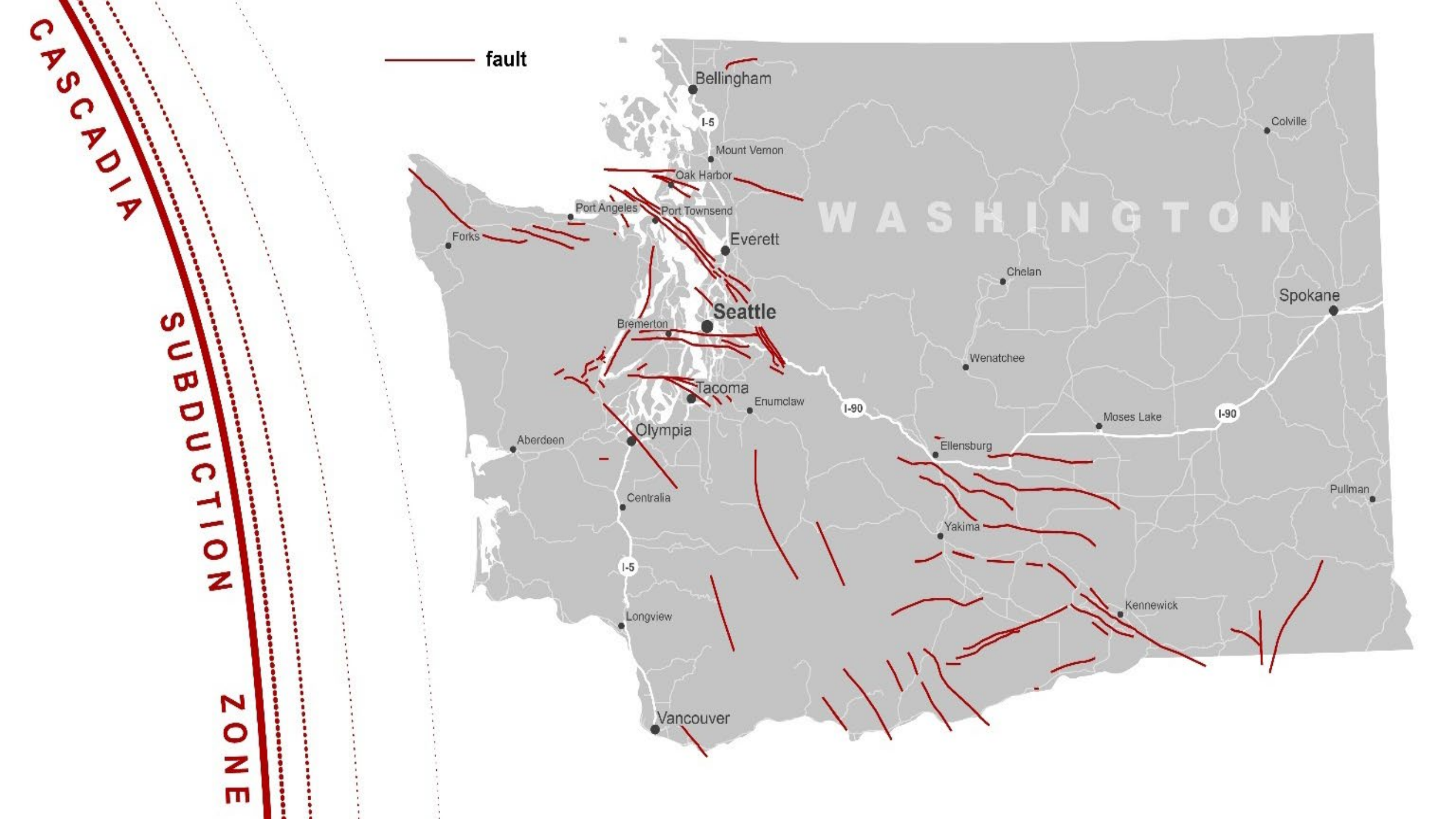
Turkey (Türkiye) Response Lessons Learned

- Apply engineering and scientific knowledge into practice
  - Building code design updates
  - Building code enforcement
  - Construction inspections
- Preparedness and building upgrades save lives
  - Mitigation programs need to be sustained long-term and funded
- In a disaster, the vulnerable populations suffer the most
- In a disaster, do not delay to activate resources

Washington has the 2nd Highest EQ risk in the US

- WA experiences a Damaging earthquake approximately every 30-50 years
  - Last was the Nisqually Quake (M6.8)
  - >$2 Billion Damage
- WA experiences a Magnitude 9 earthquake approximately every 300-600 years
  - Last was Jan 1700 (323+ years ago)
  - Next rupture will be most devastating and costly disaster in US history
- Every earthquake may be followed by numerous aftershocks possibly for years




fault
CASCADIA SUBDUCTION ZONE
WASHINGTON
Bellingham
Mount Vernon
Oak Harbor
Port Angeles
Port Townsend
Forks
Everett
Seattle
Bremerton
Tacoma
Enumclaw
Olympia
Aberdeen
Centralia
Longview
Vancouver
Colville
Chelan
Spokane
Wenatchee
Moses Lake
Ellensburg
Pullman
Yakima
Kennewick
I-5
I-90

Shallow / Crustal Fault Earthquakes

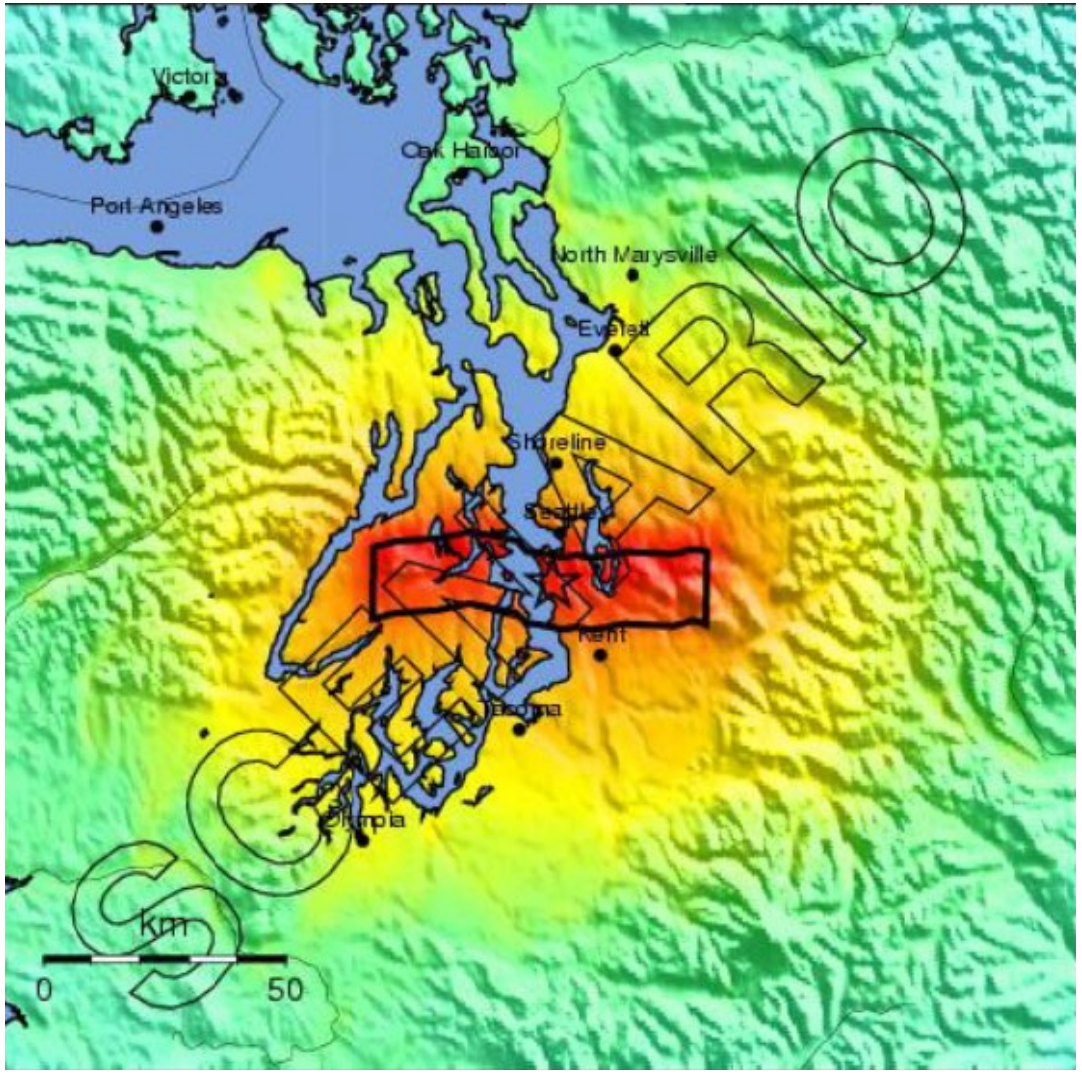
Seattle Fault

- Magnitude 7.2
- At least 4 earthquakes within the last 8,000 years. The most recent was 1,100 years ago, AD 900.

Shallow EQ: More intense shaking, heavy infrastructure damage and more aftershocks

Maximum Expected Mercalli Intensity IX (Violent)

Potential to also cause a tsunami



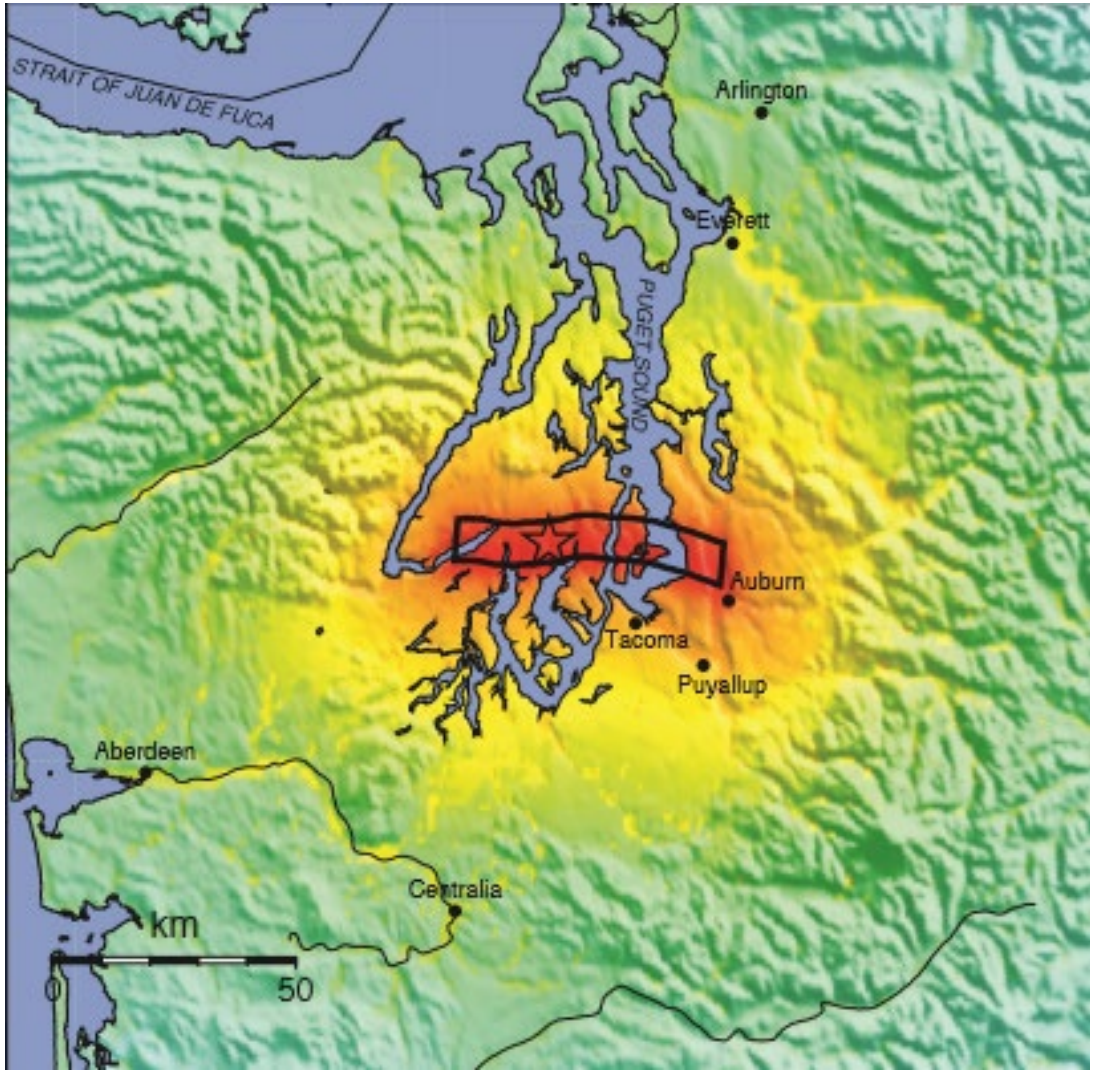
Shallow / Crustal Fault Earthquakes

Tacoma Fault

- Magnitude 7.2
- At least one earthquake 1,100 years ago, approximately Magnitude 7.

Maximum Expected Mercalli Intensity IX (Violent)

Potential to also cause a tsunami



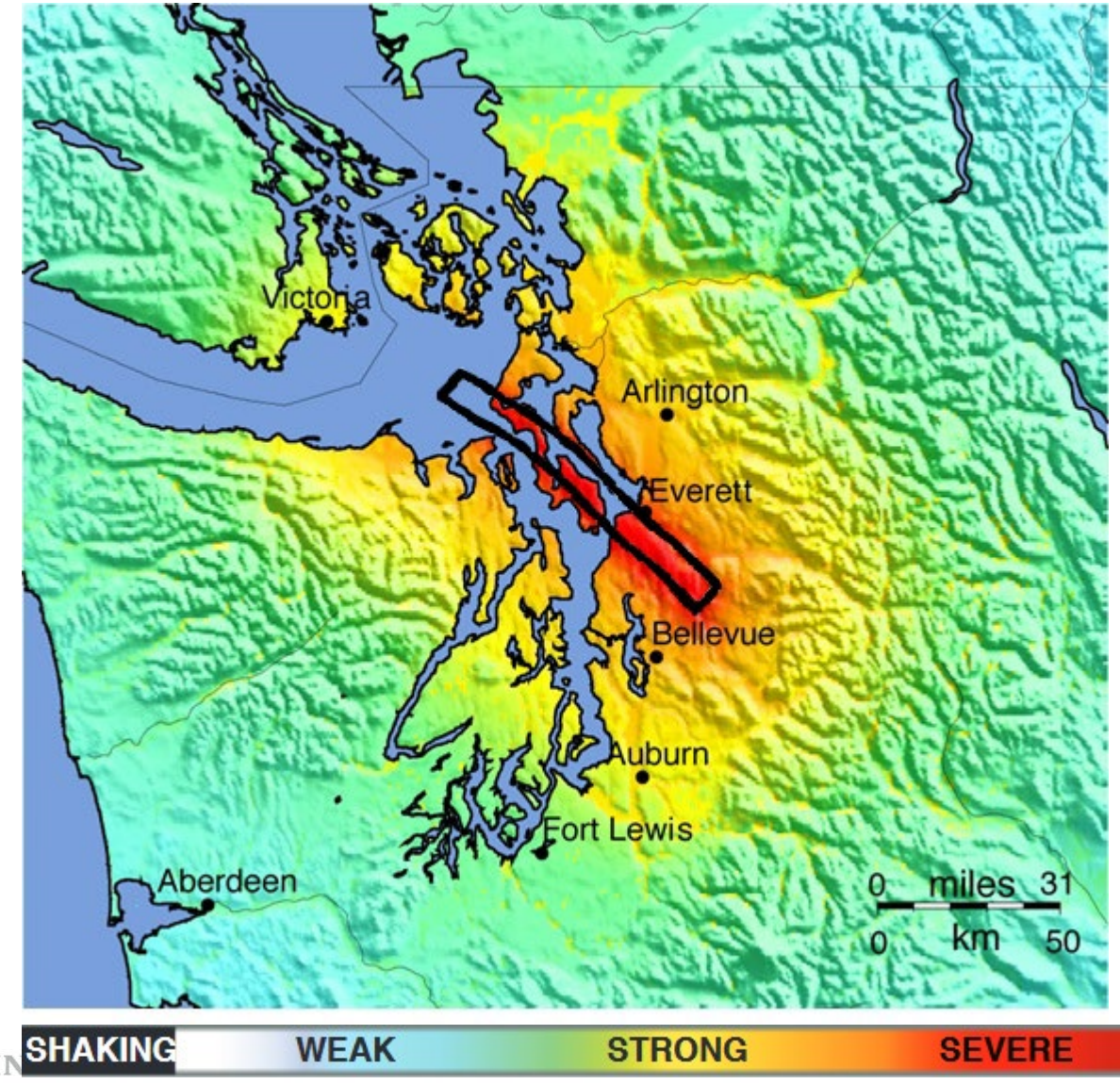
Shallow / Crustal Fault Earthquakes

Southern Whidbey Island Fault

- Magnitude 7.4
- At least four earthquakes in the last 16,000 years. The most recent was less than 2,700 years ago.

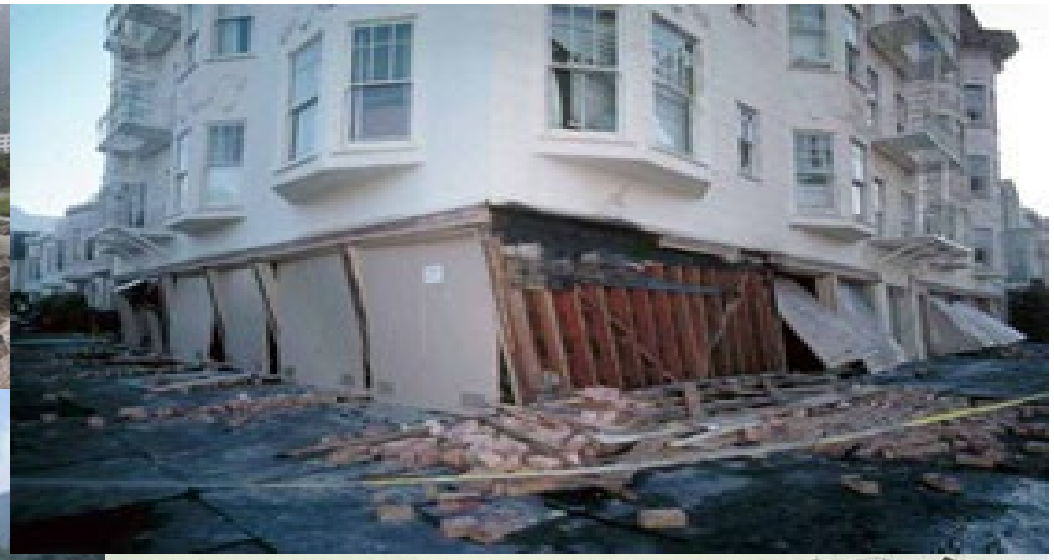
Maximum Expected Mercalli Intensity IX (Violent)

Potential to also cause a tsunami



1st Order Effects – Ground Shaking









1st Order Effects – Soil Liquefaction









1st Order Effects - Tsunami





Earthquake Damage

- Is a function of:
  - Shaking intensity and duration
    - Distance from epicenter
    - Soil type and liquefaction potential
  - Construction
    - Structural systems
    - Construction standards
    - In-building systems bracing
  - Pre-earthquake risk mitigation

ONE MITIGATION DOLLAR SPENT EQUATES TO SIX RECOVERY DOLLARS SAVED

Impacts (2012 data)

(Does Not Include Tsunami Damage)

	Seattle Fault	Tacoma Fault	Southern Whidbey Island Fault
Number of counties impacted	15	16	18
Total casualties at 2:00 p.m.	17,677	6,070	7,793
Total number of buildings extensively or completely damaged	38,156	19,867	23,760
Income losses in millions	$5,133	$1,847	$2,224
Displaced households	31,278	11,567	13,948
Capital stock losses in millions	$19,868	$8,654	$10,315
Truckloads of debris (25 tons per truckload)	296,720	117,960	142,960

Washington Building Seismic Design Post-1975

Region	Low Ductility	Moderate Ductility	High Ductility
Puget Sound	1976-1977	1978-1998	>1998
Extended Puget Sound	1978-1989	1990-1998	>1998
Coastal WA	1978-1995	1996-1998	>1998
Eastern WA	1978-1991	>1992*	

*Low-Moderate Ductility

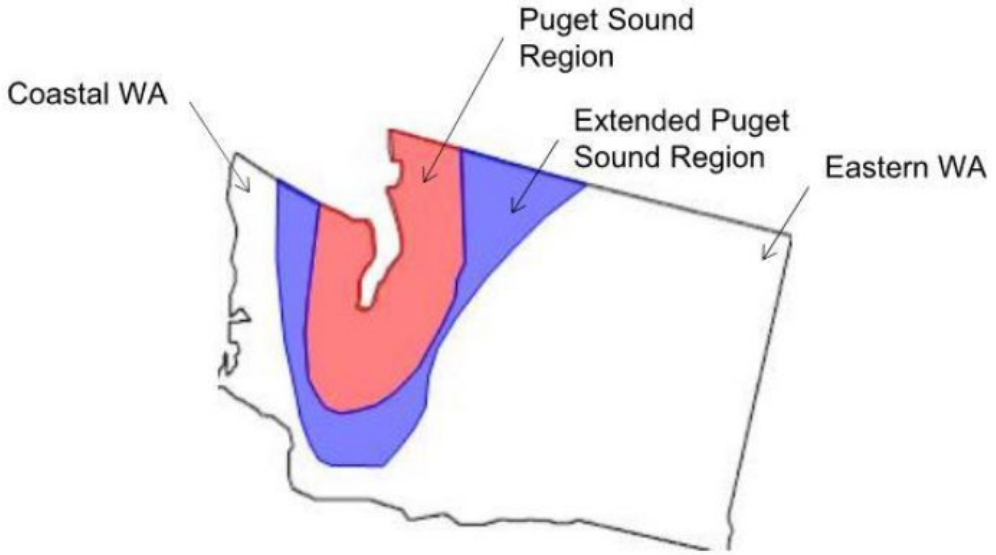
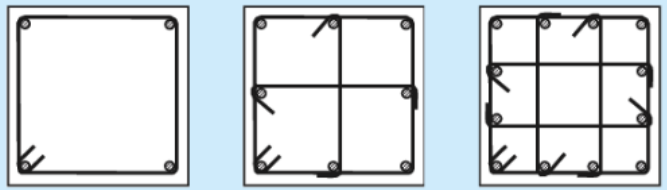


Figure 1 Summary of WA state areas for UBC Seismic Zones



***Ductility** refers to how much a structure is able to bend without breaking.
Confinement of non-ductile support structures with steel is one way to make them more ductile.

Recovery Standards

- **Life Safety** – Preserve life safety but not necessarily retain function (*current building code standard*)
- **Functional Recovery** – Retain capacity to support intended functions within a maximum acceptable time
- **Immediate Occupancy** – Retain function following a design-level event (*desired building code standard for certain structures*)

At-Risk Buildings – Unreinforced Masonry (URM)

URM Buildings	
Suspected URM	3,293
Confirmed URM	1,176
Unknown	2,211
Total	**6,680**

Note: We need funding to complete the URM inventory for the state in order to fully understand our risk. This includes creating a user-friendly online portal for decision-makers to access the data and provide guidance on how to access mitigation funding.



Benchmark year: pre-1958

Other At-Risk Buildings



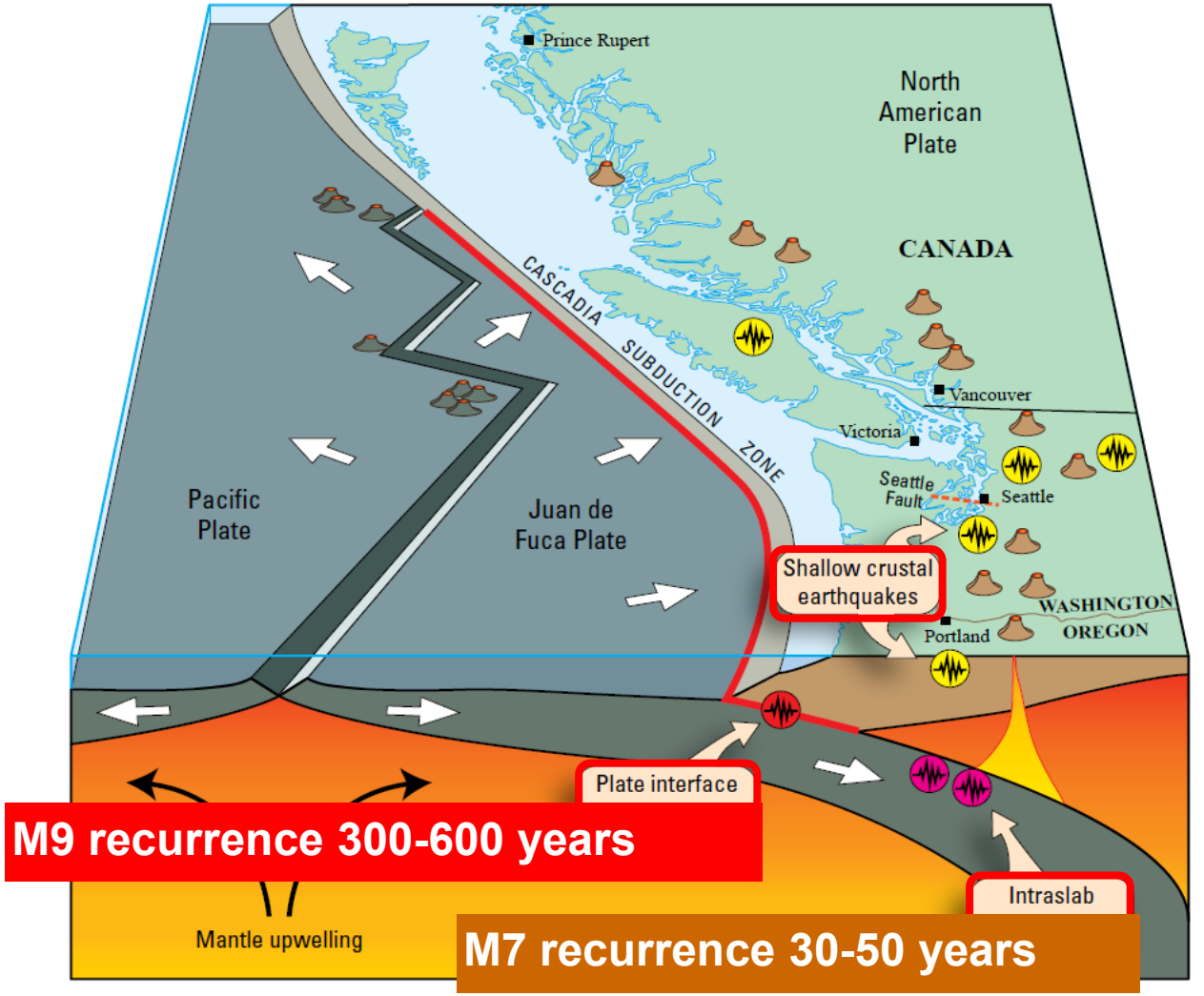
Non-ductile concrete
(lack of rebar ties)



Soft-story buildings
(extensive openings at grade)

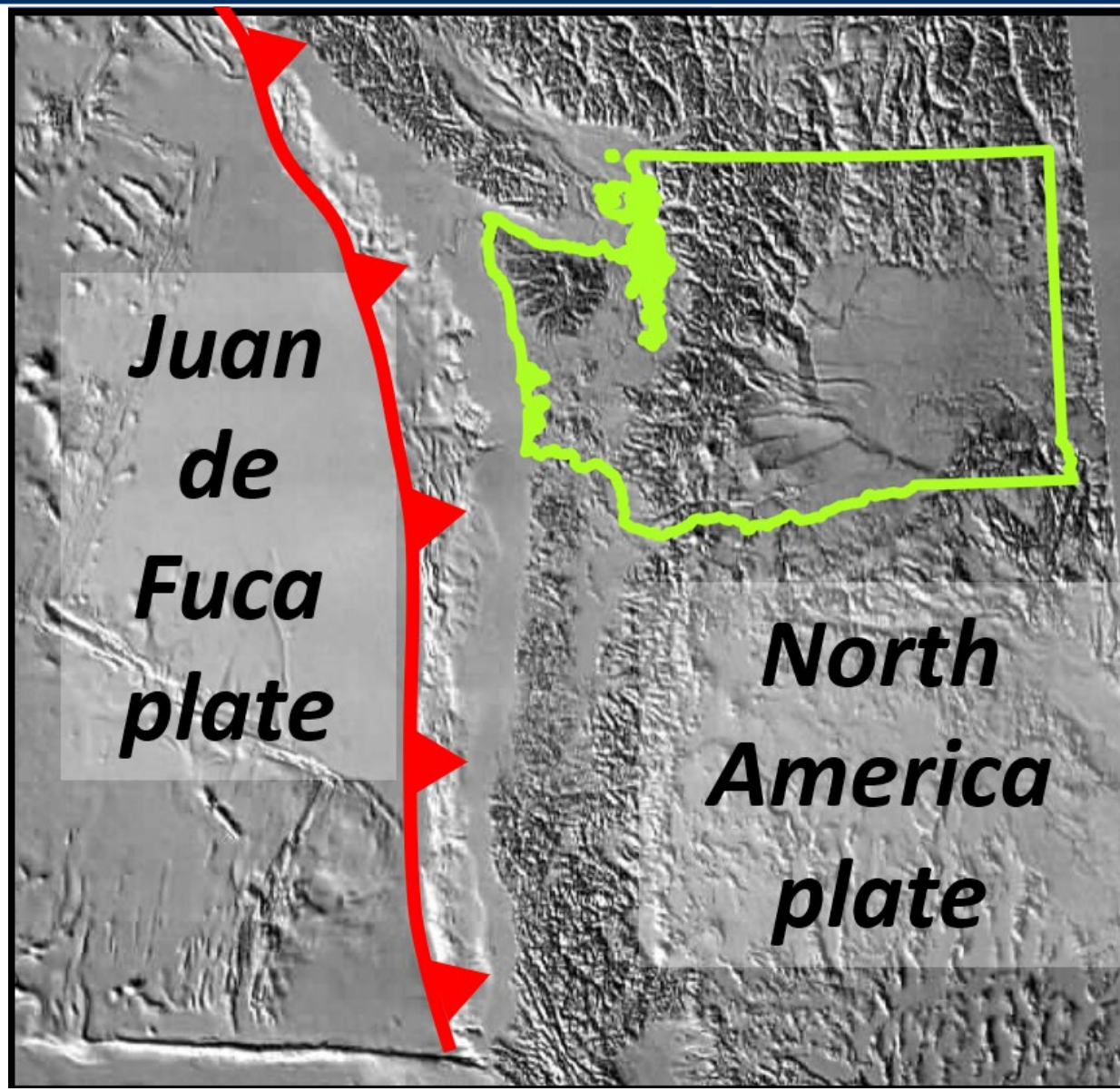
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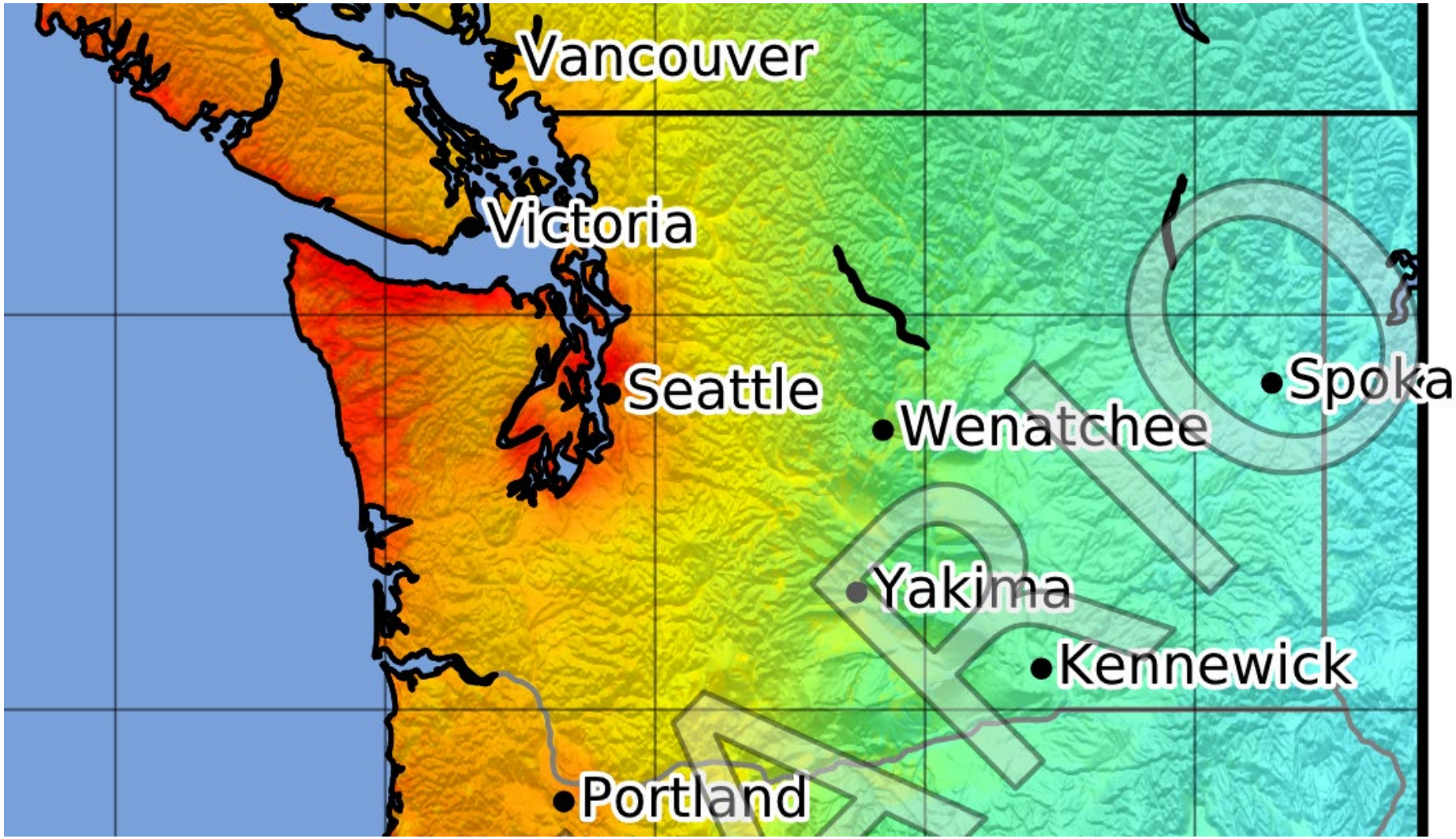


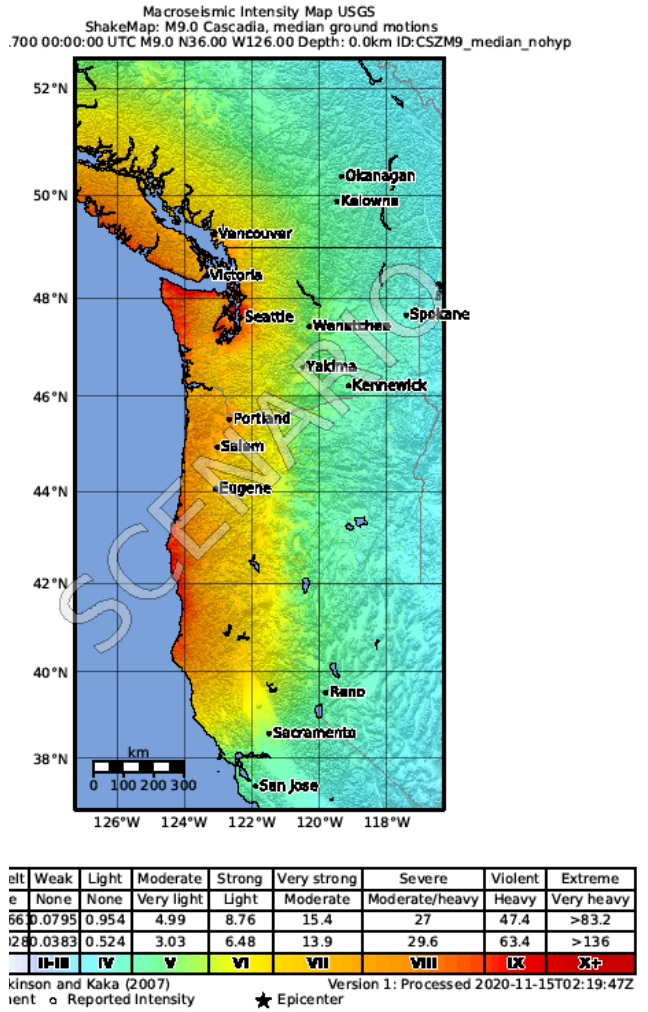
Cascadia Subduction Zone "Big One"

- Potentially largest catastrophic disaster in US
- 700 miles long
- Breaks 300-600 years
- Last great rupture in 1700 (323+ years ago)
- 15-25% chance within next 50 years
- Magnitude 8.0-9.0+
- Shaking felt for 3-6 minutes
- Earthquake followed by a **major tsunami hitting WA's outer coast in 15-20 min**
- Many large aftershocks will follow main quake and thousands of aftershocks for many years

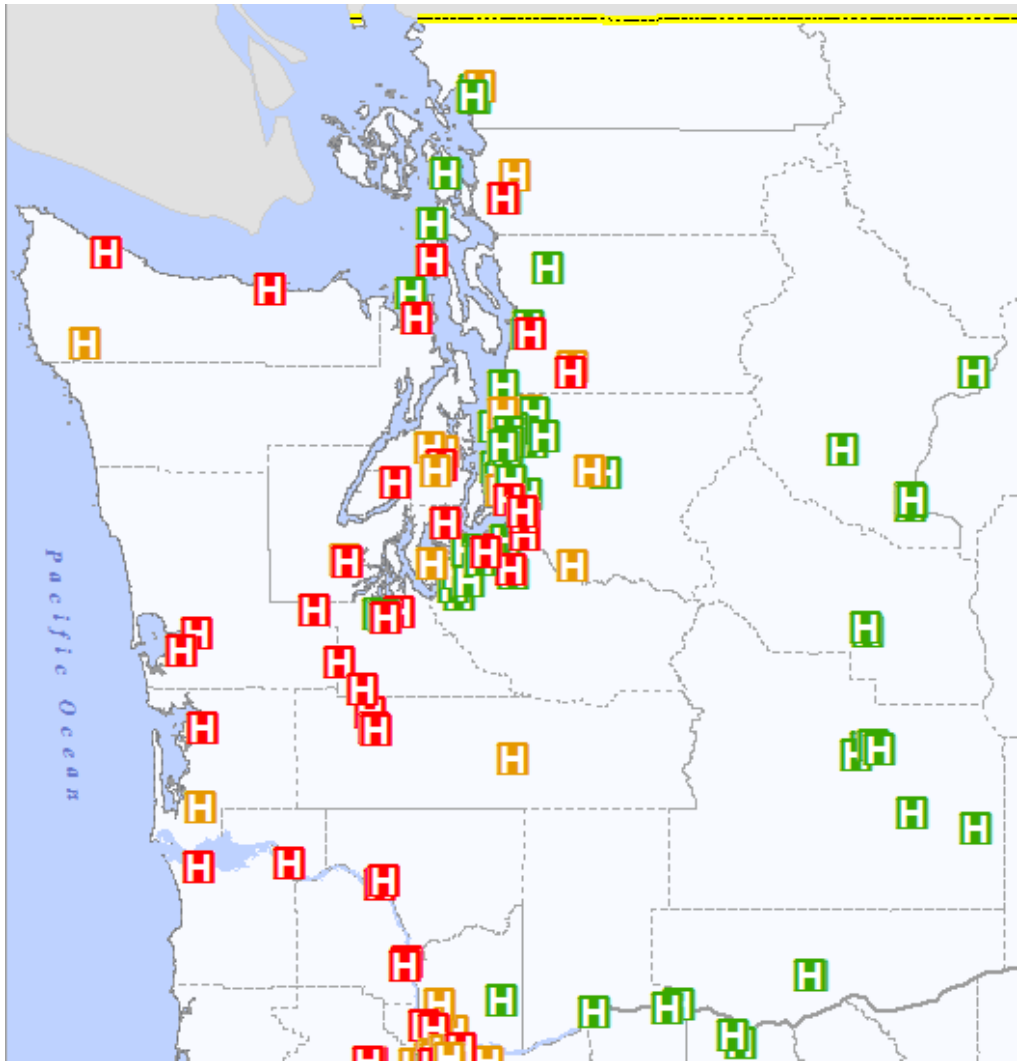


Cascadia Ground Shaking Graphic





Cascadia Impacts



Complete = Totally Destroyed.

Severe = Severely Damaged – Not Useable

Moderate = Moderately Damaged – 50% Capacity

Slight = Slightly Damaged – Useable

None = Not Damaged

Hospitals

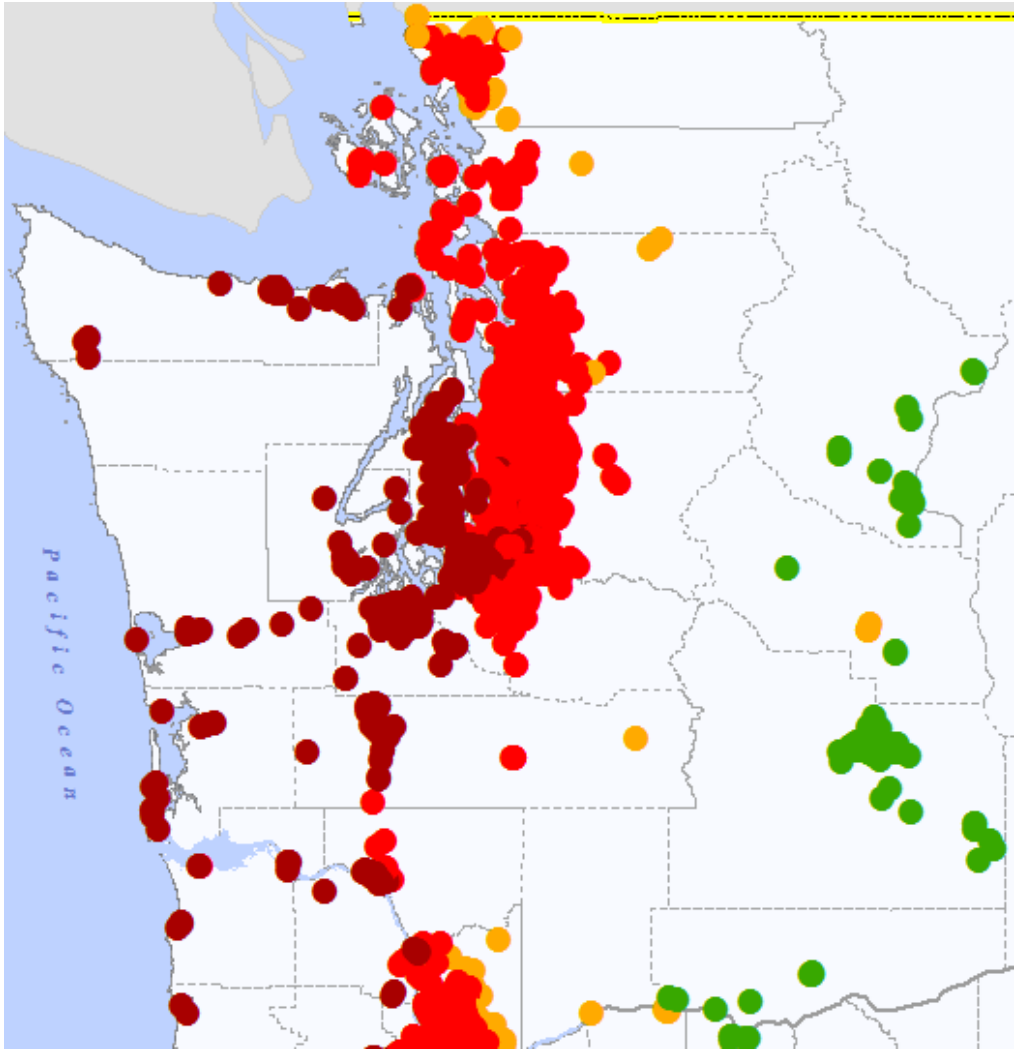
There are 112 in the impacted area
- Approx 36% suffer severe damage
- Approx 17% suffer moderate damage
- Approx 47% suffer slight damage

Total reduction in hospital capacity is projected at 45%

There will be very little hospital capacity west of the I-5 corridor

These numbers identify **Structural** capacity, not patient capacity, which is further reduced due to lack of power, water, sanitation, etc.

Cascadia Impacts



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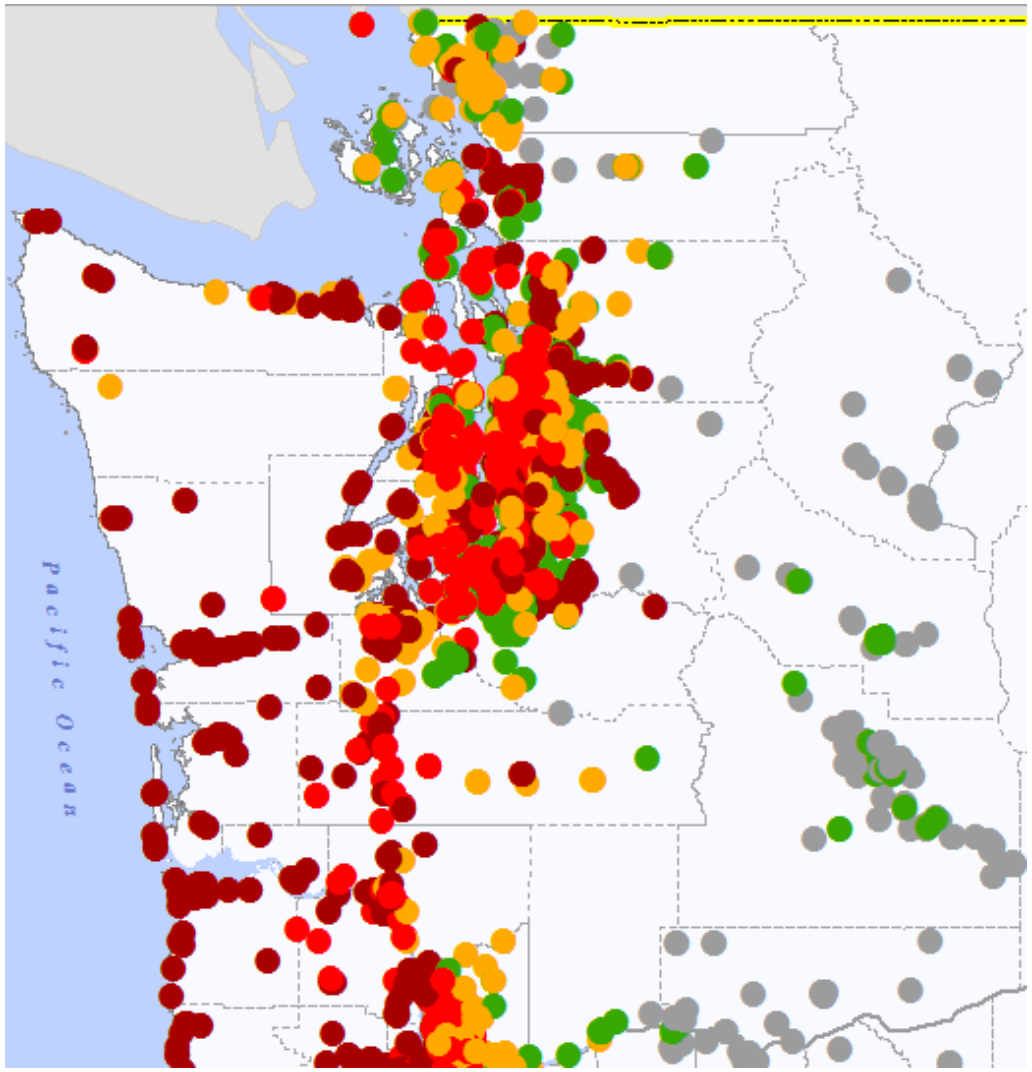
Senior Living Facilities

There are approx. 2,156 in the impacted area

Significant numbers (approaching 100%) of facilities west of the I-5 corridor suffer extensive damage and are likely unusable

The facilities nearest the epicenter suffer the most extensive damage

Cascadia Impacts



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Schools

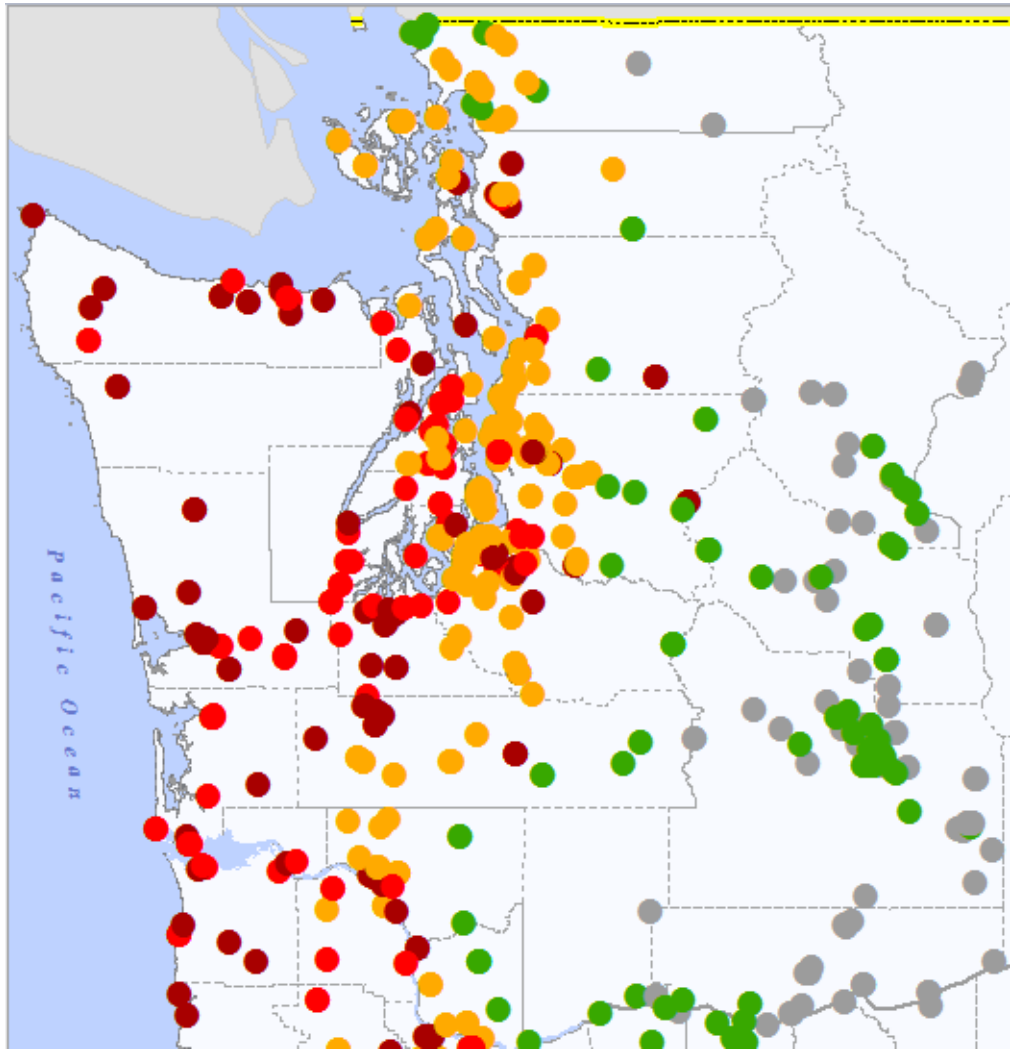
Approximately 2,286 schools in affected area.

Nearly 100% of schools West of the I-5 corridor suffer complete or severe damage, and are likely unusable.

Schools along the I-5 corridor suffer a wide range of damage from complete to slight.

Notable data: All of these schools are part of the National Sheltering System. Their loss indicates a corresponding reduction in sheltering capacity.

Cascadia Impacts



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Communication Facilities

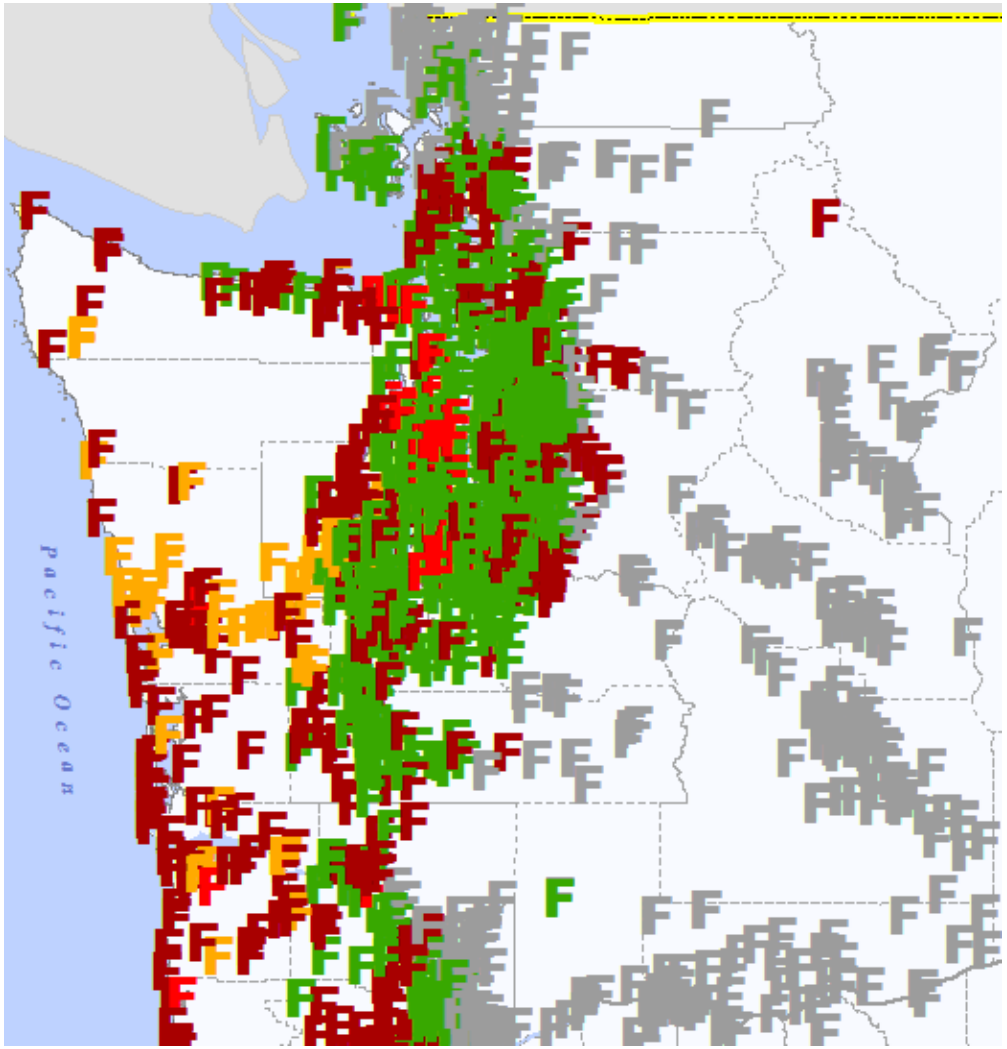
All of these slides represent facilities in the affected area at the time of the FEMA analysis.

Approximately
53 AM Broadcast Stations
42 FM Broadcast Stations
15 TV Broadcast Stations
1 Internet Exchange Point
171 Cellular Towers

Communications infrastructure suffers damage commensurate with the MMI index. Systems are also dependent upon electrical power.

These factors will greatly affect mass communications ability. Does not account for the cellular control facilities and/or switchboards.

Cascadia Impacts



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Fire Stations

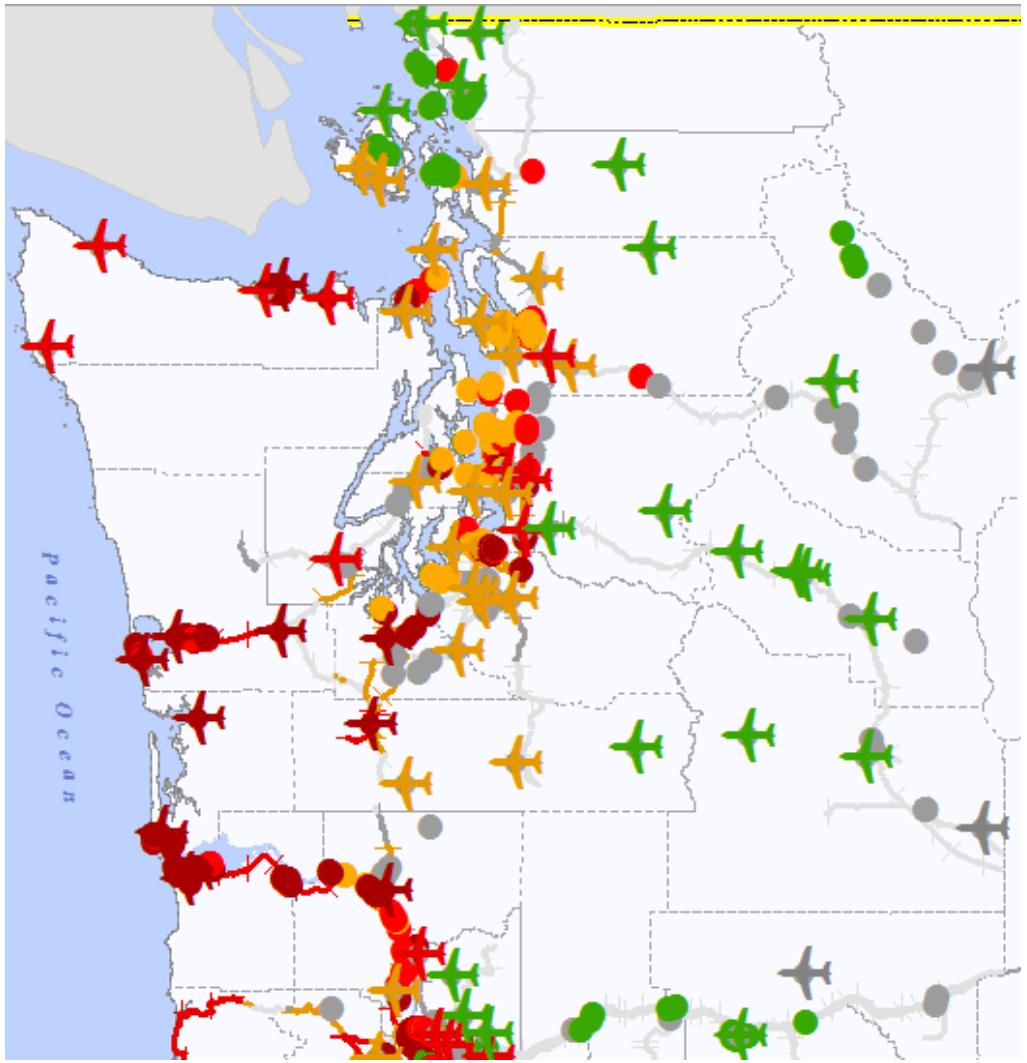
There are 971 Fire Stations in affected area.

Approximately 30% suffer severe damage
Approximately 6% suffer moderate damage
Approximately 64% suffer slight or no damage

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

Significantly reduced capability west of Shelton.

Transportation - Sea, Air, Rail



- Most facilities west of the I-5 corridor suffer complete to severe damage
- Most facilities along the I-5 corridor suffer severe to moderate damage
- Most facilities east of the I-5 corridor suffer slight to no damage
- Many of these facilities are located in liquefaction zones

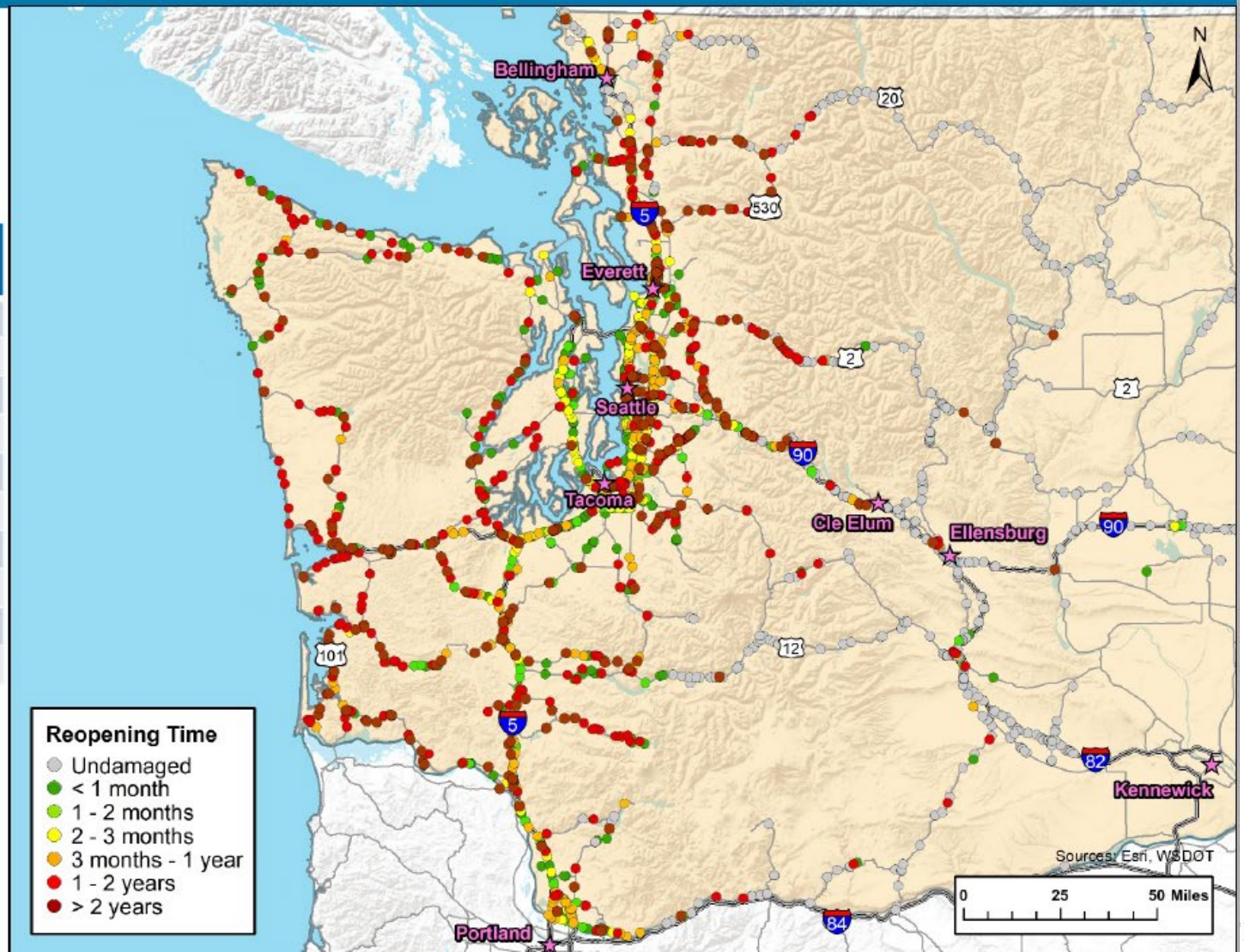
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Highway Analysis – Bridge Screening

Bridge Reopening Times

Reopening Time	Number of Bridges
None	621
1–14 days	317
2–4 weeks	46
1–3 months	627
3–6 months	165
6–12 months	159
1–1.5 years	304
1.5–2 years	120
2–2.5 years	352
> 2.5 years	6

CISA
CYBER+INFRASTRUCTURE



Cascadia Rising Exercise Series

CR 16, 7 - 10 June 2016

CR 22, 13 - 17 June 2022

CR 28, TBD

Cascadia Rising 16 and 22

PLANNING FACTORS

	CR16	CR22
Start Time (Day)	0	4
Focus Areas:		
Operational Coordination	x	x
Operational Communication	x	x
Situational Awareness	x	
Mass Care	x	x
Public Health and Medical Svcs	x	
Critical Transportation	x	x
Logistics & Supply Chain Mgt		x
Housing and Economic Recovery		x

PARTICIPANTS

	CR16	CR22
Individual Registrations	400+	750+
Participating States	2	3
Tribal Nations	12	16
State Agencies	20	13
Counties	29	32
Private Sector	17	5
NGO/Non-Profit	3	17
Healthcare		13

CR16-CR22 Conclusions

- Time is of the Essence
  - Humanitarian needs will be immediate and overwhelming
- Detailed Planning is Imperative
  - We must conduct robust planning in advance for the immediate response actions that must be taken
- Critical Transportation
  - In order to save lives and support impacted communities a drastic increase in critical transportation (ground, air, maritime, and rail) planning, mitigation, and effective coordination is needed to significantly bolster immediate response and short- and long-term recovery efforts.
- Communication Infrastructure
  - Widespread disruptions will significantly impede the emergency management community's ability to coordinate response operations, resource needs, and synchronized ground, air, maritime, and rail movement with federal partners and local jurisdictions.

CR16-CR22 Conclusions

- Mass Care Services
  - We must focus on comprehensive (local and state) mass care (shelter, feeding, hydrating, financial, housing, etc.) planning to reduce recovery time and long term costs.
- Operational Coordination Response Planning
  - We must conduct robust operational coordination planning to synchronize the restoration of critical infrastructure to support lifesaving and life-sustaining activities and facilitate the transition to long term recovery.
- Individual and Public Preparedness
  - Two Weeks Ready

What has been Done?

- Resilient Washington Subcabinet
- Published the Catastrophic Incident Annex Base Plan including:
  - Two appendices and 11 annexes
- Published the Washington Restoration Framework (WRF) including:
  - Eight (8) Recovery Support Functions (RSF)
- Improved energy and fuel public and private sector critical infrastructure planning
- Communications capabilities continue to improve with the advancement of technology
- 2 vertical evacuation shelters built

Action Plan

- Critical Transportation
  - Identify and prioritize state, tribal, and local logistical and evacuation routes across the state.
  - Identify air and maritime capabilities needed to augment and/or supplant highway and road capabilities.
- Operational Communications
  - Identify key resources to enable coordination of ground, air, maritime resource movement and evacuation.
- Mass Care Services
  - Conduct additional planning, coordination and identify necessary resources to support local and state Mass Care Services.
  - Leverage the Washington Restoration Framework to enhance our capability to begin coordinating short- / long-term economic recovery and housing.

Action Plan

- Logistics and Supply Chain Management
  - Conduct additional exercises to build public and private sector Commodity Flow and Business Re-Entry as force multipliers to recovery.
  - Further exploration needed to understand impacts to national supply chain efforts.
- Continued focus on coastal resilience
  - Includes construction of additional vertical evacuation shelters
- Emergency Communications
  - Planning and investment
- Individual and Family Preparedness

Food for Thought

- Are we willing to pay now for post incident functionality?
- To which standard do we build?
  - Roads and bridges
  - Public safety facilities
  - Schools
  - Critical infrastructure
- What do we retrofit and to which standard?
- Do we stockpile? If so, what?
- Which capabilities do we build or enhance?

ONE MITIGATION DOLLAR SPENT EQUATES TO SIX RECOVERY DOLLARS SAVED

Recommendations

- Develop a seismic resilience strategy that includes multimodal transportation, public structures, high risk buildings, communications, etc.
- Invest in resilient and survivable transportation and communications
- Complete identification and assessment of our high risk buildings
- Retrofit our high-risk buildings (URM's, schools, hospitals etc.)
- Require certain school and public buildings to be built to an immediate occupancy standard
- Plan for limited stockpiling of certain critical commodities for key responders (Police, Fire, EMS, Medical)

Questions/Discussion