



MEMORANDUM

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DATE: October 3, 2019

TO: Environmental Services Commission

FROM: Doug Lane, Utilities Senior Engineer

SUBJECT: Water Distribution System Seismic Vulnerability Assessment:
Existing Vulnerabilities and Post-Event Immediate Impacts

Action Required at this Time

None

Fiscal Impact

Information presented is only findings and has no short-term fiscal impact, but earthquake mitigation CIP projects are likely to be recommended at the conclusion of the project in 2020.

Background

As part of the Water Distribution System Seismic Vulnerability Assessment, sophisticated computer modeling was performed to model large earthquakes on the Seattle Fault and Cascadia Subduction Zone. Both events were simulated with 10,000 iterations each in a model that includes every pipe and facility, to determine the range of probabilistic customer service outcomes, resulting from damages to pipes and facilities.

Results are presented on the following pages. These results reflect the anticipated state of Bellevue's infrastructure and water service immediately following these events, and again after the regional supply and transmission system is restored. This work informs our understanding of vulnerabilities that Bellevue has direct responsibility for, and how to prepare.

Regional water supply outages, service restoration times, and economic impacts in the days and weeks following each event are important, and are also being evaluated as part of this project, incorporating regional network effects that Bellevue does not control. Those regional impacts and restoration times will be presented separately. Seattle Public Utilities (SPU) has already indicated the regional supply may be out of service for up to three weeks. However, understanding local

vulnerabilities of Bellevue assets (as presented here) allows us to prioritize the highest-value mitigation actions and improvements that are under Bellevue’s control, while we also work with partners to enhance regional resiliency.

Local main breaks cannot be found, let alone repaired, until after the regional transmission system is restored and pressurized water is available. By focusing on local resiliency, we can improve local system performance and reduce restoration times after regional service is restored.

Vulnerabilities and Immediate Impacts

For the Seattle Fault event, the predicted likely infrastructure impact includes roughly 540 pipe repairs needed (due to leaks or breaks) and 8-10 pump stations (out of 22) losing service. Reservoir performance is better, with only 2 to 3 reservoirs (out of 24) predicted to fail, owing to the City’s ongoing seismic mitigation capital improvement projects (CIP W-85) to improve reservoir resiliency.

For the Cascadia Subduction Zone event, the predicted likely infrastructure impact includes roughly 220 pipe repairs needed and 1 pump station losing service. No reservoirs are predicted to fail in the most likely scenario, although some sustain minor damage that does not impact customer service.

Figures 1 and 2 show maps of predicted main break probability for the Seattle Fault and Cascadia Subduction Zone events, respectively.

Table 1: Most Probable Existing System Performance for Simulated Earthquake Scenarios

	Seattle Fault Event	Cascadia Subduction Zone Event
Pipe Breaks or Leaks	540	220
Pump Station Failures	8-10	1
Reservoirs out of Service	2-3	0

The model simulations predict that over half of Bellevue’s service area will lose service immediately after a Seattle Fault earthquake. Figure 3 shows localized immediate service impacts by sub-area. It is also likely that the entire service area will lose all service (the entire map will be red) after 2-3 days as stored water is depleted by leakage and demands, due to regional water transmission failures.

Figure 4 shows localized immediate impacts to service for the Cascadia Subduction Zone event. This event results in less damage but is more widespread geographically.

Next Steps

The information presented here is being incorporated into continuing technical analysis:

- Estimate time to restore service to each sub-area
- Estimate economic impacts of service outage (\$\$/day x restoration time)
- Identify short- and long-term mitigation actions and benefit/cost

Following identification of mitigation actions and benefit/cost estimates, post-event level-of-service discussions will be revisited with ESC. This iterative approach to establishing level-of-service goals allows for a more informed decision-making process that considers the costs associated with proposed goals.

As part of current projects and future 2021-2027 CIP development, the City is already planning and designing for the installation of earthquake-resistant ductile iron pipe. Proposed Engineering Standards updates would require this new type of pipe for all pipes in liquefiable soils, in close proximity to the Seattle Fault, or serving critical customers (regardless of geological conditions), so that we build in resiliency to all projects, regardless of project drivers.

Figure 1: Seattle Fault Zone East - Pipe Break Probabilities

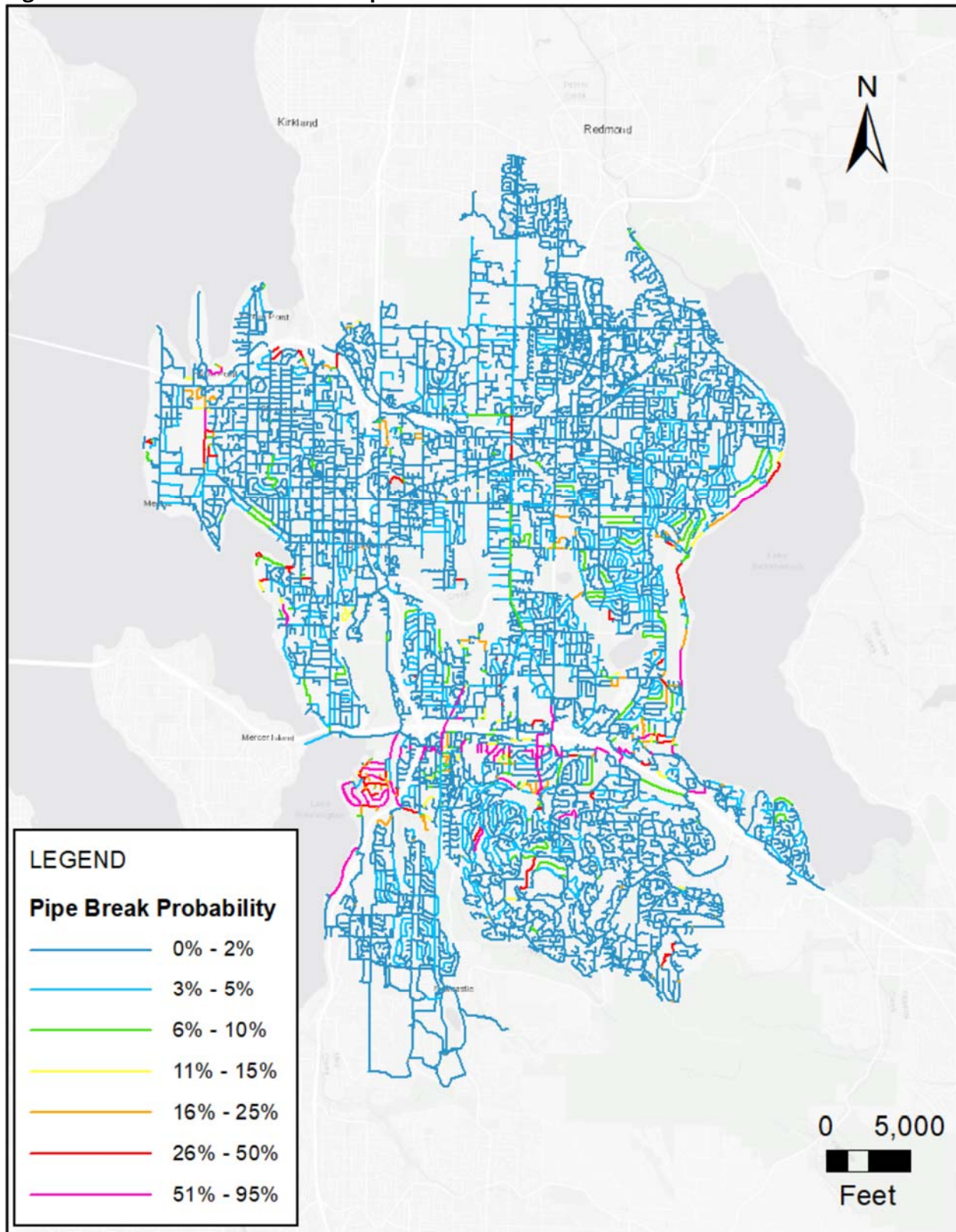


Figure 2: Cascadia Subduction Zone - Pipe Break Probabilities

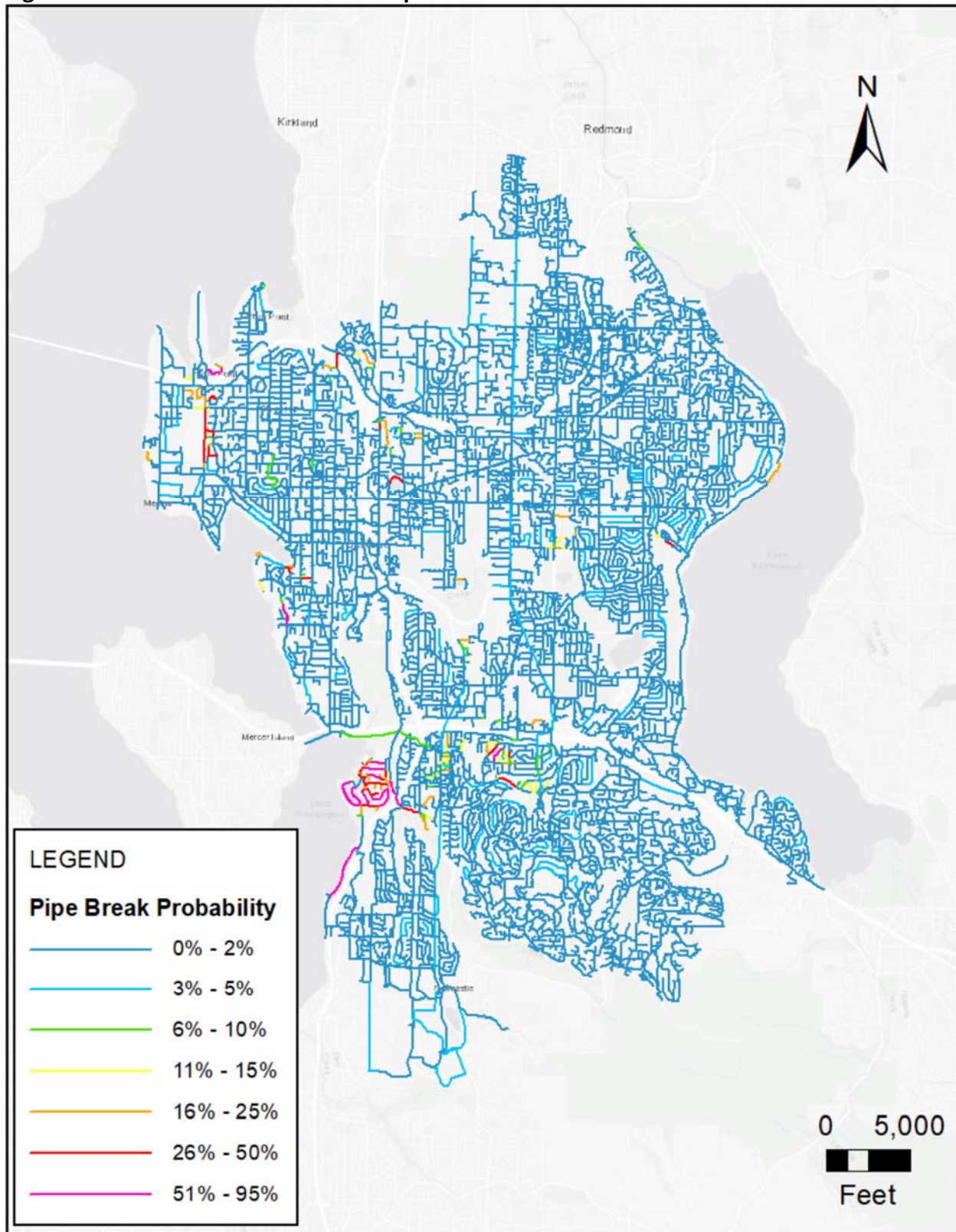
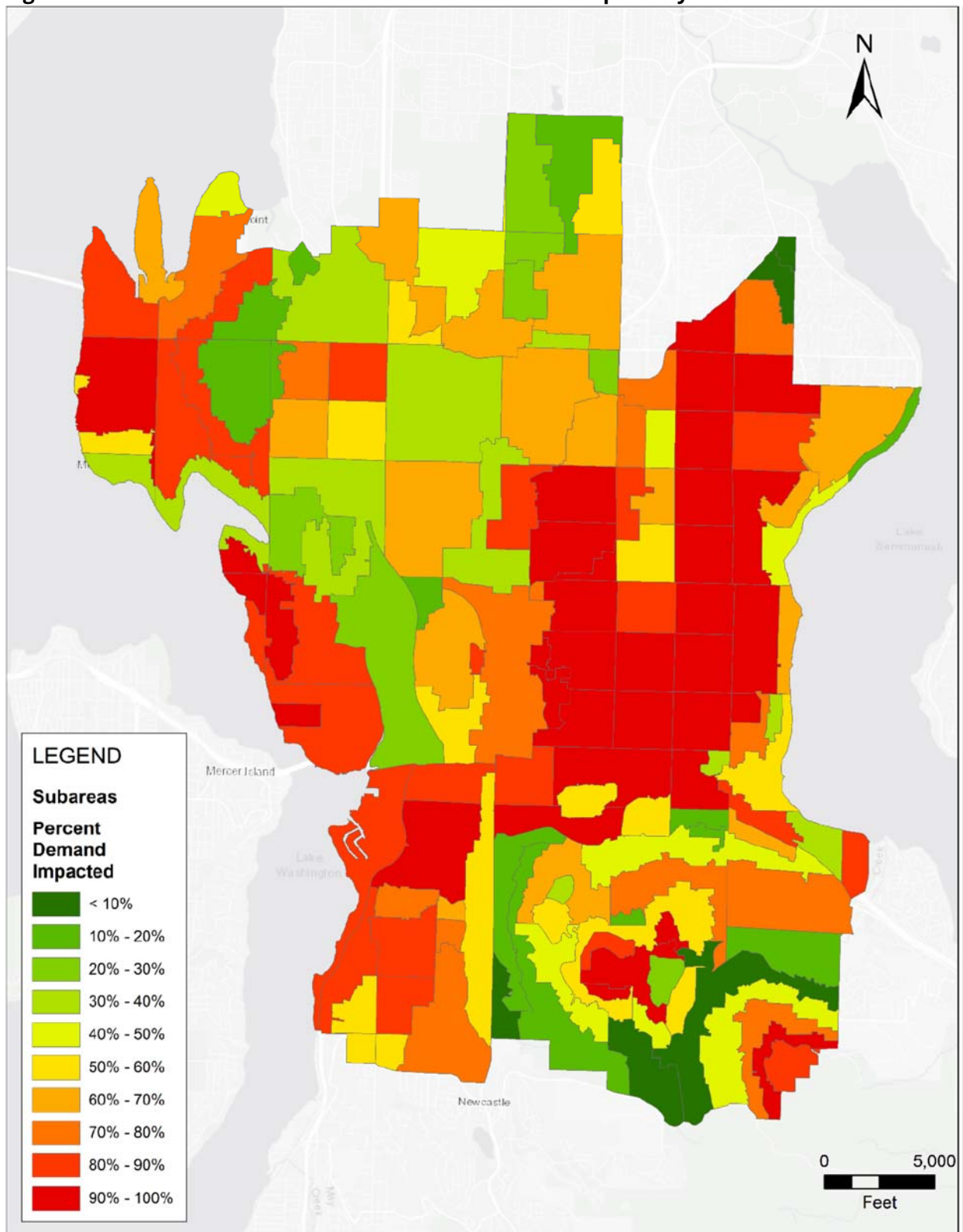
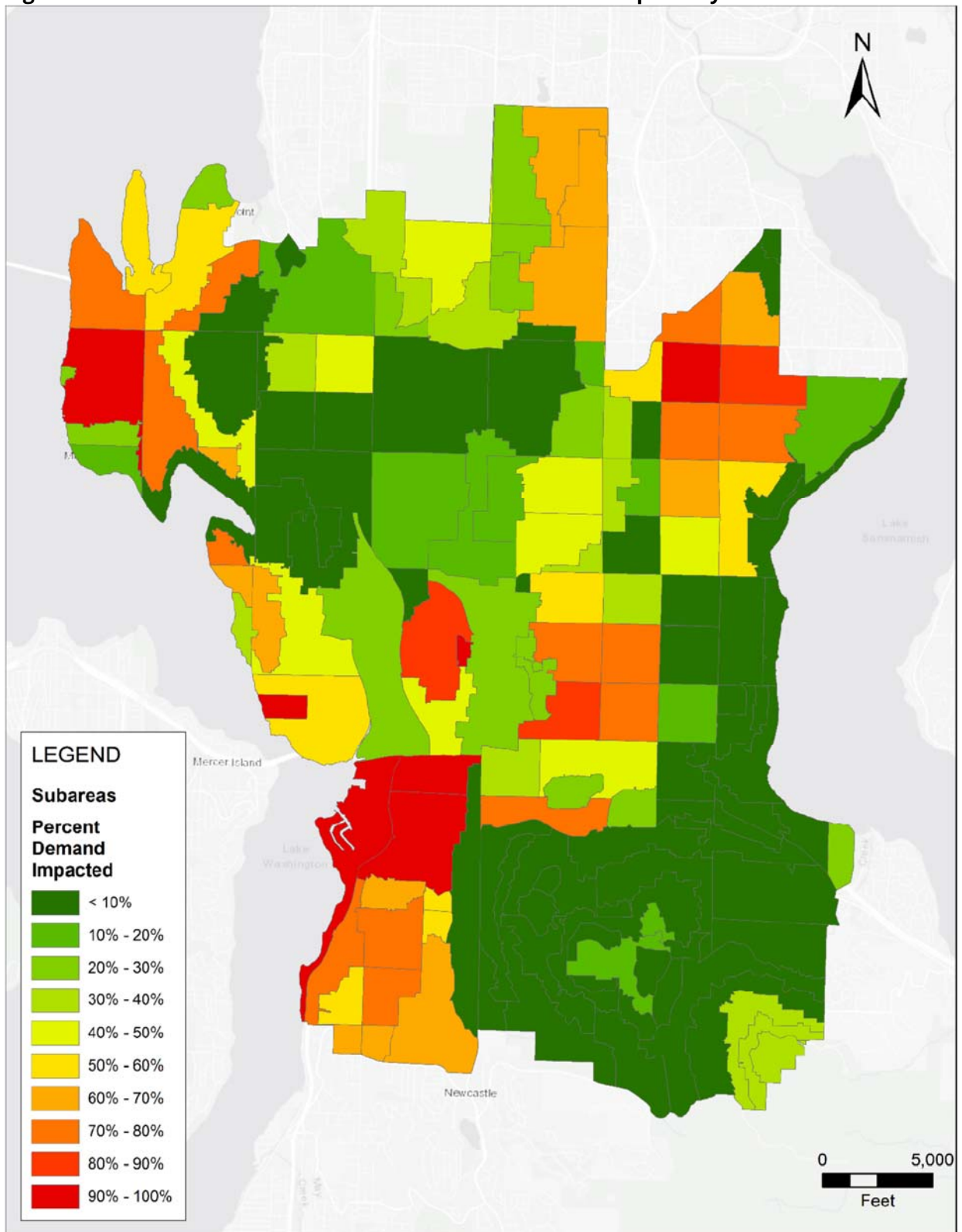


Figure 3: Seattle Fault Zone East – Predicted Immediate Impacts by % of Subarea Demand*



*NOTE: All service impacted in 2-3 days after depletion of stored water, due to regional failures.

Figure 4: Cascadia Subduction Zone - Predicted Immediate Impacts by % of Subarea Demand*



*NOTE: All service impacted in 2-3 days after depletion of stored water, due to regional failures.