Wastewater Treatment Division

Executive summary

RWSP Update – Group #4, Policy Memo #5: Climate Impact Preparedness and Natural Hazard Resiliency

This executive summary provides a synopsis of the policy questions, problem statement, issues, challenges, and the options developed for the Natural Hazard Resiliency portion of the RWSP Update.

Policy questions

1. What level of resiliency should WTD plan for regarding seismic and other natural hazards to avoid or minimize risks? What level of risk tolerance should WTD accept? How can these considerations be best informed by the long-term capital motion work in progress?
2. What level of redundancy of critical systems should WTD have? (Nexus with the Asset Renewal and Replacement work)

Problem statement

Natural hazards such as earthquakes (most prominent), landslides, and flooding could cause significant disruptions to the wastewater system. Much of WTD's infrastructure is aging and was built to codes that don't reflect today's building standards for natural hazards. Because these natural hazards are infrequent and unpredictable, it can be easy to deprioritize natural hazard resilience projects that require substantial capital investment. However, delaying these upgrades increases the time needed to restore normal operations when a major event does occur.

The long-term capital motion work was integrated into the sewer rate model and informs the sewer rate forecast. The sewer rate forecast includes natural hazard resiliency projects; however, implementation of a significant portion of the natural hazard resiliency recommendations had to be shifted to future years due to competing priorities, creating higher near-term recovery risk.

Policy issues, challenges, and opportunities

Many of WTD's assets were constructed to older seismic standards. Although these assets still have significant remaining useful life, they are not adequately prepared for today's natural hazard risks.

When wastewater projects are being completed for other reasons, like capacity improvements or asset renewal and replacement, there is an opportunity to include natural hazard resiliency upgrades at the same time.

Policy options

WTD is considering options for different levels of natural hazard resiliency and redundancy for the regional system. Increased levels of resiliency generally reduce risk and downtimes following a natural disaster but will increase costs. The long-term capital motion work, incorporated into the sewer rate model, assumes an average of about $30 million per year for resiliency projects. Adding redundancy to critical systems improves resiliency but similarly increases capital costs. The three policy options summarized below answer the question by offering decision makers varying levels of resiliency and redundancy relative to risk and cost impacts.

For natural hazard resiliency, the policy options include:

a. Retrofit, replace, or relocate infrastructure based on WTD's current practices and prioritization for natural hazards (seismic/flooding, etc.). This option prioritizes lower costs and lower impacts on the sewer rate with the tradeoff of higher risk.

   Outcomes: Higher risk. Return to service as resources allow; longer downtimes following natural disasters.

b. Proactively retrofit, replace, or upgrade critical facilities based on new studies and/or vulnerability/risk exposure assessments at current sites. This option seeks to balance level of resiliency and risk with costs.

   Outcomes: Low/medium risk. Return to service more quickly.

c. Aggressively replace, upgrade, or relocate assets and projects that are susceptible to failure caused by earthquakes, flooding, and landslides based on innovative monitoring technology and new studies to measure risk and vulnerability. By choosing this option the region prioritizes resiliency to natural hazards and is willing to trade increased costs for significantly lower risk.

   Outcomes: Lower risk. Faster return to service following natural disasters.

Relationship to other RWSP topics

Natural Hazard Resiliency relates to other RWSP topics as follows:

Asset Renewal and Replacement (Asset R&R): Natural Hazard Resiliency and Asset Renewal and Replacement efforts both relate to risk tolerance and seek to reduce service disruptions and ensure the wastewater system remains reliable during and after major hazard events and everyday conditions. The policy choice for Asset R&R will affect the chosen level of resiliency and vice versa.

Climate Preparedness: Natural Hazard Resiliency and Climate Preparedness are closely linked, with the former addressing sudden disruptive events and the latter preparing for long-term climate shifts (e.g. sea level rise, frequent regular occurring weather events, etc.). Together, they help ensure infrastructure remains reliable under both immediate and evolving conditions.

RWSP Update - Climate Impact Preparedness and Natural Hazard Resiliency

Group #4 Policy, Memo #5

A. Policy Question

This memo is focused on one of the policy questions related to the Climate Impact Preparedness and Natural Hazard Resiliency topic of the Regional Wastewater Services Plan (RWSP) Update. The policy questions explored in this memo are related to Natural Hazard Resiliency:

- **i.** What level of resiliency should WTD plan for regarding seismic and other natural hazards to avoid or minimize risks? What level of risk tolerance should WTD accept? How can these considerations be best informed by the long-term capital motion work in progress?

A second question was considered in the context of Natural Hazard Resiliency. This policy question is:

- **ii.** What level of redundancy of critical systems should WTD have?

B. Problem Statement

Natural hazards have a profound impact on both the health of the wastewater treatment system, and the health of King County more broadly. Some kinds of disasters could cause significant disruptions to the wastewater system, with long downtimes in the most impacted portions. Much of WTD's infrastructure is aging and was built to codes that don't reflect today's building standards for natural hazards.

King County is at risk for a substantial number of potential natural hazards. Among the most prominent is earthquakes. There are three major earthquake risks identified by the County: a full Cascadia Subduction Zone quake, which would have an estimated magnitude of 9.0; a South Whidbey Island Fault quake, which would have an estimated magnitude of 7.4; and a Seattle Fault quake, which would have an estimated magnitude of 7.2. Any of these scenarios would cause substantial risk to wastewater infrastructure across the county – risks which the County has mapped specifically in its 2018 wastewater disaster resiliency planning process.

There are numerous other hazards across the county which also pose serious risks to infrastructure, including flooding and heavy rainfall, tsunamis, tornadoes, high winds, snowstorms, and hail and freezing rain. Each hazard can present different risks to infrastructure depending on where and how it occurs, and therefore protecting against these hazards requires replacement, retrofit or similar upgrades to wastewater infrastructure. Because these natural hazards are infrequent and unpredictable, it can be easy to deprioritize natural hazard resilience projects that require substantial capital investment in favor of other, more costly, projects. However, delaying these upgrades increases the time needed to restore normal operations when a major event does occur.

Over the long run, proactive investment is the most cost-effective way to prevent (to the greatest extent possible) damages to and assure continued operation of County facilities after significant natural hazards.

C. Contextual and Baseline Information

i. What is known about the topic and current conditions

Natural Hazards and Resiliency

A natural hazard describes extreme physical events that arise from the Earth's natural processes, posing a threat to people, property, and the environment. These phenomena are a persistent feature of our planet's dynamic systems, arising from the interaction of internal and external forces like plate tectonics, weather patterns, and the water cycle. Understanding these processes is a foundational step in minimizing their potential for harm to infrastructure, economic activity, and human life.

Resiliency is the ability of individuals, communities, and social, economic, and environmental systems to withstand and adapt to disruptions while maintaining their core identities, functions, and structures. A resilient facility for the purposes of the RWSP Update is one built to withstand, or recover quickly from, natural hazards, as well as to perform to its intended design standard throughout its useful life in a changing climate.

Table 1. Types of Hazards[1]

Seismic/Liquefaction Scenarios	**Natural Hazards**
Cascadia Subduction Zone (CSZ) • Magnitude 9.0 • Approximately 500-year recurrence interval	Extreme Weather • Windstorms, lightning, tornadoes/funnel clouds • Significant snowfall, ice, and/or freezing rain
Seattle Fault (SF) • Magnitude 7.2 • Approximately 5,000- to 6,000-year recurrence interval	Flooding • Riverine, urban, and mechanical flooding
South Whidbey Island Fault (SWIF)	Landslides

[1] *Source: WTD Resiliency Study, 2018*

• Magnitude 7.4 • Approximately 4,000- to 5,000-year recurrence interval	• Focus on landslides caused by earthquakes.
	Tsunami (SF) • Focus on tsunami caused by 7.2 degree magnitude Seatle fault earthquake.

Hazard Mitigation Plan

King County most recently updated its Hazard Mitigation Plan for the period 2025-2030. This plan assesses natural and human-caused hazards that can impact our region and develops strategies to reduce risk and build resilience.

In 2018, WTD issued a wastewater-specific, multi-part hazard mitigation-focused plan entitled “Recommendations to Enhance the Resiliency and Recovery of King County’s Regional Wastewater Treatment Facilities”[2] and “Preparedness and Recovery Recommendations.”[3] The plan comprehensively assessed the risk to the county’s various wastewater assets from natural hazards, considering risk under two frameworks – consequence of failure on system performance, and probability of failure – vulnerability to hazard, and assessing assets on four criticality factors, including life safety, public health, consequential damage, and environmental. It also detailed strategies to handle them, prioritizing strategies by their usefulness. It also incorporated information about Equity and Social Justice. This plan is scheduled to be updated with an addendum in 2028. The three policy approaches outlined in Section F of this memo align with this ongoing resiliency work.

ii. Current policies in code, contract, or in practice

King County Code (K.C.C.) does not explicitly have wastewater specific policies relating to vertical or horizontal seismic resiliency, landslides, or flooding, but does follow policies in other parts of code or state-standard for projects, recommending some level of hazard resiliency.

[2] Recommendations to Enhance the Resiliency and Recovery of King County’s Regional Wastewater Treatment Facilities

[3] Preparedness and Recovery Recommendations

Table 2. Current policies

Relevant Policies in K.C.C.	Description
IBC (2021)	The International Building Code (IBC) is a set of regulations that governs the design, construction, and maintenance of buildings to ensure safety, accessibility, and sustainability.
Local Municipal Codes	Each jurisdiction may have its own addition to codes for vertical seismic resiliency.
Resiliency Plan (2018)	Describes how to further evaluate and replace or retrofit portion of the conveyance system identified as susceptible to damage during major earthquakes.
FEMA	100-year floodplain
WAC 365-190-120	Geographically hazardous areas
IWUIC 2021/WAC 21-55	International Wildland Urban Interface Code

Seismic Vertical (i.e., buildings)

King County's new projects are currently subject to the International Building Code (IBC) code as adopted by the permitting jurisdiction for buildings as it relates to public utility facilities. The latest version of this code mandates strict seismic provisions for public utilities, generally assigning them to Risk Category IV (Essential Facilities) to ensure functionality after a major earthquake. Beyond structural integrity, IBC requires seismic certification for equipment supports, suspended ceilings, and piping systems to ensure they do not fail.

Seismic Horizontal (i.e., pipes)

King County follows the currently accepted best design and operation practices for the design of its conveyance system. There are no specific codes or enforced standards (like the vertical facilities above) for seismic resiliency of conveyance systems. There are best management practices being developed that at a future point may develop into standards.

Landslide and Flooding

WTD considers 100-year and 500-year FEMA flood plain maps in identification of potential facilities that may be at risk for flooding. The flooding assessment also included potential for mechanical flooding due to equipment failure as well as ravine type flooding.

The landslide assessment in the 2018 report was mostly focused on the potential damage to WTD's facilities for landslides caused by earthquakes. For non-seismically induced landslides, WTD follows IBC, local and state codes such as WAC 365-190-120.

Other Hazards

Currently, there are no requirements regarding wildfires, internet outages, or cybersecurity at our facilities in the resiliency plan.

iii. The system "must-dos"

All wastewater infrastructure projects must comply with federal, state, and local codes, and other requirements such as IBC, as they are applicable. Additionally, the design should adhere to common design practices and evaluate projects for application of recommended best practices. The challenge is that much of WTD's infrastructure is aging and was built to codes that don't reflect today's building standards for natural hazards.

iv. Current and Budgeted Expenditures

Figure 1 below shows the 20-year capital forecast. It is informed by the long-term capital motion work that was integrated into the sewer rate model. The yellow bar in Figure 1 shows the capital spending on the Resiliency category (that covers both Natural Hazards and Climate Preparedness) in the first decade. Resiliency costs are grouped with other costs and shown in black for the second decade.

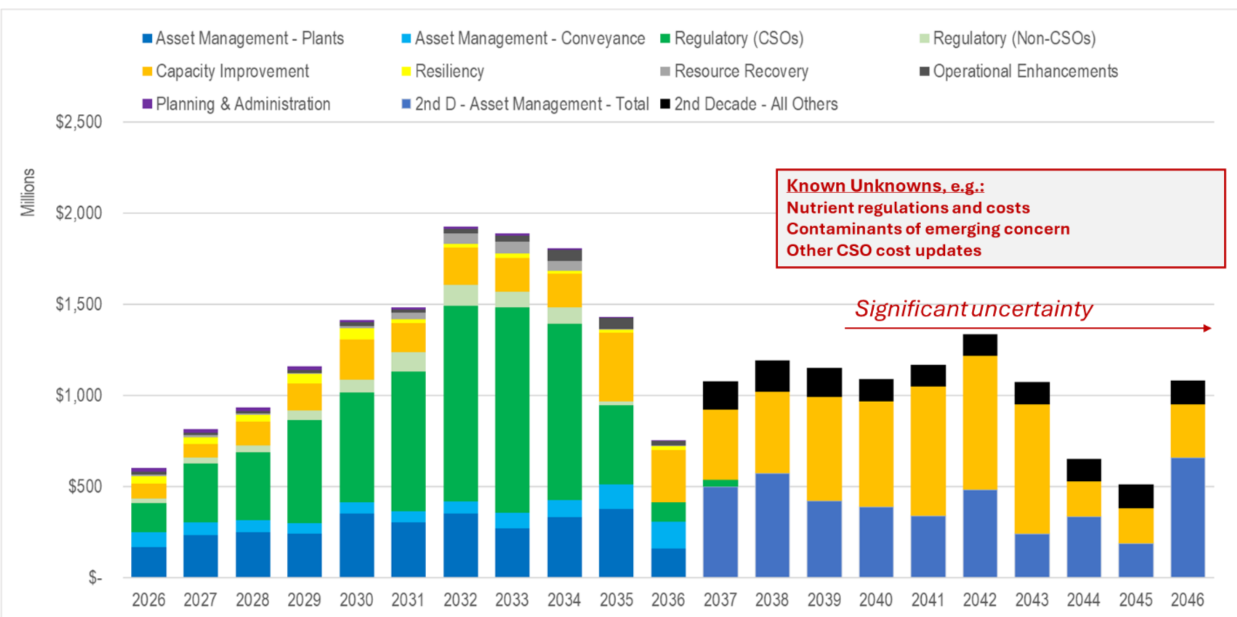
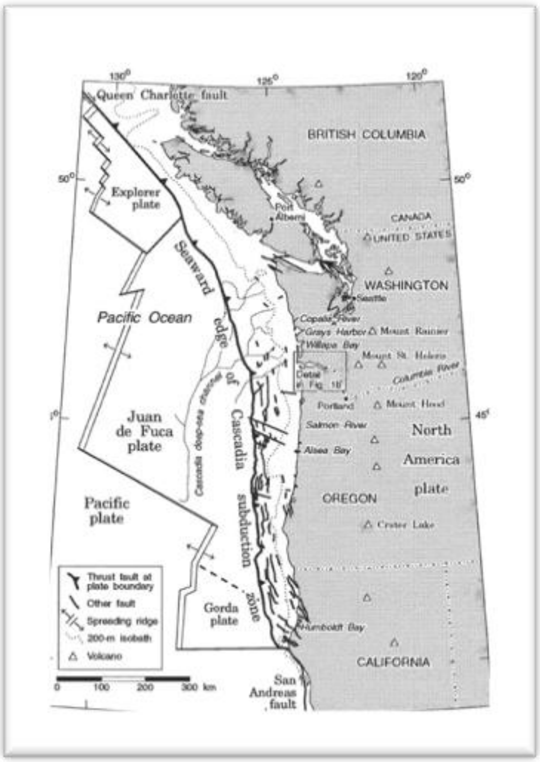


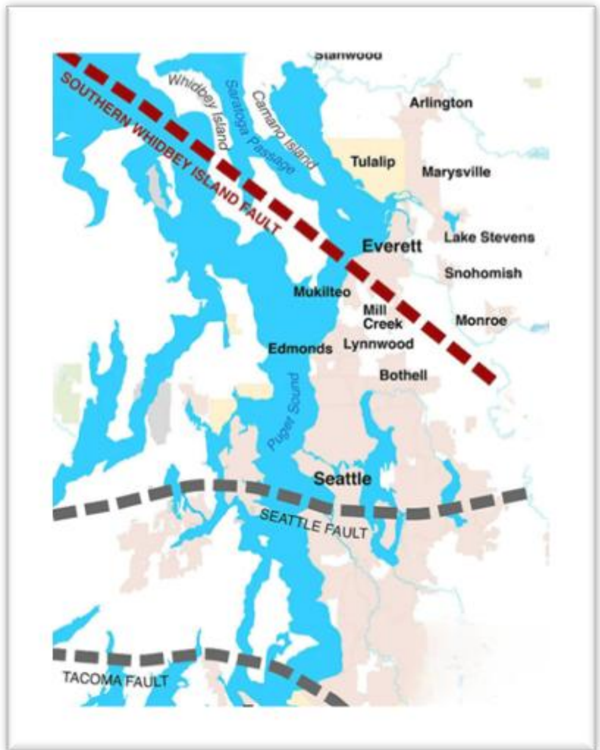
Figure 1. 20 -Year Capital Forecast

In the near future, our capital program is more focused towards our Asset Management portfolio categories to maintain the level of service of our system, Capacity Improvements to meet increased demand, and Regulatory to meet our time sensitive regulatory commitments. Current expenditures on the Resiliency category average about $30 million per year over the first decade and are based on the 2018 resiliency plan and 2017 AECOM report recommendations. WTD's long-term financial plan assumes similar levels of investment in resiliency projects as current expenditure levels.

v. Summary of science/data

The following Figures 2 and 3 show known earthquake faults that would affect WTD's service area:





Figures 2 and 3. Known major faults - Cascadia Subduction Zone, Seattle fault & South Whidbey Island Fault

River flooding occurs when heavy rainfall and snowmelt generate flows that exceeds a river's capacity, inundating adjacent areas with high-velocity water that leads to flooded facilities and could lead to structural damage. Tsunami could also lead to facility flooding in shoreline areas. Mechanical flooding of a facility could occur due to component damage or failure. Figure 4 is a map of the 100-year and 500-year floodplains as well as tsunamis.

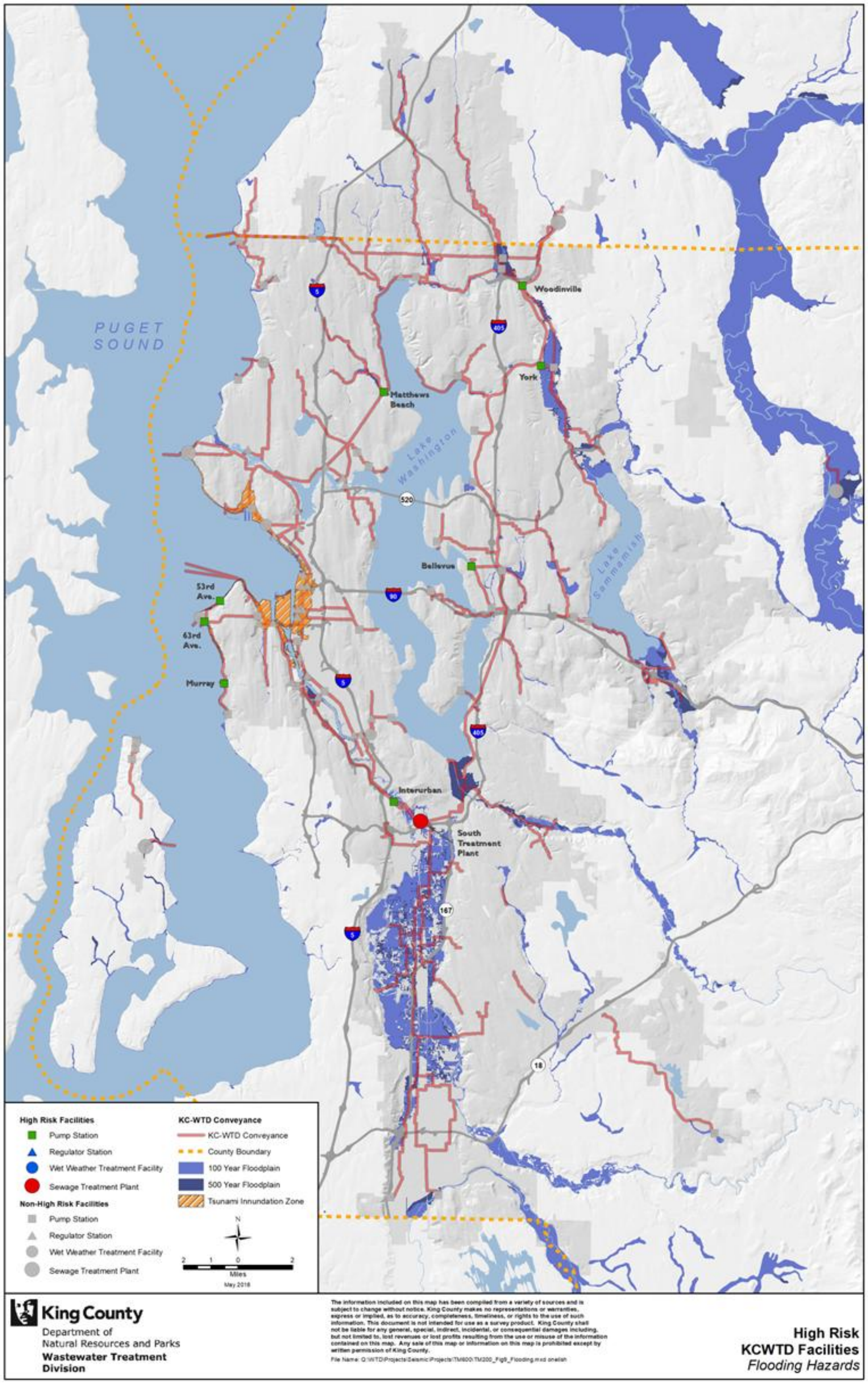


Figure 4. 100- year and 500-year Floodplains and Tsunami Map

D. Example Practices from Other Jurisdictions/Industry

Orange County Sanitation District (OC San)

Located southeast of Los Angeles, OC San provides wastewater collection, treatment, and disposal services for ~2.6 million people. This region is susceptible to seismic hazards from multiple faults, including the San Andreas fault, which has the potential for earthquake damage and service disruptions to affect their multi-billion-dollar wastewater infrastructure.

In 2017, OC San completed a resiliency study to evaluate OC San's treatment facilities for potential seismic hazards, and to develop mitigation strategies to improve resiliency.[4] This study evaluated seismic risks relating to liquefaction and lateral spread, and prioritized mitigation recommendations to prepare the wastewater system and become more resiliency to natural hazards.

E. Policy Issues, Challenges, and Opportunities

1. Long useful life of wastewater infrastructure

Many of our assets are aging and were constructed based on historic code requirements for seismic resiliency. As such, these assets may still have a significant useful life remaining but are inadequately prepared to withstand natural hazard events. These assets can be retrofitted to be more resilient to natural hazards at a high monetary cost, which would avoid the deferred cost of repair when these events occur. Underbuilding today means that future generations will face higher risk of asset failure due to natural hazards.

2. Uncertainty in hazard frequency or magnitude

Unlike predictable needs in our wastewater system, natural hazards are unpredictable in frequency and magnitude. This means that to be prepared for hazard events, we must prepare for the unknown, based on uncertainties in timing or scale.

3. Cost considerations for natural hazard resiliency investments

The cost of upgrading resiliency in our wastewater assets, particularly retrofitting or relocating for seismic and hazard-prone areas, would require significant capital outlay.

4. Opportunity to conduct natural hazard resiliency upgrades when implementing asset renewal and replacement or other asset improvements

When wastewater projects are being completed for other reasons, like capacity improvements or asset renewal and replacement projects, there is an opportunity to

---

[4] Source: WaterWorld April 2021 Issue

include natural hazard resiliency upgrades at the same time. This saves money by bundling the project with other necessary work, reducing contract procurement and construction costs.

F. Range of policy options with associated actions and considerations (including qualitative description of costs)

The policy options presented below describe potential choices and Natural Hazards-related actions that would be implemented to address the following policy questions:

- What level of resiliency should WTD plan for regarding seismic and other natural hazards to avoid or minimize risks? What level of risk tolerance should WTD accept? How can these considerations be best informed by the long-term capital motion work in progress?

A second question was considered in the context of Natural Hazard Resiliency. This policy question is:

- What level of redundancy of critical systems should WTD have?

The policy options include:

1. **Retrofit, replace, or relocate** infrastructure based on current practices and prioritization for seismic and flooding hazards**;**
2. **Proactively retrofit, replace, or upgrade** based on new studies or assessments based on vulnerability/risk exposure at current sites; and
3. **Aggressively replace, upgrade, or relocate** assets and projects that are susceptible to failure caused by earthquakes, flooding, and landslides based on innovative monitoring technology and new studies to measure risk and vulnerability.

Summary of Policy Options – Natural Hazard Resiliency

	Description	Goals/outcomes	Tradeoffs
#1	**Retrofit, replace, or relocate i**nfrastructure based on current recommendations and portfolio prioritization for natural hazards.	Infrastructure damaged from natural hazards **return to our standard level of service, as resources allow.**	• Lower costs / low impact on ratepayers • High risk tolerance • Long downtimes from natural hazards • Higher risk of negative economic impact • Highest risk of displacement and highest risk of negatively affecting people who cannot willingly relocate
#2	**Proactively retrofit, replace, or upgrade** based on new studies or assessments based on vulnerability/risk exposure at current sites.	Infrastructure damaged from natural hazards **return to our standard level of service faster**, compared to current practice.	• Higher costs / increased impact on rate payers • Medium risk tolerance • Medium downtimes from natural hazards • Medium risk of displacement and medium risk of negatively affecting people who cannot willingly relocate
#3	**Aggressively replace, upgrade, or relocate** assets and projects that are susceptible to failure caused by earthquakes, flooding, and landslides based on innovative monitoring technology and new studies to measure risk and vulnerability.	Infrastructure damaged from natural hazards **return to our standard level of service fastest**, compared to current practice.	• Highest costs / highest impact on rate payers • Low risk tolerance • Short downtimes from natural hazards • Lowest risk of displacement and lowest risk of negatively affecting people who cannot willingly relocate

G. Interested and affected parties WTD will engage to gather input

MWPAAC and the component agencies that WTD provides sewerage services to are one of the audiences that need to be engaged on the climate and natural hazards resiliency policy options. Additional engagement with tribes, community-based organizations (CBOs), and environmental non-governmental organizations (NGOs), businesses, industries, and the general public may be conducted during implementation planning.

H. Rate structure considerations (if applicable)

There are no known rate structure considerations for this policy question.

I. Relationship to contracts

There are no known contract implications for this policy question.

J. Equity and Social Justice (ESJ) impacts

There are three key ESJ impacts and risks to consider for natural hazard resiliency: the risk of negative economic impact, the risk of displacement from long-term infrastructure damage, and the unequal opportunity to willingly relocate away after a natural hazard event has occurred.

Long downtimes associated with natural hazard events can affect the economy due to road closures and other critical lifelines becoming damaged, inhibiting “business as usual” activities. For wastewater, these effects will be worse in areas of King County with aging assets that have not been upgraded to withstand natural hazards.

Studies demonstrate that economically and socially vulnerable groups can take longer to recover from disasters and suffer from lasting consequences, including facing persistent health and education costs in the face of reconstruction and recovery.[5] Additionally, disaster response measures, like buyouts and relocations, can unintentionally target marginalized communities.

K. Summary of how MWPAAC/RWQC input was addressed

This section will be added into the policy memo as “Step 1” memos are finalized.

L. Planning-level cost estimates

This section will be added into the policy memo as the “Step 2” analysis later.

M. Evaluation of outcomes: identify impacts and outcomes of each option

This section will be added into the policy memo as the “Step 2” analysis later.

---

[5] Source: The World Bank; Natural disasters, poverty and inequality

Appendix A: Policy options and actions

	Description	Natural Hazard Resiliency Actions
#1	**Retrofit, replace, or relocate** infrastructure based on current recommendations and portfolio prioritization for natural hazards.	• **Seismic Vertical** – Continue to retrofit or replace facilities based on existing periodization ranking approach and existing CIP. • **Seismic Horizontal** – Further evaluate and preplace or retrofit portions of conveyance system identified as susceptible to damage during major earthquakes under 2018 Resiliency Plan; replace or retrofit portions of conveyance system damaged after an earthquake • **Landslides and Flooding** – Retrofit or relocate at-risk facilities identified in the Resiliency Report AECOM study the PfM ranking system. Additional Flooding programmatic studies of plants and offsite facilities will be done per resiliency report.
#2	**Proactively retrofit, replace, or upgrade** based on new studies or assessments based on vulnerability/risk exposure at current sites.	• **Seismic Vertical** – Develop program to upgrade all critical (> 20 MGD) facilities within 20 years, as well as any that do not meet current International Building Code (IBC) risk category IV standards. • **Seismic Horizontal** – Study and complete targeted retrofits or replacements of very high to moderately liquefaction susceptibility zones in the next decade. • **Seismic Horizontal** – Develop design standards for our new interceptors. • **Seismic Horizontal** – Assess facility vulnerability to liquefaction to determine the likelihood of failure. Mitigate liquefaction if failure could result in blocking sewage flow. • **Landslides and Flooding** – Study to determine most flood and landslide prone major facilities. Flood proof, relocate, replace or retrofit landslide all flooding prone major facilities in the next ten years. • **Landslides and Flooding** – Mandate that new WTD projects must consider landslide or flood-prone areas in in the planning phase and add the resilience scope and cost to the project.

	Description	Natural Hazard Resiliency Actions
		• **Other Hazards** – New resiliency plan evaluating risk exposure in relationship to Fire and Cyberattacks/ outage. Add the recommended actions to the resiliency portfolio.
#3	**Aggressively replace, upgrade, or relocate** assets and projects that are susceptible to failure caused by earthquakes, flooding, and landslides based on innovative monitoring technology and new studies to measure risk and vulnerability.	• **Seismic Vertical** – Adopt aggressive (10-year) program to upgrade and replace critical facilities meeting stricter IBC requirements for Risk Category IV continuous operation after a major seismic event. • **Seismic Vertical** – Purchase and install above-ground monitoring technology (motion sensors) to assess motions and stresses across facilities. • **Seismic Horizontal** – More detailed study of the entire conveyance system. Replacing and retrofitting all pipes susceptible to failure after an earthquake. • **Seismic Horizontal** – Construct pipeline Seismic Monitoring System (fiber-optic sensors) to rapidly identify damaged areas of system. Procure contract to repair section(s) of pipe after major earthquakes. • **Landslides and Flooding** – Develop a 10-year program to relocate, replace or retrofit all projects and facilities susceptible to flooding and landslide damage.