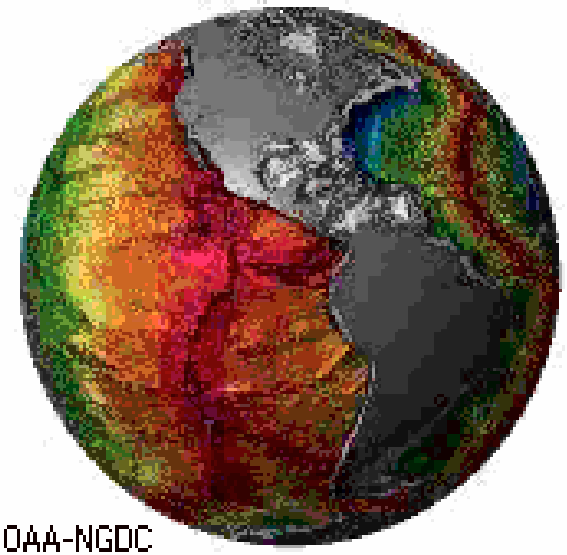
The Oregon Resilience Plan For Water & Wastewater Systems

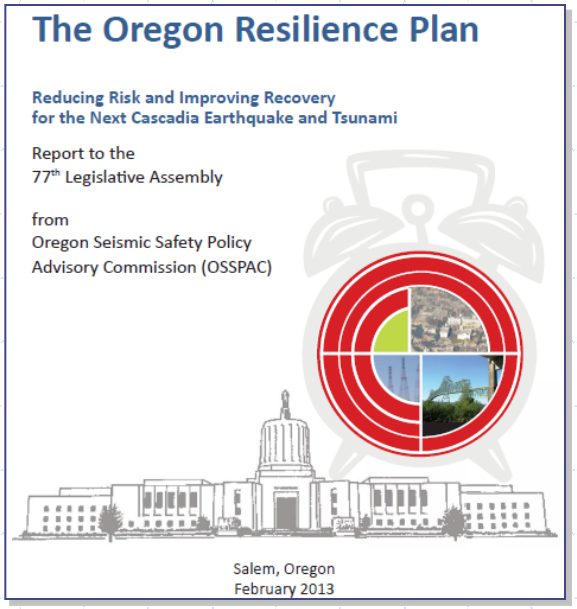
Pacific Northwest Section – AWWA

May 2013

Mark Knudson, P.E.
Tualatin Valley Water District

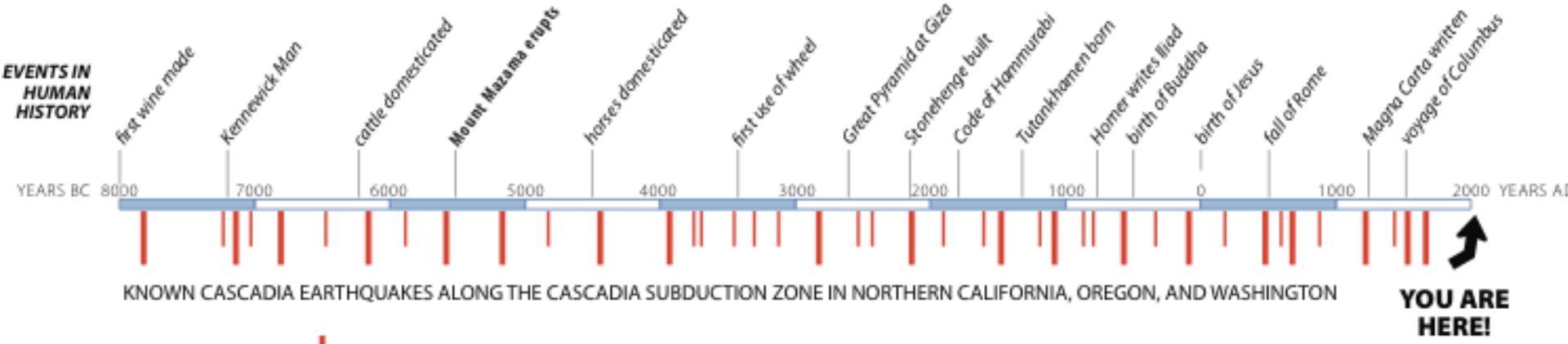


NOAA-NGDC



Cascadia Subduction Zone

CASCADIA EARTHQUAKE TIME LINE



Comparison of the history of subduction zone earthquakes along the Cascadia Subduction Zone in northern California, Oregon, and Washington with events from human history. Ages of earthquakes are derived from study and dating of submarine landslides triggered by the earthquakes. Earthquake data provided by Chris Goldfinger, Oregon State University; time line by Ian P. Madin, DOGAMI.

House Resolution 3

76th OREGON LEGISLATIVE ASSEMBLY--2011 Regular Session

Enrolled

House Resolution 3

Sponsored by Representative BOONE; Representatives COWAN, KRIEGER, ROBLAN, WITT, Senators COURTNEY, JOHNSON, KRUSE, VERGER, WHITSETT

- Goals:
  - Protect lives
  - Achieve rapid economic recovery following event
- Based on Cascadia Subduction Zone EQ, tsunami
  - Magnitude 9 Event – 500 year return period
- 50-years to implement recommendations
- Plan to Legislature by February 28, 2013

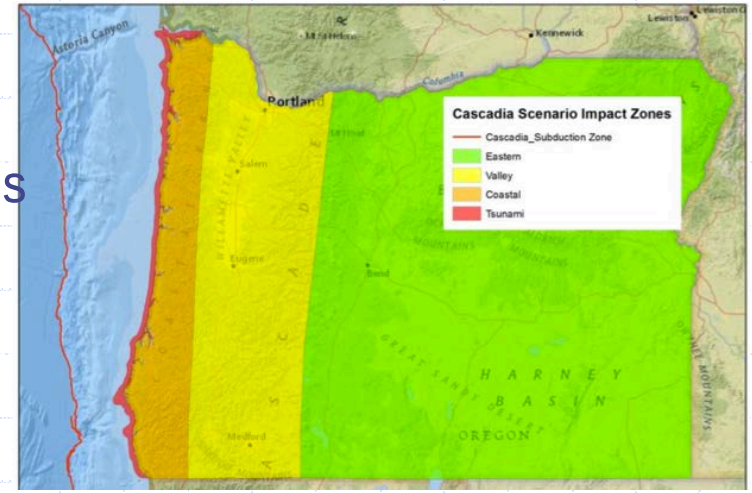
The Oregon Resilience Plan

- Coordinated by Oregon Seismic Safety Policy Advisory Commission (OSSPAC)
- Eight Task Groups
  - Magnitude 9 Event – The Scenario
  - Business Continuity
  - Critical & Essential Buildings
  - Energy
  - Information & Communications
  - Transportation
  - Tsunami Risk Mitigation
  - **Water & Wastewater**

Kobe, Japan - 1995

Water & Wastewater Resilience Plan

- Co-chairs: Mark Knudson (TVWD) and Mike Stuhr (PWB)
- Participants included representatives of ~ 45% of state
  - Portland, TVWD, Salem, Gresham, Eugene, Coos Bay, Bend, Pendleton
  - PSU, OSU, U of P, multiple consultants
- Four zones: Tsunami, Coast, Valley, East
- Approach
  - Identify event (maps)
  - Identify requirements & expectations
  - Identify performance of existing systems
  - Identify interdependencies
  - Identify “gaps” in systems performance
  - Generate recommendations



Cascadia Scenario Impact Zones

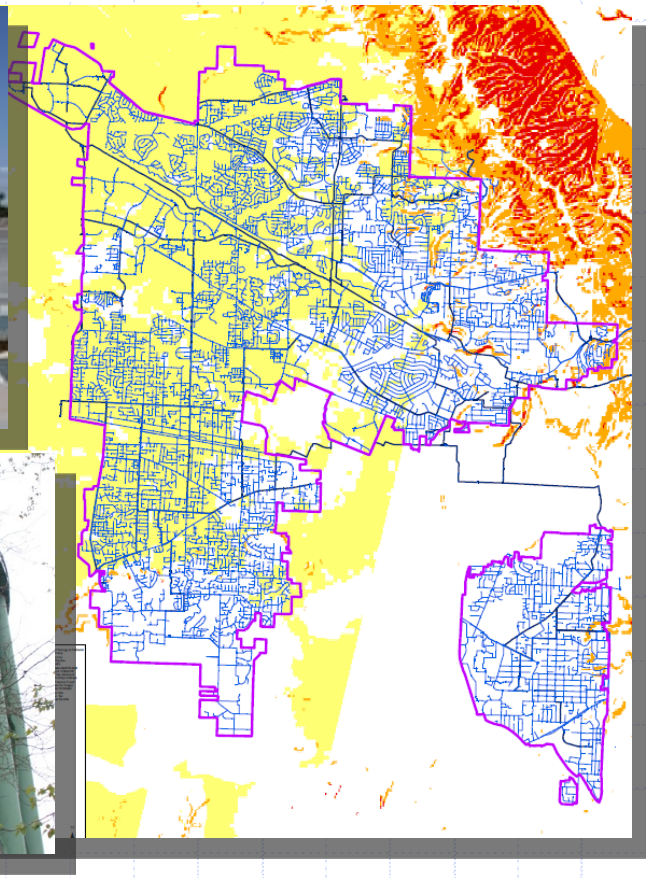
Why Are Water Systems Vulnerable?

- Causes of damage
  - Tsunami (inundation)
  - Shaking (acceleration & velocity)
  - Permanent Ground Deformation (landslide, liquefaction, subsidence)
  - Cumulative effects
- System Vulnerability

The Great San Francisco EQ - 1906

Why Are Water Systems Vulnerable?

- Large, complex systems, multiple failures
  - Source, treatment, pumping, storage, distribution



Why Are Water Systems Vulnerable?

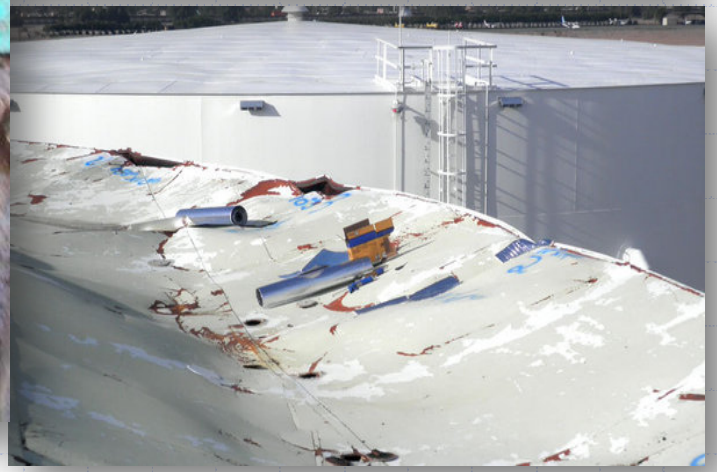
- Recovery highly dependent on other systems
  - Energy, transportation, people, equipment, financial

Why Are Water Systems Vulnerable?

- Location, location, location

Why Are Water Systems Vulnerable?

- Age, age, age (and condition)



Why Are Water Systems Vulnerable?

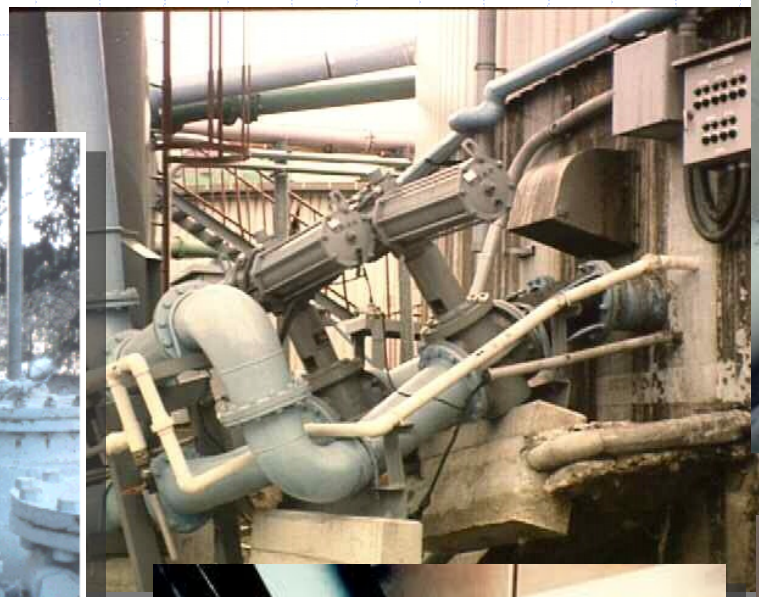
- Pipelines vulnerable to structural damage

Why Are Water Systems Vulnerable?

- Pipelines vulnerable to ground deformation

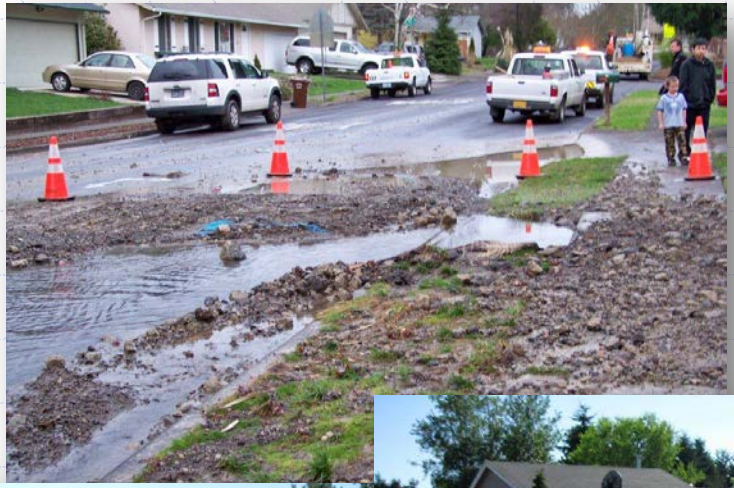
Why Are Water Systems Vulnerable?

- Connections to structures



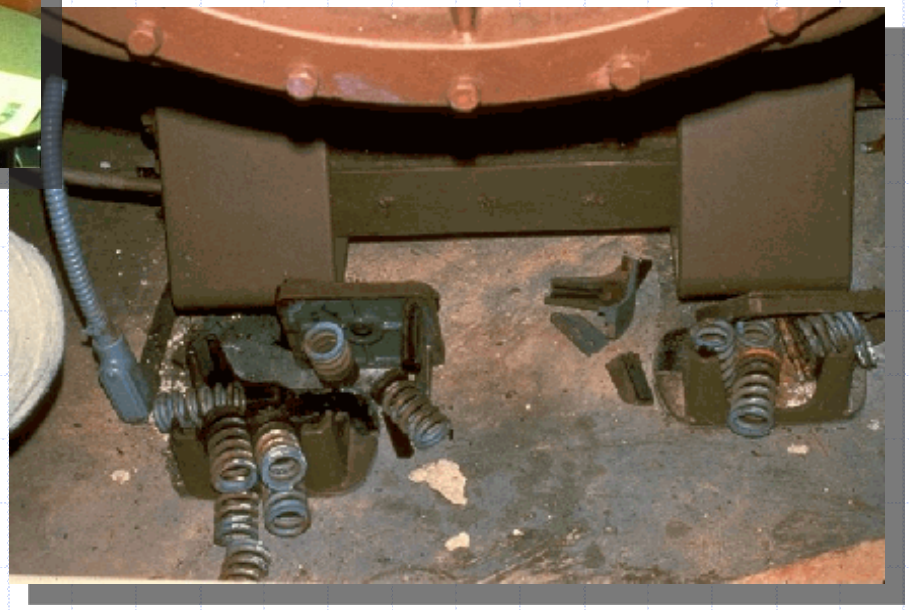
Why Are Water Systems Vulnerable?

- Leaks, breaks & damage “after the meter”



Why Are Water Systems Vulnerable?

- Collateral damage



Resiliency Requirements & Expectations

- Goals for time to restore systems
  - Assumes “should be” resiliency improvements over 50 years
  - For 30%, 60% and 90% operational capacity
  - Based on input of economic interests; < 2 weeks
  - Based on availability of interdependent sectors; energy & transpo
  - Based on practical limitations; people, material & equipment
- Goals set for key functional components
  - Emergency Water Distribution
  - Fire Fighting
  - Water source, treatment, transmission & distribution
  - Wastewater collection, treatment & disposal

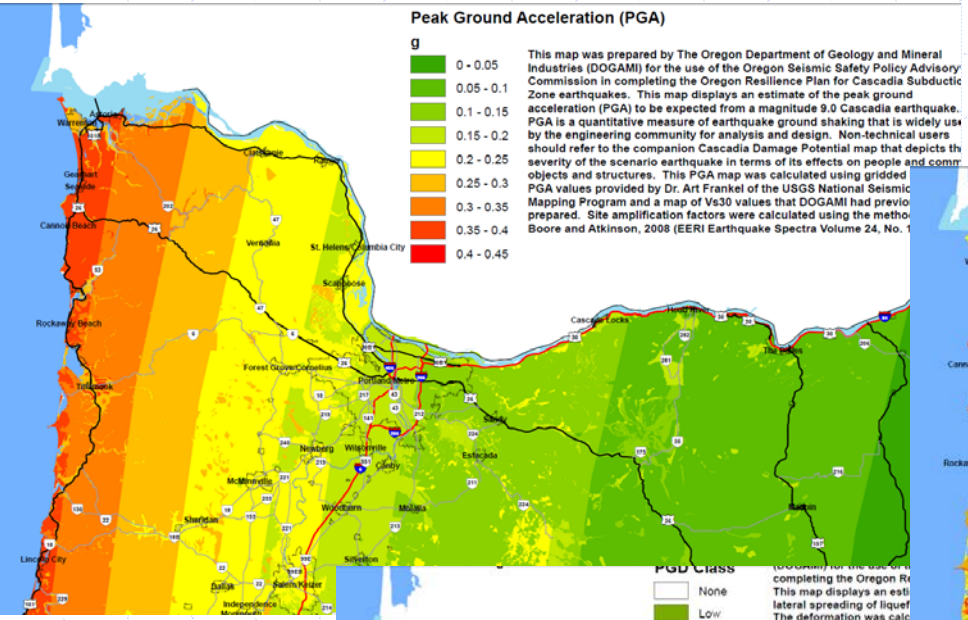
Resiliency Goals (Valley)

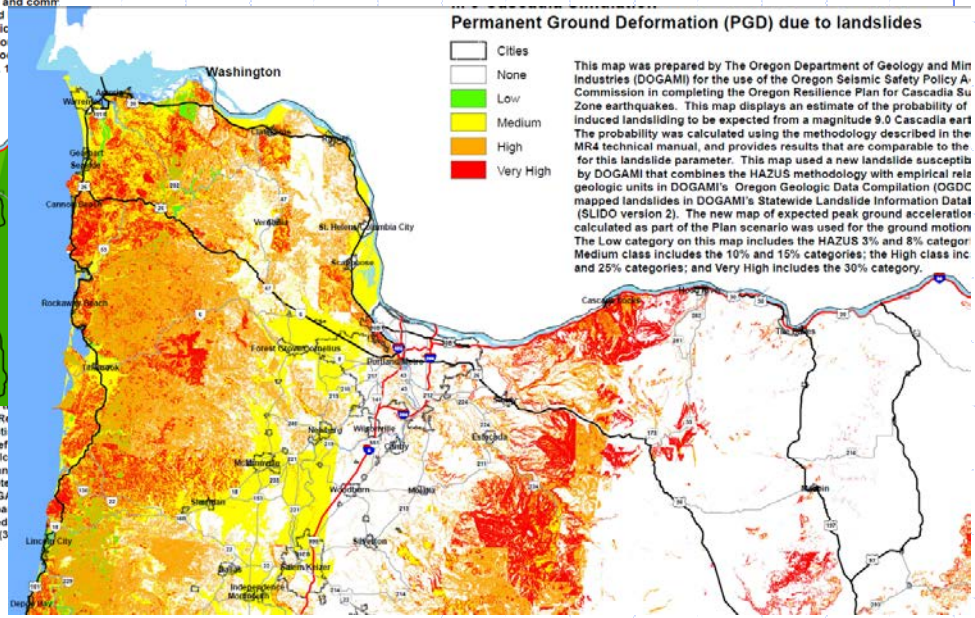
TARGET STATES OF RECOVERY: WATER & WASTE WATER SECTOR

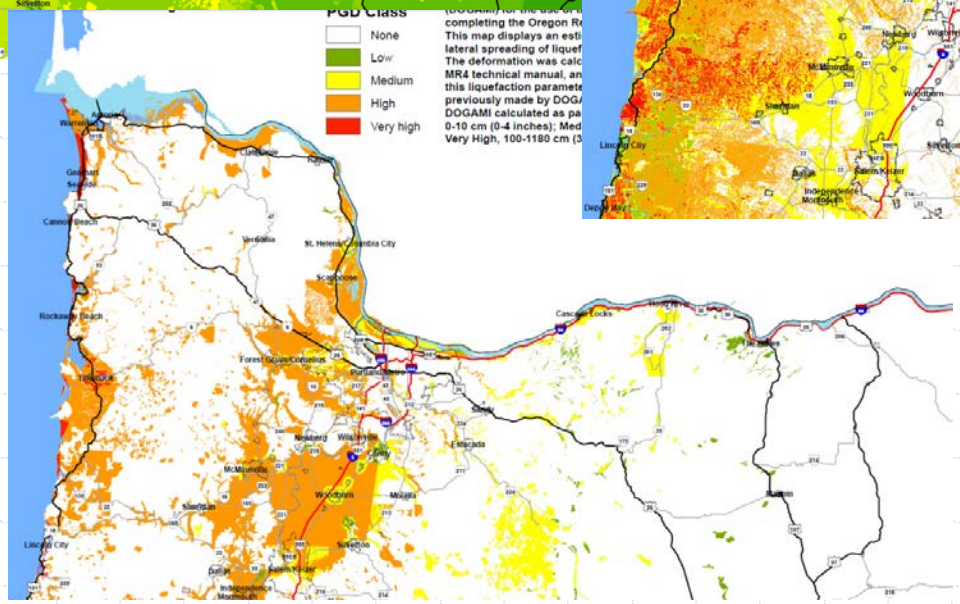
	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–2 weeks	2 weeks–1 month	1 month – 3 month	3 month – 6 month	6 month -1 year	1 year–3 years	3 + years
Domestic water supply											
Potable water available at supply source. (WTP, wells, impoundment)		R	Y		G			X			
Main transmission facilities, pipes, pump stations, and reservoirs ("backbone") operational		G					X				
Water supply to critical facilities available.		Y	G				X				
Water for fire suppression – at key supply points.		G		X							
Water for fire suppression – at fire hydrants.				R	Y	G			X		
Water available at community distribution centers/points			Y	G	X						
Distribution system operational			R	Y	G				X		
Wastewater systems											
Threats to public health & safety controlled.			R	Y		G			X		
Raw sewage contained & routed away from population		R		Y			G		X		
Treatment plants operational to meet regulatory requirements					R			Y	G		X
Major trunk lines and pump stations operational					R		Y	G			X
Collection system operational							R	Y	G	X	
	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–2 weeks	2 weeks–1 month	1 month – 3 month	3 month – 6 month	6 month -1 year	1 year–3 years	3 + years

Evaluating Pipeline System Performance

PGA, Landslides & Liquefaction

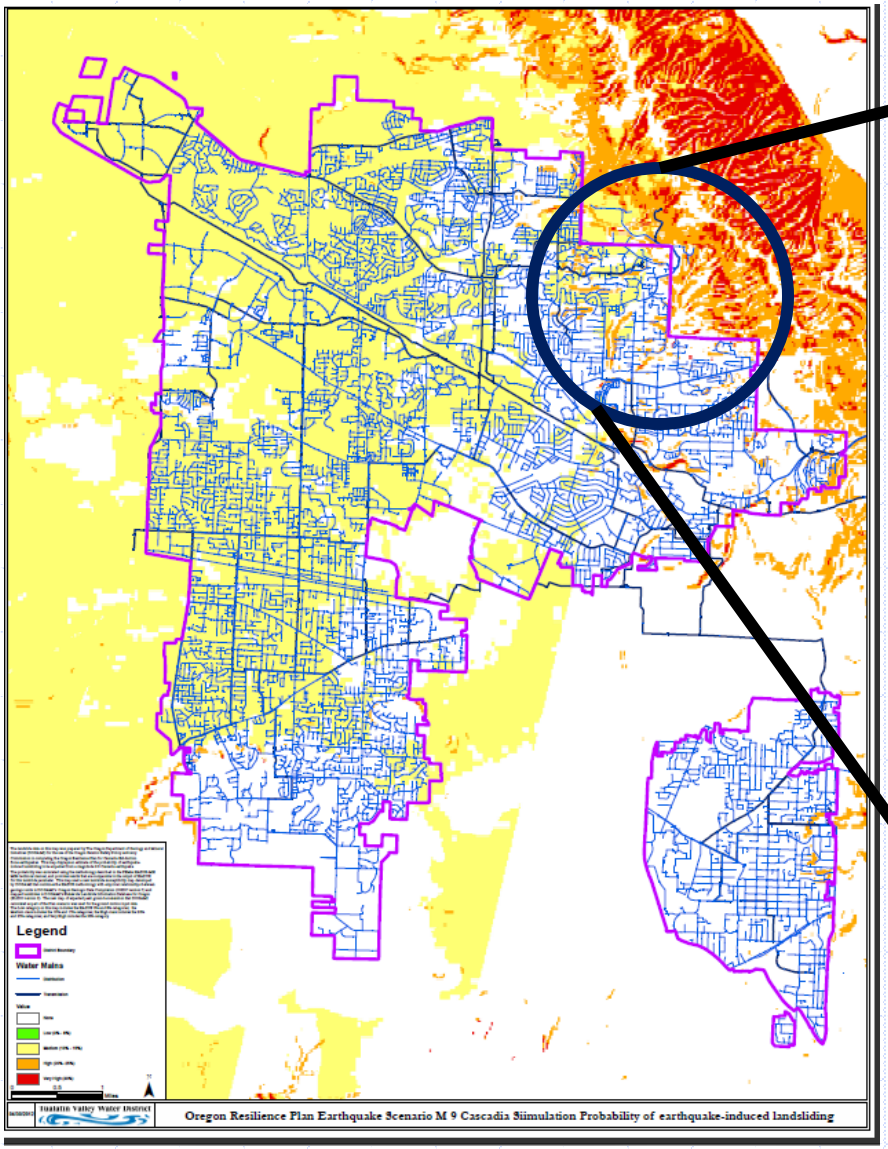


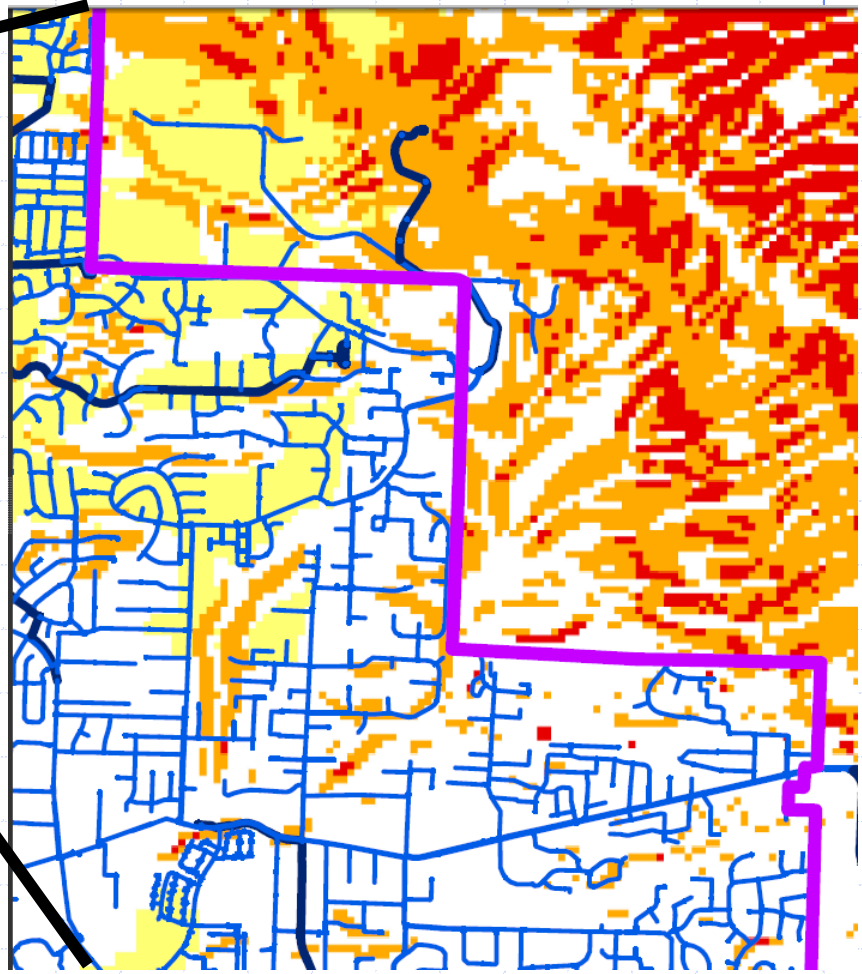




Evaluating Pipeline System Performance

System Specific Mapping





Evaluating Pipeline System Performance
System Specific Pipe Performance Estimates

- Estimate of main line leaks & breaks
  - "Seismic Fragility Formulations for Water Systems" American Lifeline Alliance, 2011
  - Based on empirical data from prior events
  - Input: Peak Ground Velocity, Permanent Ground Deformation, length of pipe, pipe material
  - Output: number of main leaks & breaks by pipe type
- Estimate of service line leaks & breaks
  - Based on anecdotal data for similar events
  - About 7% of all service lines fail (2% on utility side & 5% on customer side)

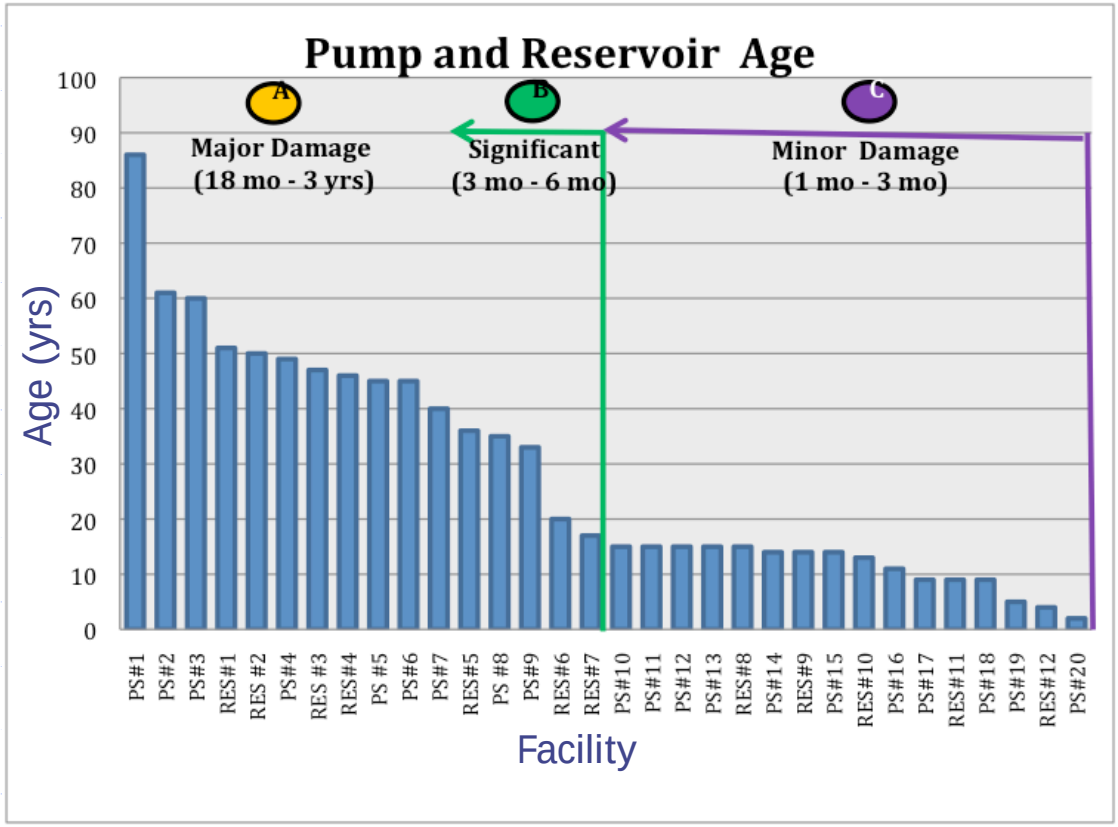
Water Pipeline System Performance

Characteristic	Main Lines	Services
Length, Number	4,592 miles	385,600 connections
Number of Breaks	2,656	7,712 (utility side)
Number of Leaks	941	19,280 (customer side)
Total Leaks & Breaks	**3,597**	**26,992**

- Unprecedented number of pipeline failures
  - Equivalent to ~16 years of breaks
- Will required ~3 months to repair
  - Assumes 3 hrs/break, 12hrs/d, 7d/wk, unlimited materials, equipment & transportation
  - Does not include repairs to customer-side

Evaluating Facility Performance

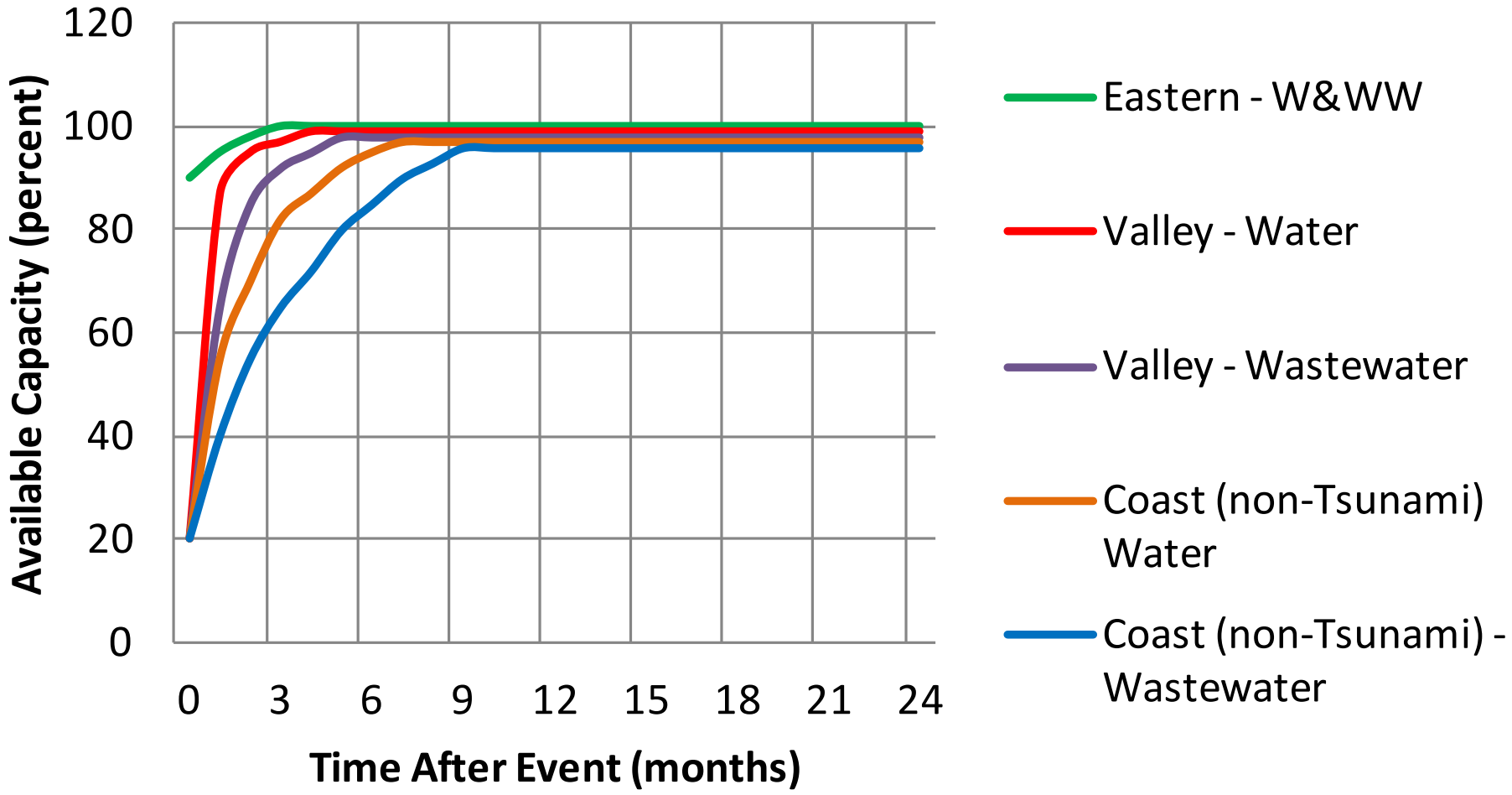
Performance of Reservoirs & Pump Stations



- Oregon Seismic Code
  - Before 1960 = none
  - 1960-70 = 0.06 g
  - 1970-90 = 0.12 g
  - 1990-2000 = ~ okay
  - 2000 → = stringent
- Pump Stations
  - 1/3 – major damage
  - 1/3 – some damage
  - 1/3 – minor affects
- Reservoirs
  - 2/3 – major damage
  - 1/6 – some damage
  - 1/6 – minor damage

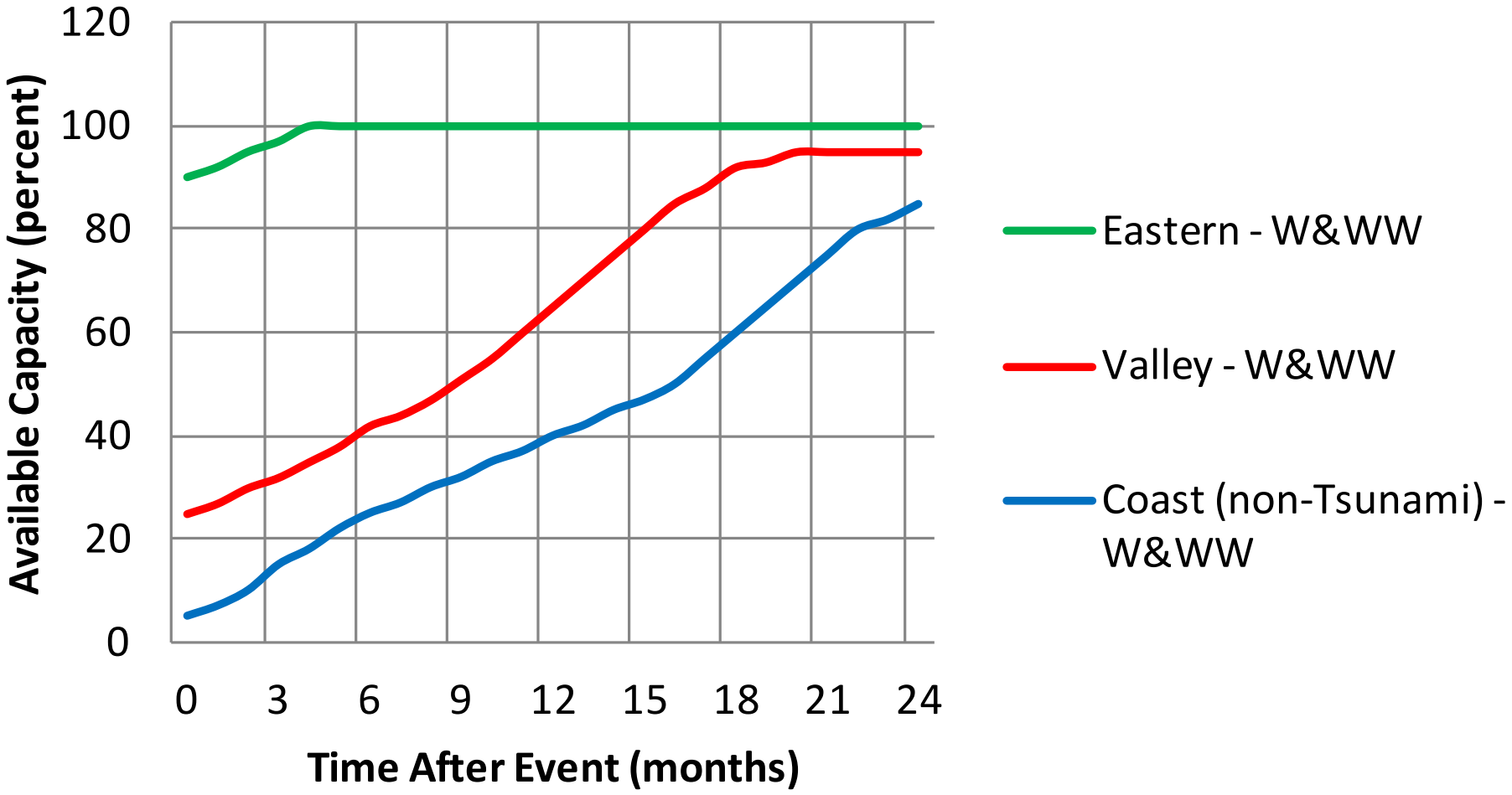
Resiliency Goals

Water & Wastewater System Performance



Existing Condition

Water & Wastewater System Performance



Water & Wastewater Findings & Conclusions

- Significant gap between goals and existing state
- If CSZ EQ occurs today, it will result in dramatic change in “life as we know it” for W & WW
  - Most water systems will drain contents
  - Major structural damage to supply facilities, WTPs, pump stations
  - Change in traditional firefighting methods
  - Emergency water distribution required
  - Significant risks to public health & safety
- Water generally better prepared than wastewater
  - Wastewater limitations will create critical public heath risks
  - Need for wide-emergency sanitation
  - Contamination of rivers, steams
  - Contamination downstream of Portland – sewage & chemicals

Water & Wastewater Findings & Conclusions

- Resiliency upgrades will improve recovery times
  - Focus on system “backbone” & water supply to critical facilities
  - Coordinate with first responders to plan priorities & response
  - Coast (non-tsunami) could recover in 1 – 6 months
  - Valley could recover in < 1 month
  - Significant improvements in public health & safety
- Costs will be significant but can be managed
  - Have long-term plan for making improvements over 50 years
  - Invest in “backbone” and “low hanging fruit”
  - Include seismic improvements with ongoing investments
  - Incremental costs are limited when part of replacement & maintenance of aging infrastructure

Water & Wastewater Recommendations

- Reset public expectations for recovery times
  - "72 hours" not realistic – more like "72 days"
  - Emergency water distribution systems
- Require seismic response plans by all sectors
  - Include business continuity, employee & family support
- Require seismic assessments for all systems
  - Part of periodic update of master plan
  - Characterize risks, impacts & recover times
- Fire & water agencies to set joint standards
  - Water supply & fire fighting expectations
  - Identify key water supply points & standards

Water & Wastewater Recommendations

- Include seismic upgrades as part of CIP
  - Focus on establishing hardened supply “backbone”
  - Additional priorities - master plan & asset management
  - State to include seismic requirements in design review
  - Industry associations to establish pipeline standards
- Agencies to set post-event compliance goals
  - Expectations for regulatory compliance & standards
  - Expectations for emergency water distribution
  - Expectations for temporary sanitation & waste disposal

State Plan
Findings & Conclusions

- Eastern Oregon will experience limited impacts
  - Can serve as resource for staffing, material & equipment
- Tsunami areas will take years to recover, if ever
- Coast critically impacted; up to 3 years
  - High seismic impacts due to proximity to fault, PGD & subsidence
  - Highly isolated due to transportation & energy disruptions
- Extensive impacts to Valley; 6 months – 1 year
  - Extensive damage to facilities built prior to early 1990s
  - Recovery hampered by impacts to transportation & energy
  - Staffing, access to material & equipment critical limitations

Report to the 77th Legislative Assembly
from
Oregon Seismic Safety Policy
Advisory Commission (OSSPAC)

State Plan
Findings of Other Sectors

- Oregon is far from resilient today to impacts of a great Cascadia Subduction Zone Earthquake
  - Casualties (1,250 to more than 10,000)
  - Economic Loss (close to 20% state GDP)
  - More than one million truck loads of debris
- Interdependencies will slow response & recovery
- Critical vulnerability of liquid fuels

Report to the
77th Legislative Assembly

from
Oregon Seismic Safety Policy
Advisory Commission (OSSPAC)

State Plan
Findings of Other Sectors

- Most businesses can tolerate only 2 - 4 weeks of disruption to critical services

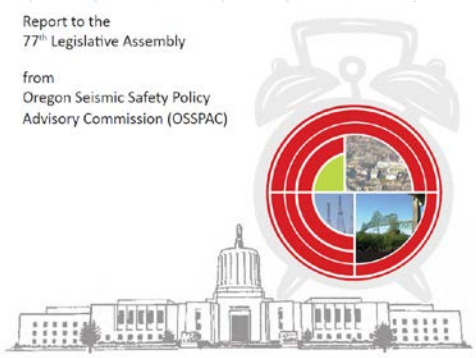
Critical Service	Zone	Estimated Time to Restore Service
Electricity	Valley	1 to 3 months
Electricity	Coast	3 to 6 months
Police and fire stations	Valley	2 to 4 months
Drinking water and sewer	Valley	1 month to 1 year
Drinking water and sewer	Coast	1 to 3 years
Top-priority highways (partial restoration)	Valley	6 to 12 months
Healthcare facilities	Valley	18 months
Healthcare facilities	Coast	3 years

State Plan
Next Steps

- Work with Oregon's Legislative Assembly to keep the 50-year goal in view
- Advocate community-level planning
- Support public / human resilience
- Invest in civic infrastructure
- Conduct joint planning with Washington

State Plan Recommendations

- Conduct comprehensive assessments of structures and systems that underpin Oregon's economy
- Launch a sustained program of capital improvement in Oregon's public structures
- Craft a package of incentives to engage Oregon's private sector to advance seismic resilience
- Update Oregon's public policies



Tualatin Valley Water District
Next Steps

- TVWD Seismic Resiliency Strategy
  - Updated design standards
  - Budget proposal
    - Facility assessment
    - Integration with master plan & asset management
    - Prioritization of capital improvements
    - Coordination with fire & emergency responders
    - Business recovery & continuity planning
  - Update Water Supply Strategy & Master Plan

Tualatin Valley Water District

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