Improved Utility Resiliency for Water Quality Protection

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01

PUGET SOUND WATER SUPPLY FORUM

PUGET SOUND WATER SUPPLY FORUM

- Voluntary organization between public water systems and local governments.

- Snohomish, King, and Pierce County.
- Provide a venue for policy discussions on critical water supply and stewardship issues while sharing utility perspectives and insights with regional stakeholders. The Forum provides members and the public with a portal for water supply and related water resource issues

MEMBER AGENCIES

- Snohomish County
  - Alderwood Water and Wastewater District
  - City of Everett
  - Everett Water Utility Committee
- King County
  - Cascade Water Alliance
  - East and South King County Regional Water Association
  - King County
  - Seattle Public Utilities
- Pierce County
  - Pierce County Regional Water Association
  - Tacoma Water

PUGET SOUND WATER SUPPLY FORUM

Vision

Provide leadership, from the utility perspective, on current and future regional water supply and related water resources issues in King, Pierce and Snohomish counties.

Mission

Provide a venue for policy discussions on critical water supply and stewardship issues while sharing utility perspectives and insights with regional stakeholders. The Forum provides members and the public with a portal for water supply and related water resource issues.

02

PLANNING BACKGROUND

REGIONAL WATER SUPPLY RESILIENCY PROJECT

- Help water utilities take proactive steps in evaluating and enhancing regionals water supply.
- Looking at across and between service area boundaries.
- Not focused on a single utility or area.

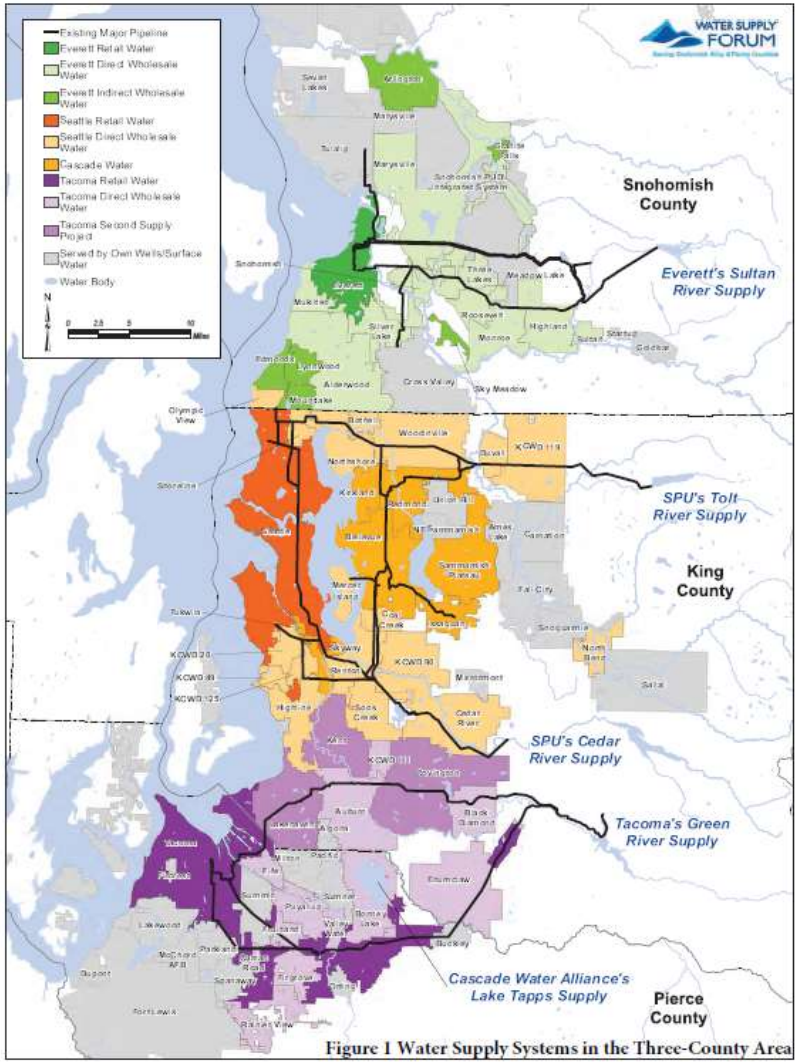


Figure 1 Water Supply Systems in the Three-County Area

REGIONAL WATER SUPPLY RESILIENCY PROJECT

- Resiliency:
  - Ability to reduce impact of and recover rapidly from disruptive events.
  - Acceptable level of service is maintained.
  - Impacts to public health and safety and the economy are minimized.
- Four risk topics:
  - Earthquakes.
  - Drought.
  - Climate change.
  - **Water quality.**

WATER QUALITY TEAM

John McClellan (Team Chair)	Alderwood Water and Wastewater District
Kim DeFolo	Tacoma Water
Joe Harbour	City of Bellevue
Wylie Harper	Seattle Public Utilities
Celine Mina	Tacoma Water
Jim Nilson	Seattle Public Utilities
Jon Shimada	Cascade Water Alliance (retired)
Julie Sklare	City of Everett
Pierre Kwan	HDR
Alex Mofidi	Confluence Engineering
Virpi Salo-Zieman	Confluence Engineering

03

WATER QUALITY RISK ANALYSIS

WATER QUALITY TEAM'S GOAL

- Identify a comprehensive list of possible risk events that could compromise drinking water quality
- Use a risk analysis framework to prioritize possible risk events
- Identify effective mitigation measures for each prioritized risk event.
- No detailed action plans or identification of best practices.

RISK IDENTIFICATION

- Multiple brainstorming sessions
- Looked at wide ranging list of risk events (threats) that could affect water quality.
- Looked at all major aspects of a utility that affects water quality:
  - Source water protection
  - Treatment
  - Transmission, storage, and distribution integrity
  - Monitoring and testing
  - “Multi-barrier approach”

IDENTIFIED RISK EVENTS

- Came up with 26 risk events
- Varying impacts on barrier of water quality protection
- Example – Volcanic eruption
  - Source water protection – high turbidity and heavy metals
  - Treatment – impairs treatment, clogs intakes
  - Transmission, storage, and distribution integrity – enters air vents
  - Monitoring and testing – many water quality impacts not readily detected in typical utility field sampling kits.

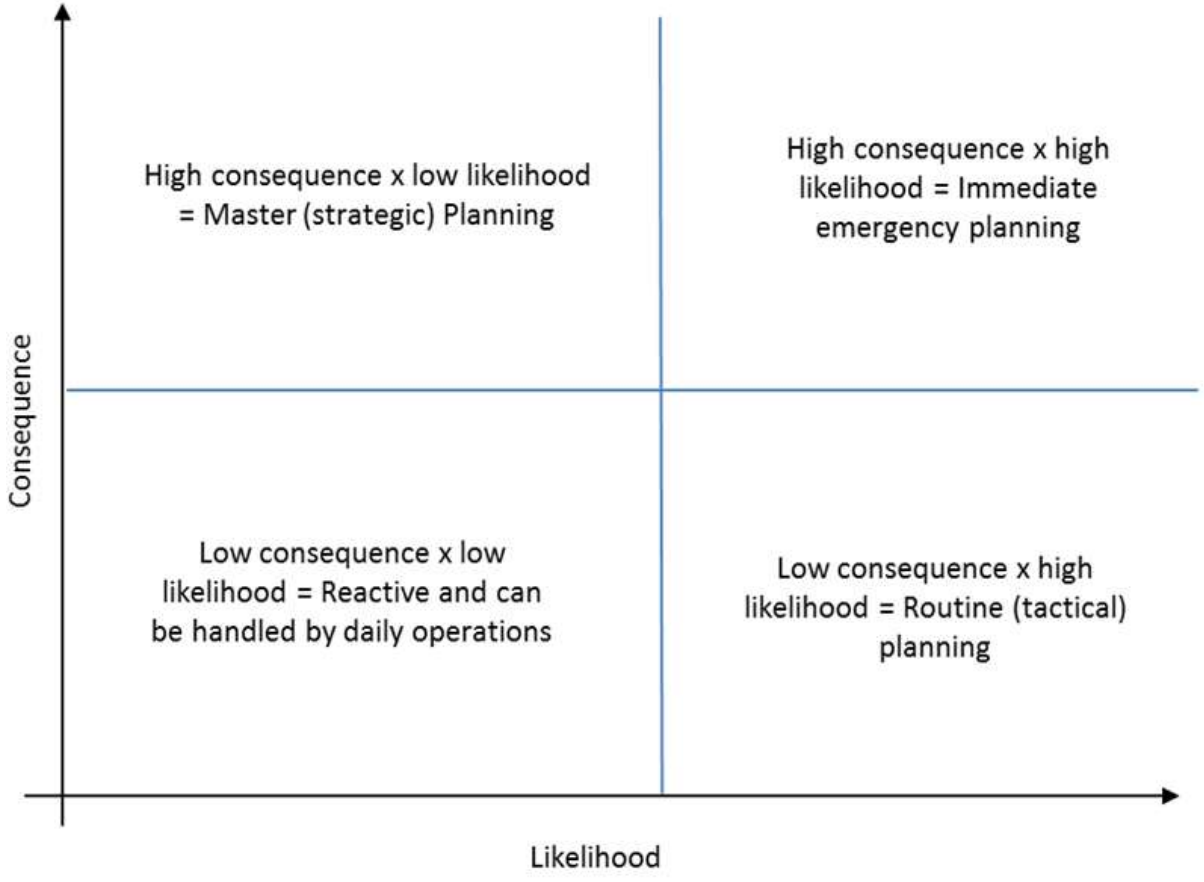
IDENTIFIED RISK EVENTS FOR FURTHER ANALYSIS

- Accidental Contamination (Vehicle, Train, Industrial, Plane, Oil/Fuel/Chemical Pipeline)
- Aesthetic Events – Distribution System (Taste, Odor, Color)
- Aesthetic Events – Raw Reservoir Management (Taste, Odor, Color)
- Changes in Aquatic Species
- Communications Failure (Radio/Telephone/Internet)
- Compromised Physical Security
- Compromised Supervisory Control and Data Acquisition (SCADA) or SCADA Failure
- Distribution System *Coliform* Contamination
- Drought (Water Quality Effects)
- Earthquake (Water Quality Effects)
- Equipment Failure
- Landslides
- Loss of Operator/Staff Continuity/Expertise
- Operator Error
- Power Failure
- Resource Supply Chain
- Severe Adverse Weather (Short-term – Storm, Flooding, Ice Storm)
- Volcanic Eruption (Ash, Lahar)
- Water Pipeline Intrusion
- Wildfire

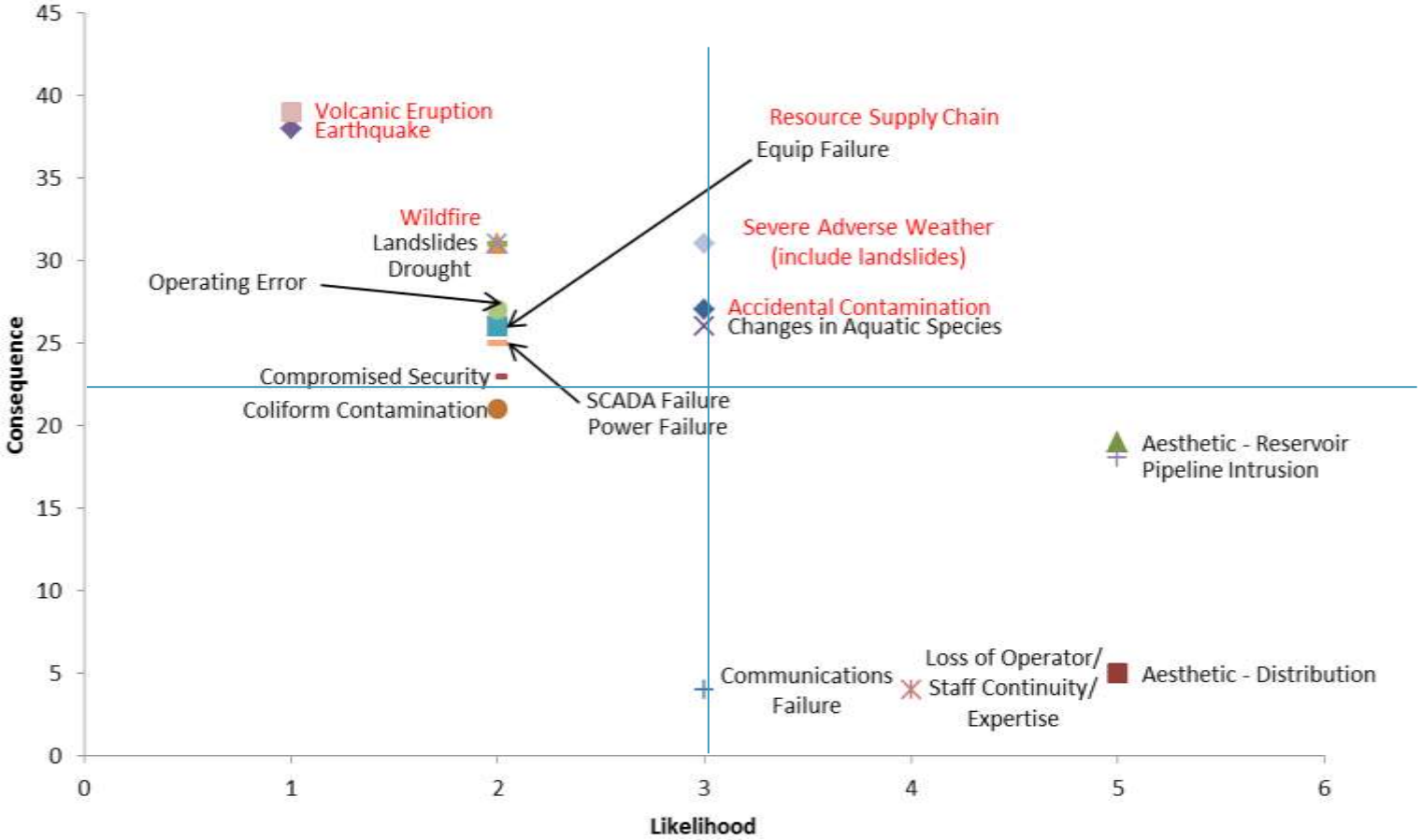
SCORING EXERCISE

- Still too many risk events.
- Likelihood x Consequence analysis
- Likelihood of occurrence
  - Often or once a century?
- Consequence
  - Water quality – loss of confidence, aesthetics, boil water, or Do Not Use
  - Financial – minor hit to budgets or crippling?
  - Affected population – small area/few people or the entire three county region?

RESULTS


High consequence x low likelihood = Master (strategic) Planning
High consequence x high likelihood = Immediate emergency planning
Low consequence x low likelihood = Reactive and can be handled by daily operations
Low consequence x high likelihood = Routine (tactical) planning
Consequence
Likelihood

RISK EVENT LIKELIHOOD X CONSEQUENCE



SELECTED RISK EVENTS

- Wildfire
- Volcanic eruption
- Resource supply chain
- Severe adverse weather
- Accidental contamination
- Earthquakes

MITIGATION

- Five step procedure:

1. Preventative – prevent the event from occurring
2. Pre-event mitigation – lessen severity and/or increase recovery speed
3. Detection – how to provide as much forewarning/early notice
4. Immediate response – what to do when the event occurs
5. Recovery – how to return to normal operations quickly

GENERAL MITIGATION

A. Preventative – no special measures
B. Pre-event mitigation
    A. Incident event command training
    B. Emergency preparedness planning and drills.
    C. Interlocal/mutual aid agreements
C. Detection – no special measures
D. Immediate response
    A. Mobilize staff
    B. Activate emergency response plan
    C. Public messaging
    D. Mandatory curtailment
E. Recovery
    A. Public message, restore public confidence
    B. Lessons learned
    C. Event documentation for FEMA reimbursement

VOLCANIC ERUPTION

A. Preventative – None

B. Pre-event mitigation

- Equipment vulnerability analysis
- Relocation or strengthening of pipes
- Enclose critical equipment and create embankments to divert lahars
- Monitoring programs
- Prepackaged supply kits
- Vehicle filters, maps, and alternative routes
- Plastic covers for mechanical treatment equipment
- Permanent covers for large treatment equipment
- Alternative operational plans
- Alternative water sources
- Predesignated ash disposal site(s)
- Manufacturer contact list

VOLCANIC ERUPTION

C. Detection
- Look for plumes/plume forecasting
- University of Washington (UW)/United States Geological Survey (USGS) seismology
- National Oceanic and Atmospheric Administration (NOAA) volcanic ash advisories

D. Immediate Response
- Secure intakes
- Monitoring/forecasting
- Draw from other supplies
- Jar testing for chemical dosage changes
- Modify treatment operations for turbidity and acidity
- Cover equipment and air vents
- Be prepared for rough driving conditions

VOLCANIC ERUPTION

E. Recovery

- Ash removal and disposal
- Long-term water quality monitoring
- Evaluate for long-term chemical treatment changes
- Inspect and/or rebuild equipment

04

BREAK THE SYSTEM ANALYSIS

BREAK THE SYSTEM ANALYSIS

- What type of event will cause a small, medium, and large utility to fail for each of the risk events?
  - Small utilities typically have less instruments and staffing to respond.
  - Big utilities have more things to break.
- Goal is to identify weaknesses for improvement

UTILITY DEFINITIONS

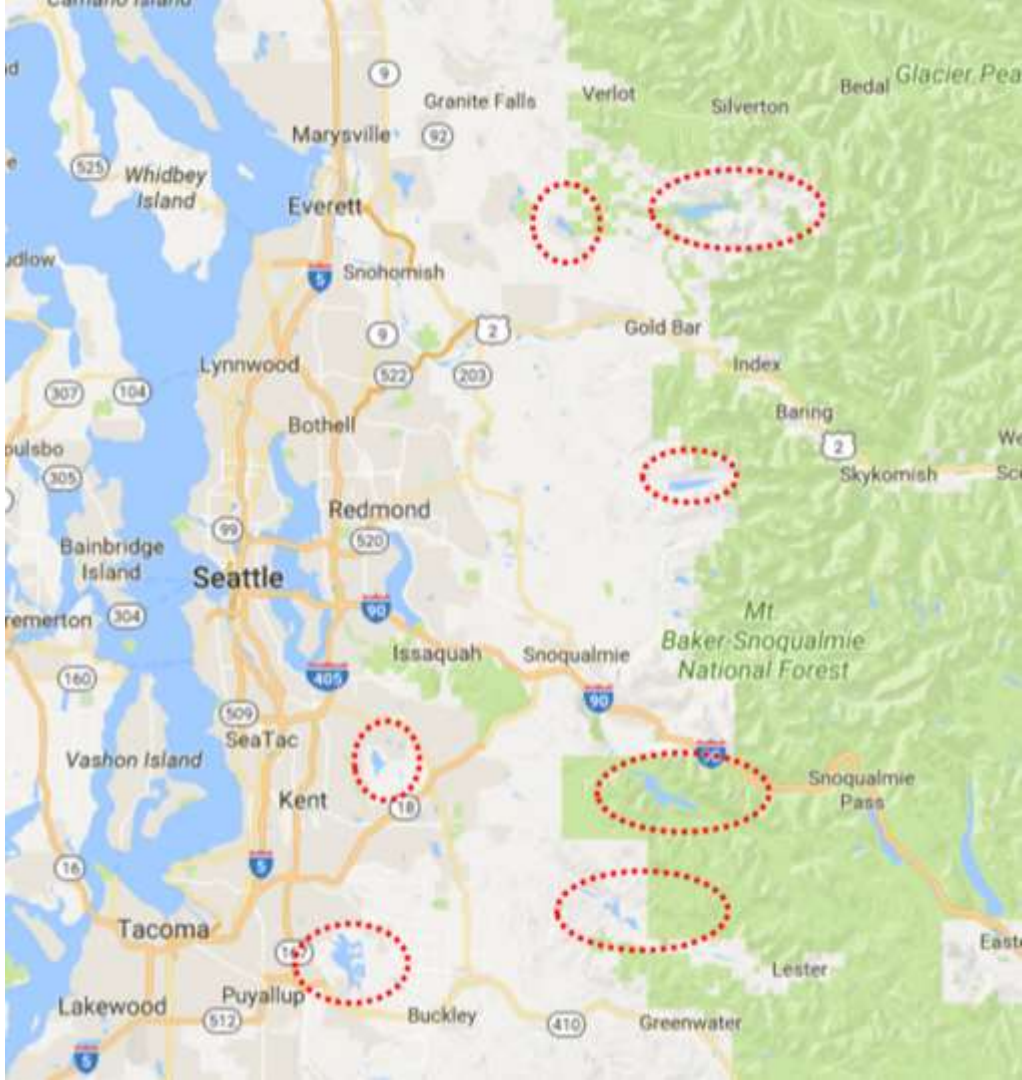
- Water supply – assume surface water
- Treatment facilities – filtered and unfiltered systems
- Distribution system water quality
- Public health and other customer impacts
- Staffing
- Financial capability
- Monitoring ability

WILDFIRES

- Causes increased turbidity, chemistry changes.
- Firefighting chemicals – Risk of accidental contamination from plane/helicopter entering lake/river/reservoir.
- Potential huge impact to Seattle, Everett, and Tacoma.
- Huge costs for protection, treatment.
- Affects millions of people.

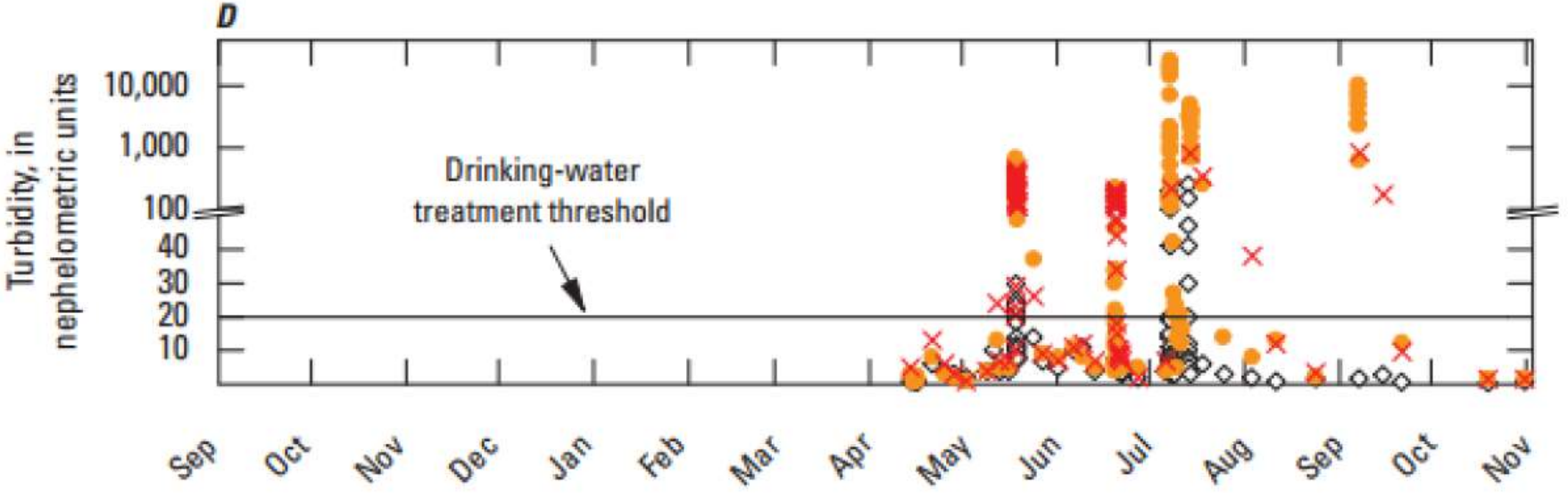
WILDFIRE RISKS

- Wildfire turbidity can easily exceed 1,000 NTU
- Turbidity limits
  - Conventional filters – up to 100 NTU
  - Direct filters – up to 10 NTU
  - Unfiltered systems – up to 5 NTU
- Filter clogging
- Excessive chemical usage
- Frequent backwashing
- Little to no net water production



LONG TERM AFTERMATH OF A FIRE

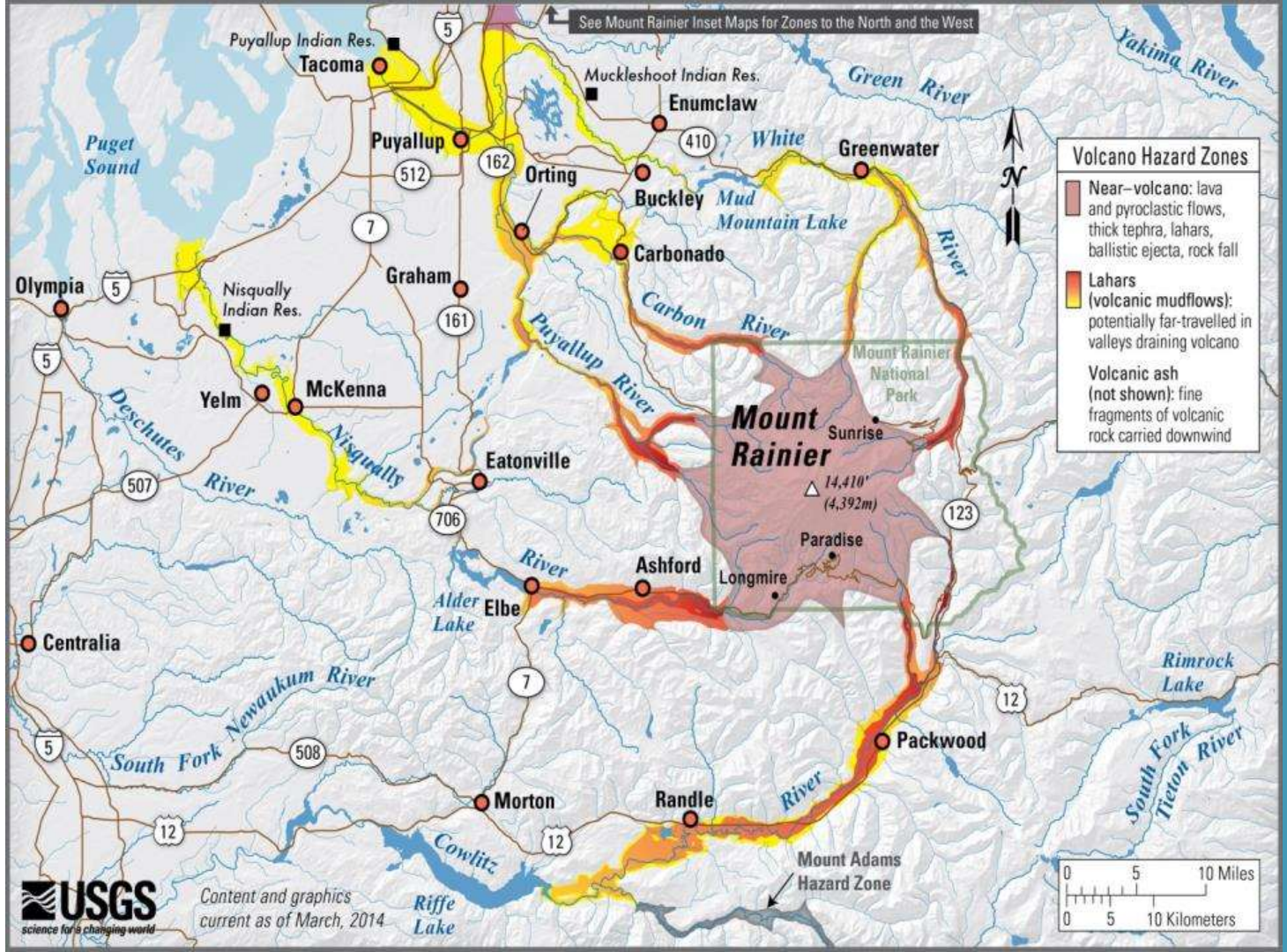
Two years after Fourmile Canyon fire in Colorado
23% of watershed burned

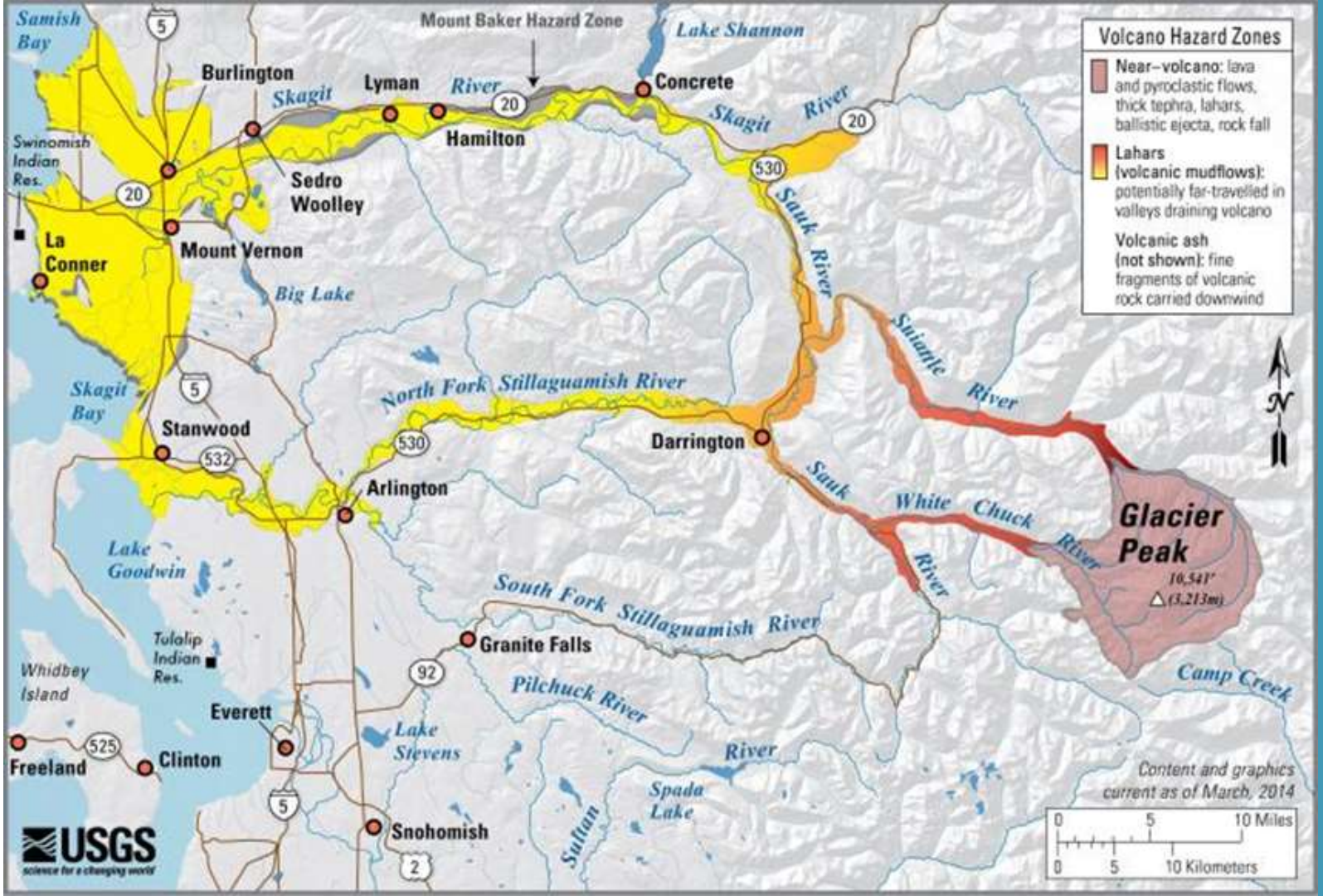


Writer and Murphy, 2012

VOLCANIC ERUPTION

- Ashfall
- Lahars
- Water quality
  - Turbidity
  - Heavy metals release
  - Damage to equipment


See Mount Rainier Inset Maps for Zones to the North and the West
Puyallup Indian Res.
Tacoma
Muckleshoot Indian Res.
Enumclaw
Green River
Yakima River
Puget Sound
Puyallup
White River
Greenwater
Orting
Buckley
Mud Mountain Lake
Carbonado
Olympia
Nisqually Indian Res.
Graham
Carbon River
Puyallup River
Mount Rainier National Park
Yelm
McKenna
Deschutes River
Nisqually River
Mount Rainier
Sunrise
14,410' (4,392m)
Eatonville
Paradise
Longmire
Ashford
Alder Lake
Elbe
Centralia
Rimrock Lake
Newaukum River
South Fork Newaukum River
Packwood
South Fork Tieton River
Morton
Randle
Cowlitz River
Riffe Lake
Mount Adams Hazard Zone
Volcano Hazard Zones
Near–volcano: lava and pyroclastic flows, thick tephra, lahars, ballistic ejecta, rock fall
Lahars (volcanic mudflows): potentially far-travelled in valleys draining volcano
Volcanic ash (not shown): fine fragments of volcanic rock carried downwind
N
0 5 10 Miles
0 5 10 Kilometers
USGS
science for a changing world
Content and graphics current as of March, 2014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Mount Baker Hazard Zone
Lake Shannon
Samish Bay
Burlington
Skagit River
Lyman
Hamilton
Concrete
Swinomish Indian Res.
Sedro Woolley
La Conner
Mount Vernon
Big Lake
Skagit Bay
Stanwood
North Fork Stillaguamish River
Darrington
Suiattle River
Sauk River
White Chuck River
Glacier Peak
10,541'
(3,213m)
Arlington
Lake Goodwin
South Fork Stillaguamish River
Granite Falls
Tulalip Indian Res.
Whidbey Island
Everett
Pilchuck River
Camp Creek
Lake Stevens
Freeland
Clinton
Spada Lake
Sultan
Snohomish
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science for a changing world

IMPACTS

- pH
  - 1980 Mt. St. Helens – river pH restored in 2 – 3 days
  - 1953 Mt. Spurr, AK – water system pH fell to pH 4.5 but returned to normal later in the day
  - 2009 Mt. Redoubt, AK – no appreciable impact on Homer 72 miles downwind
- Water chemistry
  - Heavy metals increased but as a function of turbidity
  - Anions (sulfate, chloride) returns to normal in a few days
  - Long-term change to organic carbon – vegetation die-off

RESOURCE SUPPLY CHAIN

- Inability to get staff
- Lack of chemicals, fuel, equipment to facilities by road.
- General poor availability for chemical deliveries.
- Bad chemical deliveries.
- Long-lead time.
- Obsolete supplies.
- Single source critical items.

SEVERE ADVERSE WEATHER

- Rain storms
- Ice storms
- Flooding

- Causes landslides
- Damages equipment integrity
- Turbidity
- Supply chain issues

ACCIDENTAL CONTAMINATION

- Fuel/oil/chemical spills (proximity to surface and groundwater).
- Train derailment
- Overturned vehicles
- Airplane landing in reservoir.

- Treatment plants aren’t designed for this type of contamination.

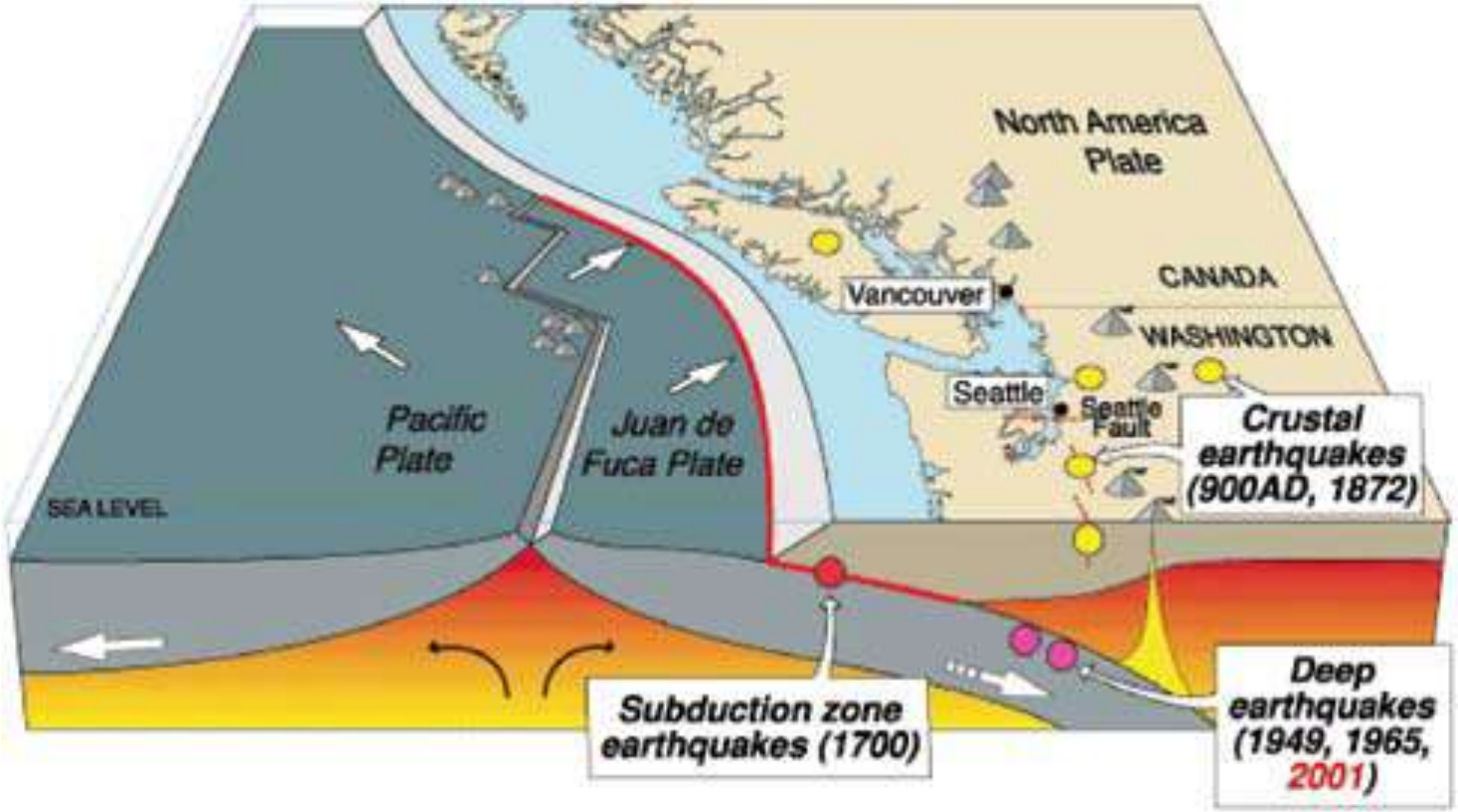
EARTHQUAKES

- Damage to infrastructure
  - Treatment plants
  - Compromised pipeline and reservoir integrity
- Landslides
- Potential huge regional costs

(a)

(b)

HISTORICAL LARGE EARTHQUAKES (SOURCE: USGS)



05

RESTORING POTABLE WATER SERVICE

RESTORING POTABLE WATER SERVICE AFTER A DISASTER

- Goes beyond basic water main breaks
- Earthquake-related widespread damage
- Multiple breaks:
  - Type III (debris intrusion)
  - Type IV (wide area depressurization breaks
- “Rapid” return to non-potable water service
  - Under/non-treated water service restored
  - Fire-fighting
  - Sanitary uses

RESTORING POTABLE WATER SERVICE AFTER A DISASTER

- Procedure for removing debris.
  - Trying to achieve 3 fps flush velocity in a 24+ inch line is a lot of water
  - 3x turnover in the pipe volume is also a lot of water

- How to chlorinate/disinfect the water in this system?

- Validation – what are some guidelines for working with DOH, health agencies to confirm “potable” status.

06

COMMUNICATIONS PLANS

Proactive Water Quality Communication and Preparation

- Coordinated communication plans:
  - General public.
  - Key customers.
  - Regulators.
  - Regional emergency managers.

07

WHERE TO GET INFORMATION?

CENTRAL PUGET SOUND FORUM

- Home page and reports
- http://www.watersupplyforum.org/

- Resiliency project
- http://www.watersupplyforum.org/home/resiliency.html

- Can also sign-up for regular updates

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