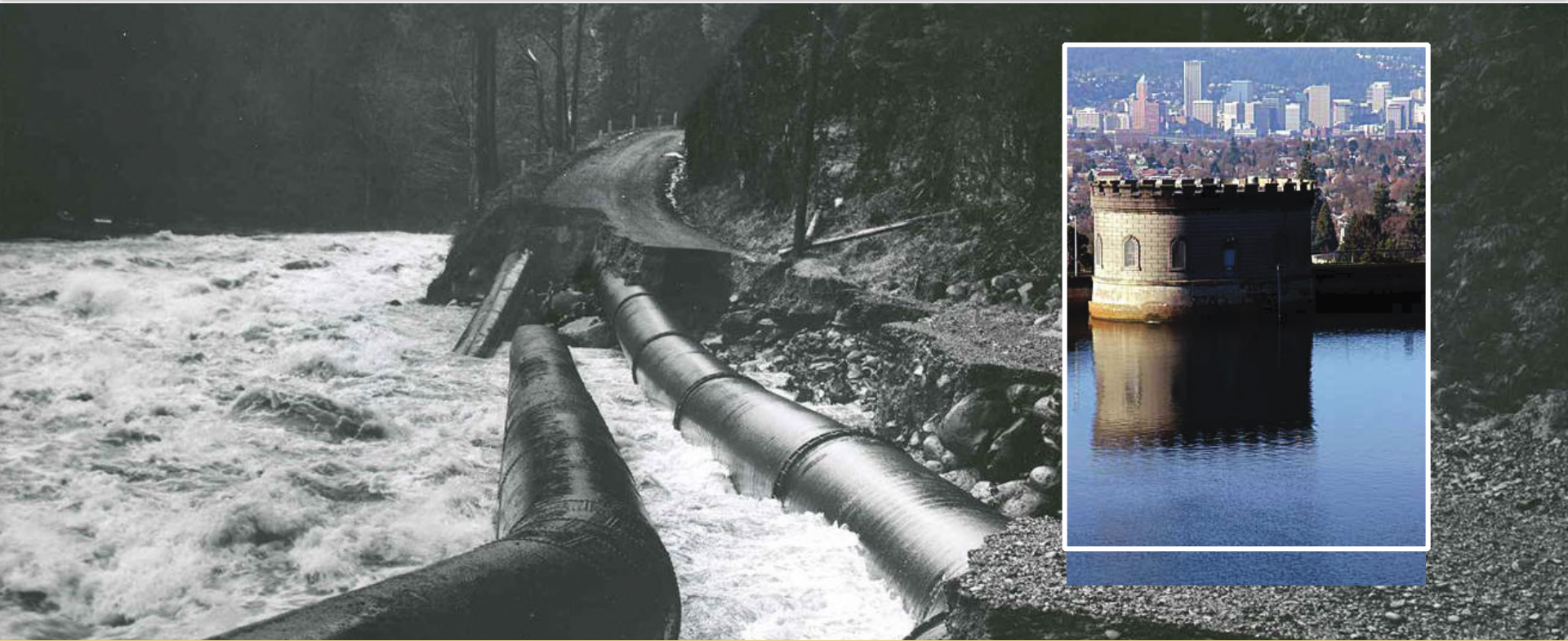
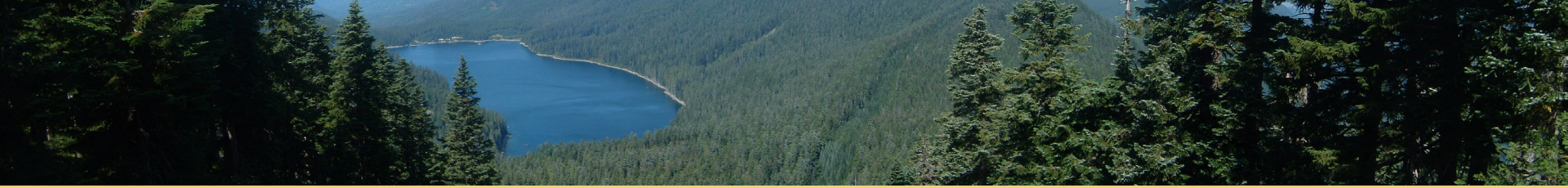


An Investigation of the Seismic Performance of Portland Water Bureau's Water System in an M 9.0 earthquake



CTWWA/JWWA/WRF Water System
Seismic Conference
October 2017



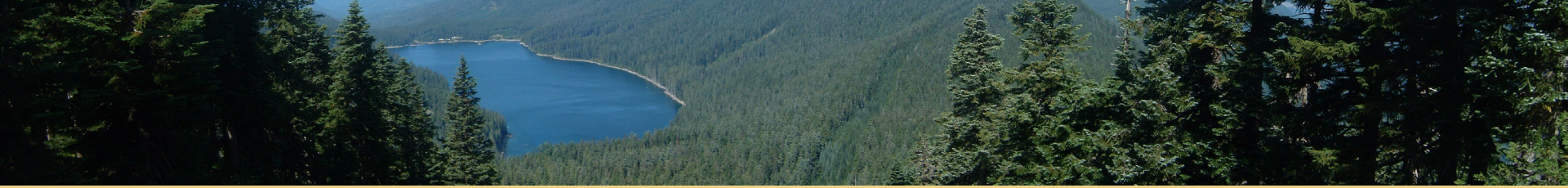


Overview

- Background
 - Portland's Water System
 - Oregon Resilience Plan
- Portland's Water System Seismic Study
- Water System Mitigation Recommendations
- Post Earthquake Repairs
- Next Steps

Portland's Water System





2 Dams



100 miles of
large pipe



2,200 miles of
Smaller dia. pipe



58 Tanks



15,000 hydrants



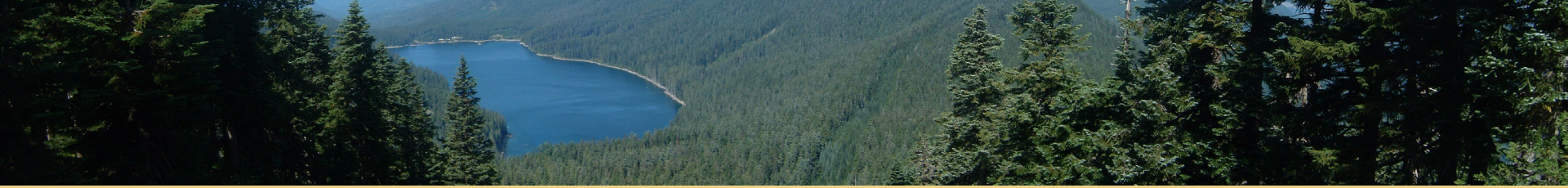
40,000 valves



180,000 meters

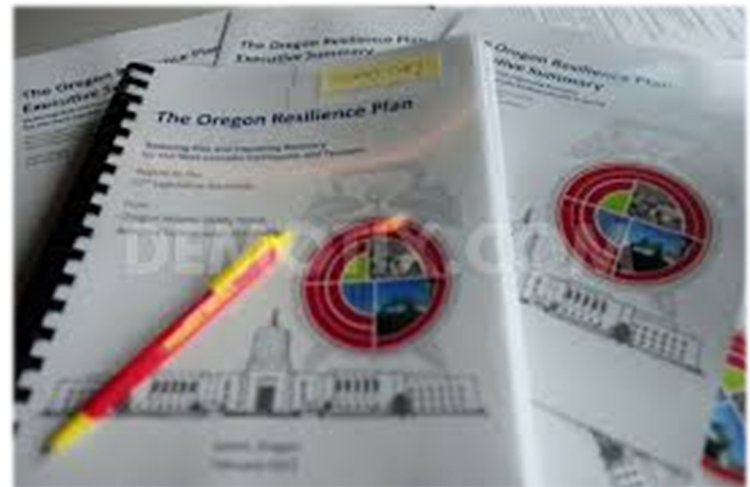


38 pump stations



Oregon Resilience Plan (ORP)

- **Specifies likely impacts of a magnitude 9.0 Cascadia earthquake.**
- Defines target states of recovery goals to be met within 50 years.
- Recommends changes in practice and policy.
- [http://www.oregon.gov/OMD/OEM/ospac/docs/Oregon Resilience Plan Final.pdf](http://www.oregon.gov/OMD/OEM/ospac/docs/Oregon%20Resilience%20Plan%20Final.pdf)

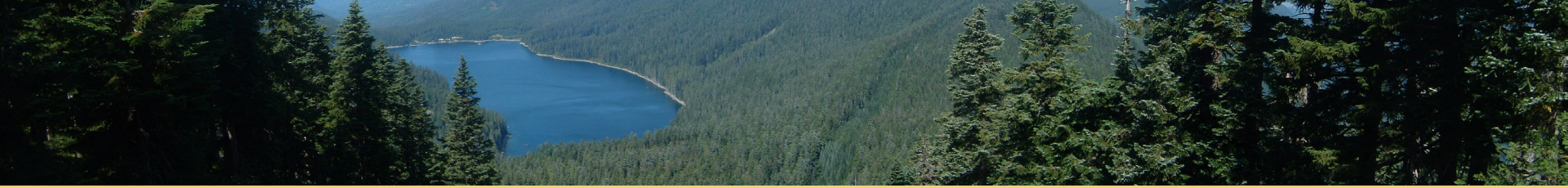




ORP – Target States of Recovery

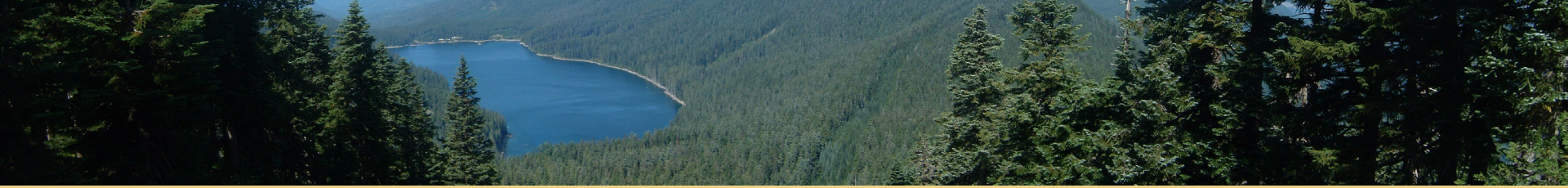
Event Occurs

Domestic Water Supply	0-24 hours	1-3 days	3-7 days	1-2 weeks	2 weeks - 1 month	1-3 months	3-6 months	6-months - 1 year	1-3 years	3+ years
Potable water available at supply source (WTP, wells, impoundment)	20%-30% operational	50%-60% operational		80%-90% operational			90% operational (current state)			
Main transmission facilities, pipes, pump stations, and reservoirs (backbone operational)	80%-90% operational					90% operational (current state)				
Water supply to critical facilities available	50%-60% operational	80%-90% operational				90% operational (current state)				
Water for fire suppression - at key supply points	80%-90% operational		90% operational (current state)							
Water for fire suppression - at fire hydrants			20%-30% operational	50%-60% operational	80%-90% operational			90% operational (current state)		
Water available at community distribution centers/points		50%-60% operational	80%-90% operational	90% operational (current state)						
Distribution system operational		20%-30% operational	50%-60% operational	80%-90% operational				90% operational (current state)		



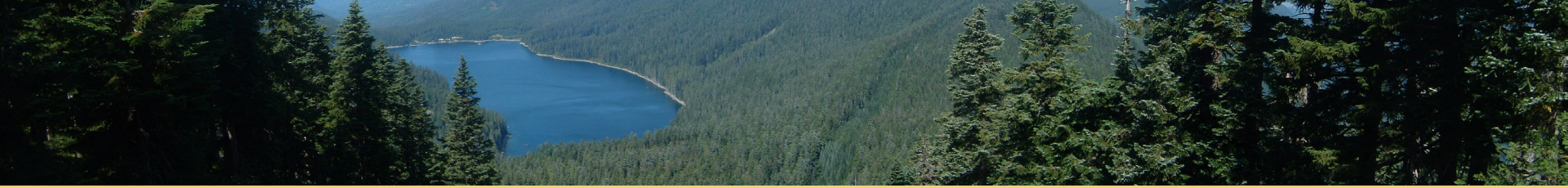
Water System Seismic Study Project Objective

- ❖ Comply with the Oregon Resilience Plan (ORP)
 - i. Complete a seismic risk assessment of PWB's water system.
 - ii. Produce an infrastructure mitigation plan to meet or exceed the water recovery goals (target states of recovery) listed in the ORP.

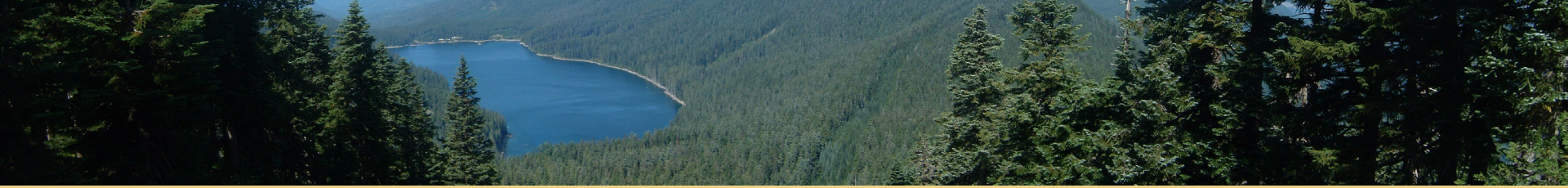


Water System Seismic Tasks

- Task 1 – Determine Permanent Ground Deformation (PGD)
- Task 2 – Assess pipeline and facility performance
- Task 3 – Model backbone system performance
- Task 4 – Emergency preparedness and response
- Task 5 – Develop & prioritize mitigation measures

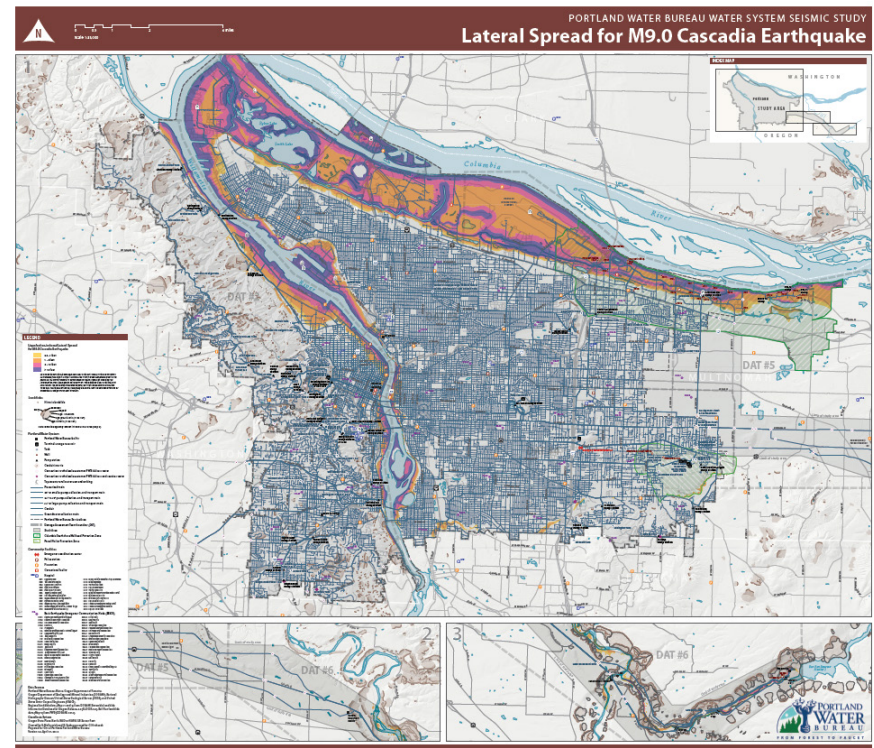


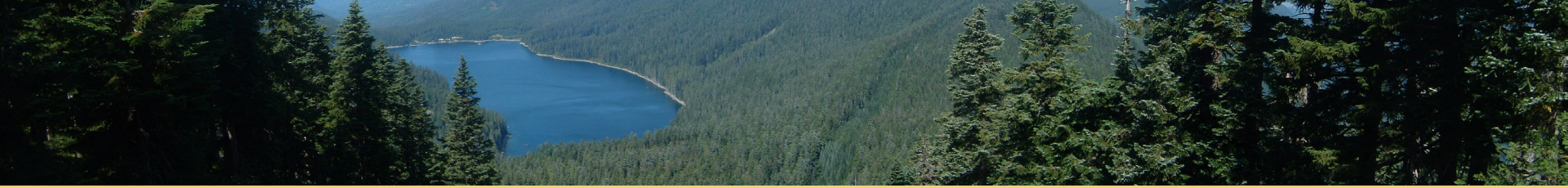
Task 1– Determine Permanent Ground Deformation



Deliverables

- Four (4) PDF Maps along with four new ArcGIS layers in the City's ArcGIS mapping system
 - Liquefaction Hazard
 - Lateral Spread
 - Ground Settlement
 - Landslide Deformation

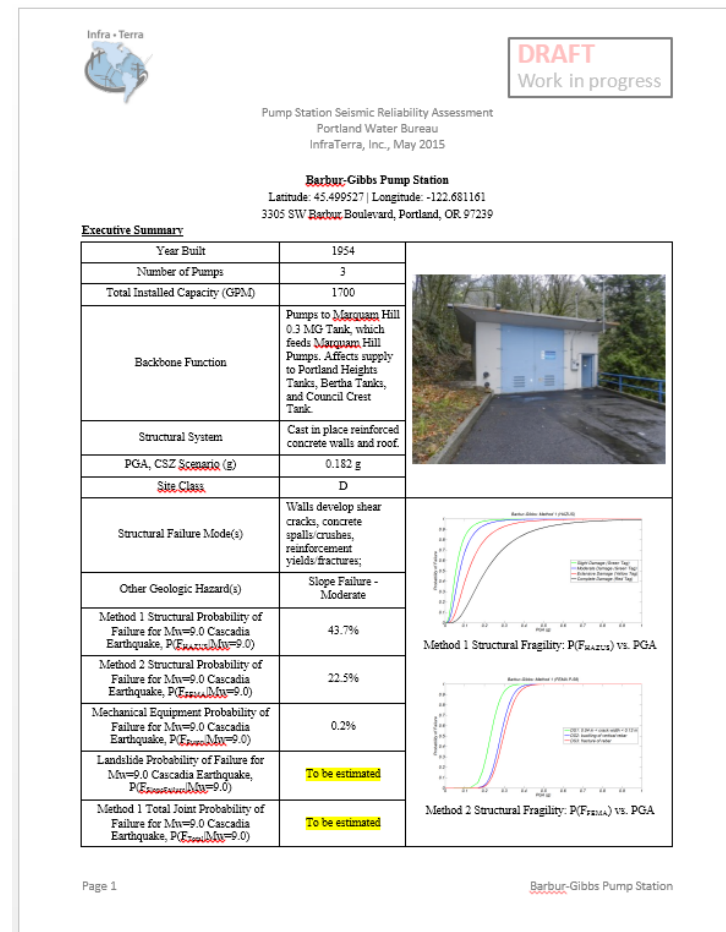


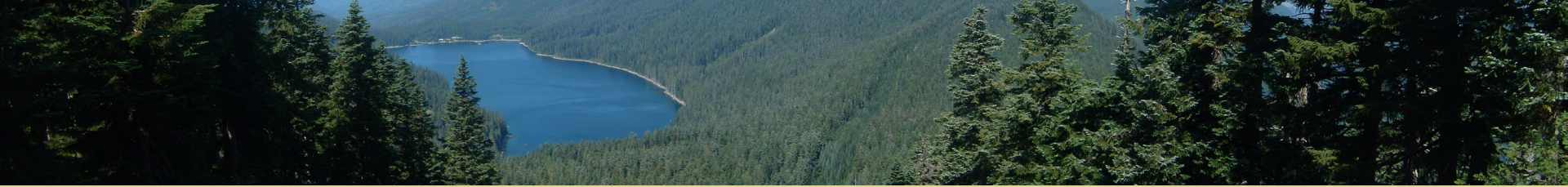


Task 2– Assess Pipeline and Facility Performance

Facility Assessment

- As-built drawings and design specs
- Site reconnaissance
- Total (38) Pump Stations
- Total (58) Tanks





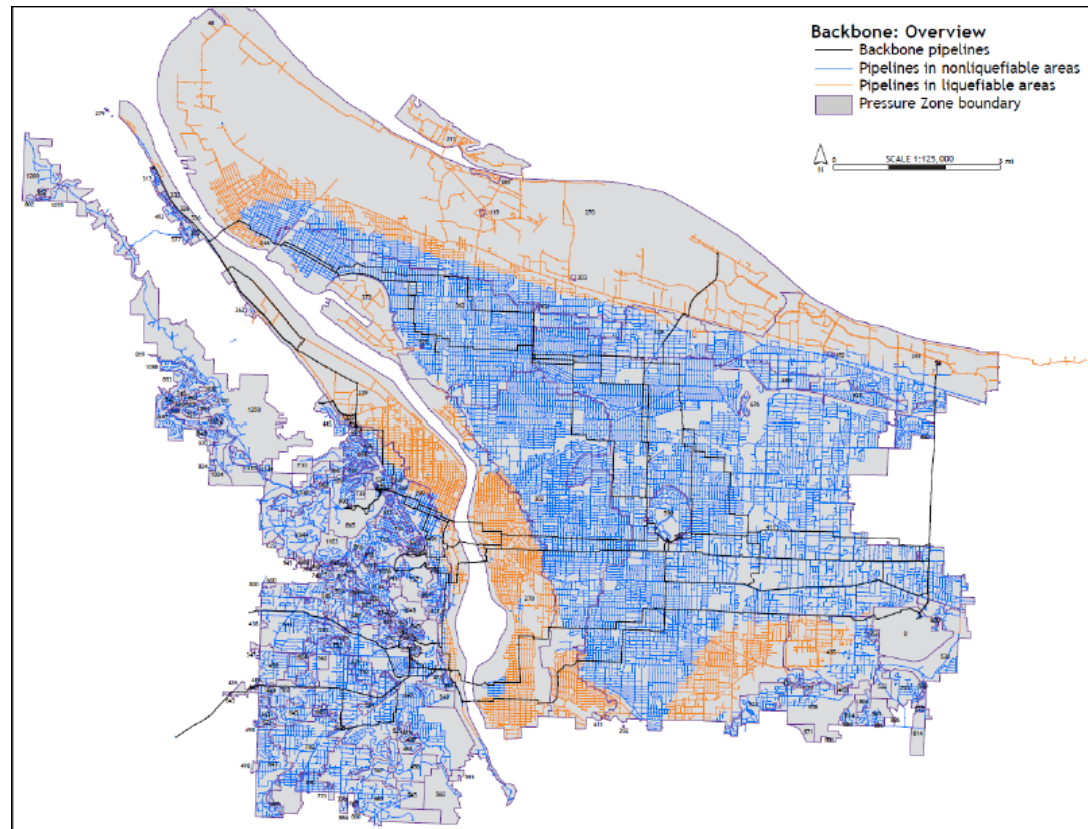
Pipeline Failures

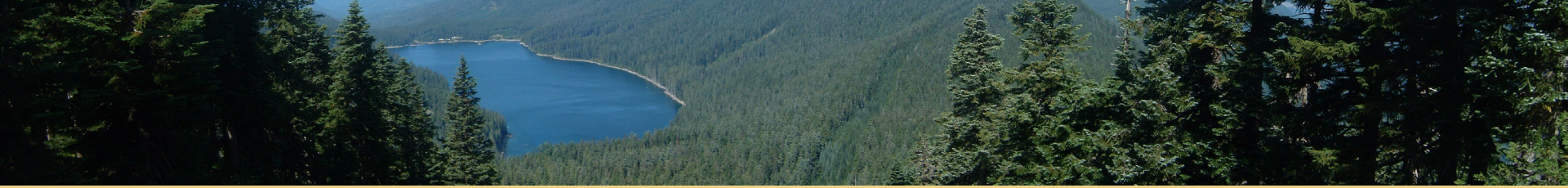
■ TGD

- 1 failure every 16 miles (1 break every 80 miles and 1 leak every 20 miles)

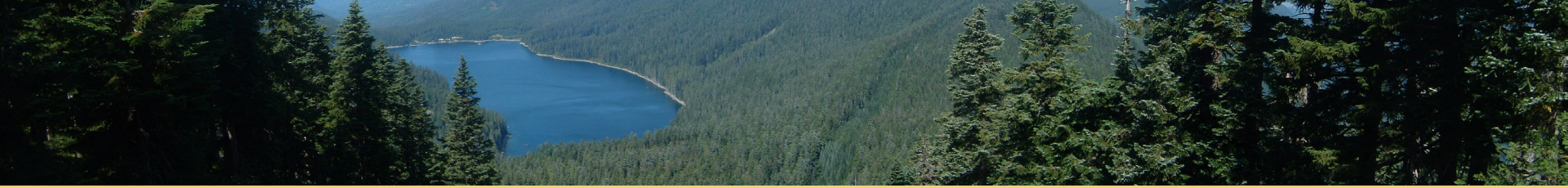
■ PGD

- 12 to 16 failures each mile

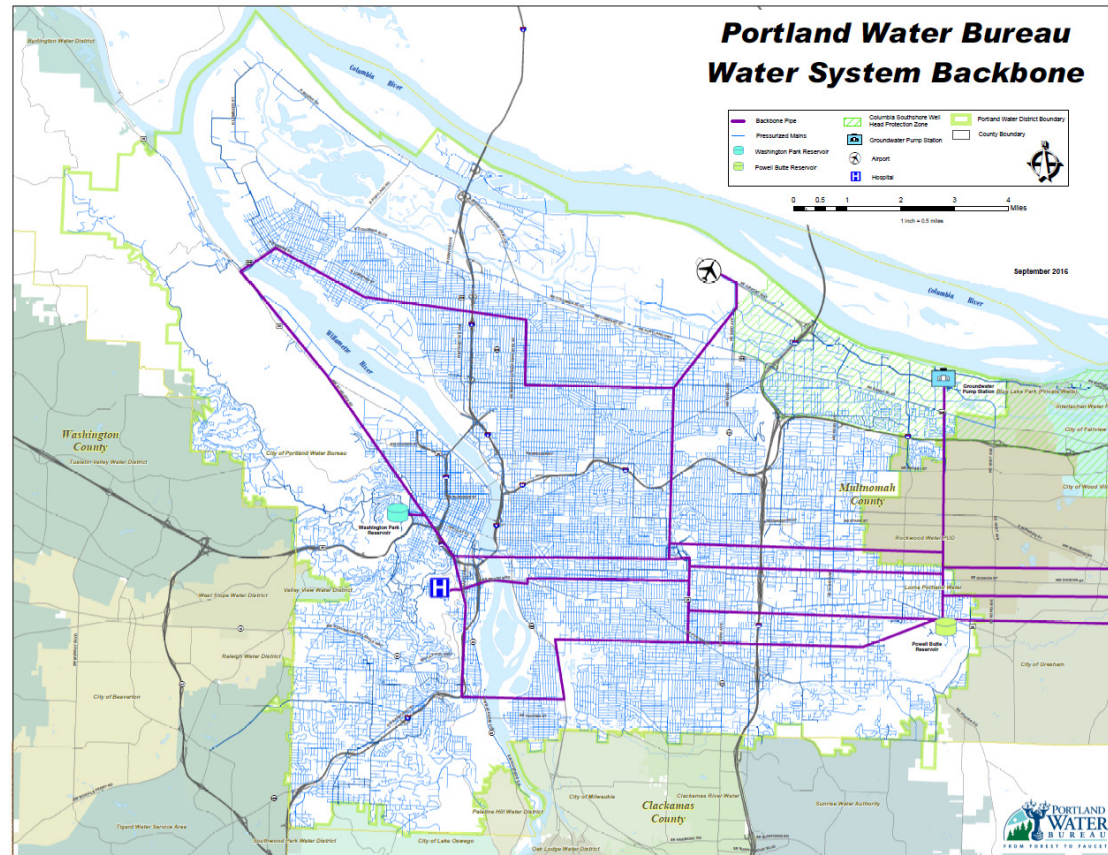


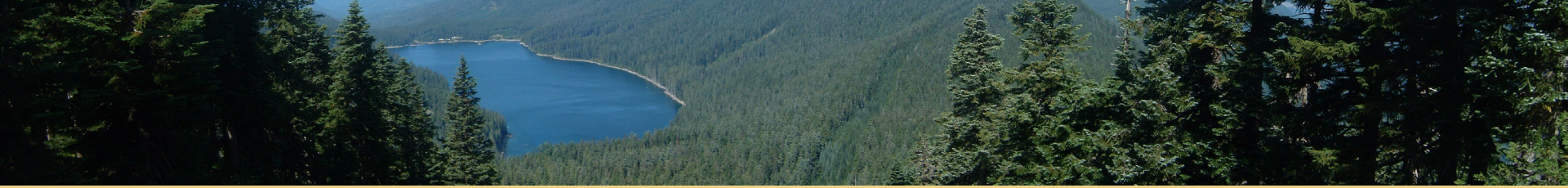


Task 3– Model Backbone System Performance



- Identified backbone including significant pipelines and critical facilities
- Used PWB's hydraulic model of the distribution system
- ORP goal is to have the backbone in service within 24 hours of the event



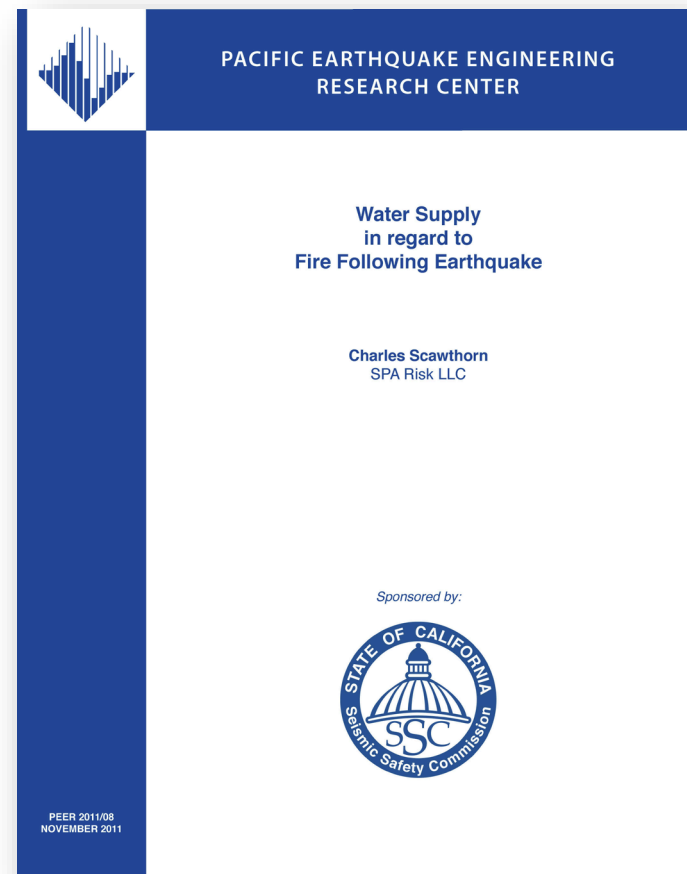


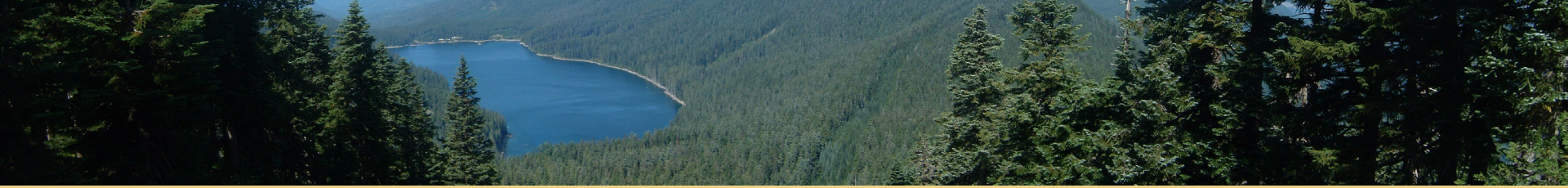
Task 4– Emergency Preparedness & Response

Task 4 – Emergency Preparedness & Response

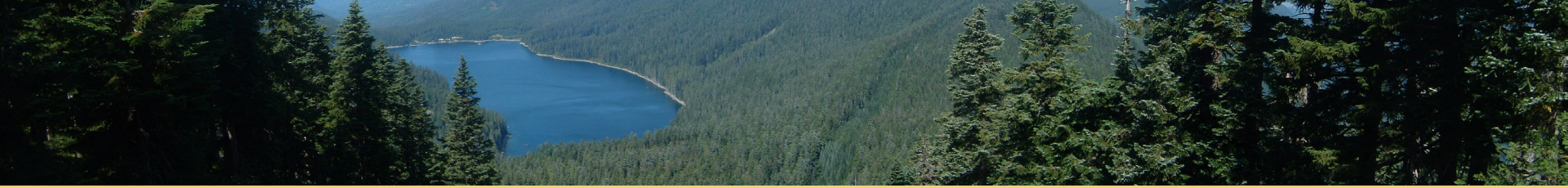
Review Emergency Plans:

- Repair Plan
- Fire Flow Plan
- Potable Water Plan



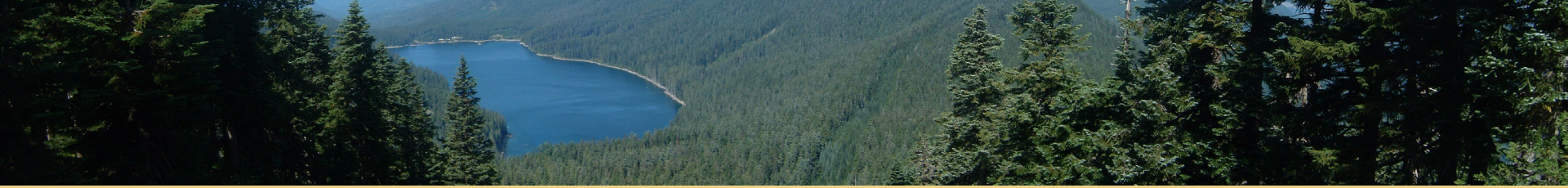


Task 5— Develop and Prioritize Mitigation Measures



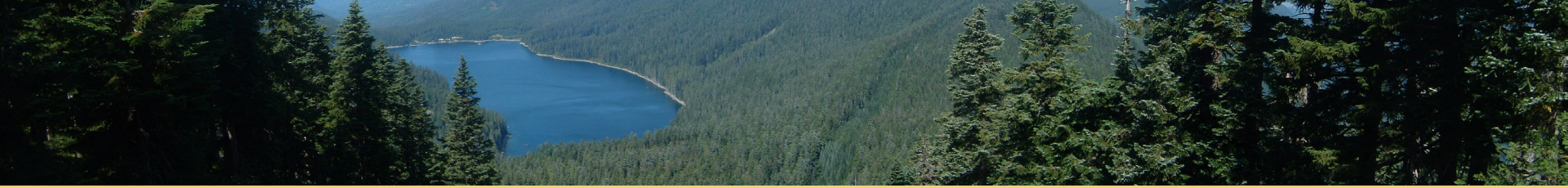
Seismic Study Recommendations

- CIP Improvements - \$980 million
 - Supply (Conduits, Groundwater)
 - Backbone (river crossings, terminal storage)
 - Distribution (liquefaction-susceptible piping)
 - Pump Stations (seismic retrofits)
 - Storage (tank anchorage, flexible piping connections)



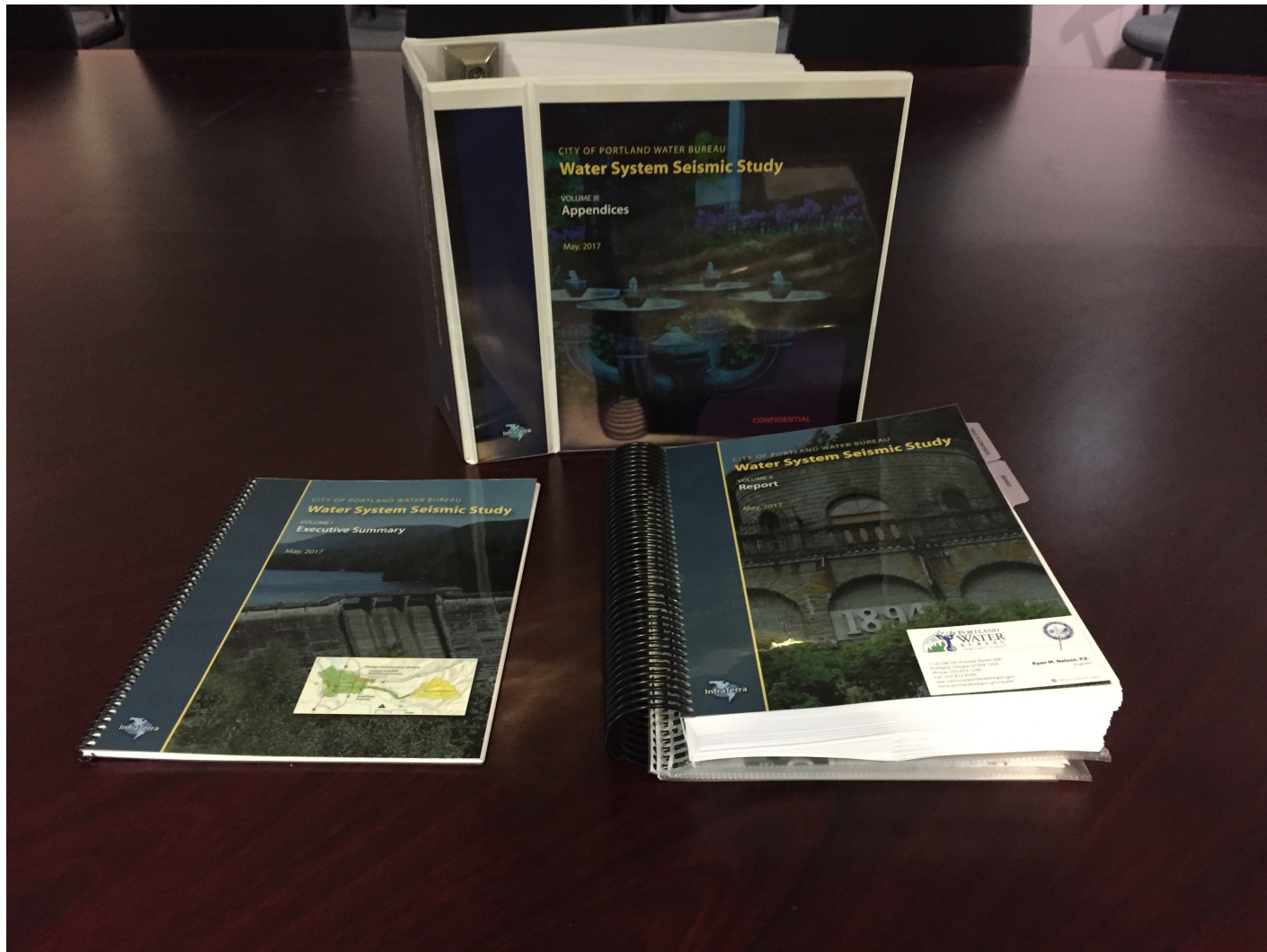
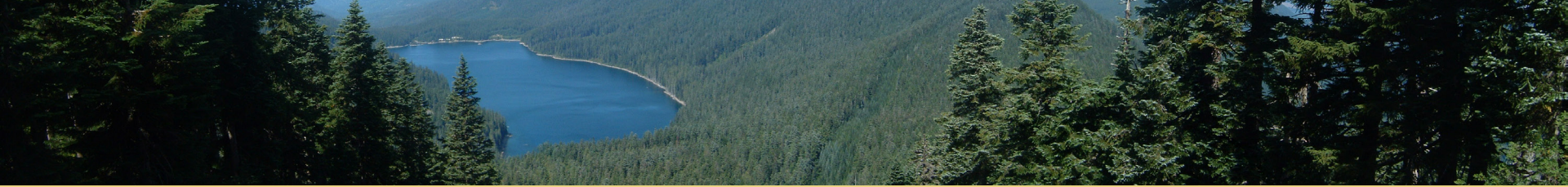
Seismic Study Recommendations

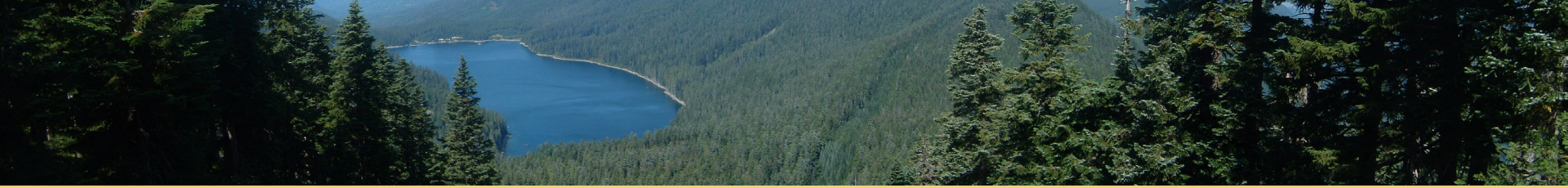
- Non-CIP projects
 - Pressure zone isolation plan to limit system leakage
 - Mutual aid agreements and on-call contracts
 - Additional seismic evaluation of Conduit bridges
 - Stockpile repair resources
 - Assess need for additional portable generators
 - Develop and maintain hard copy utility maps
 - Anchorage for electrical, mechanical, and communication equipment



Post-Earthquake Repairs

- System Restoration
 - Rapid identification and isolation of damaged areas
 - Time and resources required for restoration
 - 5 days min for backbone leak repairs (40 crews; 12-hour days)
 - 5 weeks min for distribution leak repairs (40 crews; 12-hour days)
 - Cannot currently meet ORP guidelines





Next Steps

- Water System Seismic Study completed
- Proceeding with Implementation Plan (Capital, Non-Capital)
- Coordination with other lifelines for total mitigation