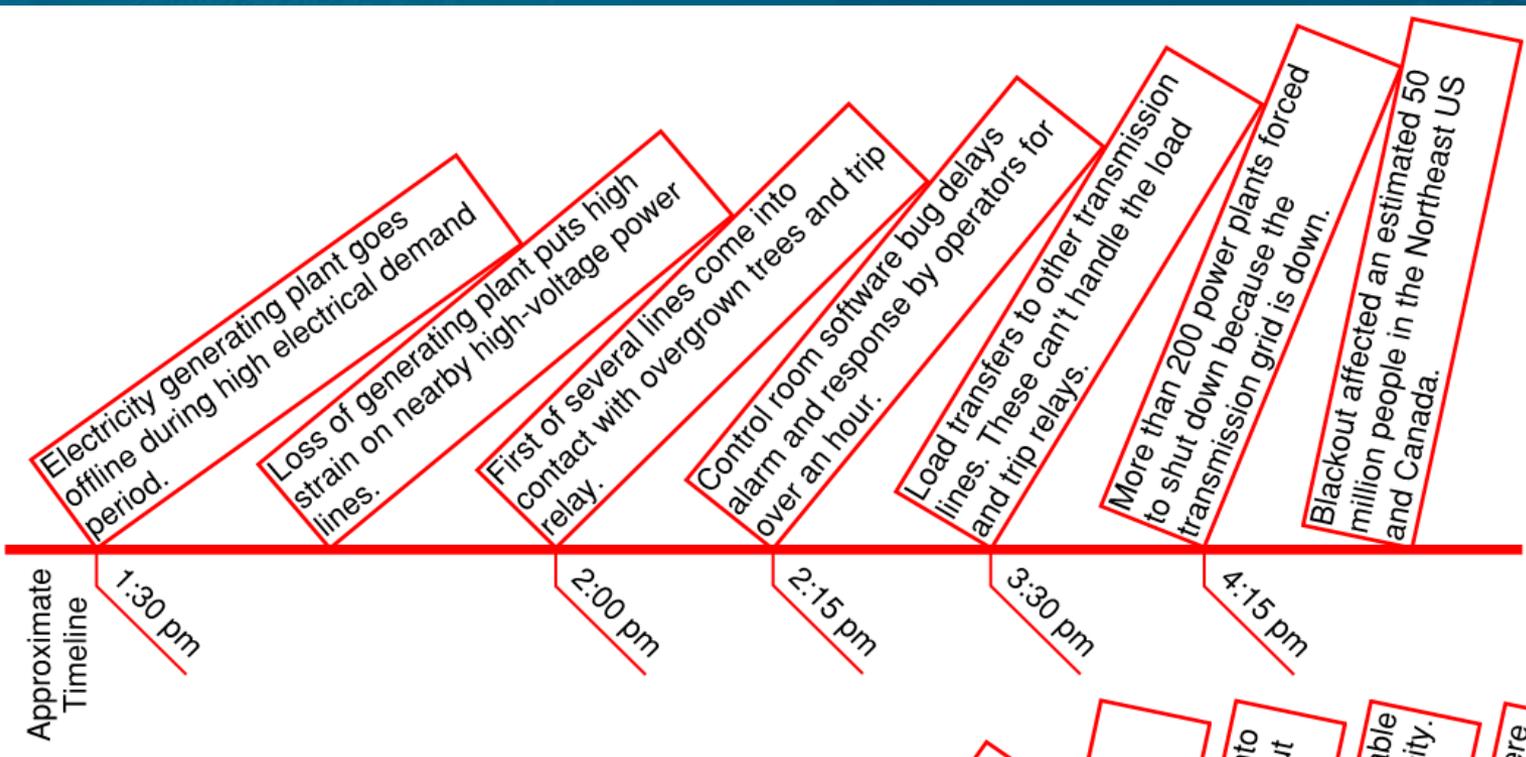


Dependencies and Cascading Effects

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SEFT Consulting Group, LLC

Cascading Effects



Power System **INTERNAL** Cascading Failure (2003 NE Blackout)

Power System **EXTERNAL** Cascading Failure (2003 NE Blackout)

- ENERGY** - Blackout affects an estimated 50 million people in the Northeast US and Canada.
- BUILDING**- Hundreds of people trapped in stalled elevators until rescued.
- TRANSPORTATION** - All trains into and out of New York City were shut down.
- ENERGY** - Gas stations were shut to pump fuel due to lack of electricity.
- COMMUNICATION** - Cell sites were down where batteries were drained and generators out of fuel.
- INFORMATION** - US networks (ABC, CBS, FOX, and NBC) couldn't broadcast from NYC as usual.
- WATER** - Loss of electricity for pumps caused a loss of system pressure and a boil-water notice.

Dimensions of Dependencies

- Internal and External
- Time
- Space
- Source

(These dimensions may not be independent)



Internal and External Dependencies

- Internal Dependency (examples)
 - Physical Infrastructure System
 - Equipment and Repair Supplies
 - Operations Center (and more)

- External Dependency (examples)
 - Transportation
 - Power
 - Communication (and more)

(It is also good to consider who may depend on your system)



Time Dimension

- Recovery Phases
 - Short-Term, Intermediate, and Long-Term
- Dependencies may change from one phase to another
- Performance goals, and restoration sequence and pace are influenced by external dependencies of other infrastructure systems and community needs

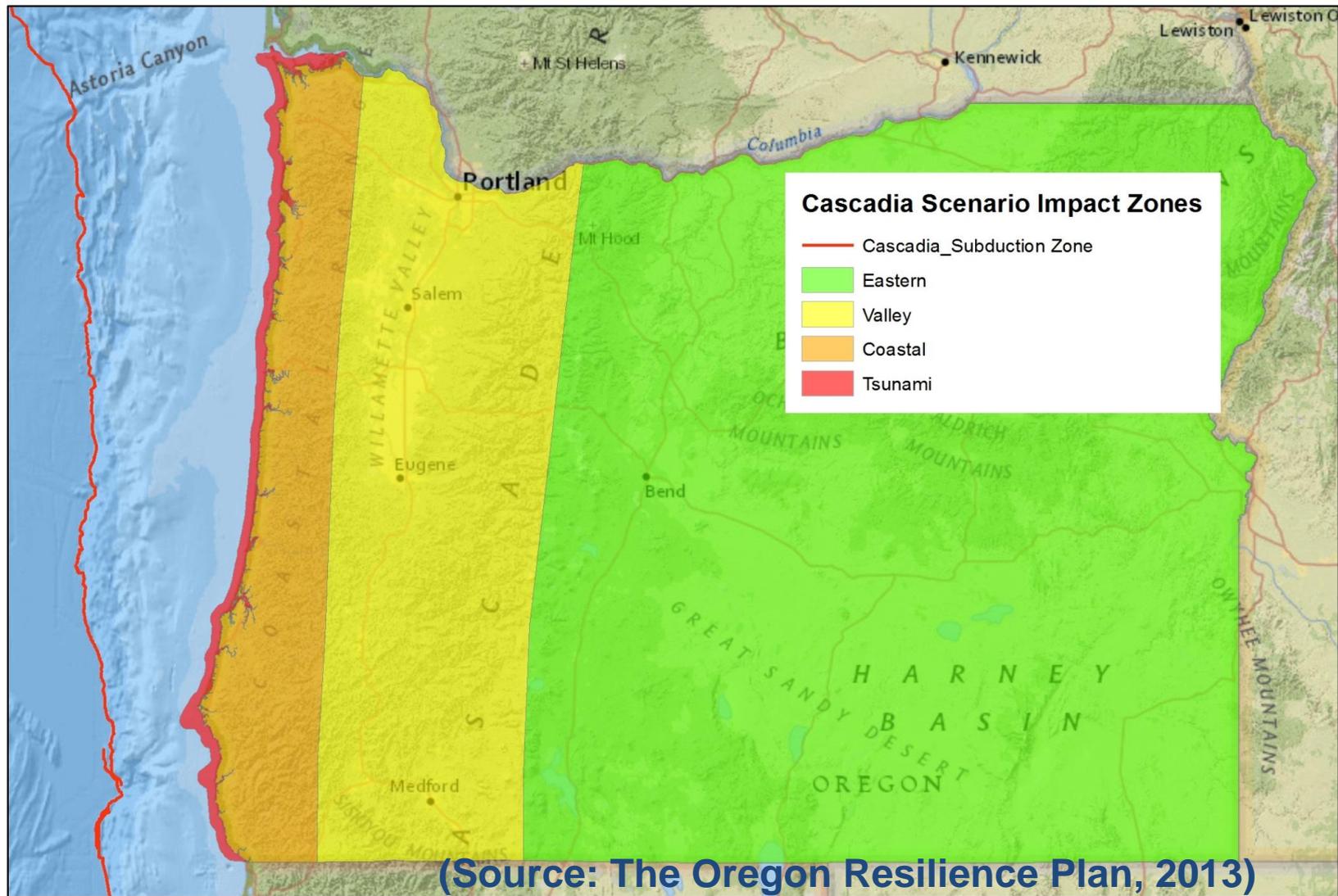


Time Dimension

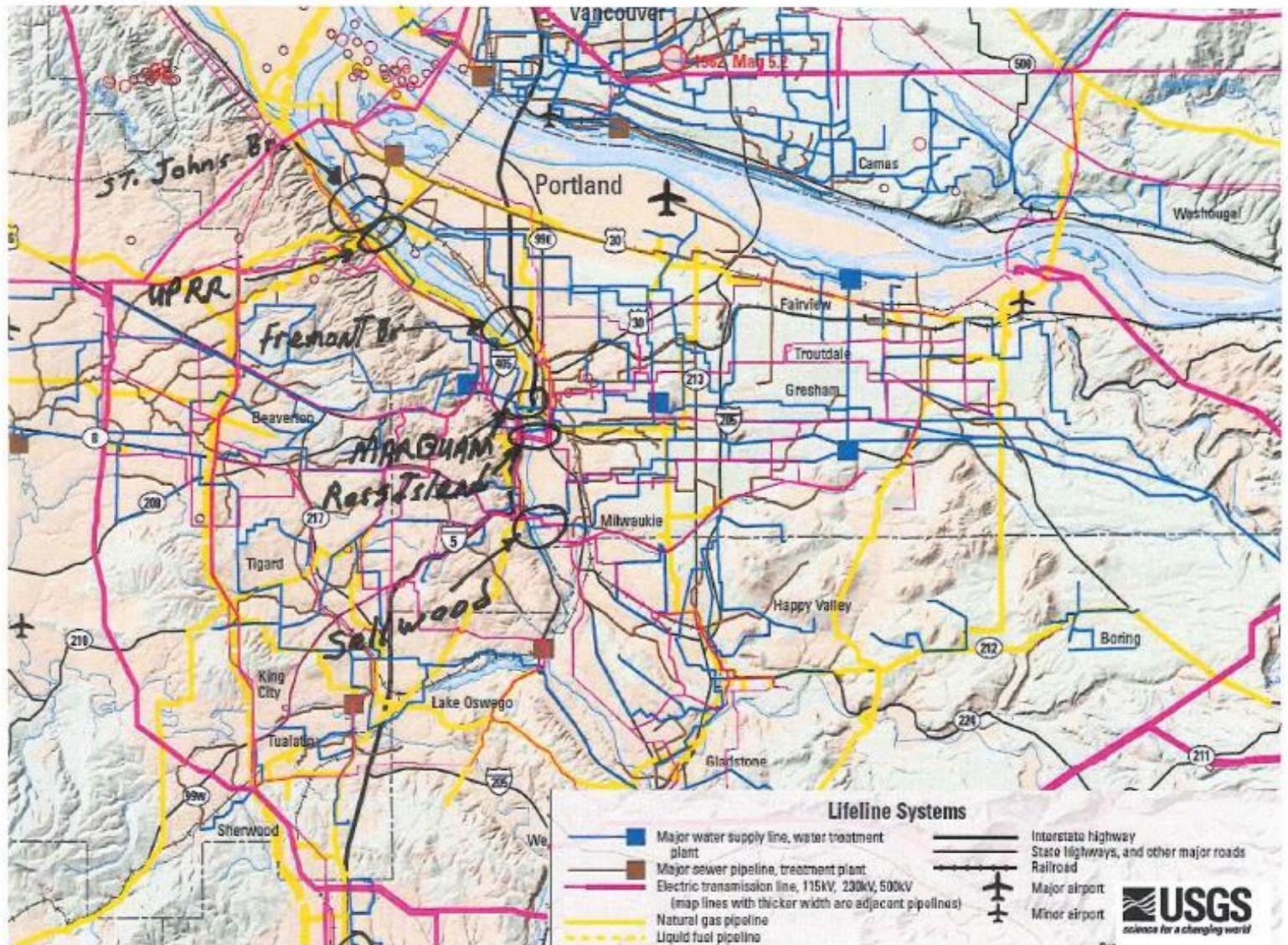
Functional Category: Cluster	Overall Recovery Time for Hazard and Level Listed								
	Phase I – Short-Term			Phase II – Intermediate			Phase III – Long-Term		
	Days 0	Days 1	Days 1-3	Wks 1-4	Wks 4-8	Wks 8-12	Mos 4	Mos 4-24	Mos 24+
Critical Facilities									
Buildings	90%							X	
Transportation		90%	X						
Energy		90%	X						
Water			90%		X				
Waste Water				90%				X	
Communication		90%		X					
Emergency Housing									
Buildings				90%					X
Transportation			90%	X					
Energy			90%	X					
Water			90%		X				
Waste Water				90%				X	
Communication				90%	X				
Housing/Neighborhoods									
Buildings						90%			X
Transportation			90%	X					
Energy			90%	X					
Water				90%				X	
Waste Water					90%			X	
Communication				90%			X		
Community Recovery									
Buildings								90%	X
Transportation				90%	X				
Energy			90%	X					
Water				90%				X	
Waste Water							90%	X	
Communication				90%			X		



Space Dimension

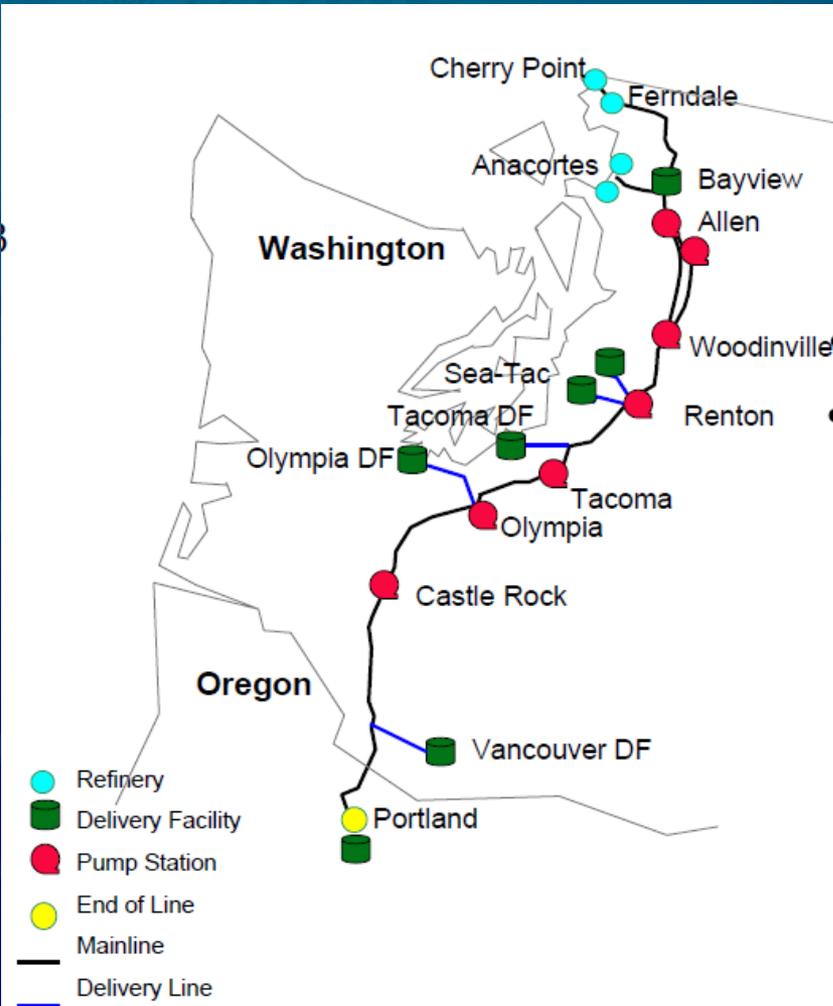


Space Dimension



(Source: City of Portland, 2012)

Source Dimension



(Source: Yumei Wang, Steven F. Bartlett & Scott Miles, 2012)

Additional Examples

- Wholesale Water Supplier
- Wholesale Power supplier
- Centralized Warehouse of A Healthcare System

Source: <http://www.bppipelines.com/cartoon-maps/olympic.pdf>



Remarks

- Dependency relationship is complex and multi-dimensional
- Consider various dimensions of dependencies within each service provider
- Community-wide coordination
- Strategies to reduce dependencies