2015/2016 SPU Seismic Study

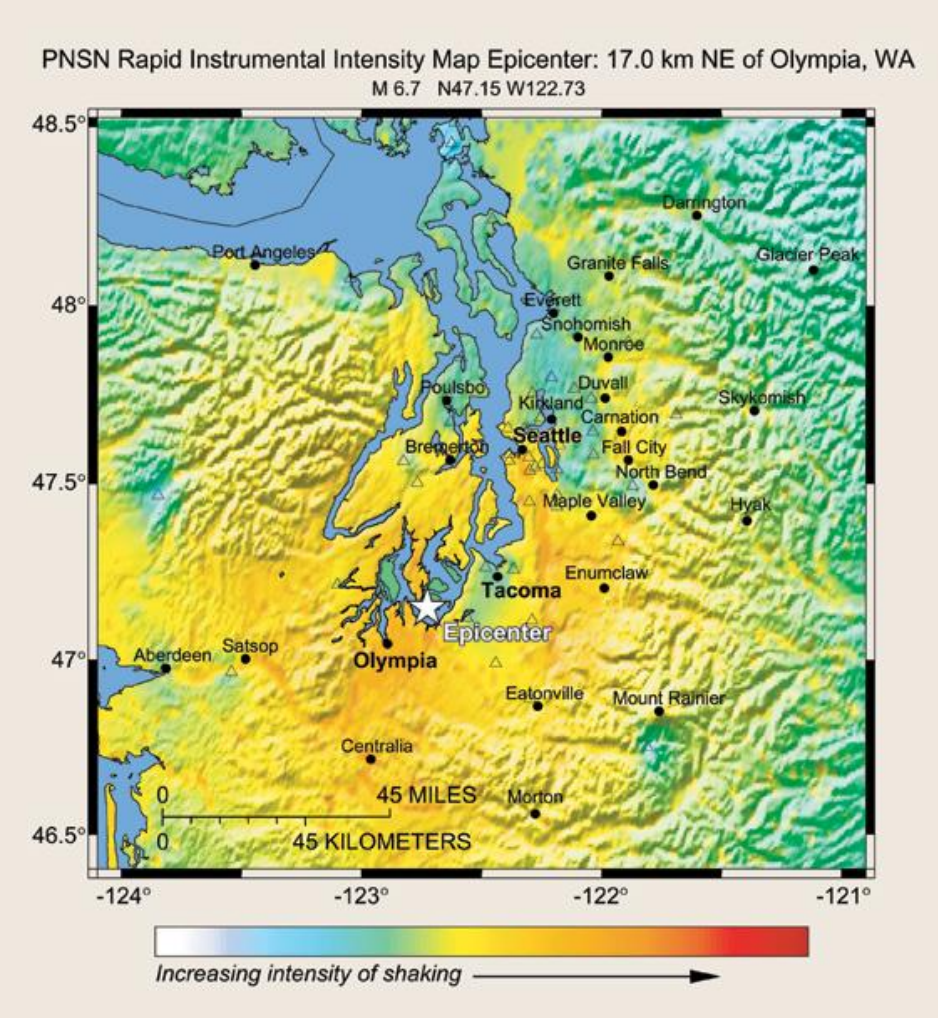
Project Briefing

February 18, 2015

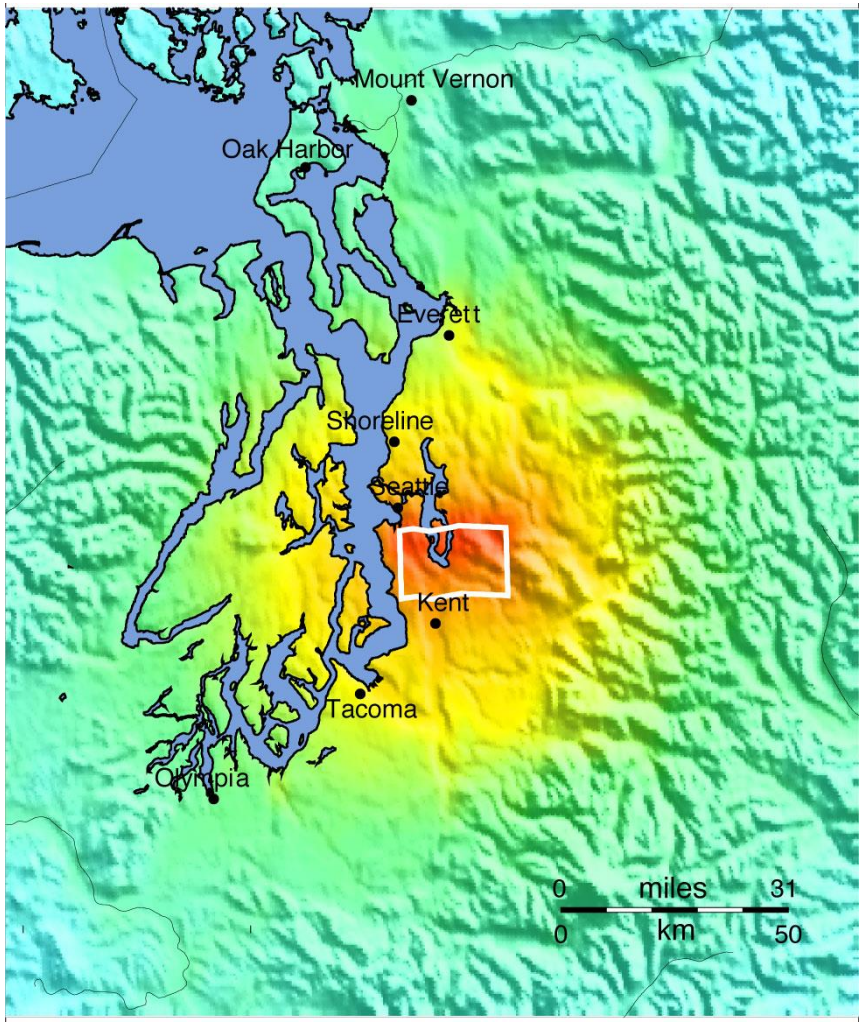
Outline

- Water system performance in past earthquakes
- Pacific Northwest/SPU earthquakes and earthquake hazards
- SPU Seismic Program background
- Seismic Study goals and schedule
- Post-earthquake performance goal development

Magnitude vs. Intensity



Magnitude 6.8 2001
Nisqually Earthquake



Magnitude 6.7 Seattle Fault
Earthquake Scenario

Loma Prieta (San Francisco) - 1989

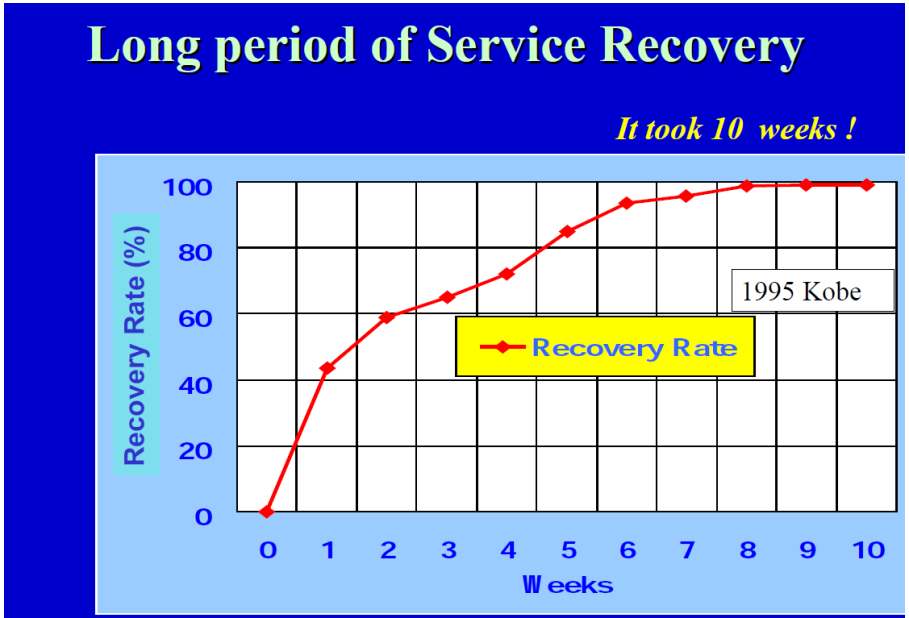
- M6.9 (epicenter 60 miles south/southeast of San Francisco)
- Approximately 1000 watermain breaks
- Water system damage mostly in areas of poor soils
  - Water outage durations usually less than a few days
  - Fire suppression water was an issue in Marina District

Northridge - 1994

- M6.7 (previously unknown fault)
- Over 1000 watermain breaks
- Over 100 fires
- Water system damage mostly in areas of poor soils
  - Outage durations over 8 days
  - Swimming pools used for fire suppression

Kobe - 1995

- M6.9
- Thousands of Pipeline Failures
- Two Months to Completely Restore Water Service
- Over 100 Fires



Christchurch – 2010/2011

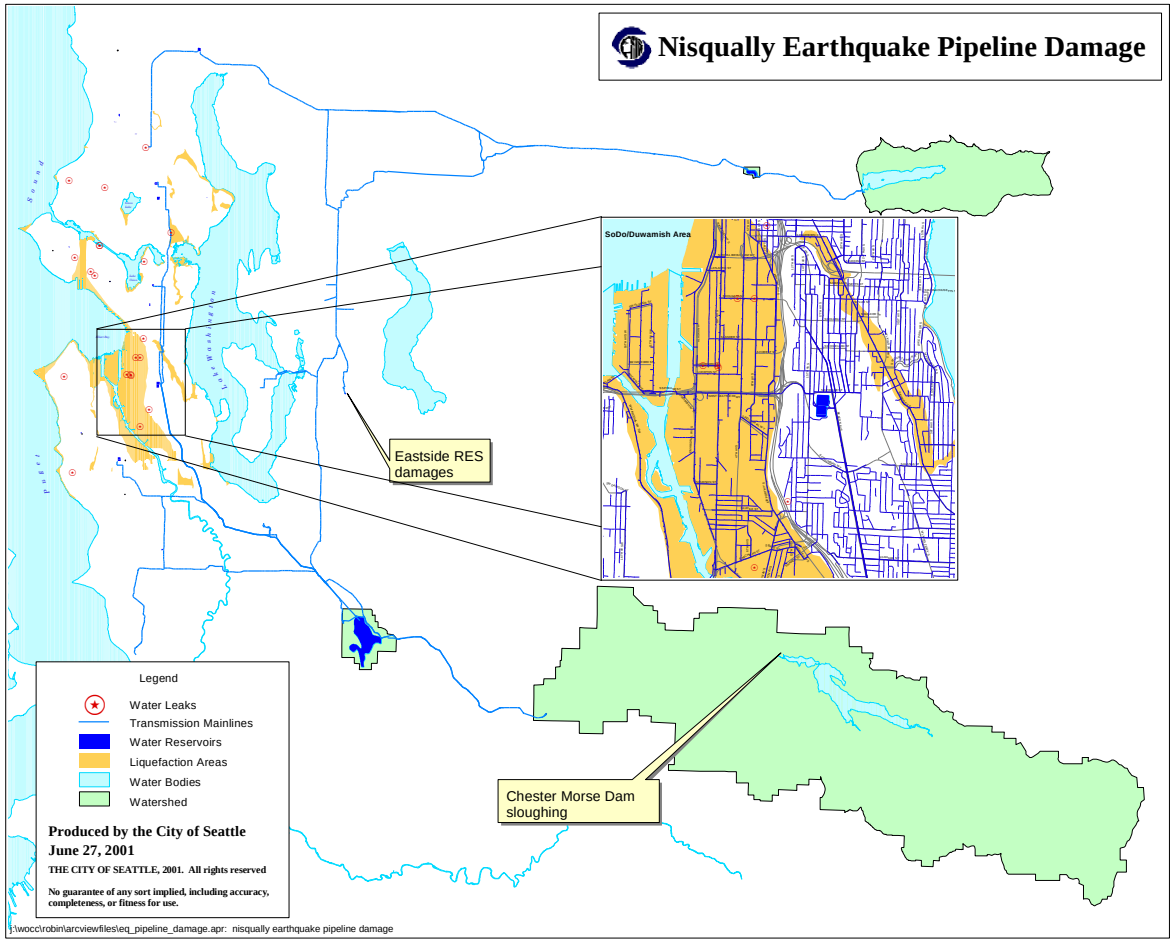
- M6.3 (direct hit)
- Restoration Times
  - Pipe System – Over One Month
  - Treatment – Two Months
- Few Fires

Earthquakes	Pipe material	Pipe length (km)	Repairs	Overall average *RR*	Repairs in LIQ[1] areas	Pipeline in LIQ[1] areas (%)	Average *RR* in LIQ[1] areas	Average *RR* in non-LIQ[1] areas
22 February 2011	AC	861.5	1,135	1.32	965	47.1	2.38	0.37
	CI	191.6	268	1.40	232	68.3	1.77	0.59
	PVC	208.7	71	0.34	67	53.6	0.60	0.04
	MPVC	149.7	16	0.11	15	32.7	0.31	0.01
	Other	301.3	155	0.51	134	47.1	0.94	0.13
	Total	1,712.7	1,645	0.96	1413	49.0	1.68	0.27

Tohoku (Japan) – 2011

- M9.0
- Over 2.2 Million Households Lost Water Service
- Water Service Restoration of Up to Two Months
- Over 300 Fires
- No ERDIP Failures

Nisqually Earthquake - 2001



- M6.8, hypocenter near Olympia, 32 miles deep
- Minimal effect on SPU functionality
- Approximately $4 million in earthquake related costs
- Masonry Pool Engineered Fill Failure
- 12 Pipe breaks and 7 pipe leaks
- 500 Ft. Long, ½-Inch wide crack in Cascades Dam

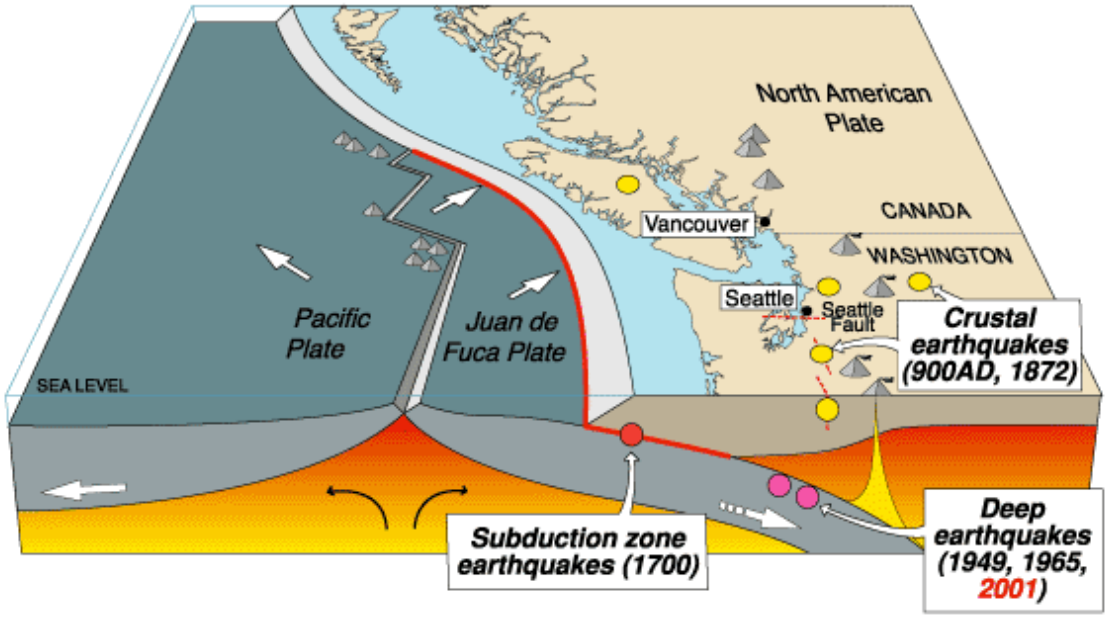
Nisqually 2001 (cont)

- TOLT EAST SIDE SUPPLY LINE JUNCTION VALVE STATION DAMAGE
- SPU ADMINISTRATION (DEXTER HORTON) BUILDING NONSTRUCTURAL DAMAGE
- EASTSIDE RESERVOIR FLOOR CRACKS AND ROOF DAMAGE
- OPERATIONS AND CONTROL CENTER DAMAGE

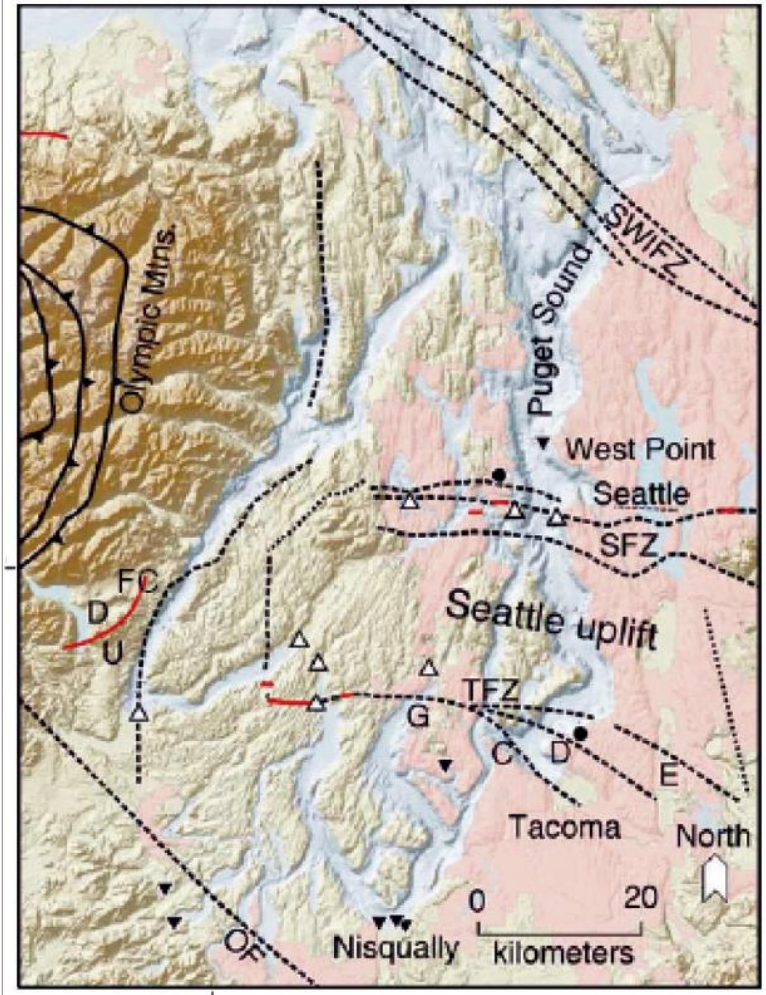
Washington Earthquake Source Zones

USGS

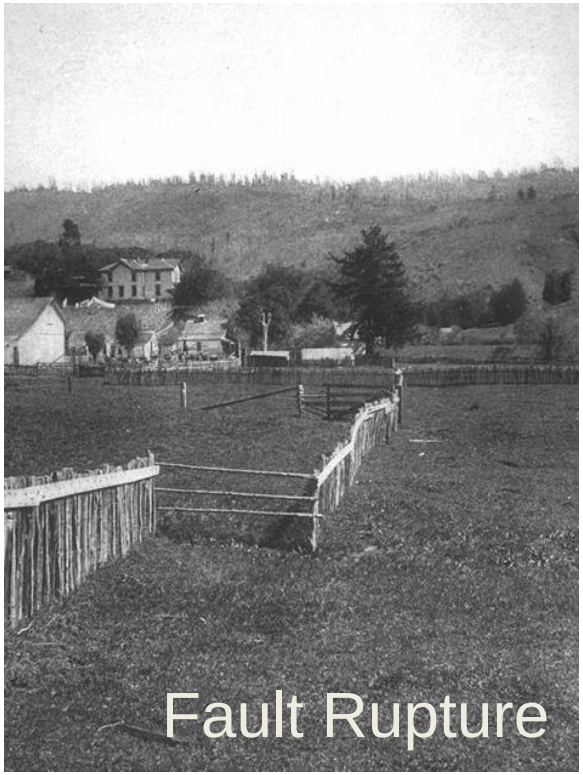
Cascadia earthquake sources



Source	Affected area	Max. Size	Recurrence
Subduction Zone	W.WA, OR, CA	M 9	500-600 yr
Deep Juan de Fuca plate	W.WA, OR,	M 7+	30-50 yr
Crustal faults	WA, OR, CA	M 7+	Hundreds of yr?



Earthquake Hazards

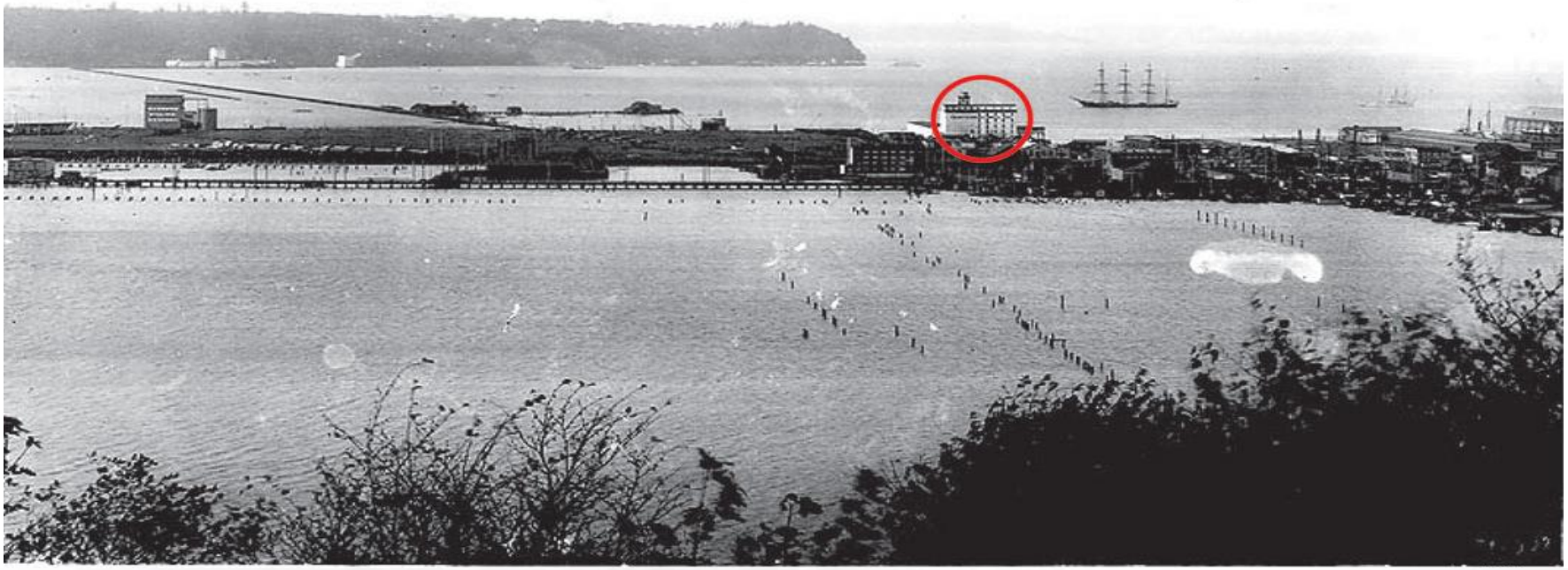


Earthquake Hazards - Liquefaction

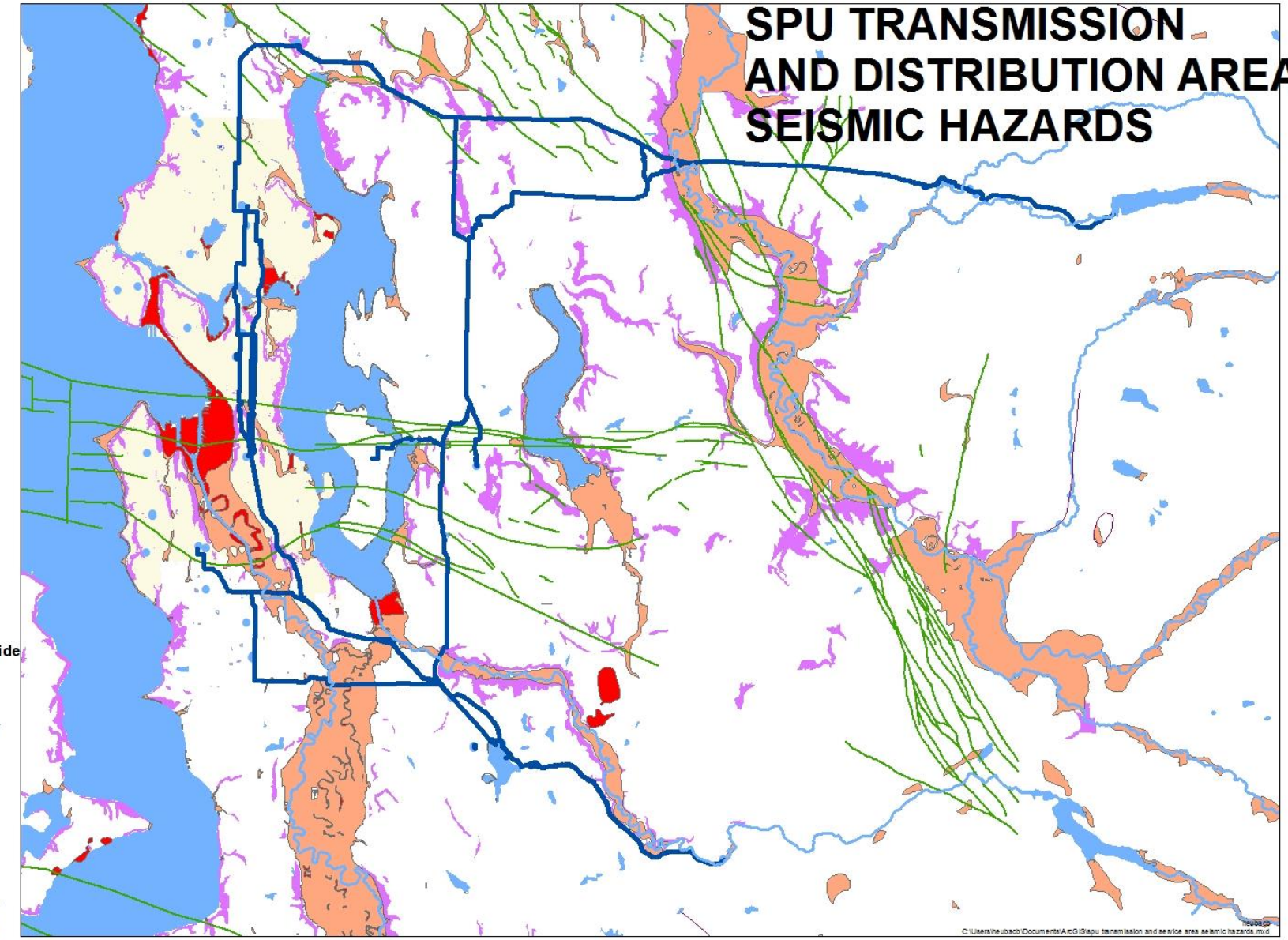
https://www.youtube.com/watch?v=-eH5fh0YEuQ

SODO from Beacon Hill - 1881

SODO from Beacon Hill – 1901 and 1914



SPU TRANSMISSION AND DISTRIBUTION AREA SEISMIC HAZARDS



LEGEND

- Supply Mains
- Active Faults
- Known or Potential Landslide
- Reservoirs/Tanks
- Liquefaction Susceptibility
  - High
  - Moderate to High

N

0 1 2 3 4 5

Miles

12/30/2014

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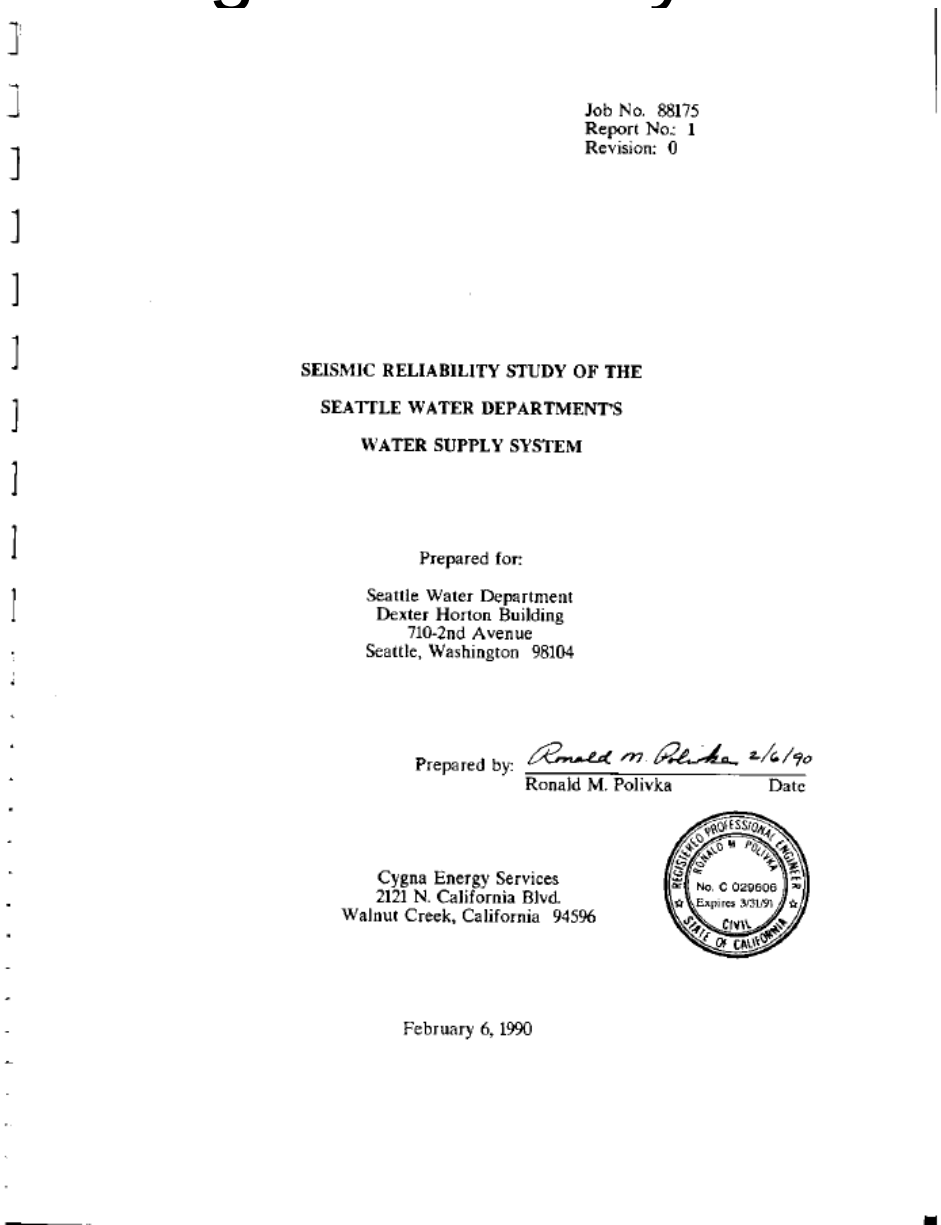
Coordinate System: State Plane, NAD83-91, Washington North Zone

C:\Users\neubacb\Documents\ArcGIS\spu transmission and service area seismic hazards.mxd

SPU Seismic Mitigation Program History

- Seismic Reliability Study of the Seattle Water Departments Water Supply System (Cygna Energy Services, 1990)
- Earthquake Loss Modeling of the Seattle Water System (Kennedy Jenks Chilton/USGS, 1990)



Job No. 88175
Report No.: 1
Revision: 0

SEISMIC RELIABILITY STUDY OF THE
SEATTLE WATER DEPARTMENT'S
WATER SUPPLY SYSTEM

Prepared for:

Seattle Water Department
Dexter Horton Building
710-2nd Avenue
Seattle, Washington 98104

Prepared by: Ronald M Polivka 2/6/90
Ronald M. Polivka Date

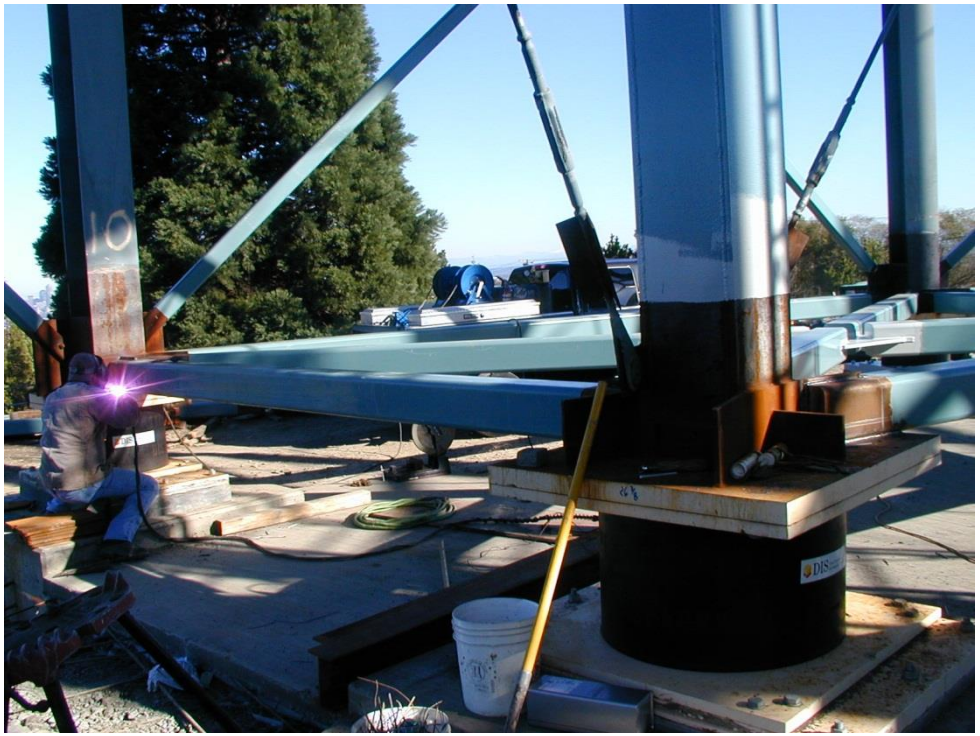
Cygna Energy Services
2121 N. California Blvd.
Walnut Creek, California 94596

REGISTERED PROFESSIONAL ENGINEER
RONALD M POLIVKA
No. C 029606
Expires 3/31/91
CIVIL
STATE OF CALIFORNIA

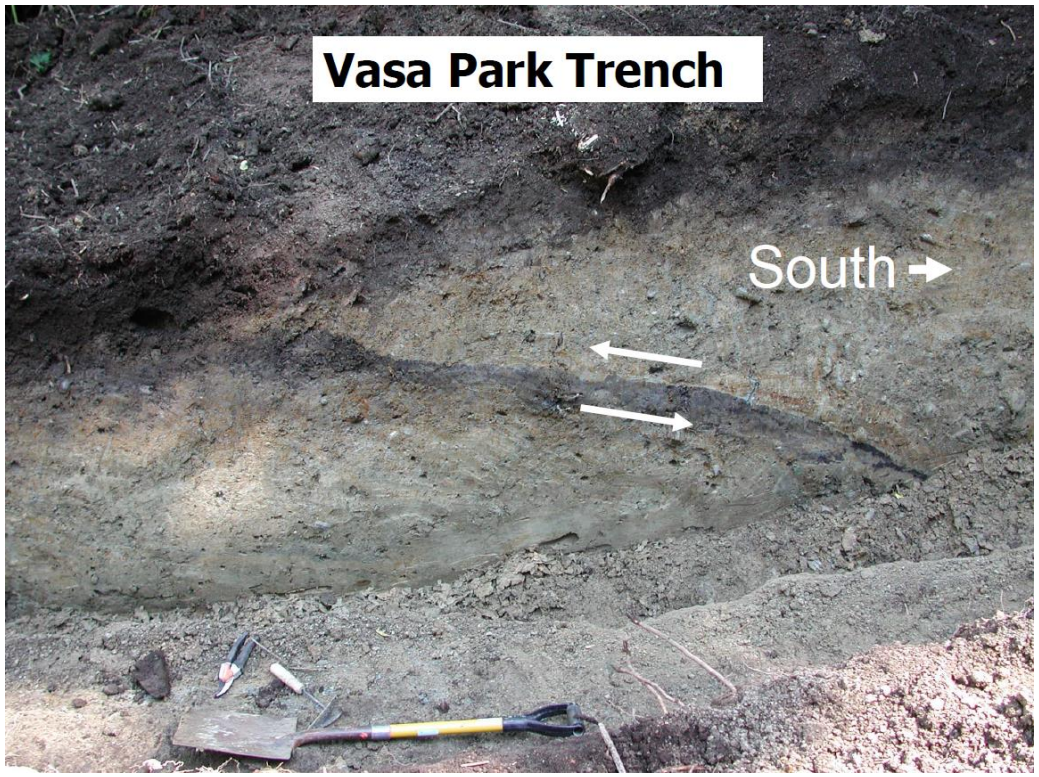
February 6, 1990

SPU Seismic Mitigation Program History (continued)

- SPU Seismic Upgrade Program (e.g., OCC, Myrtle Elevated Tanks, Barton Standpipe, etc.)
- Performance of Water Supply Systems in the February 28, 2001 Nisqually Earthquake (system post-earthquake hydraulic modeling, Water Research Foundation, 2008)



What's Changed (since 1990)



- Active surface faults identified throughout Puget Sound region (e.g., Seattle Fault, South Whidbey Island Fault, Tacoma Fault, etc.)
- Migration from 10% probability of exceedance in 50 years (475 year return interval) design earthquake to 2% probability of exceedance in 50 years (2475 year return interval) design earthquake

What's Changed (since 1990 - continued)

THE WALL STREET JOURNAL.

DOW JONES ★★★★ MONDAY, APRIL 15, 2013 - VOL. CCLXI NO. 87 WSJ.com ★★★★ $2.00

Lastweek: DJIA 14865.86 ▲ 299.81 2.1% NASDAQ 3294.95 ▲ 2.8% NIKKEI 13485.14 ▲ 5.2% STOXX 600 292.39 ▲ 1.8% 10-YR. TREASURY ▼ 7/32, yield 1.725% OIL $91.29 ▼ $1.41 EURO $1.3111 YEN 98.41

A2 | Monday, April 15, 2013 THE WALL STREET JOURNAL.

U.S. NEWS

Los Angeles Tests Water Pipes That Stand Up to Quakes

By Hamilton Kapp

Los Angeles has with a strategy t the Big One: earth water pipes made w

The Los Angeles of Water and Power ished installing a about 2,000 feet kind of iron pipli Fernando Valley.

The piping, mad Kubota Corp. and withstand ground quakes in Japan— 360-magnitude T quake that struck gering a tsunami.

Unlike traditional these so-called duc are able to withstr cause they can bend stead of buckling ure. The system to work like a chai doesn't break open various components

LADWP supervi Craig Davis learned about it—it's really only recently that you could identify this pipe system as earthquake-resistant," pipes in 2003 and negotiated to import some for the Los Angeles pilot project shortly after the

Initially, the city plans to replace only a fraction of its piping—about 2 miles of the total price of the standard water pipe used in Los Angeles. The first test installation cost

one U.S. manufacturers ductile iron pipe, rieties haven't been de- with quakes in mind, nor ey been tested through so many tremblors as in Mr. O'Rourke said.

while, the LADWP is a different kind of pipe- ng technology used in aland to protect Los An- water supply as it crosses Andreas fault through a on its way to the city. Al- continuous plastic pipes be easily integrated into the city's cast-iron dis- n system, the agency route water through one be just as it passes the Elizabeth Tunnel, uld easily save in during quake. Construction is to begin in the fall on the on project.

reduces significantly of losing the water sup- os Angeles, which would al threat to the U.S., not Southern California," Mr. e said.

said Thomas O'Rourke, an engineering professor at Cornell University who studies such pipes.

In 1994, the 6.7-magnitude Northridge earthquake cost Los Angeles more than $40 million

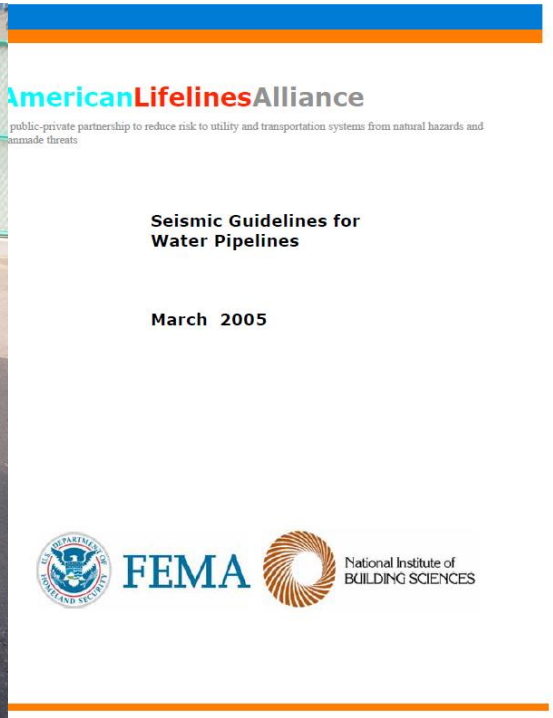
- Earthquake Experience (e.g., Northridge, Japanese, Chilean and New Zealand events)
- Potential for mass availability of earthquake-resistant pipe in U.S.

Seismic Vulnerability Assessment - Project Goals

- **Establish post-earthquake water transmission and distribution system performance goals**
- Preliminary seismic vulnerability assessments for all critical water transmission and distribution system facilities.
  - Defined earthquake scenarios
  - ASCE/SEI 7-10 (Building Code)
- Hydraulic modeling of post-earthquake water system performance

Seismic Vulnerability Assessment - Project Goals (continued)

- Develop planning level mitigation measures, cost estimates and timeframe to meet service level goals.
- Define seismic design standards for water transmission and distribution pipelines.



Seismic Project Milestone Target

- Consultant NTP – 2nd Qtr 2015
- Performance Goals – 1st Qtr 2016
- Preliminary findings – 1st Qtr of 2016
- Final report – 2nd Qtr 2016

DAILY JOURNAL OF COMMERCE

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City of Seattle
Water System Seismic Vulnerability Study

CITY OF SEATTLE
PUBLIC UTILITIES
NOTICE OF INTENT
Project: Seattle Public Utilities Water System Seismic Vulnerability Study

To Potentially Interested Party

The City of Seattle Public Utilities (SPU) is anticipating issuing a Request for Qualifications and Project Approach (RFQPA) in March 2015 for water systems lifeline earthquake engineering services. These Consulting engineering services will be needed to perform a seismic vulnerability study for the SPU drinking water system and system facilities, develop mitigation options and design standards for the installation of new SPU water main/pipes.

The selected consultant team will be expected to assist SPU with the following activities listed below.

•Use existing seismological and geotechnical information to develop earthquake hazards to SPU water system facilities for two deterministic earthquake scenarios

•Work with SPU staff to identify seismic hazard failure/damage effects and modes for SPU water transmission and distribution system facilities

•Use available previous SPU facility seismic vulnerability assessments, available design deterministic earthquake scenarios and the design ground motions defined by the Seattle Building Code/ASCE 7. Special emphasis will be placed on the transmission, backbone adn distribution pipelines/pipeline systems.

•Work with SPU hydraulic modeling staff to estimate overall system hydraulic response to the two deterministic earthquake scenarios.

•Review preliminary post-earthquake water system performance goals to be developed by SPU and assist in finalizing these goals.

•Develop mitigation measures and planning level cost estimates needed to achieve the post-earthquake performance goals and provide a recommended plan and timeframe for a seismic capital improvement program prioritized by risk/critically and consistent with a budget constraints.

•Develop seismic design standards for new SPU water system facilities with an emphasis on new pipelines since most other types of facilities are already covered by existing codes and standards.

Upon the SPU advertisement in the Daily Journal of Commerce (DJC), interested consultants are encouraged to review the RFQPA, background documents, and any RFQPA addenda online at https://www.ebidexchange.com/seattle. Note that you are required to complete a free registration to view, print or save documents posted on this website and to view contact information for other consultants who have downloaded documents from this website. SPU will also conduct an SPU Pre-submittal Meeting, immediately following the DJC Advertisement, for all prospective candidates, prime & subconsultants, to ask questions about the project, along with an opportunity for networking and Prime & Subconsultant teaming for this proposed project. Private meetings and/or communications between SPU and prospective consultants will not be held.

And for your information, this specific SPU project along with other prospective SPU Architectural/Engineering consulting projects will be generally discussed at the SPU Architectural/Engineering Opportunity Event, scheduled to be held on Wednesday, February 25, 2015 from 9:00 AM to 12:30 PM at the Bertha Knight Landes Conference Room, Main floor of the Seattle City hall bldg., at 600 Fourth Avenue, Seattle, WA 98104. Online pre-registration is encouraged to ensure seating:

http://city-consultant-forum.eventbrite.com

The City of Seattle is an Equal Opportunity Employer and selection of the Consultant is subject to applicable laws and ordinances regarding equal opportunity employment.

Date of publication in the Seattle Daily Journal of Commerce, February 12, 2015.

2/12(320418)

Performance Goals

- Water is essential for
  - Fire fighting (typically, 100 plus fires in major earthquakes)
  - Business recovery and operation
  - Public health
- Complete water system restoration often takes more than two months after a major earthquake

Oregon Resiliency Plan/Portland Water Bureau Post-Earthquake Performance Goals

TARGET STATES OF RECOVERY: WATER & WASTEWATER SECTOR (VALLEY)

	Event occurs	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
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		

20% - 30% Operational

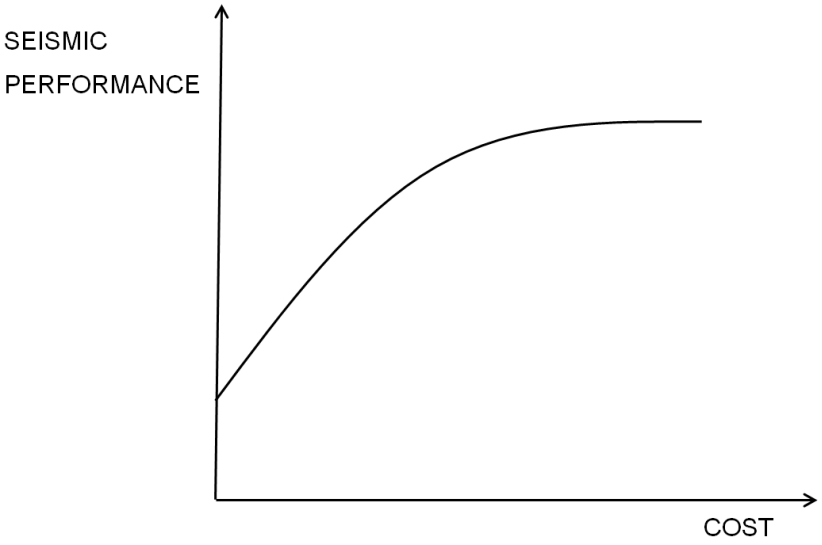
50% - 60% Operational

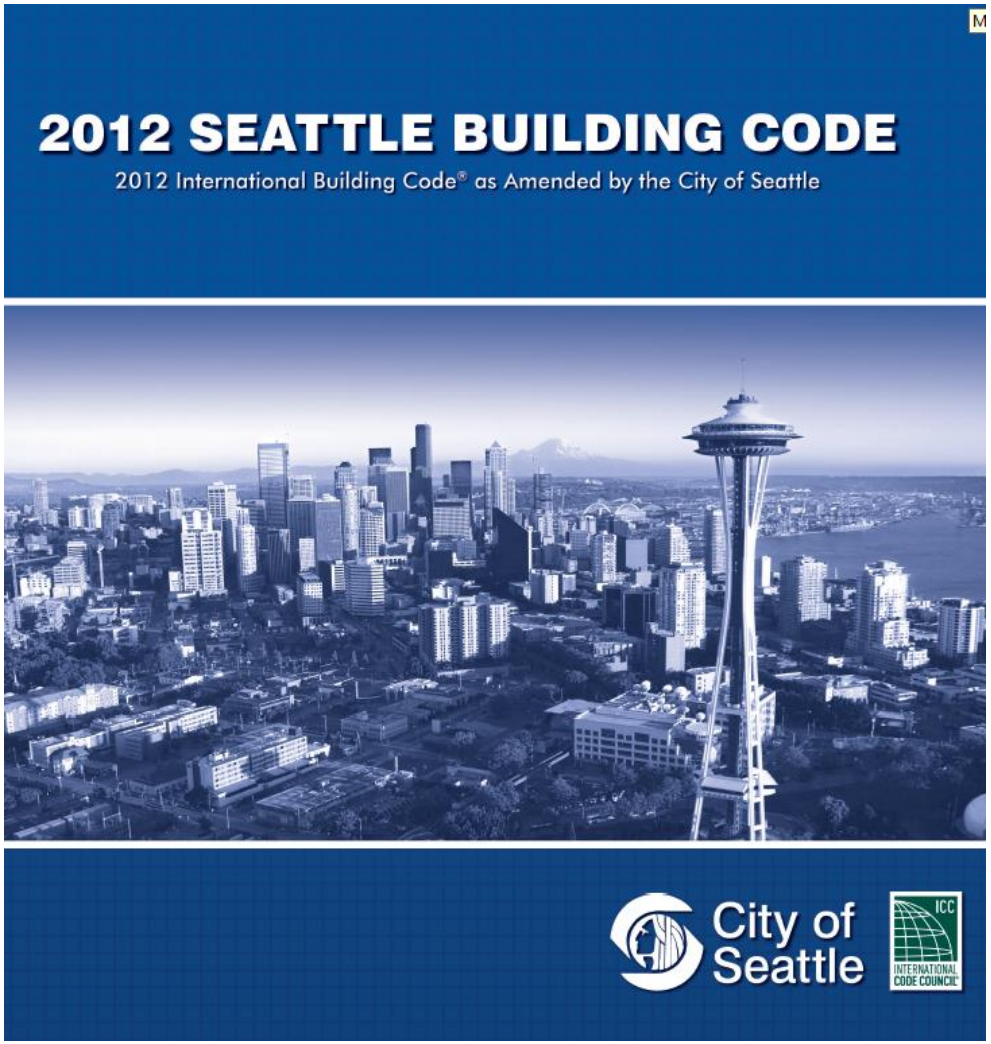
80% - 90% Operational

Pre-Earthquake Functionality X

Performance Goals - Considerations

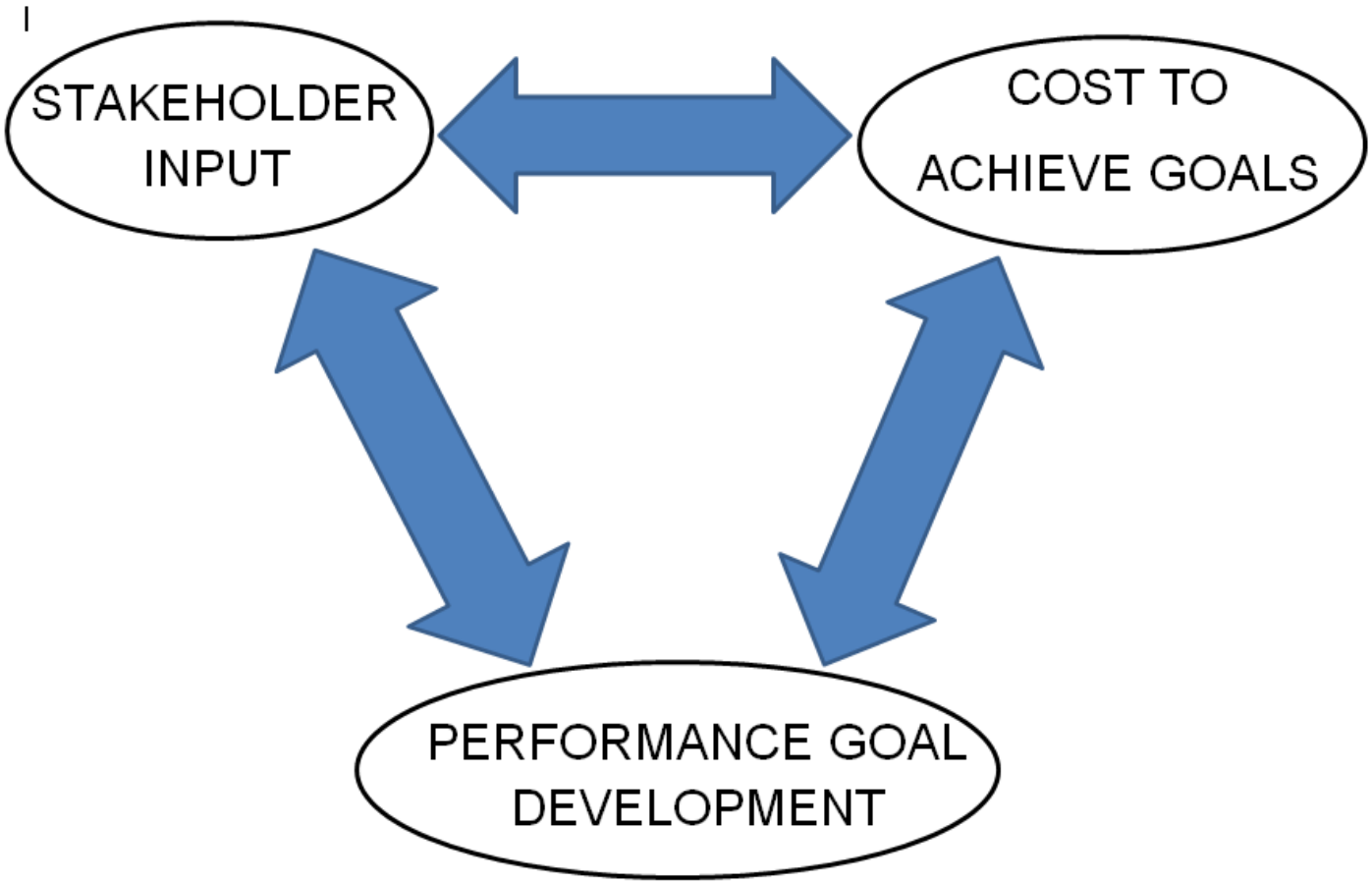
- Public policy
- Codes and design standards
- Economic reality
- Time frame (for implementation)





Performance Goals - Stakeholders

- Public/Direct Service Customers
- Wholesale Customers
- Fire Department
- City and SPU Leadership
- Seattle Emergency Management
- Water LOB Staff


STAKEHOLDER INPUT
COST TO ACHIEVE GOALS
PERFORMANCE GOAL DEVELOPMENT

Water Supply Forum Resiliency Project

- Four Subject Areas
  - Drought
  - Water Quality
  - Climate Change
  - Earthquake
- Committees
  - Water Agency Staff
  - Consultant Technical Experts

Questions?