2020-2025

King County Regional Hazard Mitigation Plan

King County
Emergency Management

EMAP Accredited

Table of Contents

Executive Summary

The King County Hazard Regional Hazard Mitigation Plan promotes programs and projects that partner with communities to build a foundation of resilience before, during, and after disasters. Hazard mitigation is the mission area of emergency management that argues *life safety is not good enough.* Disasters are not foregone conclusions. Incidents will always occur, but their impact is within our ability to change if we target investments in areas that will reinforce those areas most critical to our community, thereby making us all more resilient.

For the 2020 Plan, we identify investments and opportunities to strengthen 14 determinants[1] of equity and social justice, areas the whole community has identified as necessary to *make King County a welcoming community where every person can thrive.*

1. Access to Affordable, Healthy Food
2. Access to Health and Human Services
3. Access to Parks and Natural Resources
4. Access to Safe and Efficient Transportation
5. Affordable, Safe, Quality Housing
6. Community and Public Safety
7. Early Childhood Development
8. Economic Development
9. Equitable Law and Justice System
10. Equity in Government Practices
11. Family Wage Jobs and Job Training
12. Healthy Built and Natural Environments
13. Quality Education
14. Strong, Vibrant Neighborhoods

We can strengthen and support each of these areas through investments in better land use practices, stronger infrastructure, healthy habitats and systems, improved accessibility, and individual and family resilience. The hazard mitigation strategies contained in this plan will each be reported on biannually to help provide updates on areas where investments would be most critical.

In addition to hazard mitigation strategies, this plan includes risk profiles designed to provide an overview of the key priorities, vulnerabilities, and potential impacts of natural and human-caused hazards. We examine risk in terms of property, the economy, natural systems, infrastructure systems, government operations, and populations, with a focus on populations more likely to suffer losses or long recovery times from a disaster.

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[1] King County Office of Equity and Social Justice. 2016. Equity and Social Justice Strategic Plan. Accessed online on 11/13/19 from https://kingcounty.gov/elected/executive/equity-social-justice/strategic-plan.aspx.

Finally, this plan lays out a process to identify and prioritize hazard mitigation projects over the long term and to increase investment in communities that are more vulnerable to disasters. We do this by taking a holistic approach to prioritization.

This plan was developed through the partnership of many county staff and local jurisdictions. The work is a result of their commitment and input throughout the planning process.

Introduction

The King County Regional Hazard Mitigation Plan promotes programs and projects that partner with communities to build a foundation of resilience before, during, and after disasters. This plan update reassesses risks and vulnerabilities to eight natural and seven human-caused hazards and develops strategies to reduce risk from those hazards. In addition to a base plan covering King County as a whole, each participating jurisdiction developed an annex that independently meets most FEMA planning requirements. Each annex, plus this base plan, meets the planning requirements outlined in *44 CFR 201.6*. In addition to King County, over 60 cities and special purpose districts developed plan annexes.

Mitigation Plan Priorities:

King County Regional Hazard Mitigation Plan Steering Committee (Steering Committee) set the following priorities for the 2018 plan update process.

Break down planning silos and establish new partnerships	Collaborate with jurisdictions to build integrated hazard mitigation strategies, including around risk management, floodplain management, comprehensive planning, equity and social justice, and climate change.
Provide more education and training to partners to prepare for FEMA DRRA grants in 2020	In preparation for a tripling of federal grants for natural hazard mitigation through the Disaster Recovery Reform Act, beginning in 2020, work with planning partners and county agencies to identify projects and project champions. Build capacity among planning partners to identify vulnerability, craft a mitigation strategy, communicate project benefits, and successfully pursue hazard mitigation grant funding.
Conduct a robust public outreach process involving all planning partners.	Implement a proactive outreach strategy focused hazard mitigation success stories and hands-on demonstrations of effective mitigation projects, working with the media to follow-up on stories highlighting Washington's need for more hazard preparedness and resilience.
Develop quality hazard mitigation strategies and a method to prioritize and track them.	Work with planning partners to craft comprehensive hazard mitigation strategies that are measurable, actionable, trackable, and identify specific funding sources. Prioritize strategies in accordance with opportunity to reduce risk and further county priorities.
Integrate equity and social justice into our understanding of risk and vulnerability.	Work with King County departments to identify an appropriate way to address population vulnerability. Include this information in the plan in a way that is operationally meaningful and can support mitigation strategies that will reduce risk to these populations.

| Integrate mitigation planning and climate preparedness | Fully integrate with the update process for the Strategic Climate Action Plan. Integration includes participation in workgroups and shared strategies that increase climate and hazard resilience. |

Timeline

February-May 2019: Begin planning process	Meet with each of the 60+ jurisdictions participating in this plan update. Convene the steering committee. Draft plan format and begin GIS analysis. Begin outreach strategy. Develop first drafts of the risk assessment.
June-September: Conduct public outreach	Work with partners on community outreach; conduct media outreach; conduct mitigation strategy development workshops with planning partners.
October-December	Review the plan and submit to FEMA.
January-April, 2020	Complete revisions and adopt the plan prior to expiration on April 30, 2020.

Revisions from 2015 Edition

The 2020 plan was fully rewritten and reformatted to reflect updated priorities and a greater emphasis on hazard mitigation strategies. The most substantive change is to those strategies, which are formatted in an action-plan style, consistent with the Washington State Enhanced Hazard Mitigation Plan. With the change to mitigation strategies, the method of reporting has also been updated.

The risk assessments in this edition have been shortened and refocused to better support the intended audience - emergency managers who are called upon to plan for and respond to these hazards. The information is largely taken from the 2016 Hazard Inventory and Risk Assessment and the 2018 FEMA RiskMAP Risk Report.

The capabilities assessment in this edition has been modified to focus on the relationship between programs, plans, and policies that could support mitigation and the hazard mitigation plan and program. This change will help the plan better reflect how each capability supports mitigation instead of just listing potential capabilities. A similar process was used to document potential sources of funding.

This plan is written to meet or exceed the relevant elements of the Emergency Management Standard (ANSI standard) by the Emergency Management Accreditation Program (EMAP).

The number of participating jurisdictions increased from the 2015 update. In 2015, 53 jurisdictions participated in the plan. For this update, over 60 jurisdictions participated in the planning process and at least 50 are expected to submit complete annexes for FEMA approval.

Regional Hazard Mitigation Plan Chapters

The base plan satisfies all requirements for King County plus many of the planning requirements for local planning partners. The plan is organized as follows.

Planning Process: The planning process section corresponds roughly to Element A in the FEMA Mitigation Plan Review Guide and includes information on the planning process, including public outreach, meetings, and the planning timeline.

Capabilities Assessment and King County Hazard Mitigation Program: The capabilities chapter meets requirements associated with coordinating the hazard mitigation program with other entities as well as information on available funding.

Risk Assessment: The risk assessment chapters include profiles of each profiled natural and human-caused hazard. These profiles are brief and are designed to provide an overview to emergency managers and other users of this plan. This section meets the requirements of Element B in the FEMA Mitigation Plan Review Guide.

Hazard Mitigation Strategies: Hazard mitigation strategies are the key deliverable of this plan and include information on how strategies are identified, developed, and prioritized. This section meets most of the requirements in Element C of the FEMA Mitigation Plan Review Guide.

Hazard Mitigation Planning Process

King County's 2020 Regional Hazard Mitigation Plan (RHMP) was developed with input of a multi-agency, multi-jurisdictional steering committee. The Steering Committee supervised the writing of the plan and was consulted for final decisions made by the King County Emergency Management Planning Team. The process was led by King County Emergency Management, which facilitated both the internal county process and supported individual city planning efforts. Individual departments developed their own strategies internally and then socialized the strategies with the other county participants.

Steering Committee Members

Name	Email	Organization	Focus Area
Lara Whitely-Binder	lwbinder@kingcounty.gov	King County Department of Natural Resources and Parks	Climate Preparedness Specialist
Mitch Paine	mpaine@kingcounty.gov	King County Department of Natural Resources and Parks	Floodplain Management Program Manager
Cecelia Hayes	Cecelia.Hayes@kingcounty.gov	King County Department of Executive Services	Equity and Social Justice Program Manager
Karen Wolf	karen.wolf@kingcounty.gov	King County Executive Office	Comprehensive/Land Use Planning Policy Analyst
Cynthia Hernandez	cynthia.hernandez@kingcounty.gov	King County Department of Natural Resources and Parks	Emergency Management Program Manager
Sean Catanese	sean.catanese@kingcounty.gov	King County Risk Management	Risk Management
Andrew Stevens	astevens@sammamish.us	City of Sammamish	Emergency Manager
Ellen Montanana	emontanana@bellevuewa.gov	City of Bellevue	Emergency Manager
Jennifer Franklin	jennifer.franklin@mercergov.org	City of Mercer Island	Emergency Manager

Janet Sailer	janet.sailer@spwsd.org	Sammamish Plateau Water District	Emergency Manager
Steve Moye	smoye@ccud.org	Coal Creek Utility District	Manager
Janice Rahman	janice.rahman@kingcounty.gov	King County Emergency Management	Recovery Program Manager
Mike Ryan	mryan@bellevuewa.gov	King County Emergency Management	N/E Zone Coordinator
Sarah Miller	sarah.miller@kingcounty.gov	King County Emergency Management	S Zone Coordinator
Jeffrey Linn	jlinn@kingcounty.gov	King County GIS	GIS
Derrick Hiebert	dhiebert@kingcounty.gov	King County Emergency Management	Planning Process Facilitator, Plan Author

The team met monthly to review progress and make key decisions about the direction of the planning effort. These meetings were hosted by King County Emergency Management.

Steering Committee Meeting Topics

Month	Topic
February 2019	Outline proposed planning process and timeline and approve plan and plan annex templates.
March	Identify public outreach sites and strategy
April	Integrating equity and social justice into the mitigation plan.
May	Integrating equity and social justice into the mitigation plan.
June	Establish plan goals, priorities, and strategy prioritization method
July	Workshop 2 – hazard mitigation strategies.
August	Review capabilities assessment
September	Review risk assessment

October	Long-term mitigation plan monitoring and implementation strategy
November	Review draft base plan and King County hazard mitigation strategies
January 2020	Submit plan to FEMA
March 2020	Incorporate FEMA revisions
April 2020	Receive notice of Approval, Pending Adoption from FEMA
June 2020	Plan adoption and final approval

In addition to the multi-jurisdictional steering committee, the King County Emergency Management Coordinating Committee (EMCC) contributed to the plan update as the steering committee for the King County-specific hazard mitigation strategies. This committee consists of every King County department as well as representatives from the King County Executive's Office and the King County Council. A list of all EMCC members is available in the Capabilities chapter. The EMCC meets monthly.

Individual jurisdiction annexes were developed in partnership with King County, but with separate internal steering committees. The members of each jurisdiction's steering committee are documented in each annex.

Mitigation Planning Partner Engagement

The King County portion of this plan focuses on unincorporated areas of the county. These areas border, or are served by, cities, tribes, and special purpose districts, all of whom were invited to participate in this plan update. For the purpose of interjurisdictional coordination, King County defined 'neighboring jurisdictions' as these partners since they are the entities most critical to effective implementation of multi-jurisdictional mitigation projects and since many city residents receive county services and visa-versa. In addition to coordination with these jurisdictions, King County maintains a high level of engagement with neighboring counties, especially Pierce and Snohomish. The planning team invited counterparts in Pierce and Snohomish to attend each of the planning workshops described below. There are also multiple other concurrent planning efforts involving these counties, including the Close Coordinated Terrorist Attack (CCTA) program and the Regional Catastrophic Planning (RCPG) effort.

The planning process kicked off in November 2018 with a meeting and workshop to which all planning partners were invited. At this workshop, participants learned about the process, expectations, and were asked to provide commitment letters with billing rates to meet federal grant match requirements.

To support the more-than-60 planning partners, the planning team met individually or in small groups with each jurisdiction to discuss the planning process and go over the planning requirements. These meetings took place between February and May.

To supplement these meetings, King County hosted a webinar and two in-person planning workshops in June 2019 (June 3, 10, and 27). During these workshops, the planning team presented updated information on public outreach, plan integration, risk assessments, and strategy prioritization.

In addition to planning assistance workshops, King County partnered with FEMA RiskMAP and Washington State to offer three workshops on the identification of threats and hazards, the development of mitigation strategies, and the process to successfully fund those strategies. The workshops were held on December 13, 2018, July 25, 2019, and August 22, 2019. Approximately 70 attendees were recorded at each. Invitees included representatives from all King County departments, all cities, most special purpose districts, and other agencies and organizations such as the Port of Seattle and the Northwest Healthcare Response Network.

Following the submission of the base plan in December 2019, King County will begin a second stage of outreach targeting those jurisdictions who missed the original submission deadline and those who were not previously involved. Among the second group, school districts will be proactively engaged and offered assistance in developing annexes to the hazard mitigation plan.

Sign-in sheets for all outreach events are available upon request.

Jurisdiction Plan Annex Process

Jurisdictions may join the regional hazard mitigation plan at any time by submitting a letter of intent to King County Emergency Management and completing the planning process and plan template. Each plan can be unique, and jurisdictions may do more than what is required in the template; however, this template is designed to help walk communities through the planning process in an accessible way. Further details on how to conduct the process are available in the King County Regional Hazard Mitigation Plan. King County staff will provide technical assistance to planning partners, whenever possible.

Review and Incorporation of Reports and Studies

In addition to the data sources outlined in the Risk Assessment section of this plan, the planning team leveraged a number of existing and ongoing planning processes and other documents. More information can be found in the Program Capabilities chapter of this plan.

- The Strategic Climate Action Plan (SCAP) is a plan designed to assess the impacts of climate change on King County and develop strategies to both reduce risk from climate impacts and reduce King County's contribution to climate change. The planning team for the RHMP included the lead for the SCAP and participated in the SCAP.
- The State Enhanced Hazard Mitigation Plan was used for data on hazards and for identifying capabilities. Another contribution from that plan is the hazard mitigation strategy format, which was copied and modified for use in the King County plan.
- The Equity and Social Justice Strategic Plan was integral to establishing the hazard mitigation plan goals and the process by which mitigation projects are prioritized.
- Puget Sound Regional Council's Vision 2050 lays out planning policies and guidelines for the King-Pierce-Kitsap-Snohomish county area and is undergoing an update in 2019 and 2020. The mitigation planning team reviewed and contributed to the planning process for Vision 2050.
- The King County Floodplain Management Plan is being updated and data from that planning effort is included in sections of this plan referring to the NFIP, flood risk, and flood mitigation strategies.

- The Washington, DC Hazard Mitigation Plan (draft) was a source for inspiration for the method of prioritizing mitigation strategies and conducting the risk assessment for vulnerable populations.
- The 2018-2019 FEMA RiskMAP Risk Report for King County was reviewed for data and mapping purposes as well as for information on historic disasters and potential mitigation strategies.
- The 2019 King County Dam Inventory from the Washington State Department of Ecology and guidance from the King County Dam Safety Program.
- The Clean Water and Health Habitat Initiative, uniting departments involved in health and environmental resilience, was convened by the King County Executive and includes the hazard mitigation program.
- The draft Regional Resiliency Assessment Program report for transportation for Western Washington.

King County Plan Update Timeline

The following is a timeline of significant events and milestones for King County in the Regional Hazard Mitigation Plan Update.

Plan Update Timeline

PLANNING ACTIVITY	DATE	SUMMARY	ATTENDEES
Plan Kickoff	11/28/18	Conducted a kickoff meeting for the planning process, including discussions of expectations and the project timeline.	Designated county, city, and special district staff who are leading local plan updates
Risk Assessment Workshop	12/13/18	First workshop with FEMA RiskMAP staff to socialize hazard data and develop problem statements.	Approximately 80 attendees including GIS staff, county departments, city emergency managers, and other program managers with interest in mitigation
Steering Committee Meeting Kickoff	2/19/19	Outline proposed planning process and timeline and approve plan and plan annex templates.	Steering committee
Outreach Strategy Meeting	2/22/19	Meet with staff to identify outreach strategy	OEM Director, Outreach Team, Coordination Team
Steering Committee Meeting	3/12/19	Identify public outreach sites and strategy	Steering committee

Steering Committee Meeting	4/30/19	Integrating equity and social justice into the mitigation plan.	Steering committee
EMCC Meeting	5/1/19	Discuss planning process, DRRA funding, and mitigation strategies	County departments
Steering Committee Meeting	5/14/19	Integrating equity and social justice into the mitigation plan.	Steering committee
Mitigation Technical Webinar	6/3/19	Reviewed planning process and helped local partners on mitigation planning questions	local jurisdiction partners
EMCC Meeting	6/5/19	Mitigation strategy meeting discussions and identify points of contact in each agency	County departments
Mitigation Technical Workshop	6/10/19	Reviewed planning process and helped local partners on mitigation planning questions	local jurisdiction partners
Steering Committee Meeting	6/11/19	Establish plan goals, priorities, and strategy prioritization method	Steering committee
CSA Town Hall Outreach Event	6/18/19	Comments received included concerns about mitigation of solid waste facilities, whether or not earthquake insurance makes sense, and need for snow mitigation following February snowstorm.	Residents from central King County and the Issaquah/Hobart/Maple Valley areas. Approximately 100 attendees.
CSA Town Hall Outreach Event	6/25/19	Discussed concerns about impacts to Enumclaw area from a lahar/Mt. Rainier	Residents from southeast King County, predominately from Enumclaw and nearby unincorporated areas. Approximately 100 attendees.
Mitigation Technical Workshop	6/27/19	Reviewed planning process and helped local partners on mitigation planning questions	local jurisdiction partners
Mitigation Strategy Meetings	7/9/19	Met with internal planning partners (county departments) to develop mitigation strategies.	DES, FMD and KC International Airport

Mitigation Strategy Meetings	7/11/19	Met with internal planning partners (county departments) to develop mitigation strategies.	DNRP
Mitigation Strategy Meetings	7/11/19	Met with internal planning partners (county departments) to develop mitigation strategies.	Local Services (Roads)
Mitigation Strategy Meetings	7/15/19	Met with internal planning partners (county departments) to develop mitigation strategies.	Local Services (Permitting)
Hazard Mitigation Workshop	7/25/19	Worked through the entire strategy development process from risk identification to mitigation projects.	County and local partners, approximately 75 attendees
Steering Committee Meeting	8/20/19	Review mitigation capabilities	Steering committee
Mitigation Funding Workshop	8/22/19	Worked through process of developing a successful hazard mitigation grant application	County and local partners. Approximately 60 attendees.
Clean Water Healthy Habitat Initiative Workshop	9/4/19	Participated in a process to coordinate mitigation planning efforts with other environmental quality, climate change, and hazard reduction programs in the county.	60-100 attendees from multiple county departments, especially DNRP.
Steering Committee Meeting	9/16/19	Review risk and vulnerability assessments	Steering committee
CSA Town Hall Outreach Event	9/10/19	Residents looked at the hazard information and discussed strategies for protecting their community from an earthquake. A major concern is the likelihood that the area will be isolated by an earthquake due to liquefaction.	Dozens of residents from the areas of White Center, Highline, Skyway, and Burien.
Critical Transportation Workgroup	9/17/19	Discussed the establishment and mitigation of lifeline transportation routes for a post-Cascadia scenario.	County departments, local jurisdictions, and state agencies participated in the workshop.
Steering Committee Meeting	10/8/19	Review base plan and King County mitigation strategies	Steering committee

CSA Town Hall Outreach Event	10/17/19	Discussed flooding in the Snoqualmie-Carnation-Duvall areas.	Residents from the northeastern portion of the county, especially in Snoqualmie, Carnation, and Duvall
County Departments Strategy Coordination	11/14/19	Meet with King County departments to go over all the mitigation strategies, eliminate gaps, and ensure consistent priorities.	County departments, including OEM, FMD, DNRP, PHSKC, KCIT, DES.
Steering Committee Meeting	11/12/19	Review draft base plan	Steering committee
Submit to WA EMD and FEMA	12/15/19	Submit full mitigation plan to FEMA for review	Planning Team

Support for Community Rating System (CRS) Communities

The hazard mitigation plan update process was also closely linked to the update for King County's Flood Hazard Management Plan. To receive credit, participating jurisdictions must follow the CRS process outlined in the current version of the CRS Coordinators Manual, element 510. At a minimum, jurisdictions wanting to receive CRS planning credit must have at least two participants in one of the planning teams.

As such, a separate, parallel process was led by the King County River and Floodplain Management Section. This process was integrated into the planning effort for the overall hazard mitigation plan. Three meetings were held in addition to the regular mitigation planning meetings. The flood portion steering committee consisted of the following members:

Committee Member	Organization	Key Role
Gwyn Berry	City of Snoqualmie	Floodplain Manager/Planner
Bob Freitag	UW Institute for Hazard Mitigation Planning & Research	Director
Elissa Ostergaard	Snoqualmie Watershed Forum	Salmon Recovery Manager
Scott Smith	King County Permitting Division	Senior Engineer
Monica Walker	King County River & Floodplain Management Section	Program Manager, White-Cedar-Sammamish Basin
Ken Zweig	King County River & Floodplain Management Section	Program Manager, Countywide Policy and Planning Unit

PLANNING ACTIVITY	DATE	SUMMARY	ATTENDEES
Planning Meeting 1	10/10/19	Discussed the flood hazard assessment.	Representatives from cities, county departments, academia, and the public.
Planning Meeting 2	10/30/19	Developed flood hazard mitigation strategies.	Representatives from cities, county departments, academia, and the public.
Planning Meeting 3	11/6/19	Prioritize hazard mitigation strategies and review draft risk assessment.	Representatives from cities, county departments, academia, and the public.

Public Outreach Process

Public outreach during the plan update process is considered to be a critical part of hazard mitigation planning. For this update, participating jurisdictions are asked to conduct two outreach events. One of these events should be a meeting-style event and the other could be any event desired by the jurisdiction, including workshops, fairs, neighborhood meetings, etc. Jurisdictions were encouraged to make the meetings valuable to the community. Holding a separate, stand-alone meeting for the sole purpose of this plan update *was NOT required*, especially if using an existing event, like a commissioner's meeting, could help expand public engagement and engage elected officials simultaneously. Jurisdictions were also encouraged to partner with neighbors or special purpose districts serving their area for more effective public outreach events.

To count as outreach for the hazard mitigation plan, meetings had to meet the following requirements.

1. Be advertised to the general public. You do NOT have to publish an ad in the paper. You can use your newsletters, social media, press releases, and other mechanisms to conduct outreach.
2. Promote two-way communication between the public and the planning team.
3. Focus on hazard mitigation, resilience, risk-reduction, etc., for some significant part of the event. The focus does not have to be solely on mitigation, and you do not have to refer to the event as related to "mitigation planning;" however, the concepts of resilience, risk-reduction, etc., should be discussed.
4. Be documented. This is very important. Please summarize both who attends and what they contribute and make sure to include it in the plan.

County public outreach partnered with the Department of Local Services and other local jurisdictions to ensure that events occurred throughout unincorporated areas as well as in incorporated areas served by some county services. The unincorporated area events were part of Community Service Area (CSA) Town Halls. These events are well-attended and well-advertised, with 60-100 attendees per meeting. This outreach model, partnering with existing meetings and services, is designed to help put emergency management and hazard mitigation in context. The work done in hazard mitigation is almost exclusively

carried out by non-emergency management entities. By partnering with other departments and using outreach mechanisms where they would all be present, it may be possible to help demonstrate the role of emergency management in the community and the partnerships that good hazard mitigation requires. The following is an excerpt from the King County Department of Local Services newsletter that goes out to nearly 8000 residents.

King County holds first four 2019 town halls

King County Councilmember Reagan Dunn and the King County Department of Local Services co-hosted the county's first four 2019 Community Service Areas Program Town Hall events in June.

The evening events—in the Greater Maple Valley/Cedar River, Four Creeks/Tiger Mountain, Southeast King County, and Fairwood areas—gave participants an opportunity to meet county officials, learn about services, and talk about issues that affect them and their communities.

Each meeting was attended by 60-100 people. Residents heard from Dunn, their elected representative *(shown at right)*, as well as leaders of the Department of Local Services, which aims to serve as a "virtual city hall" for residents of unincorporated King County. These included Local Services Director John Taylor, Road Services Division Director Rick Brater, and Permitting Division Director Jim Chan.
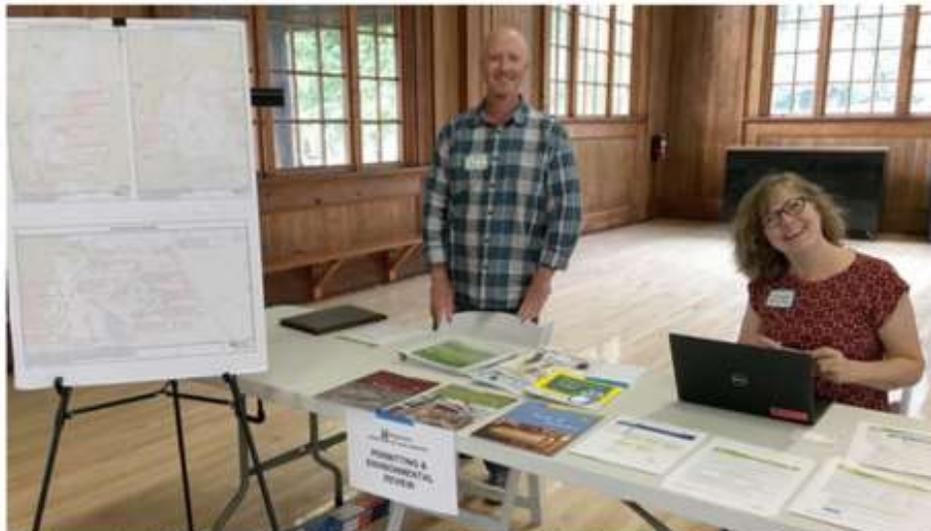
Staff members Ty Peterson and Kim Layman from the King County Permitting Division greet community members at the Southeast King County town hall in Enumclaw.

Other county departments that serve the unincorporated areas were also represented, including the Sheriff's Office (Major Troy Olmsted), Natural Resources and Parks (Director Christie True), Water and Land Resources (Division Director Josh Baldi), and Elections (Director Julie Wise).

Each event started with an open house where participants connected with both county and non-county service providers, including the Assessor's Office, Public Health – Seattle and King County, Metro Transit, Elections, Emergency Management, and Animal Services.

Local Services will host another round of town halls for the remaining Community Service Areas in the fall. Learn more on King County's Community Service Areas website.

King County Public Meetings

Date	Location	Summary	Attendees
6/18/19	Greater Maple Valley CSA	Comments received included concerns about mitigation of solid waste facilities, whether or not earthquake insurance makes sense, and need for snow mitigation following February snowstorm.	Residents from central King County and the Issaquah/Hobart/Maple Valley areas. Approximately 100 attendees.
6/25/19	Enumclaw/ Southeast King County CSA	Discussed concerns about impacts to Enumclaw area from a lahar/Mt. Rainier	Residents from southeast King County, predominately from Enumclaw and nearby unincorporated areas. Approximately 100 attendees.
9/12/19	White Center CSA	Residents looked at the hazard information and discussed strategies for protecting their community from an earthquake. A major concern is the likelihood that the area will be isolated by an earthquake due to liquefaction.	Dozens of residents from the areas of White Center, Highline, Skyway, and Burien.
10/17/19	Snoqualmie/ Carnation/ Duvall CSA	Discussed flooding in the Snoqualmie-Carnation-Duvall areas.	Residents from the northeastern portion of the county, especially in Snoqualmie, Carnation, and Duvall

The Des Moines Farmers Market public outreach event hosted by the City of Des Moines and including King County Emergency Management and Valley regional Fire Authority.

Help Identify Good Risk-Reduction Projects

The key deliverable of a successful planning process is a prioritized list of risk reduction strategies. These strategies are identified by each participating jurisdiction through an asset-based process. We would love to hear from you! Please consider these questions and either fill out the form below or email me at dhiebert@kingcounty.gov.

1. **What makes your community great?** What are the assets, features, and value, that you cannot live without? These can be both physical assets like fire stations, community assets like the business district, and intangible assets like the peace and tranquility of the community.

2. **What hazards potentially threaten those assets and values?**

3. **How susceptible or vulnerable are those assets to hazards?**

4. **What happens if you lose those assets?** What is the impact on your community? What is the impact from the asset's failure or loss?

5. **Are these assets redundant?** Can I afford to live without it? Does another asset serve a similar purpose?

6. **What can I do to reduce or eliminate the risk to this asset from hazards?**

The following is a questionnaire handed out at these events. Major topics of discussion, and any comments or feedback on the plan and planning process, are included in the summary table for the public meetings.

King County Emergency Management also joined several locally-led events. For this, the planning team developed a table-sized 3D-printed topographic map of the county with an aerial image printed on it. The interactive, 3D physical map was used to talk about the county's history of hazards, flooding, climate change, landslides, lahar zones, liquefaction areas, and more.

The model was available for use by local jurisdictions both with and without county staff so that it could be used to support a wider range of outreach activities.

Finally, in addition to in-person outreach, King County Emergency Management developed a website, https://www.kingcounty.gov/hazardplan. The website explains the purpose of mitigation and provides an overview of key hazards and examples of effective hazard mitigation. This website will be kept up for at least the duration of the plan review.

Joint Public Meetings

Date	Location	Summary	Attendees
7/16/19	City of Medina	Presented to the City of Medina Emergency Management Committee and other local residents and led a discussion afterward. The primary interest was on how residents could contribute to mitigation and resilience goals for their city. Residents in Medina will serve as the steering committee for the mitigation plan update and will help identify and prioritize mitigation strategies based on at-risk, high-priority community assets.	Community members, elected officials, and members of Medina EMC. Approximately 20 people attended.
7/24/19	City of North Bend	World Café workshop at the North Bend Public Library	No attendees were recorded at this event.

8/21/19	City of Kenmore	Presentation and hazard mitigation booth with 3D map at a Kenmore Town Square movie night. Spoke with approximately 25 people. The main focus of questions were around which areas of the community were at higher risk. Also collected feedback from community members on their ranking of Kenmore's mitigation strategies.	Lots of children plus community members attended. Over 100 attendees estimated.
8/27/19	Cities of Tukwila, Kent, Covington and SeaTac	Presented on county hazard mitigation efforts and discussed countywide risks at a joint public meeting at Fire Station 74 in Kent. Major comments included questions about how cities and the county are prioritizing mitigation investments, comments on the risk of fire from homes built very close together, and questions about the restoration of water in areas with unstable soils.	10-12 attendees, mostly from Kent, spoke with staff from their cities and King County Emergency Management
8/27/19	City of Des Moines	Hosted a booth at Des Moines Farmers Market. Discussed the possibility of Des Moines becoming an island after a major earthquake. Discussed the vulnerability of the waterfront relative to the lower-vulnerability of the rest of the city. The City of Des Moines and Valley Regional Fire Authority were also present and completed surveys for their mitigation plan annexes.	The booth was occupied continuously by residents from 10AM until 2PM.
9/28/19	Cities of Maple Valley, Covington, and Black Diamond	Annual preparedness fair 3D map booth and presentation. Spoke with dozens of residents and several elected officials and shared information on hazard risk and ways to address hazard risk. Major comments were related to length of time needed to reach residents in far-flung areas following an earthquake, especially given the response times during the February 2019 winter storms.	Hundreds of residents from the area and cities around Maple Valley. Dozens stopped by the booth.

Residents examining the 3D hazard map at a North City Water public outreach event (Source: Diane Pottinger, North City Water)

Continued Public Participation

King County and its partner cities already maintains substantial public outreach capabilities, focusing on personal preparedness and education. Information on ongoing progress in implementing the hazard mitigation plan will be integrated into public outreach efforts. The Community Service Area Town Hall events led by the Department of Local Services are scheduled annually and provide a unique opportunity to highlight mitigation successes. This will provide King County residents, already engaged in personal preparedness efforts, with context and the opportunity to provide feedback on the county's progress and priorities in large-scale mitigation. In the vertical integration of risk-reduction activities from personal to local to state and federal, it is important that the public understand how its activities support, and are supported by, larger-scale efforts.

The outreach and mitigation teams will also continue to work with media and other agency partners to publicize mitigation success stories and help explain how vulnerabilities are being fixed. When possible, public tours of successfully-completed mitigation projects will be organized to allow community members to see successful mitigation in action.

King County Regional Hazard Mitigation Program Capabilities

King County includes 39 cities, over 129 special purpose districts, and large unincorporated areas. While each city and special purpose district is responsible for its own hazard mitigation efforts, King County supports these jurisdictions through region-wide services and planning coordination, including efforts associated with land use, emergency management, and floodplain management. County departments involved in hazard mitigation efforts include Executive Services (facilities management, emergency management), local services (permitting, roads), Natural Resources and Parks (wastewater, landslides, floodplain management, climate change), and the Office of the Executive (planning).

As the lead agency for hazard mitigation, King County Emergency Management (KC EM) engages partners to promote and/or support mitigation activities. KC EM also publicizes Hazard Mitigation Assistance grant opportunities and provides technical support to develop applications and administer awards. KC EM also serves on interagency workgroups such as comprehensive planning, climate adaptation, and transportation as a way of promoting consistency in risk assessment and reduction priorities.

The focus of King County Emergency Management's hazard mitigation program is integration, including plan integration, program integration, and departmental/jurisdictional integration. Plan integration helps ensure partners use the best available data and that plan outcomes are supportive of a resilient future. Program integration helps partners find fund sources and support outside of their departments or programs. Department and jurisdiction integration builds on the role the county EOC serves for response, engaging resources to promote and implement the most effective, highest-priority hazard mitigation opportunities. In a large county with dozens of partners, a jurisdiction-by-jurisdiction approach is less effective at building resilience. KC EM's approach is to unify partners behind the vision of resilience laid out in this plan.

Hazard Mitigation Program

Hazard mitigation is most effective when implemented through a systematic program that establishes priorities and understands that resilience requires system-wide investments in mitigation.

Cohesive, comprehensive strategies and the establishment of partnerships are the core elements of a program. Individual projects matter, but are made more effective by systematic, strategic implementation.

In order to support this program, King County Emergency Management convenes multi-agency committees, offers technical assistance on federal mitigation grants, supports partners in planning and mitigation projects, and maintains and updates the King County Regional Hazard Mitigation Plan.

Plan Integration

When plans and planning processes are more integrated, it is possible to achieve greater impact through clearer definition, smarter investment, partnerships, and innovation. Successful integration requires

coordination between planning efforts and, especially, cross-participation in planning processes. The goals of plan integration are to:

- Ensure consistency with jurisdiction priorities across all planning processes
- Leverage opportunities to further multi-benefit initiatives that are supported by multiple planning processes
- Achieve common measures of success for outcomes

The hazard mitigation plan can benefit from integration with planning processes that:

- Prioritize and invest in infrastructure
- Regulate development
- Set strategic direction for programs

To other planning processes, the hazard mitigation plan brings risk and vulnerability information to help prioritize projects and set development standards or regulations. The mitigation plan also comes with potential funding for investments in cost-effective risk-reduction projects. On the other hand, the mitigation plan depends on other plans and processes to implement many strategies. Since the mitigation plan is not itself a regulatory or budgetary document, strategies identified in the mitigation plan are often best implemented through those processes or programs.

There are many plans and planning processes within King County that impact hazard risk. These include strategic plans, long-range plans, resource plans, and capital plans.

Title	Description	Lead	Integration Strategy
Capital Facilities Plans	Capital facilities plans identify and prioritize large-scale projects. Entities involved in this include the King County Facilities Management Division and the King County Flood Control District.	Various	- Integrate mitigation strategies from capital plans - Encourage the use of hazard information to prioritize capital improvements - Support county departments with funding gaps in accessing Hazard Mitigation Assistance to complete or expand projects that are identified as important but are unfunded or partially funded.

Clean Water and Health Habitat Strategic Plan	The CWHH Strategic Plan seeks to establish a strategic alignment across all plans that impact clean water and healthy habitat in order to achieve "greater impact through clearer definition, smarter investment, partnerships, and innovation." This process is just starting, and it includes over 20 separate plans and programs.	Department of Natural Resources and Parks	• Participate in plan development. • Align outcome measures and program prioritization methods • Work through this process to help align mitigation planning with other planning in the natural resource sector, such as forest health, solid waste, and salmon recovery.
Comprehensive Plan	The King County Comprehensive Plan is the long-range guiding policy document for all land use and development regulations in unincorporated King County, and for regional services throughout the County including transit, sewers, parks, trails and open space.	Executive's Office	• Encourage updates to the critical areas ordinance • Provide feedback and comments on the plan
Comprehensive Emergency Management Plan (CEMP)	The CEMP is for use by elected and appointed County officials, and King County government department directors, managers and staff in mitigating, preparing for, responding to, and recovering from disasters. This plan is a product of coordinated planning efforts between King County Emergency Management, County departments, emergency management representatives from various political jurisdictions, and selected private and nonprofit sector interests. It meets the requirements of WAC 118-30 and the Federal Emergency Management Agency's (FEMA) planning guidance for the National Response Framework and	Emergency Management	• The Hazard Mitigation Plan provides the risk profiles that support the development of the CEMP. • The Hazard Mitigation Plan is also a component (the mitigation component) of the CEMP.

	the National Incident Management System (NIMS) compliance.		
Equity and Social Justice Strategic Plan	The Equity and Social Justice Strategic Plan is a blueprint for action and change that will guide the county's pro-equity policy direction, decision-making, planning, operations and services, and workplace practices in order to advance equity and social justice within County government and in partnership with communities.	Executive's Office	• Follow guidance in the ESJ plan for the prioritization of strategies • Develop information on populations vulnerable to hazards and share with ESJ planning teams
Flood Hazard Management Plan	The current (2013) King County Flood Hazard Management Plan is a functional annex of the comprehensive plan. It outlines the County's approach to comprehensive floodplain management including land use planning, flood mitigation efforts, and flood protection facilities management.	Department of Natural Resources and Parks	• Work with department responsible for floodplain management to write the flood risk assessment. • Work with local CRS coordinators to ensure the mitigation plan is worth the maximum number of points.
Strategic Climate Action Plan	King County's Strategic Climate Action Plan (SCAP) is a five-year blueprint for County action to confront climate change, integrating climate change into all areas of County operations and its work in the community. The SCAP is King County's blueprint for climate action and provides a "one-stop-shop" for county decision-makers, employees, and the general public to learn about the County's climate change goals, priorities and commitments.	Department of Natural Resources and Parks	• Inter-workgroup participation • Integrated mitigation strategies • Consistent risk assessments
Strategic Plan for Road Services	The Road Services Strategic Plan lays out system needs and anticipated service levels and an asset management approach to road maintenance and improvement.	Department of Local Services	• Integrate mitigation strategies

Program and Policy Capabilities

With over 15,000 employees and dozens of departments and offices, King County has a tremendous capability to implement mitigation projects. Mitigation efforts are underway throughout the county, including such organizations as the Rivers and Floodplain Management Section of DNRP and the Wastewater Treatment Division of DNRP.

The hazard mitigation planning process has engaged participants from across these program and policy areas in order to establish a common assessment of hazards, identify potential mitigation strategies, partnerships for future projects, and to assess county capabilities to implement mitigation projects. The list below identifies King County policies and programs that support and implement hazard mitigation and assesses the effectiveness of each. For state-level policies and programs that support hazard mitigation, such as the Growth Management Act, please see the Washington State Enhanced Hazard Mitigation Plan.[2]

The following table identifies the programs and organizations contributing regularly to hazard mitigation.

PROGRAM/POLICY	MITIGATION ACTIVITIES	LEAD
Building and Development Codes	Building and development codes are adopted and modified from the 2015 IBC by Washington State Building Code Council and King County. These codes help ensure that new construction and substantial improvements meet international standards, accounting for our hazard risk.	Department of Local Services, Permitting
Building and Development Code Enforcement	The Department of Local Services, Permitting Division is the agency that provides land use, building and fire regulatory and operating permits, code enforcement and a limited number of business licenses for unincorporated areas of King County. Other local jurisdictions provide similar services within incorporated areas. The Code Enforcement Section investigates complaints regarding violations of King County Codes (KCC) related to zoning, building, property maintenance, shorelines and critical areas in unincorporated King County.	Department of Local Services, Permitting
Community Rating System	The CRS program rewards communities that have established exceptional floodplain management programs and undertaken certain activities to reduce flood risk. King County is one of the highest rated communities in the country. The program provides NFIP policyholders in floodplains with a discount of up to 40% on their insurance.	DNRP DLS KCEM

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[2] Washington State Enhanced Hazard Mitigation Plan. 2018. "Potential Sources of Funding and Mitigation Capability." Accessed online on 7/12/19 from https://mil.wa.gov/enhanced-hazard-mitigation-plan.

Critical Areas Ordinance	The critical areas ordinance requires the identification of geologically-hazardous and frequently-flooded areas. These areas must either be protected from development or any development in these areas must be designed to account for hazard risk.	Department of Local Services
Equity and Social Justice	King County has deep and persistent inequities – especially by race and place–that in many cases are getting worse and threaten our collective prosperity. Launched by King County Executive Ron Sims in 2008 and formalized by Executive Dow Constantine and the Metropolitan King County Council via ordinance in 2010, Equity and Social Justice (ESJ) is an integrated part of the County's work and is supported by the Office of Equity and Social Justice since it was established in early 2015.	King County Executive's Office, Office of Equity and Social Justice
Facilities Management Division	The Facilities Management Division (FMD) oversees and maintains King County's real estate assets. The Major Projects and Capital Planning section is tasked with efficiently and effectively delivering large-scale projects in alignment with the policy directives of King County government, the facility needs of employees and the public, and for overall service to the community. Part of this includes the development of hazard-resilient facilities.	Department of Executive Services, FMD
GIS	King County GIS provides analysis support, mapping, and other data to all King County departments. This data is valuable for hazard mitigation planning activities.	KCIT
Hazard Mitigation	The hazard mitigation program works with partners across county departments and local jurisdictions to coordinate and promote hazard mitigation projects. The program also coordinates applications to federal Hazard Mitigation Assistance grant programs and conducts hazard mitigation planning for the county in partnership with local jurisdictions and special-purpose districts.	KC Emergency Management
King County Conservation District	The King County Conservation District is an independent special purpose district with separately-elected commissioners. It promotes water, land, soil, and forest conservation and preservation and conducts wildfire risk reduction activities.	King County Conservation District
King County IT	KCIT leads the county's response to, and preparedness for, cyber incidents. KCIT has helped local cities recover from ransomware and other attacks.	King County Information Technology (KCIT)

King County Flood Control District	In 2007, the King County Flood Control District was established to provide a proactive, regional approach to flooding as well as funding to improve the county's nearly 500 aging and inadequate flood protection facilities. Funding for the Flood Control District comes from a county-wide property levy of 12.9 cents per $1,000 assessed value. This amounts to $54 per year on a $416,000 home. The levy raises roughly $54.5 million a year. This funding dramatically increases the number of projects that can be completed each year. The additional local funding also enhances the District's ability to receive federal and state matching funds. The King County Flood Control District is a separate special purpose district.	King County Flood Control District
Landslide Hazards	The Landslide Hazards program conducts mapping and outreach associated with landslide risk.	DNRP Water and Land Resources Division
Land Use Planning and Zoning	Land use planning and zoning establishes growth and land use patterns that are consistent with long-range plans and supported by infrastructure.	King County Executive's Office
National Flood Insurance Program	Communities that participate in the National Flood Insurance Program adopt a floodplain management code in exchange for FEMA making flood insurance available to residents and businesses.	DNRP, DLS – Permitting Division
Office of Risk Management Services	Risk Management investigates and resolves claims against King County in a fair and expeditious manner, and also provides internal services to King County agencies, including: • Insurance: King County administers a self-insurance program and purchases a variety of other insurance policies and related services consistent with good risk management practices and the needs of the County. • Contracts: Risk Management advises King County agencies on insurance requirements, indemnification, release, and hold harmless provisions in all types of contracts. Risk Management actively negotiates these provisions and, together with the Prosecuting Attorney's Office, assists agencies in pursuing and tendering claims arising out of contractual relations. • Recovery Services: The recovery section of Risk Management is charged with seeking compensation for	Department of Executive Services

	damages caused to King County property or injury to King County employees by negligent third parties. • Loss Control Program: The Loss Control Manager works with King County agencies to identify areas of potential loss and recommend strategies to reduce exposure to liability. The Loss Control Program also administers continuing workplace training and education for King County employees. Part of this work includes the development and maintenance of a risk register of events and information on how those events can impact King County.	
Public Health	Public Health — Seattle & King County (Public Health) works to protect and improve the health and well-being of all people in King County as measured by increasing the number of healthy years that people live and eliminating health disparities. Public Health is the one of the largest metropolitan health departments in the United States with 1,400 employees, 40 sites, and a biennial budget of $686 million. The department serves a resident population of nearly 2.2 million people in an environment of great complexity and scale, with 19 acute care hospitals and over 7,000 medical professionals. Over 100 languages are spoken here, and King County is an international destination welcoming nearly 40 million visitors annually. Public Health protects the public from threats to their health, promotes better health, and helps to assure that people are provided with accessible, quality health care. Health protection functions include disease control, such as tuberculosis, HIV, communicable disease epidemiology and immunizations, and ensuring that the air is safe to breathe, and water and food are safe to consume. Health promotion functions include preventing behaviors that lead to disease, averting injuries and managing chronic health conditions. Health provision functions include convening and leading system-wide efforts to improve access and quality, advocating for access to quality health care for all, forming partnerships with service providers and directly providing individual health services when there is a public health need.	Public Health Seattle-King County

Road Services Division	Road services builds and maintains over 2000 miles of road and 200 bridges. They are responsible for many mitigation activities, including those related to culvert replacement, pavement preservation, and bridge retrofits.	Department of Local Services
Shoreline Master Program	King County has nearly 2,000 miles of shoreline along major lakes and rivers and Vashon-Maury Island. These shorelines provide habitat for fish and wildlife, places for public enjoyment and space for wide-ranging waterfront land uses. The Shoreline Master Program helps preserve these spaces and uses, thereby reducing risk to hazards including sea-level rise.	DLS – Permitting Division
Wastewater Treatment Division	Invest in upgrades to pipe and water treatment facilities to make them more resilient to earthquakes, severe weather, flooding, and climate-change.	DNRP

Integration with Departments and other Jurisdictions

Beyond departmental integration, King County works with local jurisdictions, special purpose districts, and tribes to support effective risk reduction. King County coordinates activities related to emergency management and hazard mitigation through two bodies, the Emergency Management Coordinating Committee (EMCC) and the Emergency Management Advisory Committee (EMAC), which are each described in greater detail in the table below.

King County Stakeholder Integration Capabilities

ORGANIZATION	DESCRIPTION	MEMBERSHIP
Clean Water / Healthy Habitat Initiative	An initiative convened by the county executive to help streamline projects, increase collaboration, and improve results for the work accomplished through the spending of $6 Billion over the next decade on clean water and habitat protection in King County.	All county agencies
King County Community Rating System Users Group	King County and the cities who are part of CRS meet to coordinate efforts and provide technical assistance to each other on maintaining and improving CRS ratings.	• Auburn • Bellevue • Issaquah • Kent • North Bend • Renton • Snoqualmie • Carnation

		• Redmond • King County
Emergency Management Coordinating Committee (EMCC)	EMCC is charged by the King County Council with coordinating interdepartmental emergency preparedness matters. EMCC works to support departments in developing continuity of operations plans, preparedness plans, and hazard mitigation plans. It also contributes to after action reports. EMCC has played an important role in the mitigation plan update process for the county by identifying and dedicating key staff to participate in planning and by reviewing and providing feedback on planning team activities.	All county departments are included in the EMCC. The following are those who attend meetings more regularly. • King County Emergency Management • Department of Human Resources • Metro Transit Department • Department of Local Services • Public Health - Seattle and King County • Department of Natural Resources and Parks (DNRP) • Department of Community and Human Services • Department of Adult and Juvenile Detention • Facilities Management Division of the Department of Executive Services • Director's Office of the Department of Executive Services • King County Information Technology • Office of Labor Relations • King County Sheriff's Office • Office of the King County Executive • Department of Assessments • King County District Court • King County Elections • DNRP Solid Waste Division • DNRP Waste Treatment Division
Emergency Management Advisory Committee (EMAC)	EMAC advises, assists, reviews, and comments on emergency management and homeland security issues, regional planning, and policies. They measure and prioritize core capabilities and recommend homeland security allocations and work products to sustain and enhance preparedness and operational levels. Members, as set forth in code, provide regional and multi-disciplinary perspective, and represent cities, fire service, law enforcement,	The membership for EMAC is established by the King County Council and includes the following entities/interests: • Central region EMS and Trauma Care Council • City of Bellevue • City of Kent • City of Renton • City of Seattle • 1 Utility • 1 Faith-Based Organization • 1 Financial Community Organization • American Red Cross • KC DNRP

	hospitals, the Port of Seattle, government, special purpose districts, tribes, utilities, non-profit agencies, and the private sector.	• KC Metro • KC Roads • KC Executive Office • King County Fire Chief's Association • King County Fire Commissioner's Association • King County Police Chief's Association • King County Sheriff's Office • KC Local Emergency Management Planning Committee • Muckleshoot Tribal Nation • Northwest Healthcare Response Network • Port of Seattle • 1 Private Industry Representative • Public Health Seattle and King County • Puget Sound Educational Services District • Snoqualmie Tribal Nation • Sound Cities Association • Washington Association of Building Officials • 1 Water and Sewer District Representative

Potential Sources of Hazard Mitigation Funding

Hazard mitigation projects are most often completed with funding from capital budgets as part of the normal building and maintenance processes that occur in any jurisdiction. There is also source and use-specific funding, such as that provided by the King County Flood Control District that is part of regular program funding and is highlighted in the program section above. Beyond regular capital funding, there are dedicated mitigation programs operated by state, county, and federal agencies.

Potential Sources of Hazard Mitigation Funding

PROGRAM	LEAD AGENCY	DESCRIPTION	PROJECT TYPES
BUILD Grants	US Department of Transportation (USDOT)	Grants support investments in surface transportation infrastructure and are to be awarded on a competitive basis for projects that will have a significant local/regional impact.	Transportation and related infrastructure retrofits, including stormwater projects
Building Blocks for Sustainable Communities	U.S. Environmental	This EPA program provides targeted, technical assistance to communities to	Planning and feasibility studies

	Protection Agency (EPA)	develop resilience plans, development plans, sustainability strategies, etc.	
Building Resilient Infrastructure in Communities (BRIC)	Federal Emergency Management Agency (FEMA)	New annual mitigation grant program that is expected to replace PDM. Will focus more on large-scale infrastructure projects that reduce risk to natural hazards.	Most long-term risk-reduction projects that protect against fire, flood, earthquake, and other natural hazards.
Community Development Block Grants	U.S. Department of Housing and Urban Development (HUD)	CDBG funds comprehensive plans, limited infrastructure planning/construction, feasibility studies, community action plans. Income and population restrictions apply.	Housing and infrastructure retrofits, feasibility studies, planning
Community Economic Revitalization Board	WA Department of Commerce	CERB provides loan funding to local jurisdictions for public infrastructure to support private business growth and expansion.	Infrastructure retrofits, public-private partnerships
Combined Water Quality Funding Program	WA Department of Ecology	Fund sources for projects associated with publicly-owned wastewater and stormwater facilities. The integrated program also funds nonpoint source pollution control activities.	Drinking-water system improvements, feasibility studies, source-water protection, infrastructure retrofits
Cooperating Technical Partnership Program	FEMA	The program creates partnerships between FEMA and qualified local and state partners to create, maintain, and publicize up-to-date flood and other hazard maps and data.	Planning, outreach, feasibility studies
Drinking Water State Revolving Fund	WA Department of Health	The Drinking Water State Revolving Fund (DWSRF) provides loans to drinking water systems to pay for infrastructure improvements. In some cases, partial loan forgiveness is offered.	Infrastructure retrofits, source-water protection, planning, drinking-water system improvements
Emergency Watershed Protection Program	Natural Resource Conservation Service (NRCS)	Emergency recovery measures for runoff retardation and erosion prevention to relieve imminent hazards created by a natural disaster.	Infrastructure retrofits, slope stabilization, source-water protection, flood risk reduction, erosion prevention
Estuary and Salmon	Department of Fish and	ESRP provides funding restoration and protection efforts in Puget Sound,	Acquisitions, slope stabilization, flood risk

Restoration Program	Wildlife (DFW)	including projects such as flood storage, erosion control, and climate resilience measures.	reduction projects, ecosystem restoration
FireWise Fuel Mitigation Grant Program	WA Department of Natural Resources	The Fuel Mitigation Grant provides a cost share for communities engaged in defensible space and fuels reduction projects.	Wildfire fuels reduction, defensible space
Floodplains by Design	WA Department of Ecology	Floodplains by Design is the primary grant program for projects that reduce flood hazards while restoring the natural functions that Washington rivers and floodplains provide.	Slope stabilization, ecosystem recovery, flood-risk recovery
Flood Mitigation Assistance Grant Program	FEMA	FMA provides funding to local jurisdictions and states for projects and planning that reduces or eliminates long-term risk of flood damage to structures insured under the NFIP.	Flood risk reduction projects that benefit the NFIP, including acquisitions, elevations, and some structural mitigation such as local risk reduction structures and dry floodproofing.
Hazard Mitigation Grant Program	FEMA	HMGP is authorized statewide after a disaster declaration and is the most flexible of FEMA's three mitigation programs. Jurisdictions must have an approved hazard mitigation plan and projects must be cost effective.	Most long-term risk-reduction projects that protect against fire, flood, earthquake, and other natural hazards.
King County Flood Control District Flood Reduction Grants	King County Flood Control District	The Flood Reduction Grants target medium and small local flood reduction projects including projects where the control of stormwater will have a direct benefit in reducing flooding. Eligible applicants include homeowners, special districts, tribes, cities, and county agencies.	Projects can address either existing or potential flooding and proposals should show that the flooding has current or potential economic impacts.
King County Budget	King County	The two-year King County budget for 2019-2020 was approximately $11.6 billion dollars. Approximately 15% of this money makes up the general fund. Major Expenditures are: Metro Transit (21%), Wastewater (14%), Health & Human Services (13%), and Law, Safety, & Justice (12%). There are ~15,000 full-time-equivalent (FTE)	Various

		county employees with most employed in Transit (35%), Criminal Justice (25%), and Public Health (9%).	
King County Loss Control Fund	Office of Risk Management	The Loss Control Fund is for internal county projects and is limited to emergent risks where advance planning and budgeting were unavailable. $2M has been appropriated for the 2019-2020 biennium.	Emergent risks, to include likely infrastructure failure
King County Parks Levy	King County	Revenue generated by the parks levy goes to fund open space protection, new parks, trails, and other assets. This funding could theoretically be used for the acquisition of threatened properties for preservation as open space.	Acquisition of high-hazard properties for preservation as open space
Post-Fire Hazard Mitigation Grant Program	U.S. EPA	Program authorized following a Fire Management Assistance Grant (FMAG) declaration. Program focuses on wildfire risk and post-fire risk mitigation, including fuels reduction and post-fire flood control projects. Program prioritizes the county receiving the FMAG declaration.	Fire-related mitigation, including defensible space, generators, and post-fire flood risk reduction, planning, feasibility studies
Pre-Disaster Mitigation Grant Program	FEMA	Annual program for cost-effective mitigation projects and plans. Jurisdiction must have a current mitigation plan to be eligible. Following the 2019 grant round, this program will be replaced by BRIC.	Most long-term risk-reduction projects that protect against fire, flood, earthquake, and other natural hazards.
Public Works Board	WA Department of Commerce	Low-interest loans for pre-construction or new construction for replacement/repair of infrastructure for stormwater, solid waste, road, or bridge projects. Emergency loans are available for public projects made necessary by a disaster or imminent threat to public health and safety.	Utility and infrastructure retrofits
Rural Community Assistance Corporation	Rural Community Assistance Corporation	Water, wastewater, stormwater, and solid waste planning; environmental work; to assist in developing an application for infrastructure	Planning, feasibility studies

		improvements for small, rural communities.	
Rural Water Revolving Loan Fund	National Rural Water Association	The RWLF provides low-cost loans for short-term repair costs, small capital projects, or pre-development costs associated with larger projects to small, rural communities.	Source-water protection, drinking water system improvements, other retrofits
Source Water Protection Grant Program	WA Department of Health	Projects and studies to identify solutions to source water protection problems, implement protection plans, or update data that directly benefits source water protection.	Source-water protection, drinking water system improvements, other retrofits, feasibility studies
Washington Transportation Improvement Board	Transportation Improvement Board	TIB makes and manages street construction and maintenance grants to 320 cities and urban counties.	Infrastructure retrofits, flood risk reduction
Urban and Community Forest Program	U.S. Department of Agriculture	Program provides technical, financial, research and educational services to local jurisdictions and organizations for the preservation, protection, and restoration of forestlands.	Natural resource protection, public information, planning

King County Hazard Mitigation Grant Assistance Program

A major initiative launching as part of this plan update is the King County Hazard Mitigation Grant Assistance Program. Led by KC EM, this program seeks to lower the barriers to applying for FEMA grants, especially given the new opportunities associated with the Disaster Recovery Reform Act of 2018.

King County will support jurisdictions by ensuring the mitigation projects are identified in the regional plan, offering technical assistance in developing applications, and, when requested, by administering grants on behalf of communities that lack internal grant management capabilities. This program reflects KC EM's focus on end-to-end emergency management, supporting partners across all mission areas from mitigation to recovery.

Participation in the National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. The County and most of the partner cities for this plan participate in the NFIP and have adopted regulations that meet the NFIP requirements.

King County and 34 of the 39 incorporated areas in the County are participants in NFIP; all are currently in good standing with the provisions of the NFIP. The five jurisdictions that do not currently participate in NFIP are Beaux Arts Village, Hunts Point, Maple Valley, Newcastle and Yarrow Point. Except for Newcastle, these communities have no special flood hazard areas.

Participants in the NFIP must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent. The Washington State Building Code Act requires new construction to be elevated to 1 foot above the base flood elevation or to the design flood elevation, whichever is higher. Some communities in King County have adopted more stringent standards. For example, a 3-foot freeboard (height above the 100-year flood elevation) is standard for most structures in unincorporated King County.

Additionally, in the Puget Sound watershed, communities are required to regulate development in floodplains in a way that doesn't cause habitat loss or negative impacts to Chinook, coho, and steelhead salmon species. This is part of the FEMA/NOAA Biological Opinion related to communities' participation in the National Flood Insurance Program.

New Flood Insurance Rate Maps (FIRMs) are currently in a preliminary stage and are scheduled to be published in mid-2020.

In Washington State, the Department of Ecology is the coordinating agency for floodplain management. Ecology works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, and participating in statewide flood hazard mitigation planning. Compliance is monitored by FEMA regional staff and by Ecology. Maintaining compliance under the NFIP is an important component of flood risk reduction. All planning partners that participate in the NFIP have identified initiatives to maintain their compliance and good standing. Planning partners who do not currently participate have identified initiatives to consider enrollment in the program.

Participation in CRS

The Community Rating System is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements and rewards discounts to ratepayers in participating communities. King County is a Class 2 community. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community receives a 45-percent premium discount, and a Class 9 community receives a 5-percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes are based on 18 creditable activities in the following categories:

- Public information

- Mapping and regulations
- Flood damage reduction
- Flood preparedness

As of this writing, there are 10 CRS-rated communities in King County.

Community Name	Class	% Discount in SFHA	% Discount in non-SFHA
Auburn	5	25	10
Bellevue	5	25	10
Issaquah	5	25	10
Kent	5	25	10
North Bend	5	25	10
Renton	5	25	10
Snoqualmie	5	25	10
Carnation	7	15	5
Redmond	5	25	10
King County	2	40	10

Regional Risk and Probability Summaries

While most of the risk and probability of future occurrence for hazards is similar for all jurisdictions in King County, some are at greater risk due to specific geographic features including proximity to floodplain (increases flood probability and risk from earthquakes due to liquefaction). For natural hazards, the relative probability of occurrence within 25-50 years (High, Medium, or Low) and relative risk as described in each jurisdiction's annex are identified in the table below.

The table below does not include Avalanche risk (high annual probability of occurrence, but only in unincorporated areas) nor tsunami (low probability of occurrence for all areas, exposure is currently only mapped for the cities of Des Moines and Seattle. Acronyms: WSD = Water and Sewer District, WD = Water District, SD = School District, RFA = Regional Fire Authority, UD = Utility District.

Community Name	Earthquake		Flood		Landslide		Weather		Volcano		Wildfire	
	Prob	Risk	Prob	Risk	Prob	Risk	Prob	Risk	Prob	Risk	Prob	Risk
Auburn	Medium	High	High	Medium	Medium	Medium	High	Medium	Low	High	Low	Low
Beaux Arts Village	Medium	Medium	Low	Low	Low	Low	High	Medium	Low	Low	Medium	Medium
Bellevue	Medium	High	Medium	Low	Low	Low	High	Low	Low	Low	Low	Low
Bothell	Medium	High	High	Medium	High	Medium	High	Medium	Low	Low	Low	Low
Burien	Medium	Medium	Low	Low	Low	Low	High	Medium	Low	Low	Low	Low
Clyde Hill	Medium	Medium	Low	Low	Medium	Low	High	Medium	Low	Low	Low	Low
Covington	Medium	Medium	Low	Low	Low	Medium	Low	Medium	Low	Medium	Low	Low
Des Moines	Medium	High	Low	Low	Low	Low	High	Medium	Low	Low	Low	Low
Duvall	Medium	Medium	High	High	Low	Low	High	High	Low	Low	Medium	Medium
Hunts Point	Medium	Medium	Low	Low	Low	Low	High	Medium	Low	Low	Low	Low
Issaquah	Medium	High	High	Medium	High	Medium	High	Medium	Low	Low	Medium	Medium

Community Name	Earthquake	Flood	Landslide	Weather	Volcano	Wildfire
Kenmore						
Kent						
Kirkland						
Lake Forest Park						
Maple Valley						
Mercer Island						
Medina						
Newcastle						
North Bend						
Redmond						
Renton						
Sammamish						
SeaTac						
Shoreline						
Snoqualmie						
Tukwila						
Woodinville						
Cedar River WSD						
Covington WD						
Coal Creek UD						
Highline WD						
King County WD 20						
King County WD 90						
King County WD 125						
Lake Meridian WD						
North City WD						
NE Sammamish WSD						
Northshore UD						
Renton SD						
Sammamish Plateau WSD						
Skyway WSD						
Soos Creek WSD						
South King Fire						
Valley RFA						
Valley View Sewer						
Vashon Island Fire						
Woodinville WD						
Muckleshoot Indian Tribe						

Risk Assessment Overview

The King County Regional Hazard Mitigation Plan Risk Assessment covers 8 natural and 6 human-caused hazards.

- Avalanche
- Earthquake
- Tsunami
- Volcano
- Landslide
- Wildfire
- Flood
- Severe Weather
- Hazardous Materials
- Health Incident
- Terrorism
- Civil Disturbance
- Cyber Incident
- Dam Failure

These assessments were developed using the best available data from sources including:

- Washington State Fusion Center (Terrorism, Civil Disturbance)
- King County Dam Safety Program (Dam Failure)
- King County IT (Cyber Incident)
- Public Health Seattle-King County (Health Incident)
- Washington State Emergency Management LEPC Program (Hazardous Materials)
- King County Flood Control District (Flood)
- Washington State Emergency Management Geologic Hazards Program (Tsunami, Earthquake, Volcano)
- King County Strategic Climate Action Plan (Wildfire, Severe Weather)
- Washington State Department of Transportation (Avalanche)
- King County Department of Natural Resources and Parks (Landslide)
- King County Department of Permitting (Structure Fire)
- Washington State Enhanced Hazard Mitigation Plan
- Washington State Department of Natural Resources (Landslide, Earthquake, Tsunami, Volcano, Wildfire)
- King County Facilities Management Division
- King County Hazard Inventory and Risk Assessment, 2016
- FEMA RiskMAP Program, King County Risk Report (Earthquake, Landslide, Volcano, Flood)

Data sources are cited with footnotes throughout the plan. In addition to using data and report information from the above sources, many also contributed time and expertise to the review and development of the individual risk assessment chapters.

Methodology

This risk assessment is intended to provide a robust overview containing key details, vulnerabilities, and considerations to enable emergency managers to plan for disasters. The profiles are designed to be brief, and yet also comprehensive enough, to be useful during a disaster response to help provide information on potential impacts and priority vulnerabilities.

This assessment focuses on examining impacts (consequences) from hazards on 10 different topic areas. These areas reflect best practices as identified by the Emergency Management Accreditation Program (EMAP) plus priority areas identified by King County.

- King County residents – all residents in King County
- Vulnerable populations – populations more likely to experience losses and recover more slowly from an incident. Different vulnerable populations may be highlighted depending on the incident type. For example, wildfire in King County is overwhelmingly a problem of smoke and smoke impact people with respiratory vulnerabilities most severely.
- Property – private property
- The economy – economic functions and assets
- The environment – natural resources, wildfire, fish, plants, and natural systems
- Health systems – hospitals, pharmacies, and the ability for people to find and receive care
- Government operations (continuity of operations) – King County government operations
- Responders – fire, police, EMS, and related services
- Lifeline infrastructure – power, water/wastewater, transportation, communications
- Public confidence in jurisdiction's governance and capabilities

Each profile also looks at priority vulnerabilities in order to identify those areas requiring immediate focus before, during, and after an incident.

Data

GIS data was taken from a variety of King County, Washington State, and federal sources. The data was sourced via King County GIS, including layers owned by both GIS and by other entities. Some of the GIS data analyzed in completing this risk assessment include:

TITLE	DESCRIPTION	SOURCE
Active Faults	Known active faults in the Puget Sound region	WA State Department of Natural Resources (DNR)

Wastewater Systems	King County wastewater treatment and conveyance systems	King County Department of Natural Resources and Parks Water Treatment Division (DNRP)
Water Supply Facilities	Seattle water supply facilities and conveyance systems. These are used to supply Seattle as well as many cities.	City of Seattle Public Utilities
Bridges	King County-maintained bridges	King County Roads
Rail Routes	All rail routes, including BNSF and Sound Transit	King County GIS
Transit Routes	Metro transit routes	King County Metro
Arterials	Arterial streets	King County Roads
Levees and Revetments	County-maintained flood protection structures.	DNRP, King County Flood Control District
BPA Transmission Lines	Bonneville Power Administration power transmission systems	Bonneville Power Administration
Historic Buildings	Designated historic buildings	King County GIS
Schools	School facilities	King County GIS
Government Buildings	King County government buildings	King County GIS, Facilities Management Division
Hospitals and Medic Units	Hospitals and medic unit locations	King County GIS
Pharmacies	Pharmacy locations	King County GIS
First Responder Facilities	Locations of fire, police, and EMS	King County GIS
City Boundaries	City jurisdictional boundaries	King County GIS
Rivers and Lakes	Waterbodies	King County GIS
Building Address Points	Building address points and age	King County Assessor
Building Age	Building address points and age	King County Assessor

Volcanic Hazard Areas	Lahar, lava flow, and lahar sediment areas	WA DNR, U.S. Geological Survey
Landslide Hazard Areas	Historic, deep landslide risk areas	WA DNR
Preliminary 100-year Floodplain	1% annual chance, special flood hazard area as mapped by FEMA. Will take effect as the regulatory floodplain in 2020.	FEMA, King County Flood Control District
Floodways	The regulatory areas including the channel and adjacent land areas that must be preserved in order to discharge the base flood without increasing the water surface elevation by more than a designated height.	FEMA, King County Flood Control District
Liquefaction Potential	Areas of NEHRP soil classes D, E, and F.	WA DNR
Landslide Buffer Areas	Buffers of 50 feet around known landslide areas.	King County GIS
Statewide Roads	State and federal highways	King County GIS
Health Insurance Coverage	Individuals with health insurance, by Census Tract	US Census, American Community Survey (ACS)
Travel Time to Work	Travel time to work on average by Census Tract	US Census, ACS
Means of Transportation to Work	Means of transportation to work, by percent, by Census Tract	US Census, ACS
Race	Self-identified race	US Census, ACS
Ethnicity	Self-identified ethnicity	US Census, ACS
Income	Income (range)	US Census, ACS
Languages	Languages other than English spoken at home	US Census, ACS
Disability Status	Counts of disabled persons	King County GIS
Education	Educational attainment by years, by Census Tract	US Census, ACS

Tenure	Housing tenure (ownership) status	King County GIS
HAZUS for earthquake (Seattle Fault, Cascadia Subduction Zone)	HAZUS runs for Seattle Fault 7.1 and Cascadia Subduction Zone 9.0 scenarios	FEMA RiskMAP

This and any additional data can be viewed on the ArcGIS online hazard map. This map will be available at least during the plan review and adoption phase and may be made available permanently: http://kingcounty.maps.arcgis.com/apps/View/index.html?appid=41abdeae1bf44907a9c14b98a2e5fb92.

Vulnerable Populations and Population-Based Vulnerability

Population vulnerability (or social vulnerability) measures factors that theoretically increase the likelihood of a population to suffer more losses during disasters or recover more slowly after being impacted. There is a growing body of work on this kind of vulnerability; however, how the data is reported can obscure the root causes of vulnerability when converted into an index or score. Knowing the root causes of vulnerability and how those vulnerabilities contribute to losses during disasters is critical for hazard mitigation professionals since each cause may require a unique strategy to address. For example, if the vulnerability results from language differences, then this can be addressed with robust translation and outreach services.

Communities that consider population-based vulnerability and social justice, often do it as an overlay – examining the impacts of a proposed project on vulnerable populations, for example, after the project has already been prioritized or mapping the location of vulnerable populations in accordance with some composite score and institutionally-defined definition of vulnerability. It is unclear if mapping alone, if awareness alone, has had much impact on where the bulk of resources are directed.

For this analysis, we examine the best available data of factors that have been found to lead to increased losses or recovery times following hazard events. This is to establish areas with different kinds of heightened vulnerability. We then overlay data on race, ethnicity, and income. This is to establish where equity may be a concern, where causes of vulnerability overlap with historically underrepresented minority populations.

Determinants of Population Vulnerability

Good data at the appropriate scale was not available for all the below factors. However, these are factors that were identified through research and by the planning team as critical determinants of vulnerability. Maps of a selection of these factors, along with priority hazard areas, follow the list of variables.

Population factors (population-based measures)

1. Home Ownership Status (Renter)
2. Age (old or young)

3. Unemployment
4. Income
5. Wealth
6. Access and Functional Needs/Disability
7. Dependence on public transportation
8. Language other than English spoken at home
9. No health insurance
10. Hazard insurance coverage
11. Minimum wage employment/service sector employment
12. Families with dependents
13. Living in poverty
14. Crime rate
15. Years of schooling completed (HS, BA, MA, etc.)

Accessibility and capital factors (access/infrastructure measures/social capital)

- Access to services (schools, libraries, community centers, county/city facilities)
- Quality of public facilities (public facility effective age)
- Quality of schools
- Access to hospitals or health clinics
- Quality of hospitals/health clinics
- Access to phone and internet
- Average age of housing
- Average commute time/distance to work
- Per capita government spending
- Neighborhood engagement (civic engagement, neighborhood association, something else?)

Meta-factors (determinants of equity)

- Race/ethnicity
- Age
- Income
- Immigrant/refugee status

The results from this analysis will be used to promote more effective, equitable disaster mitigation, response, and recovery by identifying key vulnerabilities and areas that may require additional investment. Also, this analysis will help identify areas where public infrastructure is older or less resilient, or where hazard risk is greater, so that additional investments can be targeted in those areas.

The following maps illustrate several of the above variables associated with greater hazard risk along with high hazard areas and non-white populations. This is just a selection of potential variables and illustrates how high-hazard areas, factors associated with hazard risk, and communities of color or with higher rates of disability may overlap. The highest population-risk areas in King County tend to be areas south of Seattle in the Green River Valley. These areas also are areas with the highest hazard risk. Investments that target critical public infrastructure and support structures in these communities would likely have the best cost-benefit ratio. Investments in these areas would have the added benefit of also promoting more equitable access to high-quality infrastructure and services for populations historically underserved by public investment.

Homeownership (Darker=More Homeowners)	Disability (Darker=Higher Rate)
Median Household Income (Darker=Higher)	People of Color (Darker=Higher Percentage)
Liquefaction Potential (Darker=More Risk)	100-Year Floodplains

Speak Language Other Than English (High-Low)	Car Dependency (Darker=More Car Dependent)
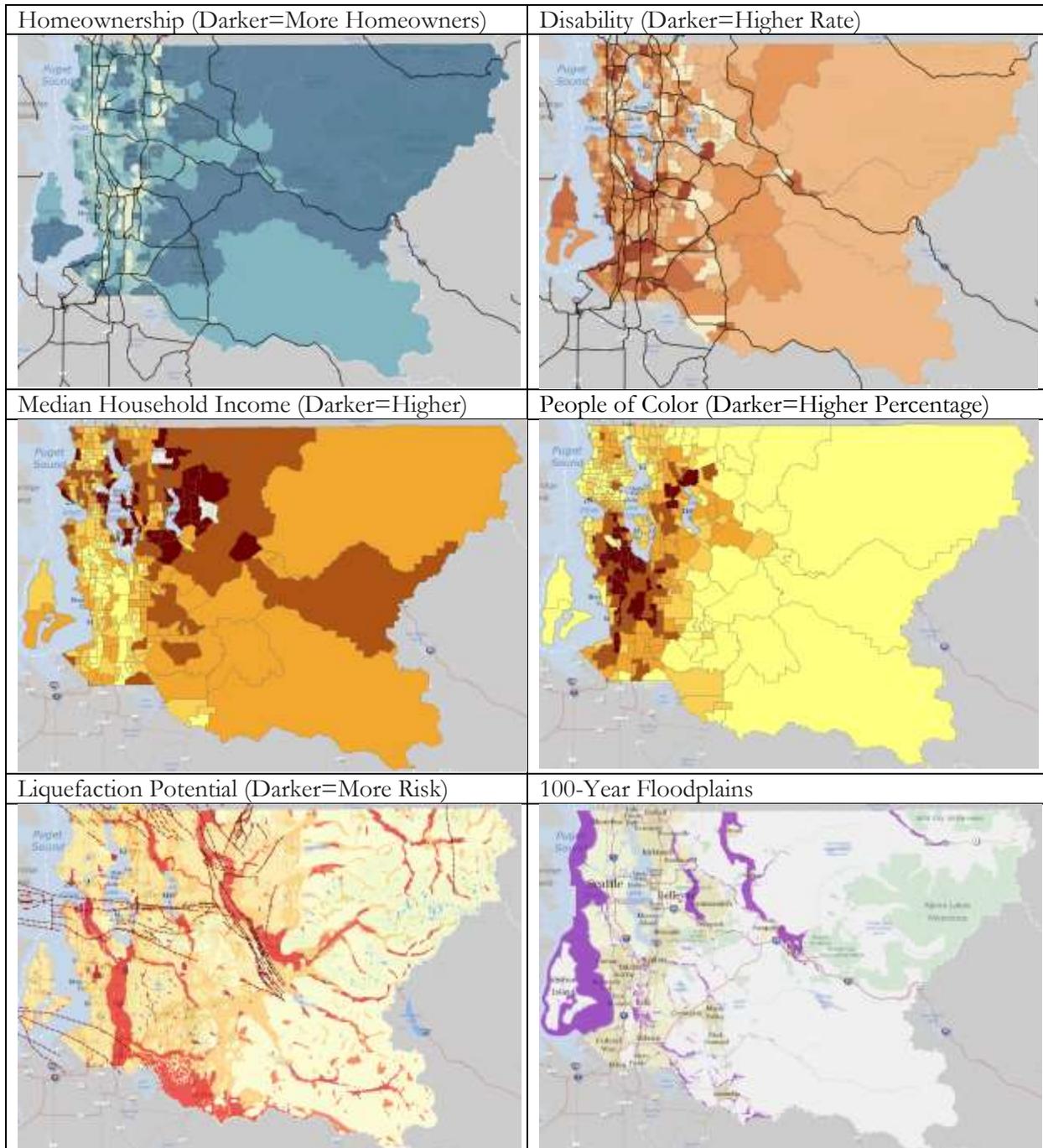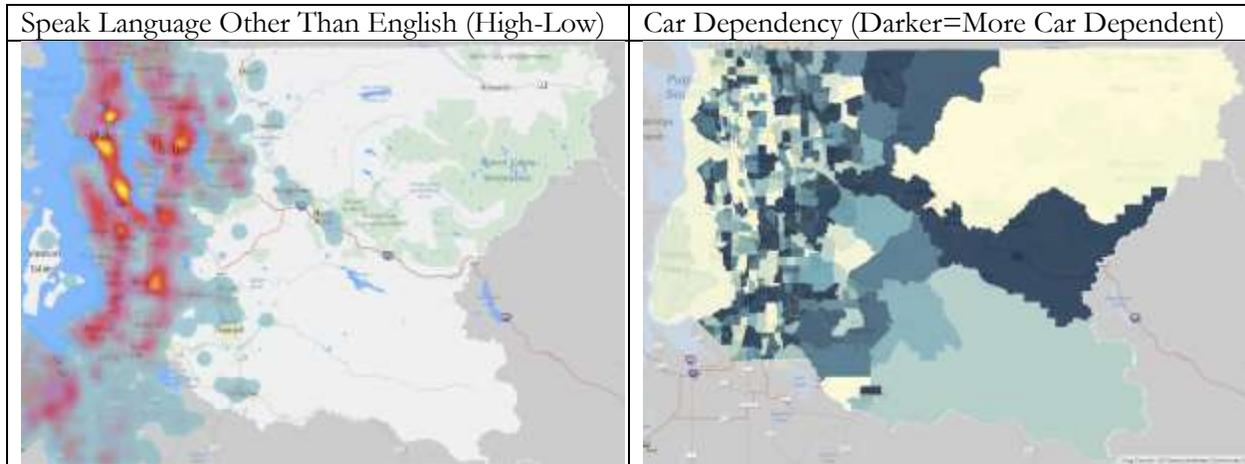
Jurisdiction-Specific Risk Assessments

In addition to this countywide risk assessment, each planning partner completed a risk assessment focusing on the priority hazards, vulnerabilities, and consequences. These assessments are contained in each planning partner annex. These assessments will have much more detail about individual jurisdiction risks and should supplement the wider lens of the risk profiles contained in the core plan.

To complete their assessments, jurisdictions were provided with GIS data and an ArcGIS online map containing relevant data on hazards and impacts. The data is the same as that used in the base plan risk assessments, but jurisdictions were asked to focus on impacts specific to their assets and boundaries. Jurisdictions assessed risk in two ways.

First, jurisdictions looked at hazards that could impact them, how susceptible/vulnerable they are to those hazards, and the consequences/impacts of a hazard event. The task was to develop "risk elevator pitches" that summarize the key elements of hazard risk in a way accessible to elected officials and the public.

Second, jurisdictions were asked to consider an asset-based approach, looking at their priority assets, the hazards that threaten those assets, and the consequences of losing the asset. All jurisdictions were encouraged to complete this process, but only special purpose districts were required to complete it. The goal of this approach was to identify assets that needed mitigation.

In addition to these risk summaries, a map showing the spatially discrete hazards (flood, liquefaction potential, steep slopes) was developed for cities.

In developing their risk assessments, jurisdictions held internal meetings to select the list of hazards that would be included and to assess the relative risk of each hazard. Most used a high-medium-low approach for impact, where high impact is a debilitating event and moderate impacts are serious events that disrupt operations for multiple days. For those that also considered probability separately from the base plan, a high probability event is likely to occur on an annual basis. These jurisdiction-specific risk assessments are not designed to be exhaustive but should give a much clearer picture of risk and vulnerability than is normally available from countywide assessments.

King County Development Trends and Risk Trajectory

From 2010 to 2018 King County has grown at a rate of 13.4% per year.[3] This population growth has coincided with a near doubling of total assessed property values in the county from $340 billion in 2014 to $606 billion in 2019.[4] Over $44 billion worth of new construction was assessed from 2014-2018. Property values stabilized in most of the county in 2018, although many unincorporated areas, especially in the northeast of the county around Carnation and Duvall, continued to grow at double-digit rates.

The huge growth in property values and development of new lands has also coincided with a growth in diversity. In 2018, the total population identifying as white declined by nearly 5000 persons while the non-white population grew dramatically. While this is a small change, it indicates that the future of King County will be more diverse and more populous.

Also, since 2015 the available science on risk has improved markedly. King County has new landslide hazard data from Washington State Department of Natural Resources (WA DNR). There is also updated tsunami data indicating far greater risk than previously recognized in the coastal areas. New climate change data is available in the Puget Sound State of Knowledge Report.[5] Finally, WA DNR is expected to publish a draft wildland-urban interface fire risk map by the end of 2019, helping to show the extent of fire risk, much of it spurred by the growth indicated above.

As development has occurred, jurisdictions have invested in risk reduction measures such as the installation of ductile iron pipe to replace cast iron pipe in water systems. While this work is critical, in most jurisdictions it is unlikely to be complete for 20-30 years. Other work has included bridge retrofits, wastewater system improvements, flood risk reduction projects, and risk assessments and planning. Nevertheless, there are dozens to hundreds of bridges in need of upgrades to keep the transportation system functioning in the event of a major earthquake.

New science showing more risk and a dramatic increase in population, especially in areas not previously developed, indicates that the county trajectory is toward more exposure and vulnerability. While there is ongoing work to reduce risk, it is not keeping up with existing needs, much less the needs of a larger, more diverse population living across a larger area.

ESTIMATED CHANGES IN RISK 2015-2020		
SECTOR	RISK CHANGE (Increased -, Decreased +, No Change =)	EXPLANATION

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[3] King County Office of the Executive. 2018. 2018 King County Quick Facts. Accessed online on 8/28/19 from https://kingcounty.gov/depts/executive/performance-strategy-budget/regional-planning/Demographics.aspx.
[4] King County Office of Economic and Financial Analysis. July 19, 2019. July 2019 King County Economic and Revenue Forecast. Accessed online on 8/28/19 from https://www.kingcounty.gov/~/media/business/Forecasting/documents/July2019_Forecast.ashx?la=en.
[5] Climate Impacts Group. 2015. Puget Sound State of Knowledge Report. Accessed online on 8/28/19 from http://cses.washington.edu/picea/mauger/ps-sok/ps-sok_cover_and_execsumm_2015.pdf.

King County Residents	▬	With a larger population that is likely no more prepared, risk to King County residents is estimated to have increased.
Vulnerable Populations	▬	While there has been a large increase in median income, there is more income inequality and housing insecurity due to housing costs and other issues. There are also many new immigrants who may not be reached by disaster messaging or be familiar with the region's hazards. Overall risk to vulnerable populations has increased as these populations have grown.
Property	▬	While the construction boom is reducing risk in some areas, some construction patterns, such as building homes close together, is increasing risk from fire. Also, the new development, some of it in marginal areas is increasing risk. This is especially acute in areas in the wildland-urban interface, near floodplains, or on unstable soils.
The Economy	▬	The economy has grown but is also susceptible to a shock caused by a disaster that could permanently displace the major companies that make this region so competitive. Many of these companies are highly mobile and a disaster that destroys the region's infrastructure could devastate the economy.
The Environment	▬	With heightened climate change and more development, the environment is more threatened by hazards including wildfire and flooding.
Health Systems	✚	Health systems have seen modest improvement in overall risk as hospitals are upgraded to higher seismic standards.

Government Operations	▬	No increase or decrease in risk to government operations is identified. While there continues to be some modest investment in the resilience of public facilities, there is still significant risk of disruption of services during a major incident, as demonstrated during the 2019 snow event. A seismic event would still threaten the ability of King County government to provide services and many buildings may not be useable.
Responders	▬	No change in the risk to responders is identified.
Infrastructure Systems	✚	Although not sufficient to meet the need, investments in infrastructure have modestly reduced risk.
Public Confidence	Mixed	Public confidence in the jurisdictions' capabilities is estimated to be mixed. On one hand, emergency management and county government are delivering services on a huge scale and received relatively positive feedback from the February 2019 storms. On the other, there has been little movement to systematically improve earthquake resilience, something frequently reported by the media.

Regional Risk Profile: Avalanche

Hazard Description

Avalanche hazards in the Northwest are associated with winter storms in the Cascade and Olympic Mountain ranges. Avalanches occur when a snow pack loses its grip on a slope and slides downhill. Typically, slopes of between 20 to 30 degrees and snow packs of 34 inches or more may produce avalanches. Most natural avalanches occur in back country little used by humans during such weather conditions. This tends to minimize exposure to avalanche impacts. Most vulnerable are travelers and

Stevens Pass WSDOT avalanche control areas

winter recreation enthusiasts using Stevens Pass in northeastern King County, Snoqualmie Pass in central-eastern King County, and Crystal Mountain Ski Area near Chinook and Cayuse passes in just outside of southeastern King County.[6]

Regionally, severe winter weather in the form or snowfall in the Cascade Mountains results in a snowpack that – when conditions are right – can lead to a natural or man-made/induced avalanche. Avalanches can result in impacts to transportation through mountain passes and injuries or death to people using the mountain backcountry recreationally. Avalanche danger in King County is highest during severe winter weather from October through March annually. When moist air from the Pacific rises to climb the Cascade Mountains and meets the colder air of the U.S. interior, precipitation often falls as snow from late October through March or April each year.

The most frequent impact from avalanche is from pass closures, especially along Snoqualmie Pass on I-90. In particularly severe events, both Snoqualmie and Stevens pass may close for days at a time, effectively cutting the state in half. The other routes that cross the cascades, US 12, US 20, SR 410, and SR 14, are not suitable for large traffic volumes and large trucks and are often closed when I-90 and US 2 are closed. This occurred most recently during the February 2019 snowstorm. In that event, all the east-west highways were closed, limiting King County's road salt supply from the east side of the state. The snowfall totals at the pass exceeded normal, with 118 total inches in February alone (average accumulation in February is 73.9 inches). February 12, 2019 broke the 24-hour snowfall record, with 31.5 inches recorded

Snoqualmie Pass WSDOT avalanche control areas.

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[6] Washington State Department of Transportation, Prediction of Snow and Avalanches in Maritime Climates: Final Report, WA-RD 203.1, December 1989, p.3.

by Washington State Department of Transportation (WSDOT) crews recorded at the summit. During this event, I-90 was closed beginning Monday afternoon, February 11, reopening on Thursday morning due to avalanche danger.

Avalanche impact areas are mapped for Snoqualmie and Stevens passes, which are maintained throughout the winter by WSDOT crews. Chinook and Cayuse passes are closed during the winter due to avalanche danger and difficulty of maintaining a clear roadway.

In addition to the roadway risk, two of the state's three cross-state railways pass through the Cascades. These railroads travel along a route similar to the major highways and are similarly susceptible to avalanche. Major snowfall and avalanche danger can disrupt rail freight traffic across the state, with significant economic impacts.

Vulnerability Characteristics and Previous Occurrences

Recreational areas that support snowshoeing, alpine and cross-country skiing, snowmobile areas, and winter hikers and campers are most at risk from avalanche incidents. Typically, injuries to recreational hikers, skiers, snow boarders, and climbers occur outside managed areas. Several stretches of Interstate 90 and Highway 2 in King County are vulnerable to avalanches between October and April each year, depending on snow packs and weather conditions. Both Snoqualmie and Stevens Pass are significant commercial routes. Cargos are carried between the Ports of Tacoma and Seattle, and eastern Washington. When Stevens and Snoqualmie Passes are closed, I-84 in Oregon or air travel are the only practical ways to travel between Spokane and Seattle.

The popular backcountry skiing areas around Stevens and Snoqualmie passes are high-hazard zones where avalanche fatalities are relatively common. WSDOT posts signs, though these warnings are frequently ignored. People engaged in snow sports in these areas are often among the most experienced enthusiasts; however, even with safety equipment, they may trigger or fall victim to avalanches. There are, on average, one to three fatalities in avalanches statewide each year. Hundreds of avalanches are thought to occur around the Cascades each winter, though most without any human cause or impact.

There are twelve common factors that contribute to avalanche danger, including old snow depth, old snow surface, new snow depth, new snow type, snow density, snow fall intensity, precipitation intensity, settlement, wind direction and wind speed, temperature, subsurface snow crystal structure, and tidal effect.[7] Research done at Snoqualmie Pass indicates that most natural avalanches occur within one hour after the onset of rain over a weakened snow pack.[8] Large amounts of new snow accumulation also increases avalanche risk, especially when coupled with wide temperature swings.

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[7] Kruse, Scott M. "Avalanche Evaluation Check List," Avalanche Review vol. 8, No 4, February 1990
[8] Washington State Department of Transportation, Washington State Department of Transportation – Avalanche Control http://www.wsdot.wa.gov/maintenance/avalanche4

Significant Historic Avalanches 2001-2019 – Stevens and Snoqualmie Passes[9]

YEAR	PASS	FATALITIES AND INJURIES
1910 (Historic Maximum)	Stevens Pass (railway)	96 Fatalities
2001	Stevens Pass, Snoqualmie Pass	1 Fatality, 2 Injuries
2002	Stevens Pass, Snoqualmie Pass	10 Injuries
2003	Snoqualmie Pass	1 Fatality, 1 Injury
2004	None	None
2005	Snoqualmie Pass	1 Injury, 1 Fatality
2006	None	None
2007	Snoqualmie Pass	1 Injury, 2 Fatalities
2008	None	None
2009	None	None
2010	Snoqualmie Pass	3 Injuries
2011	Stevens Pass, Snoqualmie Pass	6 Injuries, 2 Fatalities
2012	Stevens Pass, Snoqualmie Pass	12+ Injuries, 6 Fatalities
2013	Stevens Pass, Snoqualmie Pass	4+ Injuries, 2 Fatalities
2014	Stevens Pass, Snoqualmie Pass	7+ Injuries, 1 Fatality
2015	Stevens Pass, Snoqualmie Pass	2 Injuries, 2 Fatalities
2016	None	None
2017	Stevens Pass, Snoqualmie Pass	2 Injuries, 1 Fatality
2018	Stevens Pass, Snoqualmie Pass	1 Injury, 3 Fatalities
2019	None	None

[9] Northwest Avalanche Center, Accident Reports. Accessed online on 5/13/19 from
https://www.nwac.us/accidents/accident-reports/

Scenario Drivers

There are two kinds of avalanches, loose and slab. Loose avalanches occur when light-grained snow exceeds its "angle of repose", collapses a snow drift or bank and fans out as it slides downhill. A slab avalanche occurs when heavy or melting snow resting on top of looser snow breaks away from the slope and moves in a mass. The latter often occurs when rains soak the top layer of snow on moderately sloped terrain.

Priority Vulnerabilities

Back-country recreationists	Snowmobilers, hikers, and skiers in back-country and off-trail environments are at the highest risk from avalanche.
Transportation networks	I-90 and US-2 are the most vulnerable routes to avalanche. Disruptions to both are common during the winter, though most are for a short duration. A long-duration disruption could have significant economic consequences.
Public safety officers and volunteers	Search and Rescue regularly travel on search missions for missing recreationists, putting them at risk from avalanche as well.

Priority Impact Areas

King County residents	Avalanche conditions can cause closure of ski areas like: Alpental, Hyak (Summit East), Ski Acres (Summit Central), Stevens Pass, and/or Crystal Mountain. The recreational skiers and the people who are seasonally employed can be impacted when these conditions close ski areas. People who ski "out of bounds" take exceptional risks in locations where avalanche control does not maintain safe conditions and search and rescue operations may be hampered.
	Pass closures may inconvenience people by causing them to either take commercial flights between eastern and western Washington or cause them to take wide routes around the mountain area through the Columbia Gorge between Washington and Oregon.
	There are no major populations in King County that are exposed to avalanche terrain. The King County community closest to avalanche country is Skykomish. It has not experienced an avalanche in recent memory.
Vulnerable populations	No specific impacts are expected to vulnerable populations for this hazard.
Property	Property exposed to avalanches include ski area lifts and equipment, small clusters of seasonal vacation homes and utilities supporting ski areas, ski lodges, ski area support operations, and those vacation properties.

The economy	Closure of ski areas from avalanche danger usually lasts only a short time. While revenue to one or more ski areas may be reduced, no long-term economic impacts can be expected from avalanche issues. Heavy snows and avalanche danger may close Stevens and/or Snoqualmie Pass for extended periods. These pass closures can impede transportation of goods between eastern/western Washington, impact the Port of Seattle and port/countries around the/Pacific Rim. Avalanche closure of King County passes may cause motorists and truckers to reroute through Interstate 84 in Portland. The most significant avalanche event in Washington State, and the deadliest in US history, occurred in 1910 near Stevens Pass. Two trains carrying passengers were hit by an avalanche killing 96 people. Economic impacts are also substantial. A WSDOT study claimed that a four-day closure at Snoqualmie Pass in the winter of 2007/2008 cost the state $27.9M in economic output, 170 jobs, and $1.42M in state revenue (2008 dollars).[10]
The environment	Avalanches are natural events; however, they kill wildlife and trees and can reshape the landscape.
Health systems	There are no known healthcare facilities or systems exposed to avalanches.
Government operations (continuity of operations)	Avalanche areas are remote to most King County operations. Where avalanches may occur, King County Sheriff's Office Search and Rescue, Ski patrols, and volunteers may be involved. This may include BARK, a group that provides K-9 search capability for avalanche victims. Support may also be required from the aviation unit of the King County Sheriff's Office and from Emergency Medical Service units. Support personnel for avalanche control are provided by Washington State Department of Transportation.
Responders	When avalanches bury or injury skiers and backcountry hikers, the King County Sheriff's Office Search and Rescue team(s) may be deployed along with trained volunteers and specially trained volunteer K-9 units like BARK (Backcountry Avalanche Rescue K-9). Most search missions occur in or around the off-trail perimeter of ski areas like Snoqualmie Acres, Hyak,

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[10] Ripley, Richard, "Four-day Snoqualmie Pass closure cost $27.9 million," Spokane Journal, 11/20/2008. Accessed online: https://www.spokanejournal.com/local-news/four-day-snoqualmie-pass-closure-cost-279-million/

	Alpental, Crystal Mountain, and Steven's Pass. Buried skiers are often severely injured or may be killed from their injuries or suffocation under large amounts of snow in areas difficult to reach.
Infrastructure systems	There are no critical facilities located in areas of the county subject to avalanches. Critical infrastructure that may be impacted includes the BNSF railway (also used by Amtrak) and the east west highways, US 2 (Stevens Pass) and I-90 (Snoqualmie Pass). Chinook Pass usually closes from October through May.
Public confidence in jurisdiction's governance and capabilities	The public at risk has a good understanding of the risks from avalanche. Warnings are regularly posted and announced to skiers and back country hikers during the winter months.

Regional Risk Profile: Civil Disorder

Hazard Description

Civil Disorder and civil disturbances can range from minor to significant events that can disrupt the functioning of a community for a few days, weeks or months. A worst case-scenario for a King County civil disorder would be an incident that takes place in a large urban environment and lasts for an extended period of time. An example of a worst-case scenario was the 1999 Seattle World Trade Organization rioting which significantly impacted the City and led to numerous injuries and arrests. The rioting raised Seattle's cost of handling the conference to $9 million from an earlier estimated city cost of $6 million surpassing worst-case projections[11]. In addition, downtown Seattle businesses lost an estimated $20 million in property damage and lost sales during the WTO conference.

Title 18 of the United States Code defines civil disorder and lists the crimes associated with civil disorder. In Section 231 of Chapter 12, defines civil disorder as: "any public disturbance involving acts of violence by assemblages of three or more persons, which causes an immediate danger of or results in damage or injury to the property or person of any other individual…(a)(1)…use, application or making of any firearm, or explosive or incendiary device, or technique capable of causing injury or death to persons…or…(a)(2)…transports or manufactures for transportation in commerce any firearm, or explosive or incendiary device, knowing or having reason to know or intending that the same will be used unlawfully in furtherance of a civil disorder…or…(a)(3)…commit any act to obstruct, impede, or interfere with any fireman or law enforcement officer lawfully engaged in the lawful performance of official duties incident to and during the commission of a civil disorder…".[12]

The term civil disobedience in contrast is a non-violent form of protest or resistance to obeying certain laws, demands and commands of a government or of an occupying power. Civil disobedience has been promoted by nationalist movements in Africa and India, the civil rights movement of the U.S., and labor and anti-war movements in many countries. Civil disobedience is sometimes equated with protests or non-violent resistance. Acts of civil disobedience can start peacefully but can lead to violence. In this context, civil disorder arising from civil disobedience in which participants turn violent and antagonistic toward public safety and civil authority is illegal. Washington state law defines civil disorder as "any public disturbance involving acts of violence that is intended to cause an immediate danger of, or to result in, significant injury to property or the person of any other individual." Under Revised Code of Washington 9A.48.120, civil disorder training "as (1)…a person is guilty of civil disorder training if he or she teaches or demonstrates to any other person the use, application, or making of any device or technique capable of causing significant bodily injury or death to persons, knowing, or having reason to

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[11] CBC News. January 6, 2000. WTO protests hit Seattle in the pocketbook. Accessed online on 8/26/19 from https://www.cbc.ca/news/world/wto-protests-hit-seattle-in-the-pocketbook-1.245428.
[12] Office of the Law Revision Council. 18 USC Ch. 12: Civil Disorders. Accessed online on 8/26/19 from https://uscode.house.gov/view.xhtml?path=/prelim@title18/part1/chapter12&edition=prelim.

know or intending that same will be unlawfully employed for use in, or in furtherance of, a civil disorder"…and (2) classifies it as a "class B felony."

Vulnerability Characteristics and Previous Occurrences

Civil disorder may result from many situations and encompass a broad spectrum of civil action that ranges from peaceful events to other forms of disturbance caused by a group of people. The severity of such disturbances often reflects the degree of public displeasure or expression of discontent. Examples of civil disorder include, but are not necessarily limited to: violent demonstrations and other forms of obstructions, riots, sabotage, and other forms of crime. Civil disorder can be a dangerous condition that can become increasingly chaotic and volatile.

Laws have evolved that govern civil disorder and peacefully resolve conflict. In the United States, gathering in a crowd is constitutionally protected under "the right of the people to peacefully assemble." However, assemblies that are not peaceable are generally not protected. The laws that deal with disruptive conduct are generally grouped into offenses that disturb the public peace. They range from misdemeanors, such as blocking sidewalks or challenging another to fight, to felonies, such as looting and rioting.[13]

The circumstances surrounding civil disorder may be spontaneous or may result from escalating tensions as was demonstrated during 1999 Seattle World Trade Organization protests. Civil disorder can erupt anywhere but the most likely locations are those areas with large population groupings or gatherings.[14] Sites that are attractive for political rallies should be viewed as potential locations for the epicenter of civil disorder events. Disruption of critical infrastructure may occur during very severe civil disorder events. Public services such as water, power, communication, and transportation may be temporarily unavailable.

Civil disorder can also occur in proximity to locations where a 'trigger event' occurred as was the case in January 2017 at University of Washington when demonstrators and counter-demonstrators gathered as a politically conservative commentator was scheduled to speak. Violent protests took place on campus and a person was shot.

The Seattle Mardi Gras riot occurred on February 27, 2001, when disturbances broke out in the Pioneer Square neighborhood during Mardi Gras celebrations. There were numerous random attacks on revelers over a period of about three and a half hours. There were reports of widespread brawling, vandalism, and weapons being brandished. Damage to local businesses exceeded $100,000. About 70 people were

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[13] Revised Code of Washington Title 9A.
[14] Mid-America Regional Council. 2015. Regional Multi-Hazard Mitigation Plan. Accessed online on 8/26/19 from https://www.marc.org/Emergency-Services-9-1-1/pdf/2015HMPdocs/HMP2015_Sec4-HAZ-CivilDisorder.aspx.

reported injured. Several women were sexually assaulted. One man, Kris Kime, died of injuries sustained during an attempt to assist a woman being brutalized.[15]

Civil disorder can also occur as a collective outburst from a causal factor or driver. For example, past May Day protests in Seattle have routinely exhibited violence or vandalism. A 2013 May Day protest in downtown Seattle turned violent with police responding to demonstrators throwing rocks, bottles, metal pipes, fireworks -- and even a skateboard. The clashes left eight officers with injuries, and police reporting the arrests of 17 people on various offenses including property destruction and assault. During the clashes, police deployed flash-bang grenades and tackled unruly protesters to the ground.[16] In 2016 May Day protest in Seattle a peaceful march turned violent when protesters lit fireworks and threw rocks and Molotov cocktails at police. Nine people were arrested and five officers were injured in the clashes.

While May Day is not recognized as an official holiday, many treat it as a nationwide day of strike with thousands turning out for peaceable protests and marches in Seattle.[17] Other groups, such as anti-capitalists, anti-fascists, radical environmentalists and anarchists plan May Day events too with chaos and violence often resulting in arrests, infrastructure damage and interruption to transportation services. These aren't the only groups to demonstrate on May Day. In the 1970s, anti-war protesters took to the streets of Seattle. Anti-police brutality activists joined anarchists in 2015.[18]

The ultimate severity of any civil disorder event will depend on the magnitude of the event and its location. The more widespread an event is, the greater the likelihood of excessive injury, loss of life and property damage. Additional factors, such as the ability of law enforcement to contain the event, are also critical in minimizing damages.

Against this backdrop and historical precedence, King County will continue to experience civil disorder stemming from civil disturbance in which participants turn violent and antagonistic toward civil authority in Seattle and other communities. However, based on King County's experience with such disturbances, the probability that such incidents will develop into mass violence of civil disorder remains low.

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[15] Burton, Lynsi. February 16, 2015. Looking back: Mardi Gras riots of 2001. *The Seattle Times*. Accessed online on 8/26/19 from https://www.seattlepi.com/seattlenews/article/Looking-back-Mardi-Gras-riots-of-2001-6084162.php.
[16] Watts, Amanda and Lindy Royce-Bartlett. May 2, 2013. 17 arrested as Seattle May Day protests turn violent. *CNN*. Accessed online on 8/26/19 from https://www.cnn.com/2013/05/01/us/seattle-may-day-protests/index.html.
[17] Mirfendereski, Taylor. April 30, 2017. What is May Day? *King 5 News*. Accessed online on 8/26/19 from https://www.king5.com/article/news/local/what-is-may-day/281-435393398.
[18] Guevara, Natalie. May 1, 2019. May Day: A primer on the labor, immigrant rights rally and its history in Seattle. *The Seattle Post-Intelligencer*. Accessed online on 8/26/19 from https://www.seattlepi.com/seattlenews/article/May-Day-Seattle-protest-immigration-labor-anarchy-13808200.php.

Scenario Drivers

Civil Disorder can arise from many situations and be triggered by a specific issue or by combination of causes. Instances of police violence have often been a scenario trigger for civil disorder (e.g. 2009 Oakland police shooting of Oscar Grant).[19] In King County, the 2008 video of a King County deputy assaulting a teen girl in a holding cell was referenced in a Seattle 2010 'March Against Police Brutality' flyer.[20] During the Capital Hill demonstration Seattle police arrested five individuals for investigation of crimes ranging from trespassing to inciting a riot.

While demonstrations and protests can occur throughout King County, these civil actions often involve free speech rights in public places and do not evolve into chaos and violence. Civil disorder within King County remains centered in the Seattle area. For planning purposes, civil disorder occurs in areas of government buildings, military bases, schools/universities, city council meetings, state/city parks and within a downtown core.

The lines between civil disorder, civil disobedience, civil unrest and protest/demonstrations are often times blurred and encompass a wide range of actions from peaceful to violent, from legal to illegal and from spontaneous to highly planned. Further, while a group of people may organize and bring attention to a specific cause through peaceful protest/demonstrations, a smaller, separate group may engage in illegal tactics. This group of anarchists are seen as purveyors of violence and destruction.[21] Typically, criminal anarchists employ a common mode of dress which is part of a tactic frequently called "Black Bloc." In the "Black Bloc" stratagem, throngs of criminal anarchists all dress in black clothing in an effort to appear as a unified assemblage, giving the appearance of solidarity for the particular cause at hand. This tactic is particularly troubling for law enforcement security forces, as no anarchist rioter can be distinguished from another, allowing virtual anonymity while conducting criminal acts as a group.

Black Bloc gained attention in the United States in 1999 after violent protests at a meeting of the World Trade Organization in Seattle, according to a 2001 history of the tactic on the anarchist news website, A-Infos. Hundreds of people were arrested in the Seattle riots, which involved anarchists vandalizing businesses.[22]

Not every public protest or demonstration will attract an element of criminal anarchists. The types of demonstrations unlawful anarchists most commonly attend include those against environmentally harmful practices, those against gentrification, and anti-police rallies.

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[19] Associated Press. June 13, 2011. Ex-BART Officer Johannes Mehserle Released From Jail. *KPIX CBS SF Bay Area.* Accessed online on 8/26/19 from https://sanfrancisco.cbslocal.com/2011/06/13/ex-bart-officer-johannes-mehserle-released-from-prison/.
[20] JSeattle. April 9, 2010. Protest against police brutality starts at Seattle Central. *Capitol Hill Seattle Blog.* Accessed online on 8/26/19 from https://www.capitolhillseattle.com/2010/04/protest-against-police-brutality-starts-at-seattle-central/.
[21] Flowers, Kory. January 30, 2015. Understanding the Black Block. *Police: The Law Enforcement Magazine.* Accessed online on 8/26/19 from https://www.policemag.com/341767/understanding-the-black-bloc.
[22] Rossman, Sean. February 2, 2017. G-20 summit protests: What is a Black Bloc? *USA Today.* Accessed online on 8/26/19 from https://www.usatoday.com/story/news/nation-now/2017/02/02/what-black-bloc/97393870/.

Priority Vulnerabilities

Government facilities	Civil disorder incidents often target government organizations or visible images of the government such as police vehicles, city halls, or court facilities.
Businesses	Businesses such as banks, businesses in downtown areas or along transportation routes, and other commercial establishments are often targeted during looting or may be targeted for political or racist reasons such as ownership by an immigrant group in the case of anti-immigration riots or because they are associated with an industry being targeted by the manifestation (banks, abortion clinics, oil company offices, etc.).
Minority and immigrant communities	There have been multiple incidents in recent years of white-supremacist organizations holding events that turn violent, including the Charlottesville, VA marches that resulted in the death of a woman at the hands of a white supremacist terrorist who drove his vehicle into a crowd.

Priority Impact Areas

King County residents	All King County residents can be impacted, though those who live or work in downtown areas tend to be more exposed and impacted by civil disorder incidents.
Vulnerable populations	Ethnic minority and immigrant communities are historically targeted by civil disorder events. While rare in our region, the United States has a long history of racially-motivated riots that burn and destroy minority-owned businesses and homes.
Property	Much of the impact from civil disorder is to property, secondary only to economic impacts. During the World Trade Organization protests in 2000, over $20 million in damage was recorded by businesses and $9 million in costs to the city.
The economy	Economic impacts caused by loss of business, destruction of businesses, and business interruption can exceed the property damage dollar figures by a factor of two or more. Lost sales and uninsured losses can permanently destroy many businesses. Areas can also become perceived as unsafe or unwelcoming for business, further hurting the economy.
The environment	Civil Disorder will have a minimum impact on the environment; unless, hazard material facilities such as petroleum, chemical, and recycling are targeted in arson fires or vandalism. The impact on the environment in such cases could be significant.
Health systems	Health systems can be overwhelmed by civil disorder incidents, such as when large numbers of demonstrators are brought to the hospital due to exposure to tear gas or due to clashes with counter-demonstrators or with police.

Government operations (continuity of operations)	Major incidents can bring government services to a standstill. In King County, with both City of Seattle and King County offices are in the same area, along with court facilities. A major incident in this area would prevent employees from getting to work or home. Furthermore, government buildings are often targeted and can be damaged or destroyed.
Responders	Responders are often on the front line of events. Responders can be targeted, causing injury to personnel, damage to facilities, and the loss of equipment. Responders are often injured during major incidents and, even when events are brought under control, may be seen as an enemy of the community causing long-term trust issues.
Infrastructure systems	• Energy: Pipelines carrying oil are a potential target for demonstrators. Oil trains have been targeted frequently in Washington; however, these protests do not tend to turn violent. • Water/Wastewater: Water systems are rarely the primary target of a demonstration and may only be peripherally impacted. • Transportation: One of the largest impacts from a major incident is disruption to transportation. Transit facilities and assets like busses may be destroyed. Roads can be closed for hours or days. • Communications: Communication systems are redundant and are unlikely to be severely impacted by a civil disorder incident.
Public confidence in jurisdiction's governance and capabilities	Major incidents can cause long-term damage to public confidence in the jurisdiction or, especially, public safety elements of jurisdiction governance. This can cause either alienation or, when response is proactive, help rebuild confidence and trust. To best preserve and grow confidence, a jurisdiction must respond quickly and effectively but without excessive force. The general public expects a quick restoration of order and protection of property while activists may demand accountability from officials and safety for peaceful demonstrators.

Regional Risk Profile: Cyber Incident

Hazard Description

Information technology has become embedded in the ways we conduct business, work and live. In a government context technology is fundamental to public services such as providing healthcare, public transportation, law enforcement, citizen engagement, public utilities, and supporting tax and rate payers.

A cyber-incident can have a severe impact on technology and therefore local government's capability to deliver services and conduct daily operations.

A cyber incident is defined by the Department of Homeland Security (DHS) in the 2016 National Cyber Incident Response Plan as "an event occurring on or conducted through a computer network that actually or imminently jeopardizes the confidentiality, integrity or availability of computers, information on communication systems or networks, physical or virtual infrastructure controlled by computers or information systems, or information resident thereon[23].

- Confidentiality refers to the ability to preserve authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information.
- Integrity speaks to guarding against improper information modification or destruction and ensuring information non-repudiation and authenticity.
  - Data Integrity – The property that data has not been altered in an unauthorized manner. Data integrity covers data in storage, during processing, and while in transit.
  - System Integrity – The quality that a system has when it performs its intended function in an unimpaired manner, free from unauthorized manipulation of the system, whether intentional or accidental.
- Availability refers to the ability to ensure timely and reliable access to and use of information[24]

The nature of a cyber-incident differs from other hazards such as a landslide or an earthquake because it often lacks physical presence or evidence. The Ponemon Institute estimates the average time to identify a data breach is 206 days. When the breach is discovered it has already occurred or is still ongoing.[25] The average time it takes to fully contain a breach, after it has been identified, is 73 days. Organizations have seen an increase in the identification and containment mean time over the last few years, which has been attributed to the increasing severity of criminal and malicious attacks.[26]

Wherever information technologies exist and are used, cyber incidents can occur. As the County becomes more and more dependent on its IT infrastructure it also becomes more vulnerable to IT related disruptions. Most cyber incidents can be categorized as malicious attacks, human errors or as

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23 National Cyber Incident Response Plan, Department of Homeland Security, December 2016 p. 8
24 https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-12r1.pdf 10/14/19

25 IBM 2019 Cost of a Data Breach Report: Global Overview. p 50

26 IBM 2019 Cost of a Data Breach Report: Global Overview. p 50

system glitches. More than 50% of the incidents are estimated to be caused by malicious or criminal attackers.[27]

Cyber incidents based on actors with malicious intent can be driven by criminal motives for profit, extortion, and theft or to damage, destroy or interfere with infrastructure systems. Organizations worldwide experience malicious attacks on a daily basis. Most of the attacks are unstructured with little to no organization behind them such as a phishing attack or malware hidden in a downloaded file. Attacks are carried out with tools aiming to take advantage of well-known flaws and are often detected by security tools such as antivirus programs before they cause harm. However, an undetected attack can cause significant harm to an organization before it's detected and fully contained. More sophisticated attacks with a specific target are less common, harder to detect and take longer to contain. These attacks are more likely to have a catastrophic impact on an organization causing disruptions over some or all of the network. Over the last few years attackers have been targeting organizations using sophisticated ransomware, which encrypts the organizations' data and demands a ransom to decrypt it. Other attacks include cyber terrorism, aiming to cause sufficient destruction or disruption, to generate fear or undermine entities such as an organization, a region, a sector or a country.

Cyber incidents due to human errors or system glitches can occur because of negligence, lack of implemented policies and/or process, unclear roles and responsibilities, insufficient training, misconfigurations etc. Such incidents are often identified and contained faster than disruptions caused by malicious actors[28]. Human errors and system glitches can expose confidential data, decrease availability and put data integrity at risk.

Data centers, physical IT infrastructure and hardware are vulnerable to other hazards such as long lasting power outages, flooding, earthquakes and fires. In the event of such hazards it is likely that the disruption to information technology will slow down the recovery time of critical communication systems, essential services and hardware.

Unshielded electronic and electrical equipment is sensitive to electromagnetic pulses (EMP). An EMP is an intense burst of electromagnetic energy resulting from natural (e.g. solar storms or space weather) or man-made (e.g. nuclear or pule-power device). An EMP can temporarily affect or permanently damage electronic equipment. Solar storms which affects electronic equipment are rare but have occurred in the past impacting GPS satellite systems and signals sent to ground-based receivers[29].

The impact of a cyber-incident ranges from minimal to catastrophic depending on factors such as; magnitude of internal and external impact, affected systems, length of the incident, the nature of the data and so on. A small earthquake, a misconfiguration which was discovered early without any implications or a stolen encrypted laptop without sensitive data could have a minimal impact on the County. Whereas a ransomware attack which encrypts all or most of the County's data could have a

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27 IBM 2018 Cost of a Data Breach Report: Global Overview. p 6
28 IBM 2018 Cost of a Data Breach Report: Global Overview. p 9
29 NASA Solar Flares, https://www.nasa.gov/mission_pages/sunearth/news/X-class-flares.html 2019-10-14

catastrophic impact on the organization leading to loss of County operational capability, economic and reputational loss as well as life, health and safety risks and financial loss for individuals who live, work or visit the region.

Vulnerability Characteristics and Previous Occurrences

Regardless of the nature of the cyber incident, any area where an IT system supports the County services can be vulnerable. In order to reduce the risk of cyber incidents it is important to manage threats and vulnerabilities, have established backup systems, incident response plans and exercises, disaster recovery and continuity of operations. The magnitude of a cyber-incident varies greatly based on the extent and duration of the impact. The extent varies based on which specific system or data is affected, possible warning time, the ability to preempt the incident and activate a well-known and effective incident response plan.

Minor cyber incidents which are identified early and are recoverable may have some impact on daily operations before fully contained but won't have any significant effect on the County. A significant incident can have a major impact not only to the County but the region. Such incidents may result in safety and health risks, financial losses for the County and the region, reputational damage and inability to comply with regulatory requirements including penalties and fines. It may also affect the County's ability to achieve critical strategic objectives and fulfill Executive priorities.

The County's business essential services are critical to support life, health and safety in the region. Cyber incidents affecting those systems and services can have catastrophic impact on people who live, work or visit the region if they're not available within 0-72 hours after the initial disruption. The business essential services also include functions with legal requirements.

The County manages public, sensitive and confidential data on behalf of people who live, work and visit the region. Some of the data is regulated by federal law, Revised Code of Washington and national or global compliance regulations. Unauthorized, unanticipated, or unintentional disclosure of confidential data could result in loss of reputational damage, or legal action against the County and can, amongst other things result in identity theft or financial loss for impacted individuals. Personal Health Information (PHI) is more valuable on the black market than regular Personally Identifiable Information (PII). Therefore, there is a higher incentive for malicious attackers to target PHI than sensitive data such as PII. Loss of critical system or data availability, functionality and operational effectiveness, for example, may result in loss of productivity, thus impeding the end users' performance of their functions in supporting the County's operations. If hardware, computer systems, networks, servers and backups are damaged due to other hazards or accidental or deliberate damage, it can cause additional delays. System and data integrity is lost if unauthorized changes are made to the data or IT system by either intentional or accidental acts. If the loss of system or data integrity is not corrected, continued use of the contaminated system or corrupted data could result in inaccuracy, fraud, or erroneous decisions.

King County has services relying on SCADA (Supervisory Control And Data Acquisition) systems. SCADA systems are industry control systems which are used to control infrastructure and facility based

processes such as wastewater treatment and airports. Cyber incidents affecting those type of services can have severe impact on areas such as the environment, health, safety and financial consequences for the region.

Not all IT systems utilized by the County are owned or managed by the County. The County relies on numerous third party vendors and partners who are also exposed to cyber incidents and can therefore be vulnerable to cyber disruptions in other organizations.

Cyber incidents occur daily across the globe. The quantity of information being stolen by malicious attackers, destroyed or exposed as a result of a human error or made unavailable due to a system glitch is growing each year. King County is the recipient of a constant variety of attacks ranging from scans for weaknesses in our defenses, malware, phishing, and internet based attacks, as well as insider threats. The timeline below comprises state, national and international events and exemplifies consequences of a cyber-incidents.

Year	Location	Description
2006	United States	Geomagnetic storms and solar flares disabled the Global Positioning System (GPS) signal acquisition over the United States.
2007	Estonia	Dispute regarding movement of a Russian statue led to a cyber-attack that crippled websites for government services, banks, media outlets etc.
2008	Turkey	Hackers disabled communications, alarms, and caused a crude oil refinery the Turkish pipeline to explode, destroying operations and facilities.
2013	United States	Hackers stole credit card information from over 40 million Target custom
2014	Washington State	Washington State experienced a six hour long 911 system outage due to human error.
2014	United States	280 000 AT&T accounts was breached by insiders who accessed user information with malicious intent.
2015	United States	The Office of Personal Management experienced a malicious attack result in over 20 million compromised personnel records.
2016	Global	Over 1 billion Yahoo user accounts were compromised in 2013 and was discovered and communicated in 2016.
2017	Global	Geomagnetic storm affected power grids and radios.
2017	Sweden	Due to human error the National Transport Agency exposed its entire database including military secrets and personal identifiable information o individuals in the witness protection program, military personnel, and poli officers.

2017	Global	WannaCry, a ransomware virus affected over 200 000 computers across 150 countries.
2017	Washington State	The University of Washington suffered a HIPAA data breach exposing information of nearly 1 million patients due to human error.
2018	United States	The City of Atlanta, Georgia and the Colorado Department of transportation suffered a ransomware attack named SamSam.
2018	United states	The City of Valdez in Alaska was targeted by a ransomware attack that remained dormant for weeks before doing any damage.
2019	Washington State	The City of Sammamish was targeted by a ransomware attack that shut down many city online services, requiring the city manager to declare an emergency and request support from law enforcement and King County IT and hire a tech company to help resolve the crisis.

Scenario Drivers

Cyber incidents can occur at any time, with or without pervious warnings. Cyber incidents based on an actors malicious intent can be driven by criminal motives for profit, extortion, and theft or to damage, destroy or interfere with infrastructure systems. Cyber incidents due to human errors or system glitches can occur because of negligence, lack of policy and/or process, unclear roles and responsibilities, insufficient training, misconfigurations etc.	
Advanced Persistent Threat (APT)	An attack in which the attacker gains access to a network and remains undetected. APT attacks are designed to steal data instead of cause damage.
Adware	A form of software that displays advertising content in a manner that is potentially unexpected and unwanted by users, which may also include various user-tracking functions (similar to spyware).
Denial-of-Service Attack (DoS)	Attacks that focus on disrupting service to a network in which attackers send high volumes of data until the network becomes overloaded and can no longer function.
Drive-by Downloads	Malware is downloaded unknowingly by the victims when they visit an infected site.
Electro Magnetic Pulse (EMP)	Intense burst of electromagnetic energy resulting from natural (e.g. solar storms or space weather) or man-made (e.g. nuclear or pule-power device) which can temporarily affect or permanently damage electronic equipment.

Hazards	Earthquakes, flooding and extreme weather can cause a verity of cyber incidents including loss of data and system availability and communications.
Malvertising	Malware downloaded when the victim clicks on an affected ad.
Malware	Software that can destroy data, affect computer performance, cause a crash, or even allow spammers to send email through an account.
Man-in-the-Middle	MITM attacks mirror victims and endpoints for online information exchange. In this type of attack, the MITM communicates with the victim who believes is interacting with the legitimate endpoint website. The MITM is also communicating with the actual endpoint website by impersonating the victim. As the process goes through, the MITM obtains entered and received information from both the victim and endpoint
Password Attacks	Third party attempts to crack a user's password and subsequently gain access to a system. Password attacks do not typically require malware, but rather stem from software applications on the attacker's system. These applications may use a variety of methods to gain access, including generating large numbers of generated guesses, or dictionary attacks, in which passwords are systematically tested against all of the words in a dictionary. Due to users reusing the same password for different systems a password attack targeting an unrelated system can give the attacker access to a more sought after system.
Pharming	Arranging for a web's site traffic to be redirected to a different, fraudulent site, either through a vulnerability in an agency's server software or through the use of malware on a user's computer system.
Phishing	Malicious email messages that ask users to click a link or download a program. Phishing attacks may appear as legitimate emails from trusted third parties.
Physical damage	Intentional or unintentional damage to physical infrastructure such as data center, hardware, power grids etc.
Ransomware	Malware that locks a person's keyboard or computer to prevent them from accessing data until you pay a ransom, usually in Bitcoin. A

	popular variation of this is ransom crypto ware, which corrupts files using a private key that only the attacker possesses
Social Engineering	In the context of cyber-security, this refers to an effort to psychologically manipulate a person, especially through misrepresentation or deception, to gain access to information. The manipulation often relies on the trusting nature of most individuals, or makes use of many persons' natural reluctance to offend others or appear too mistrustful. The ruse may involve creating impressions that make things appear more benevolent, trustworthy, and reliable than they actually are. Some schemes are very complex, and involve several stages of manipulation over a substantial period of time.
Social Engineered Trojans	Programs designed to mimic legitimate processes (e.g. updating software, running fake antivirus software) with the end goal of human-interaction caused infection. When the victim runs the fake process, the Trojan is installed on the system.
Spear Phishing	A form of phishing that targets a specific individual, company, or agency, usually relying on an accumulation of information to make subsequent ruses more effective when further probing the target, until a successful security breach finally becomes possible.
Spoofing	Attempting to gain access to a system by posing as an authorized user, synonymous with impersonating, masquerading, or mimicking. Attempting to fool a network user into believing that a particular site was reached, when actually the user has been led to access a false site that has been designed to appear authentic, usually for the purpose of gaining valuable information, tricking the user into downloading harmful software, or providing funds to the fraudsters.
Spyware	Software that allows others to gain private information about a user, without that person's knowledge or consent, such as passwords, credit card numbers, social security numbers, or account information.
Structured Query Language injection (SQLi)	Attackers use malicious SQL code for backend database manipulation to access information that was not intended to be displayed.
Virus	A program or code that attaches itself to a legitimate, executable program, and then reproduces itself when that program is run.

Worm	A self-contained program (or set of programs) that is able to spread copies of itself to other computer systems, usually through network connections of email attachments
Zero-day exploit	An attack which occurs the same day a vulnerability is discovered in the software. The vulnerability is exploited by the attacker before it can be fixed by a patch or a permanent solution.

Priority Vulnerabilities

Essential Services	The County has identified a number of essential services which are critical to support life, health, safety and legal requirements in the region.
Critical SCADA Systems	Industrial control systems which are used to control infrastructure and facility based processes such as wastewater treatment and airports.
Critical facilities	Facilities such as data centers and incident response facilities.
Critical devices	Smart devices paired to essential services such as medical devices.
Communication system	Although separate communication systems can be utilized in the event of a severe incident the County still relies on its communications systems for daily operations.

Priority Impact Areas

King County residents	Anyone who is present in King County during a cyber-incident can be impacted. Impact on residents may include: delayed services such as transportation, impaired or cancelled healthcare services, decreased or no availability of public services, information, and financial loss and exposed or lost information.
Vulnerable populations	Individuals who have a direct dependency on King County for health and safety reasons are vulnerable to cyber incidents impacting their needed services. Other vulnerable populations include individuals and organizations who depend on an income from the County if payments can't be processed, who are dependent on critical public services or County provided transportation.
Property	Cyber incidents can cause physical damage if property such as facilities, devices, infrastructure, or end consumers are affected by the disruption. An incident including utilities, life support devices, transportation or telecommunications may lead to extensive property damages.

| The economy	The financial impact of a cyber-incident ranges from little or minimal to significant depending upon duration, scale, affected systems, devices and users. A significant, extended cyber incident affecting most or all of the County's operations would likely impact the local and possibly regional economy for some time. An incident of that magnitude would likely creates significant, potentially long-term or ongoing challenges to the County's ability to fund essential services and activities related to Executive priorities.
	Organizations who experiences cyber incidents which leads to data breaches of sensitive or confidential information can be subjects to legal fines and financial penalties if, for example, Personal Healthcare Information (PHI) is lost or exposed or personal identifiable information including social security numbers, credit card information or driver's license information is breached. Organizations who fail to meet regulatory and contractual obligations due to a cyber-incident may have significant cost for legal fees, settlements and fines.
The environment	The loss of control or availability of the County's SCADA systems could potentially impact the environment in the region if, for example, it causes the release of hazardous materials or improper disposal of waste water.
Health systems	Last years' cyber incidents including ransomware attacks, distributed denial of service attacks, system glitches and human error in healthcare systems all demonstrate that cyber incidents, are capable of triggering emergencies that impact patient care and public health. If an agency cannot access its own EHR, patient care could be delayed or hindered. Furthermore if other critical healthcare related systems and devices can't be accessed or data integrity guaranteed patient safety will be at risk.
Government operations (continuity of operations)	Minor cyber incidents which are identified early and are recoverable may have some impact on daily operations before fully contained but won't lead to significant loss of operations. A significant incident impacting one or more functions and businesses can severely affect the County's capability to perform critical operations. However, not all daily operations are critical. The County has defined its essential services, which need to become operational within 0-72 hours after disruption to ensure the organizations capability to maintain critical healthcare, safety and legal and regulatory needs.

	In the event of a cyber-incident which render a non-critical service unavailable the County may lose revenue, experience loss of productivity and risks losing data over time.
Responders	Emergency responders may not be able to access their mission critical system, experience delays or performance issues. If data confidentiality is lost the public may lose their trust in organization and system. If data integrity is lost it may put patients and first responders at risk. King County may experience a prolonged incident response if the disruption is long lasting, complexed and exhausting internal resources.
Infrastructure systems	• Energy – Information technology has a direct dependency to energy. A hazard impacting the power system can therefore have a secondary effect on the County and lead to a cyber-incident due to loss of power to devices rendering systems and data unavailable, loss of power to cooling systems which can cause overheating and fires in server rooms and data centers. Critical infrastructure have backup generators. Ensuring fuel delivery during long lasting power outages for the generators is critical. A cyber incident impacting King County and no other organization should not have an effect on the energy system. • Water/Wastewater – Both water and wastewater facilities and infrastructure are vulnerable to cyber incidents on their SCADA systems, which can result in the release of hazardous material and malfunctioning systems. Such scenarios can result in environmental impact and create health and safety risks in the region. • Transportation – Transportation systems are vulnerable to attacks on their SCADA systems, which may result in trains and vehicles not operating as planned, airport functionality issues, delays, cancellations which can result in a secondary economic impact in the region due to loss of productive if people can't access public transportation to and from work. • Communications – The County relies on different types of technology based communications methods such as its website, VOIP and email to conduct its daily operations. A cyber incident impacting the VOIP or email system would quickly result in a loss of productivity, a negative consumer experience and could potentially halter or delay some of the County's operations.
Public confidence in jurisdiction's governance and capabilities	Recent cyber-incidents involving government agencies such as the ransomware attack on the City of Atlanta shows that such large scale disruption generate National media interest; third party actions; jeopardizes perceptions of effective operations, Executive priorities, and public confidence.

Regional Risk Profile: Dam Failure

Hazard Description

Dam failure is an uncontrolled, oftentimes, rapid release of water from an impoundment.[30] The impact of failure varies on factors such as impoundment size, steepness, land use downstream of the dam, and speed of failure. For larger dams, failure is characterized by a flood wave with high velocities. Smaller dams may only raise water levels slightly and slowly. The result of a dam failure can result in loss of life, property, infrastructure damage, public health impacts, safe drinking water, and environmental degradation within the inundation zone, but may have secondary effects on populations outside of the flooded area.

To better understand the threat locally of dam failure, the planning team worked with our own Dam Safety Officer who manages the King County Emergency Management's Dam Safety program. The program consists of creating response plans for high hazard dams in the community, educating at-risk populations of the threat of dam failure, and connecting poor condition dams to resources that are available for repair or removal of the dam. The King County Emergency Management Dam Safety

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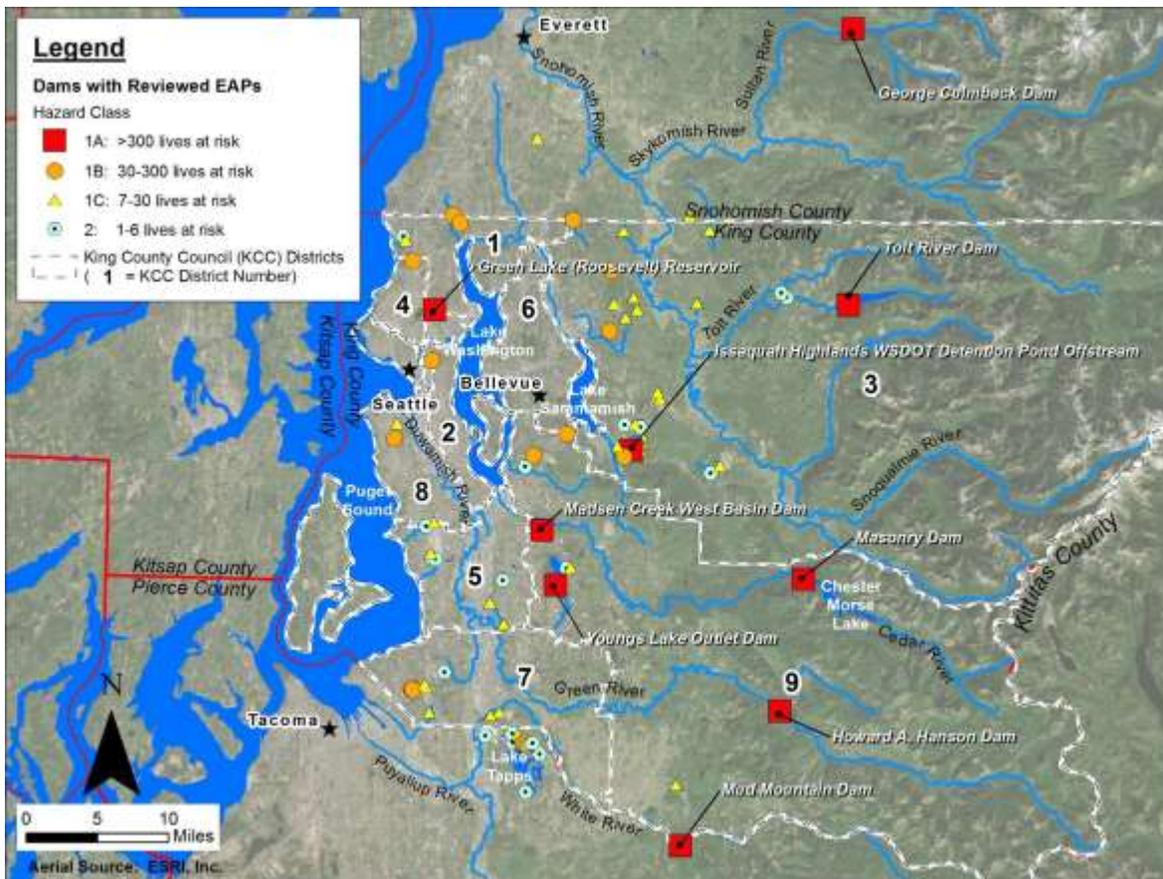
[30] Tetra Tech. 2017. King County Dam Safety Emergency Planning Gap Analysis Report. Page 10.

Officer works closely with Washington State Department of Ecology's Dam and Wells Manager to share information and create a regional effort to heighten dam safety in the County. The information on dams in the hazard profile are from the State Department of Ecology's Inventory of Dams.

The Washington State Department of Ecology Dam Safety Office is the regulating body over non-federal dams that impound at least 10-acre feet of water in the State of Washington. The DSO permits all new dam construction, inspects all high and significant hazard dams every 5 years, and requires that all deficiencies be remedied.

Dams serve the County in a variety of ways, agriculture, hydroelectric power generation, flood control, and recreation. King County has 127 dams located in the County. All but eleven of these dams are embankment-type dams. Contrary to the popular images of dams like Hoover, these dams are smaller and are typically made of a mixture of compacted materials such as soil, clay, and rock. A semi-pervious outer covering with a dense impervious core gives embankment dams their ability to resist seepage and water pressure. The other dams are made of concrete.

While there are 127 dams in King County, there are 21 other dams situated in neighboring counties that impact the County if they were to fail. Out of the 147 total dams, 94 threaten human life. A full list of dams that impact King County can be found at the end of this section.

Hazard Class	Number
1A = High – Greater than 300 lives at risk	10
1B = High – 31 to 300 lives at risk	18
1C = High – 7 to 30 lives at risk	42
2* = Significant – 1 to 6 lives at risk	17
2D = Significant – 1 to 6 lives at risk	7
2E = Significant – Environmental or economic impact	3
3 = Low – No lives at risk	50

* Legacy classification, parsing all 2's into 2D's and 2E's [31]

Dams fail for a variety of reasons, but the four most common are:[32]

- Overtopping, 34% - caused by the reservoir reaching capacity and water spilling over the top of a dam
- Foundation defects, 30% - caused by settlement and slope instability
- Piping and seepage, 20% - when water travels through the dam and causes internal erosion
- Conduits and valves, 10% - Piping of embankment material into the conduit through joints or cracks

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[31] Washington State Department of Ecology - Water Resources Program - Dam Safety Office. 2019. Inventory of Dams Report.
[32] Washington State Department of Ecology – Water Resource Program – Dam Safety Office. Accessed 8/28/2019. https://ecology.wa.gov/Water-Shorelines/Water-supply/Dams/Emergency-planning-response/Incidents-failures.
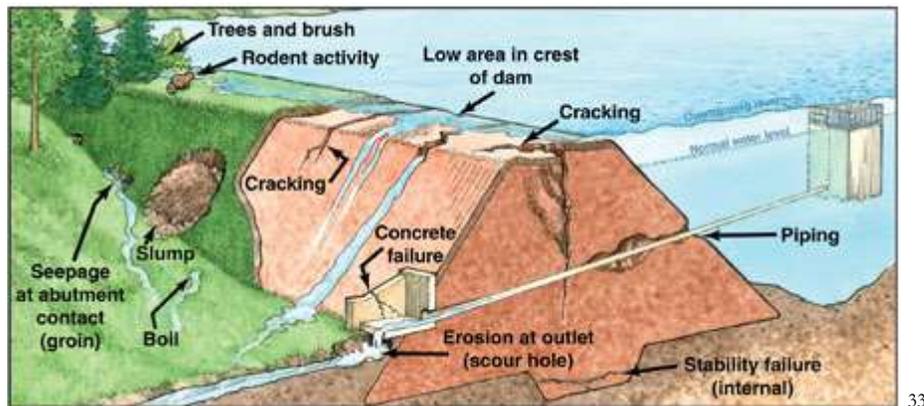
Dam failure events are infrequent and may coincide with other events, such as earthquakes, landslides, excessive rainfall, wildfires, lahars and snowmelt. The average age of dams in King County is 47. As infrastructure ages, increased spending is needed to maintain its integrity.

Following are a selection of events that may cause a dam to fail.

Earthquake[34]	Earthquakes can result in damage or failure of a dam. Earthquake effects on dams mainly depend on dam types. For example, the 2011 Tohoku Earthquake damaged 48 dams, causing one embankment type dam to fail[35]. Safety concerns for embankment dams subjected to earthquakes involve either the loss of stability due to a loss of strength of the embankment and foundation materials or deformations such as slumping, settlement, cracking and planer or rotational slope failures. Dams are engineered to withstand the Maximum Considered Earthquake, but older dams may have been engineered before we fully understood the earthquake risk in the region.
Climate Change[36]	While dam failure probabilities are low. The chance of flooding associated with changes of dam operation in response to weather patterns is higher. Dam designs and operations are developed in part from hydrographs and historical records. If weather patterns experience significant changes over time due to the impacts of climate change, the dam design and operations may no longer be valid for the changed condition. Release rates and impound thresholds may have

[33] Washington State Department of Ecology – Water Resource Program – Dam Safety Office. 2018. Status of High and Significant Hazard Dams. Page 6.
[34] KUOW. Seattle's Faults: Maps that Highlight Our Shaky Ground. Accessed 8/29/19.
http://archive.kuow.org/post/seattles-faults-maps-highlight-our-shaky-ground
[35] International Commission on Large Dams. 2013. The 2011 Tohoku Earthquake and Dams. Page 9.
[36] Climate Impacts Group - University of Washington. 2018. New Projections of Changing Heavy Precipitation in King County. Page 40.

Landslides[37]	to be changed. This would result in increased discharges downstream, thus increasing the probability and severity of flooding. The integrity of a dam or reservoir can be affected by a landslide if they fail or move. Landslides can be triggered by heavy rainfall, snowmelt, reservoir drawdown, or earthquakes. Landslides can occur upstream in the reservoir, in a canyon downstream of a dam, or within the abutment of a dam. A landslide into the reservoir can generate a wave large enough to overtop a dam. Sloshing back and forth in the reservoir can result in multiple waves overtopping the dam. If the waves are large enough, there could be downstream consequences can just from a wave overtopping the dam even if it doesn't fail. If enough large waves overtop an embankment dam or a concrete dam with erodible abutments, a failure could potentially result[38]. Some dams in the County have been built abutting a landslide. Often, these are ancient landslides that have stopped moving or are moving very slowly. However, if a landslide moves far enough, it can crack the core of an embankment dam, resulting in pathways for internal erosion to initiate, or disrupting the abutment support of a dam, resulting in failure.[39]
Wildfires[40]	Many of the County's highest hazard dams lie within wildfire-prone areas. Wildfires can damage dams, such as Eightmile dam near Leavenworth, directly by burning the surface of the dam or spillway and damaging other facilities at the dam. But the main threat from wildfires is how the surrounding watershed behaves. Heavy rains in a burned area can create: • More and faster runoff from rainfall events, especially high-intensity storms. • Large amounts of sediment, which may reduce storage capacity in a reservoir. • Debris flows (mudslides) or downed timber, which may obstruct access to the dam. • Debris flows from hill slopes near spillways, which may obstruct spillways. • More floating debris (dead trees, branches, sticks) in a reservoir, which may obstruct spillways[41]

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[37] Washington State Department of Natural Resources. Geological Portal Information. Accessed 8/28/2019. https://geologyportal.dnr.wa.gov/#natural_hazards

[38] U.S Department of the Interior: Bureau of Reclamation. 2015. Risk Management: H-2 Landslide Risks. Page 1.

[39] Quartz. 2015. The World's Biggest Hydro Power Project May Be Causing Giant Landslides in China. https://qz.com/436880/the-worlds-biggest-hydropower-project-may-be-causing-giant-landslides-in-china/

[40] NW News Network. 2019. Eightmile Dam Near Leavenworth Has New Spillway, Is Being Monitored. https://www.nwnewsnetwork.org/post/eightmile-dam-near-leavenworth-has-new-spillway-being-monitored

[41] Washington State Department of Ecology - Water Resources Program - Dam Safety Office. 2015. Focus on Dams and Wildfires. Page 1.

| Green River 2009 | Green River 2012 | 100-Year Floodplain |
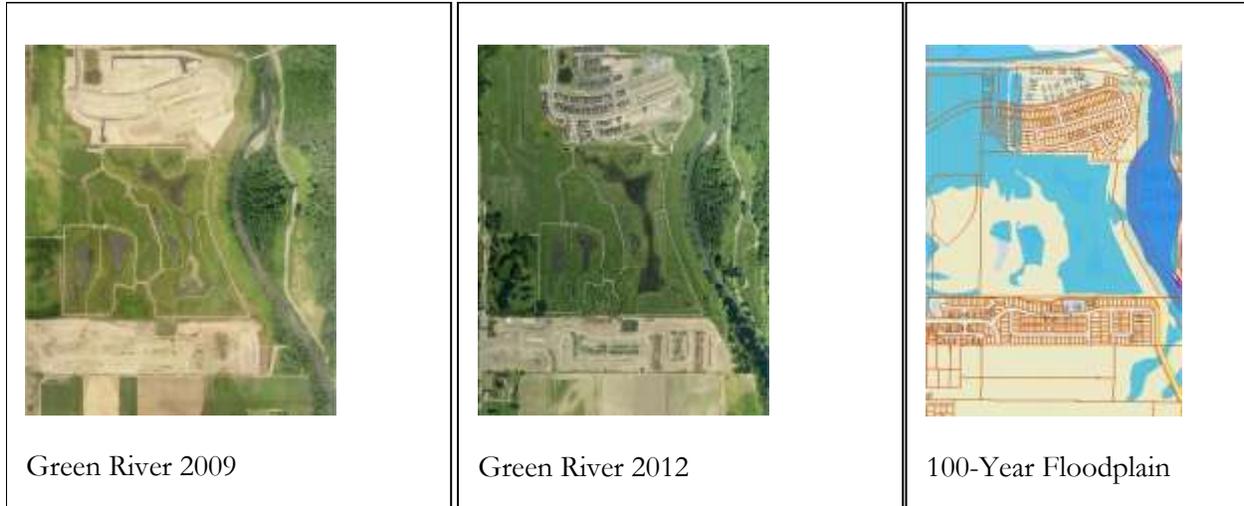
Additionally, new development, outside of the 100 year flood plain, continues in dam inundation zones, meaning the population-at-risk from dam failure will continue to rise. Below shows development outside of the floodplain, but within a dam failure inundation area.

Vulnerability Characteristics and Previous Occurrences

King County has high hazard 1A dams that sit on the Green, White, Cedar, and Tolt Rivers. Additionally, Culmback dam in Snohomish County would flood parts of the Lower Snoqualmie Valley. The Green, White and Lower Snoqualmie Valleys are the areas of greatest concern for dam failure. Smaller privately owned and government dams are also a concern, as they may not have access to funding streams that other larger municipal governments do.

Four dam failure incidents have occurred in King County; they account for all lives lost due to dam failure in Washington State:[42]

- December 1918 - Masonry Dam near North Bend had excessive seepage, which caused a mudflow, destroyed a railroad line and damaged the village of Eastwick; no lives lost.
- February 1932 - Eastwick railroad fill failed. A slide caused railroad fill to back up and fail, destroyed a railroad line and damaged the village of Eastwick; 7 lives were lost.
- July 1976 - Increased discharge from Mud Mountain Dam caused a surge in flow killing two children playing in the White River near Auburn.
- January 1997 - N. Boeing Creek Dam in Shoreline failed due to excessive seepage, poor hydraulics, and no emergency spillway during a large storm event; no lives were lost.

Other notable dam incidents in King County:

- In January 2009 two depressions were discovered in the right abutment of the United States Army Corps of Engineers' Howard Hanson Dam. While repairs were being conducted, there

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[42] Washington State Department of Ecology - Water Resources Program - Dam Safety Office. 2019. Washington State Notable Dam Failures and Incidents.

was a 1 in 3 chance of a 25,000 cfs release down the Green River which would have caused significant flooding. The USACE was able to fully fix the dam by 2011 before a substantial flood ensued. King County and local jurisdictions spent $30 million on flood protection that wasn't reimbursed by FEMA.[43]

- In January 2009, Mud Mountain Dam, owned and operated by the USACE, released a higher than usual flow down the White River during a heavy rain event. As a result, 100 homes were flooded. Since then, King County Flood Control District, Washington State, and Pierce County jointly funded a levee setback to reduce the risk of flooding and increase habitat restoration[44].

Scenario Drivers

Howard A Hanson	Howard Hanson, constructed in 1961, is a federally owned and operated dam by the United States Army Corps of Engineers. Its primary purpose is to provide flood control in the winter and fish enhancement in the summer. It dramatically reduced the amount of flooding that the Green River Valley experienced before its construction. The right abutment of the dam is the toe of a large landslide. Seepage problems can occur for dams built into landslides. As mentioned previously, landslide activity can pose a serious risk to dams. Many mitigation actions have been taken to reduce risk at the dam, such as a gravel blanket and additional vertical and horizontal drains in the drainage tunnel have all drastically improved the safety of the dam. If preventative actions are not taken, internal erosion could fail the dam.
South Fork Tolt Dam	The South Fork Tolt Dam is owned and operated by the City of Seattle. It is a hydroelectric dam that also provides drinking water for 30% of 1.3 million people across the greater Seattle area. South Fork Tolt Dam is a large embankment type dam, equipped with a morning glory spillway. The Tolt dam has known landslide hazards below the dam, and above the reservoir. If a slide were to occur below the dam, the slide may create a dam of its own. Engineers would need to evaluate what action should be taken. The Tolt Dam would have to lower the amount of flow downstream why the risk is being assessed. Additionally, if a slide were to occur in the reservoir, an overtopping wave may be generated that could cause the dam to fail or send a flood wave downstream.
Mud Mountain Dam	Mud Mountain Dam is a United States Army Corps of Engineer owned and operated dam on the White River. Its primary purpose is to provide flood control for nearly

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[43] Seattle Times. 2011. FEMA won't pick up $30 million tab to prepare for flooding.
https://www.seattletimes.com/seattle-news/fema-wont-pick-up-30-million-tab-to-prepare-for-flooding/
[44] King County Department of Natural Resources and Parks – Water and Land Resource Division. 2018. Lower White River Countyline Levee Setback Project. https://www.kingcounty.gov/depts/dnrp/wlr/sections-programs/river-floodplain-section/capital-projects/lower-white-river-countyline-a-street.aspx

400,000 residents in King and Pierce Counties. Typically, there isn't a reservoir being impounded by the dam. During heavy rains or times of snowmelt, engineers will impound the water and slowly release it downstream to avoid flooding residents.

The White River is a glacial river fed by Mt. Rainier. This leaves the possibility that a lahar, triggered by an earthquake, volcanic activity, or heavy rains could cause a debris flow that would block the intake structure on the dam. Such an event would decrease the storage capacity of the reservoir and cause flows to travel over the spillway. The loss in flood control capabilities on the White River would leave the Green, White, and Puyallup River Valleys susceptible to flooding.

Culmback Dam	Situated in Snohomish County, but inundating a portion of the King County's Lower Snoqualmie Valley, the Culmback Dam is owned and operated by Snohomish Public Utility District One. Culmback offers hydroelectric power generation, flood control, drinking water, and recreational benefits to the region. Culmback's morning glory spillway is designed to maintain adequate levels of freeboard in maximum probable flood events. Changes in hydrology affect the amount of water a dam would need to convey downstream to keep it from failing. Culmback Dam's watershed lies within a densely forested area that slows the speed in which water enters the reservoir, prevents sediment from entering the reservoir, and prevents debris flows. A wildfire around the dam would increase the hydrologic strain on the dam. An increased flow could be compensated with larger releases from the dam, but would result in flooding of the Town of Sultan. If not enough water could be discharged, an overtopping scenario at the dam would prove very dangerous.
Lake Tapps	Lake Tapps is a reservoir that sits in Pierce County made up of a system of dikes. If particular dikes were to fail, they would inundate Auburn and portions of the Green and White River Valley. Lake Tapps was built by Puget Sound Energy in 1911 and ran a hydroelectric program until 2004. Lake Tapps was purchased by Cascade Water Alliance in 2009 who currently owns and operates the reservoir. Its primary function is to provide drinking water to a group of contracting King County cities and water districts. In addition to providing drinking water, Lake Tapps is also a residential community, many of whom use the Lake for recreational purposes. While residents are instructed to stay off the dikes, there is no physical security to keep individuals from accessing the structure. Many dikes have publically accessible roads. Acts of terrorism or sabotage could provide a serious threat to the integrity of the levees.

Madsen Creek Flow and Water Control Pond	Madsen Creek Pond is a King County-owned dam. Constructed in 2008, its primary purpose is to provide flood control in extreme rainfall events. There is oftentimes no impoundment behind the dam in summer months when there isn't consistent rainfall. Madsen Creek Pond is designed to store runoff from a 100-year 24-hour storm and still maintain freeboard necessary to prevent flooding downstream. While the dam is comparatively very young as climate patterns become more unpredictable, Madsen Creek Pond and other dams may need to be retrofitted to accommodate the change in probable maximum precipitation. If actions were not taken to adjust to the new hydrology, chances of failure from an overtopping situation or an uncontrolled release would become higher.
Cedar Falls Project Masonry Dam	The Masonry Dam within the Cedar Falls Project is one of the oldest dams in the County. It was built in 1914 and currently is owned and operated by the City of Seattle. The dam serves two purposes, hydroelectric power generation and water supply. The dam is a concrete gravity dam with an emergency spillway, service spillway, power tunnel intake, and a low-level outlet. While there have been fewer failures of concrete dams than earthen dams in general[45], this doesn't mean that failure is unrealistic. The Masonry dam sits near the Rattlesnake Mountain Fault. While concrete dams have escaped failure in earthquake scenarios, minor damage has been observed. The Masonry Dam would need to be assessed for damage after an earthquake for cracking or other deficiencies in the structure or supporting structures. If deficiencies are noted, action must be taken to ensure that the dam doesn't fail. Earthquakes can also trigger landslides around the dam. Finally, large earthquakes can devastate communities, created a resource-scarce environment, potentially making it more difficult to find resources.

Priority Vulnerabilities

Small Local Government and Privately Owned Dams	These dams may not have access to funding, or have employees dedicated to dam safety. This means that there is a higher chance that maintenance and deficiencies go unmediated. Thus, leading to a higher chance of dam failure.
Lack of Public Knowledge	Most dams use a "For Official Use Only" designation on their inundation maps. This means that inundation maps only be shared on a need to know basis. A lack of public knowledge about dams, their presence in the community, and their failure potential creates an added challenge in creating a resilient community.

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[45] Association of State Dam Safety Officials. 1989. Failure of Concrete Dams. Page 4.

Out of Date or Missing Emergency Action Plans	High and significant dams are required to have Emergency Action Plans in Washington State. Missing EAPs and out of date EAPs pose a risk if owners are unequipped to deal with an emergency at their dam.
Poor and Unsatisfactory Dams	Any dam that is designated as "poor" or "unsatisfactory" by the Washington State Dam Safety Office should be brought to a higher standard.

Priority Impact Areas

With all the dams in the county, only a small amount of information can be shared here due to "For Official Use Only Designation". Another reason is that there is a lack of in-depth study done on dam failure impacts to King County. The best and most available estimates for dam failure damages/impacts are from the potential high release scenario at Howard Hanson Dam in 2009. Examples provided here relate to those studies.

King County residents

Dam Name	Estimated Impacted King County Population (Full Pool Failure)	Estimated Impacted King County Population (Sunny Day Failure)*
Mud Mountain	24,480	2,031
Howard Hanson	20,845	6,235
South Fork Tolt	2,291	N/A
Lake Youngs	2,744	2,139
Culmback	145	N/A
Other Dams Combined (Estimate)**	5,295	N/A

[46]

*Sunny day failure assumes a regular pool

**Hazard class median reach of range

Populations are based on census data. Areas such as the Green River Valley experience drastic differences in day time/night time population being an economic hub. The

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[46] Tetra Tech. 2017. King County Dam Safety Emergency Planning Gap Analysis Report. Page 27.

	number of people that would need to be evacuated could drastically differ from the numbers identified in the hazard classification. An estimate in 2009 put a 25,000 cfs release from Howard Hanson triggering an evacuation on the scale of 200,000 to 300,000 people.[47]
Vulnerable populations	Dam inundation areas consist of some of the highest Limited English Proficiency populations in the County. Spanish, Vietnamese, African Languages, and Mandarin are all spoken in high percentages in dam inundation areas. Auburn, Kent, and Riverview School District, as well as private schools, have locations that are vulnerable to dam failure. Riverview school district practices an evacuation of Carnation Elementary School and Tolt Middle School every September in the City of Carnation. Both of these schools would need to be evacuated if the South Fork Tolt Dam failed. Preliminary studies indicate that there are at least 15 assisted living facilities within dam inundation areas.[48] Evacuation will take longer for this population than most. A 2019 report indicates that there 11,199 individuals experiencing homelessness in the County.[49] Alert and warning can be especially challenging for this population as they may not be tied to a geo-coded database.
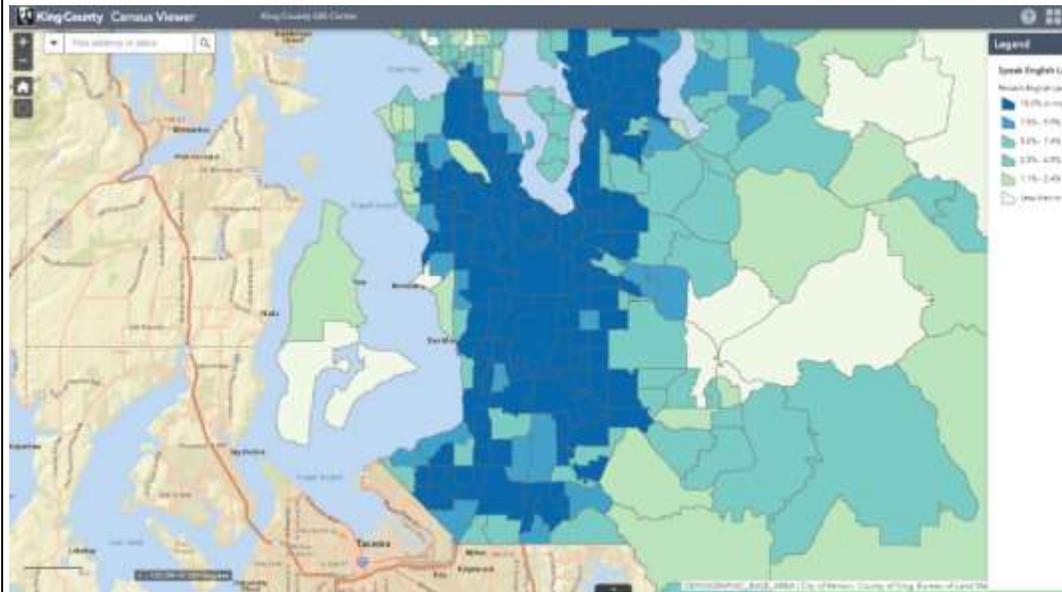
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[47] Seattlepi. 2019. 300,000 might have to evacuate if Green River Floods.
https://www.seattlepi.com/seattlenews/article/300-000-might-have-to-evacuate-if-Green-River-889468.php
[48] FEMA Region X. 2009. HAZUS Analysis for the Green River Valley. Page 168.
[49] All Home. 2019. Seattle/King County Point-In-Time County of Persons Experiencing Homelessness.

Property	Dam Name	Residential Buildings Impacted in King County (Full Pool Failure)	Estimated Impacted in King County (Sunny Day Failure)*
	Mud Mountain	9,992	829
	Howard Hanson	8,508	2,545
	South Fork Tolt	935	N/A
	Lake Youngs	1,120	873
	Culmback	59	N/A
	Other Dams Combined (Estimate)	N/A	N/A

[50]

*Sunny day failure assumes a regular pool

2009 modelling of a high release from Howard Hanson.

Structures impacted	Lower Green	In 17,000 cfs impact area	In 25,000 cfs impact area
Residential	3,486	1,743	1,937
Commercial	16,798	12,245	13,667
Industrial	7,839	6,549	6,644

[51]

The economy | The Green River Valley is an economic powerhouse in the region. Flood damage prevented in the valley by Howard Hanson Dam since the January 2009 flood is

[50] Tetra Tech. 2017. King County Dam Safety Emergency Planning Gap Analysis Report. Page 168.
[51] FEMA Region X. 2009. HAZUS Analysis for the Green River Valley. Page 166.

estimated at $6 billion alone[52]. The economic impact of a failure would devastate the region. With large employers, such as Boeing, and economic centers like the South Center Mall, in the Valley, a dam failure would leave the local economy crippled. Commutes, roadways, and rail lines would all be impacted by a high release from Howard Hanson. Unemployment may follow after areas that experience a dam failure.

2009 Hazus modeling for a high release from the Howard Hanson Dam show impacts:[53]

- At 17,600 cfs flows from a dam failure: - $1.34 billion in economic losses
- At 19,000 cfs flows from dam failure: - $1.97 billion in economic losses
- At 25,000 cfs flows from dam failure: - $3.75 billion in economic losses

An economic analysis is needed to quantify how much impact a complete failure would have on the local economy.

The environment	The primary environmental impact from dam failure is natural and manmade debris from the inundation. Silt, wood, rocks and gravel, hazardous materials, construction debris, vehicles, dead animals may be carried by inundation waters to locations that may be spawning areas for local fish, wetlands for birds and reptiles, or inhabited areas that the County has invested in heavily. While recovery and impact will vary with each inundation area. - At 17,600 cfs – 84,000 tons of debris - At 19,000 cfs – 208,000 tons of debris - At 25,000 cfs – 280,000 tons of debris [54] Isolating the potential environmental impact of dam failure is obscured by the likelihood that another hazard, like an earthquake, may have triggered the dam failure.
Health systems	MultiCare Auburn Medical Center lies within a dam failure inundation area, but further study is needed to fully understand the impacts on health systems from dam failure.
Government operations (continuity of operations)	Auburn, Kent, Tukwila, Carnation, Pacific, and Algona all have city halls within inundation areas. Courts, the County Elections office, King County Regional Justice Center in Kent where Superior Courts, Adult Detention, and other county agencies are located within dam failure inundation areas as well.
Responders	Kent, Pacific, Seattle, Renton Regional Fire Authority, Valley Regional Fire Authority, and Eastside Fire and Rescue all have fires stations within dam inundation areas.

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[52] USACE. Howard A. Hanson Dam. Accessed 8/28/2019. https://www.nws.usace.army.mil/Missions/Civil-Works/Locks-and-Dams/Howard-Hanson-Dam/
[53] FEMA Region X. 2009. HAZUS Analysis for the Green River Valley. Page 166.
[54] FEMA Region X. 2009. HAZUS Analysis for the Green River Valley. Page 169.

	Auburn, Algona, Pacific, Kent, Seattle, State Patrol Crime Lab, and King County Sherriff all have stations in dam failure inundations.
Infrastructure systems	Infrastructure impacts vary dramatically based on the individual dam and type of failure. • Energy- While there are dams that generate power in the County, they provide a relatively small amount of power. The Cedar, Snoqualmie, Twin Falls and, Tolt projects account for only 126 max MW output[55]. Power outages may be long term in areas where there has been a failure. • Water/Wastewater – Drinking water availability would be drastically impacted by a failure of the Masonry, Lake Tapps, Lake Youngs, and Howard Hanson Dams. A failure of one of the many of the reservoirs around the County would also challenge water systems. The King County South Treatment Plant also lies within a dam failure inundation area. • Transportation- Rail lines (commercial and commuter), LINK Light Rail, bus routes, numerous state highways, and numerous bridges can be impacted by dam failure.
Public confidence in jurisdiction governance and capabilities	A dam failure may cause the public to lose confidence in dam owners to manage local dams. Depending on the success of the response, the public may also lose confidence in first responders.

Full List of Dams That Impact King County

Dam Name	NIDID	Max Storage (acre-feet)	Age (Years)	Hazard Classification	Lat,Long	County
ISSAQUAH HIGHLANDS WSDOT DETENTION POND	WA00707	53	11	1A	47.541919,-122.013939	King
MADSEN CREEK WEST BASIN DAM	WA01862	27	11	1A	47.45887,-122.146561	King
GREEN LAKE RESERVOIR	WA00212	25	109	1A	47.681486,-122.314571	King

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[55] Bonneville Power Administration. 2018 Transmission Plan. 2018. Page 77.

HOWARD A HANSON DAM	WA00298	136700	57	1A	47.27797,-121.78603	King
MASONRY DAM	WA00255	175000	105	1A	47.41221,-121.75259	King
YOUNGS LAKE OUTLET DAM	WA00254	18908	98	1A	47.402843,-122.124665	King
MUD MOUNTAIN DAM	WA00300	156000	71	1A	47.139329,-121.931859	King
TOLT RIVER - SOUTH FORK	WA00177	67200	57	1A	47.693158,-121.689555	King
TAPPS LAKE DIKE NO. 1	WA00418	22000	108	1A	47.241348,-122.184894	Pierce
CULMBACK DAM	WA00208	200000	36	1A	47.974825,-121.687897	Snohomish
PANTHER LAKE BALLFIELD DAM	WA01737	102	25	1B	47.293417,-122.337225	King
LAKEMONT STORMWATER POND	WA01651	30	27	1B	47.557275,-122.111876	King
ISSAQUAH HIGHLANDS REID POND DAM	WA00680	69	17	1B	47.537831,-122.027253	King
PANTHER LAKE DETENTION DAM	WA01733	339	25	1B	47.295169,-122.338302	King
PANTHER LK. FIRST AVE. DETENTION POND	WA01747	18	19	1B	47.293334,-122.336049	King
VOLUNTEER PARK RESERVOIR	WA00210	69	118	1B	47.629988,-122.316676	King
HIGH POINT REDEVLOPMENT STORMWATER DAM	WA01869	22	13	1B	47.549375,-122.371263	King
LAKE FOREST PARK RESERVOIR	WA00217	208	57	1B	47.770339,-122.278611	King
HIRAM M. CHITTENDEN LOCKS & DAM	WA00301	458000	103	1B	47.667639,-122.39853	King

BITTER LAKE RESERVOIR	WA00213	31	61	1B	47.7311,-122.348669	King
RADAR LAKE (OBRIAN) DAM	WA00186	68	46	1B	47.730511,-122.024173	King
JOHNSON POND DAM	WA01999	25	7	1B	47.66287,-122.050033	King
CRYSTAL LAKE DAM	WA00195	6	88	1B	47.775751,-122.107419	King
TAPPS LAKE DIKE NO. 6	WA00423	43000	108	1B	47.238839,-122.163482	Pierce
TAPPS LAKE DIKE NO. 5	WA00422	40000	108	1B	47.240926,-122.167596	Pierce
TAPPS LAKE DIKE NO. 4	WA00296	58340	108	1B	47.240789,-122.170259	Pierce
NEWCASTLE VISTA DEVELOPMENT POND 3	WA01908	13	13	1B	47.5347,-122.161437	King
CEDAR WAY STORMWATER DETENTION DAM	WA01404		34	1B	47.778205,-122.289697	Snohomish
REDMOND RIDGE EAST POND SRN 2 NO.1	WA01892	52	11	1C	47.697463,-122.013921	King
ISSAQUAH HIGHLANDS SOUTH POND DAM	WA00688	67	16	1C	47.541353,-122.000025	King
SPRINGWOOD STORMWATER DETENTION DAM	WA01668	50	27	1C	47.361671,-122.170302	King
TALUS P5 STORMWATER DETENTION DAM	WA01844	12	17	1C	47.534487,-122.06288	King
SNOQ. RIDGE DOUGLAS AVE. POND D1 DAM	WA01804	18	21	1C	47.527247,-121.880358	King
SOUTH 336TH STREET STORMWATER DAM NO. 1	WA01754	46	23	1C	47.295591,-122.317872	King
PETERSON STORMWATER DETENTION DAM	WA01337	90	31	1C	47.665661,-122.021473	King

REBA LAKE STORMWATER DETENTION DAM	WA006 18	105	27	1C	47.467583,-122.317944	King
MILL POND STORMWATER DETENTION DAM	WA017 16	16	25	1C	47.268797,-122.219347	King
YELLOW LAKE OUTLET DIKE	WA005 59	220	33	1C	47.568281,-122.009515	King
SOUTH RIDGE STORMWATER DETENTION DAM	WA018 20	25	17	1C	47.545498,-122.035664	King
TROSSACHS DETENTION POND PC-3	WA017 87	18	20	1C	47.601051,-121.975774	King
TROSSACHS DETENTION POND PC-2	WA018 33	55	17	1C	47.594216,-121.972376	King
GARRISON CREEK - 98TH AVENUE DETENTION DAM	WA006 50	8	23	1C	47.394045,-122.209814	King
MILL CREEK CANYON STORMWATER DETENTION DAM	WA014 43	18	37	1C	47.383155,-122.222898	King
UPPER MILL CREEK STORMWATER DETENTION DAM	WA005 82	100	29	1C	47.362116,-122.201882	King
SOUTH 336TH STREET STORMWATER DAM NO. 2	WA017 67	49	23	1C	47.29782,-122.316762	King
WEYERHAUSER-ENUMCLAW FLOOD CONTROL DAM	WA006 36	140	26	1C	47.188673,-121.929254	King
ISSAQUAH HIGHLANDS NPE POND	WA018 67	36	16	1C	47.555811,-121.998433	King
REDMOND RIDGE CEDAR DAM	WA018 02	62	21	1C	47.690857,-122.04408	King
REDMOND RIDGE DRIVE EC 4N ROADWAY DAM	WA018 37	148	16	1C	47.67683,-122.026237	King
PORT OF SEATTLE - LAGOON #3 EXPANSION	WA006 71	256	18	1C	47.432537,-122.31332	King

ISSAQUAH HIGHLANDS NP2 POND DAM	WA018 58	28	17	1C	47.548397,-122.000606	King
ICON MATERIALS AUBURN SEDIMENT POND	WA006 83	200	22	1C	47.271936,-122.206424	King
BOEING CREEK STORMWATER DETENTION DAM	WA004 83	41	36	1C	47.752036,-122.360075	King
SNOQUALMIE MILL POND DAM	WA003 07	396	102	1C	47.529342,-121.819312	King
WELCOME LAKE DAM	WA001 94	260	60	1C	47.724532,-122.048251	King
TUCK LAKE DAM	WA001 80	290	53	1C	47.764918,-122.03081	King
YOUNGS LAKE NEW INLET DAM	WA004 15	16836	93	1C	47.420921,-122.102904	King
MARCEL LAKE DAM	WA002 00	350	55	1C	47.692486,-121.918558	King
LOREENE LAKE DAM	WA001 93	86	56	1C	47.31269,-122.385452	King
MARGARET LAKE DAM	WA002 36	1200	86	1C	47.766978,-121.901433	King
DES MOINES CREEK REGULATORY DETENTION FACILITY WEST BERM	WA006 92	160	11	1C	47.428554,-122.312781	King
DES MOINES CREEK REGULATORY DETENTION FACILITY EAST BERM	WA006 93	53	11	1C	47.427034,-122.311192	King
ICON MATERIALS SEDIMENT POND 6	WA007 41	1200	4	1C	47.268341,-122.193221	King
SOUTHWEST GENESEE STREET DETENTION DAM	WA003 80	52	45	1C	47.564882,-122.36751	King
TAPPS LAKE DIKE NO. 11	WA004 27	38000	108	1C	47.238152,-122.147596	Pierce

TAPPS LAKE DIKE NO. 3	WA00421	28000	108	1C	47.249352,-122.177817	Pierce
KAYAK LAKE DAM	WA00199	230	54	1C	47.782211,-121.931649	Snohomish
REDMOND RIDGE EAST POND SRS 1 No. 1	WA01922	39	6	1C	47.685272,-122.008553	King
SEATAC AIRPORT POND M	WA02038	27	8	1C	47.464811,-122.309788	King
SILVER FIRS DETENTION POND NO. 3	WA01792	36	21	1C	47.858218,-122.163964	Snohomish
DES MOINES CREEK STORMWATER DETENTION	WA01649	23	31	2	47.426777,-122.305916	King
204TH STREET STORMWATER DETENTION BASIN	WA01819	17	18	2	47.419722,-122.30375	King
NEWCASTLE RAILROAD EMBANKMENT DAM	WA00648	200	119	2	47.522983,-122.173869	King
QUADRANT EAST CAMPUS PARCEL 1 DAM	WA01815	13	19	2	47.311672,-122.289382	King
SNOQUALMIE FALLS DIVERSION DAM	WA00295	818	121	2	47.54149,-121.837891	King
TOLT RIVER REGULATED BASIN WEST DAM	WA00237	35	57	2	47.70383,-121.791131	King
YOUNGS LAKE CASCADES DAM	WA00209	12320	69	2	47.419569,-122.10876	King
LAKE KITTYPRINCE DAM	WA00201	96	52	2	47.519114,-121.894508	King
TOLT RIVER REGULATING BASIN SOUTH DAM	WA00238	1100	57	2	47.699823,-121.782893	King
TAPPS LAKE DIKE NO. 8	WA00424	34000	108	2	47.239469,-122.160082	Pierce
TAPPS LAKE DIKE NO. 9	WA00425	26000	108	2	47.239893,-122.157987	Pierce

TAPPS LAKE DIKE NO. 2B	WA004 20	28000	108	2	47.250305,-122.186157	Pierce
TAPPS LAKE DIKE NO.10	WA004 26	32000	108	2	47.240913,-122.155031	Pierce
TAPPS LAKE DIKE NO. 2A	WA004 19	20000	108	2	47.249683,-122.187505	Pierce
TAPPS LAKE DIKE NO.13	WA004 29	10000	108	2	47.190787,-122.164775	Pierce
TAPPS LAKE DIKE NO. 12	WA004 28	25000	108	2	47.229823,-122.14456	Pierce
LAKELAND SOUTH POND NO.1	WA018 45	12	16	2	47.247554,-122.226014	Pierce
BOEING CREEK M1 DETENTION DAM	WA017 82	14	21	2D	47.755515,-122.363653	King
MUTH STORMWATER POND	WA018 83	37	12	2D	47.411031,-122.277469	King
KLAHANIE STORMWATER DETENTION DAM NO. 2	WA014 85	14	35	2D	47.564342,-122.019611	King
KLAHANIE STORMWATER DETENTION DAM NO. 13	WA006 02	56	29	2D	47.565061,-122.001408	King
KLAHANIE STORMWATER DETENTION DAM NO. 1	WA014 84	28	35	2D	47.567181,-122.024633	King
GARRISON CREEK STORMWATER DETENTION DAM	WA005 77	45	28	2D	47.406392,-122.203895	King
CONNER JARVIS EAST POND	WA020 62	14	1	2D	47.573849,-122.024296	King
SEATAC AIRPORT POND G	WA019 72	27	10	2E	47.459923,-122.321072	King
SEATAC AIRPORT SE POND	WA019 01	14	12	2E	47.433611,-122.300306	King
CEDAR HILLS LANDFILL CSW POND	WA020 61	53	3	2E	47.457243,-122.05295	King

ECHO LAKE DAM	WA01264	900	84	3	47.50649,-121.871224	King
FOSTER WATERSKI POND	WA00599	80	29	3	47.635375,-121.929033	King
FRATT DAM	WA01700	30	63	3	47.688042,-122.061542	King
BEAR CREEK FAIRWAY ESTAE DETENTION POND 1	WA01435	43	18	3	47.724374,-122.07023	King
BELLEVUE DETENTION POND (133)	WA00477	90	36	3	47.61931,-122.14265	King
BELLEVUE DETENTION POND (149)	WA00476	92	36	3	47.581056,-122.167666	King
BELLEVUE DETENTION POND (104)	WA01440	25	36	3	47.581056,-122.167666	King
I-405 COAL CREEK STORMWATER DETENTION DAM	WA01647	40	32	3	47.566555,-122.180361	King
LINDSLEY DAM	WA01749	13	69	3	47.58387,-121.980395	King
STAR LAKE CONTROL WORKS	WA01176	70	69	3	47.352621,-122.286532	King
LANDSBURG DIVERSION DAM	WA01543	15	84	3	47.375929,-121.961535	King
TAYLOR DAM	WA01474	10	69	3	47.45545,-122.025472	King
HIGH WOODLANDS STORMWATER DETENTION DAM	WA00613	29	28	3	47.730592,-122.194303	King
PRESTON MILL POND	WA01297	10	72	3	47.521821,-121.92759	King
QUADRANT LAKE NO. 1	WA01740	113	25	3	47.298433,-122.315121	King

SAWYER LAKE OUTLET STRUCTURE	WA011 77	1116	67	3	47.335379,-122.045013	King
REDMOND RESERVOIR DAM	WA006 18	33	92	3	47.713047,-122.056138	King
SOUTH 120TH STREET RESERVOIR	WA013 45	15	43	3	47.494916,-122.315985	King
SNOQUALMIE RIDGE GOLF COURSE POND M1	WA006 56	70	22	3	47.538501,-121.863171	King
TROSSACHS STORMWATER DETENTION POND	WA017 53	14	24	3	47.584739,-121.971619	King
BOEING AUBURN DRAINAGE DITCH DETENTION DAM	WA016 75	7	25	3	47.291489,-122.251231	King
QUEENS BOG DAM	WA016 33	132	32	3	47.579896,-122.017182	King
WETZEL FAMILY LLC	WA020 15	19	39	3	47.213244,-122.041401	King
VERDANA POND C	WA019 07	11	12	3	47.335,-122.180556	King
BELLEVUE DETENTION POND (179 NORTH)	WA013 98	26	42	3	47.62593,-122.146391	King
WILDWOOD POND	WA011 64	29	67	3	47.400369,-122.492826	King
REDMOND RIDGE DETENTION POND BC-2, NO.2	WA018 43	12	17	3	47.6959,-122.031538	King
REDMOND RIDGE DENTION POND ECC-1B-1	WA018 26	13	15	3	47.682759,-122.028926	King
REDMOND RIDGE DETENTION POND ECW 1B1	WA018 32	18	17	3	47.682345,-122.041503	King
TUKWILA SOUTH PROJECT SOUTH POND	WA007 27	164	8	3	47.420628,-122.269055	King

ALDARRA POND DF-R1	WA018 18	53	18	3	47.587773,-121.954399	King
CEDAR HILLS REGIONAL LANDFILL STORMWATER POND	WA020 60	40	3	3	47.456374,-122.052682	King
CARNATION WASTE POND NO. 2	WA013 41	25	38	3	47.667648,-121.948802	King
WEST CAMPUS DAM NO. 6	WA014 18	18	45	3	47.290947,-122.325197	King
WEEKS FALLS HYDRO PROJECT	WA015 84	10	33	3	47.432483,-121.645884	King
BELLEVUE DETENTION POND (197)	WA004 78	11	36	3	47.63173,-122.152261	King
MORSE LAKE DAM	WA002 56	75000	115	3	47.409604,-121.725455	King
GREEN RIVER DIVERSION DAM	WA015 83	10	69	3	47.300919,-121.840592	King
BELLEVUE DETENTION POND (165)	WA004 79	12	36	3	47.624358,-122.171261	King
MARTINDALE LAKE DAM	WA010 89	10	59	3	47.378439,-122.311706	King
RAVENSDALE PIT	WA003 39	165	47	3	47.347285,-121.996183	King
JEAN LAKE DAM	WA001 92	12	56	3	47.311983,-122.380264	King
BLACK DIAMOND AERATED LAGOON	WA015 61	15	38	3	47.303243,-122.010413	King
LOUTSIS DAM	WA001 87	97	49	3	47.721992,-121.979478	King
WEYERHAEUSER DAM	WA001 91	80	49	3	47.297176,-122.29882	King
KEEVIES LAKE DAM	WA004 98	500	59	3	47.314814,-122.050117	King

DEJONG DAIRY WASTE POND NO 1	WA018 66	16	20	3	47.211114,-122.096129	King
NORTH CLEAR ZONE DETENTION DAM	WA013 21	33	46	3	47.468754,-122.314808	King
TAPPS LAKE DIKE NO. 14	WA004 30	400	108	3	47.196489,-122.132892	Pierce
TAPPS LAKE DIKE NO. 15	WA004 31	400	108	3	47.194076,-122.13531	Pierce

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[56] Washington State Department of Ecology Dam Safety Office. 2019. Inventory of Dams Report.

Regional Risk Profile: Earthquake

Hazard Description

Puget Sound has a high risk of experiencing damaging earthquakes. The most common damaging quake is deep M6+ event, six of which occurred over the past ~100 years. In comparison, the Seattle Fault has been active three-four times in the past 3000 years and a subduction zone quake occurs approximately every 200-600 years, with a 10-20% chance it will rupture in the next 50 years, according to the Pacific Northwest Seismic Network (PNSN). With many potentially active faults in the area, Earthquake impacts can occur anywhere in King County, with earthquake risk focused near faults and in areas with less stable soils. Washington has the second-highest earthquake risk in the United States, after California. According to the USGS, there is a 5% chance of a Seattle Fault and a 10-15% chance of a Cascadia Subduction Zone earthquake striking the region by 2055. This equates to an up to 20% chance of a major earthquake striking King County with potentially catastrophic damages in the next 35 years.[57]

Earthquakes can last from a few seconds to over five minutes. Earthquakes may also be accompanied by a series of foreshocks, or aftershocks in the weeks to months leading up to and following the earthquake, which can cause additional damage and injury. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris as the shaking damages or demolishes buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines, and transportation routes should be expected. Earthquakes may cause, or lead to fires, dam failures, landslides, tsunamis, or releases of hazardous materials, compounding their disastrous effects. An earthquake on the Cascadia Subduction represents the largest potential risk to the entire Pacific Northwest. However, local sources such as faults immediately beneath King County may have a much more intense shaking over a shorter period of time leading to focused damage on the area. The earthquake hazard presents the greatest regional potential for damages, casualties, economic, and social impacts.

Vulnerability Characteristics and Previous Occurrences

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking and secondary impacts. Ground shaking, or earthquake intensity, measured by the modified Mercalli scale, depends on distance from the source of the quake, and the soil type. A shallow earthquake that is relatively small, but nearer to populated areas with a hypocenter closer to the surface, is potentially more damaging than a much larger earthquake that is farther away. Even when an earthquake is distant, unconsolidated soils, such as sands, clays, or gravels, found in many floodplains or river valleys, amplify shaking, leading to more potential damage.

Secondary impacts of earthquake shaking include things like soil liquefaction and landslides. Liquefaction is a secondary effect of an earthquake in which soils lose their shear strength and flow or

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[57] LaForge, Gordon. 2019. Critical but Not Urgent: Seattle Prepares for the Big One. Innovations for Successful Societies, Princeton University.

behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft sedimentary soils. Landslides, or ground failures, are also a common hazard that can occur with ground shaking, ranging from singular rocks falling down a hill, to mass movements of land large enough to dam rivers. Landslides falling into bodies of water, can potentially generate tsunamis, as occurred in the Tacoma Narrows during the 1949 Puget Sound Earthquake.

Earthquakes on the Cascadia Subduction Zone, and on the Seattle Fault are also capable of producing Tsunamis. Tsunamis are a destructive movement of the ocean involving at least one 'wave', and strong currents. Even a relatively 'small' tsunami could be devastating to port and maritime infrastructure within Puget Sound.[58] There is evidence that an earthquake on the Seattle Fault that occurred around 900 AD produced a 16-foot tsunami. The National Oceanic and Atmospheric Administration (NOAA) recreated this tsunami using a model.

Soil type impacts ground Shaking. The National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to amplification and liquefaction during earthquakes. . Areas with NEHRP soils classes D, E and F are prone to shaking amplification, and structures in these areas experience greater damage during earthquake shaking. These also tend to be more susceptible to liquefaction.

NEHRP Soil Classification System

NEHRP SOIL TYPE	DESCRIPTION	MEAN SHEAR VELOCITY IN METERS PER SECOND
A	Hard Rock	1500
B	Firm to Hard Rock	760-1500
C	Dense Soil / Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clay	<180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays > 36 meters thick)	

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[58] Seattle Office of Emergency Management. Tsunamis and Seiches. Accessed online on 11/12/19 from https://www.seattle.gov/emergency-management/hazards/tsunamis-and-seiches.

Hazard Mitigation Plan
Liquefaction Potential

Very Low | Low to Very Low | Low | Moderate to Low | Moderate | High to Moderate | High | Very High
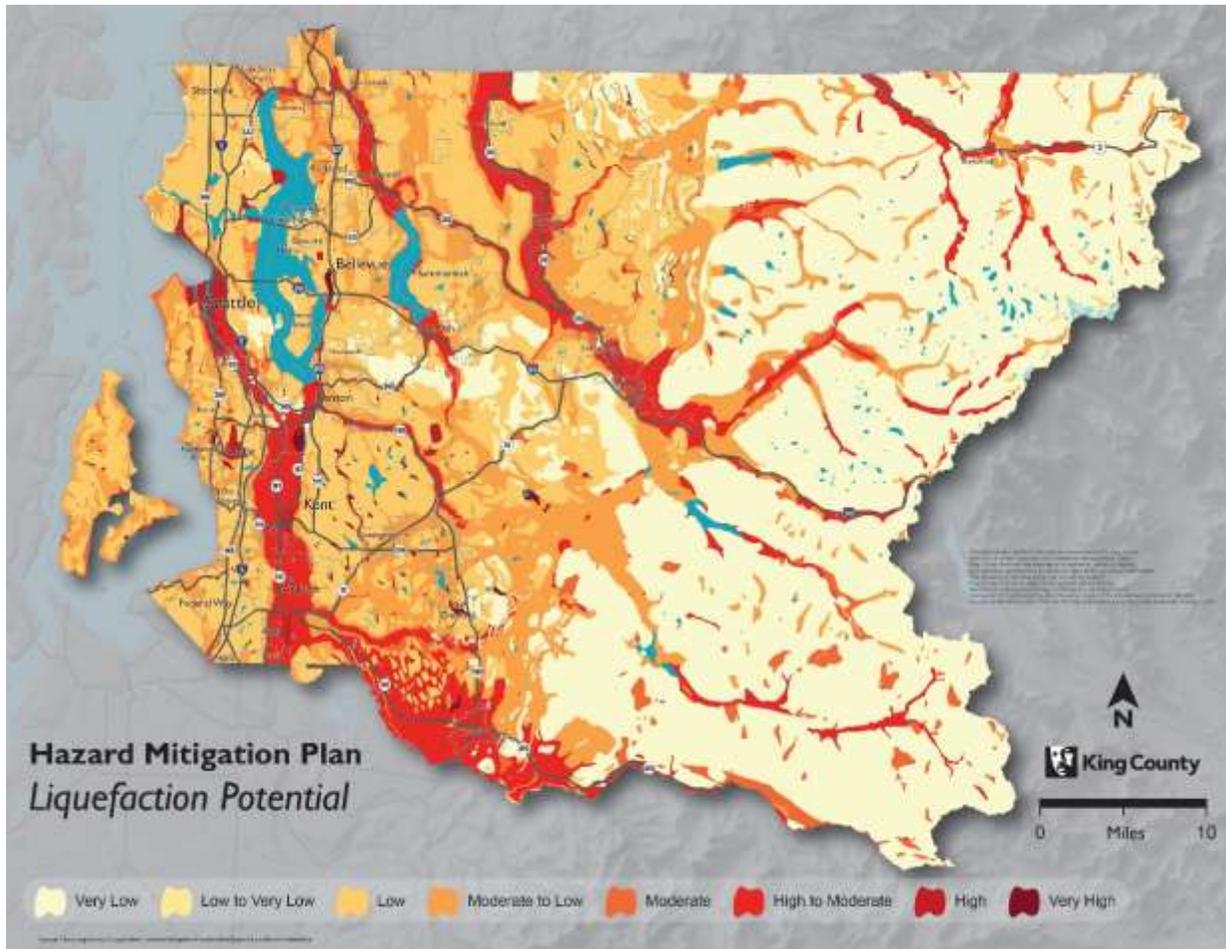
King County has a long history of documented earthquake activity. The most recent significant activity was the Nisqually Earthquake – February 28, 2001. This earthquake, with an epicenter 10 miles northeast of Olympia in Thurston County (over 40 miles from Seattle), resulted in statewide losses exceeding $2 billion and injured 700 people, many in King County.[59] A slide in King County generated from the 2001 Nisqually Earthquake partially blocked the Cedar River – flooding several homes.

The 6.8 magnitude Nisqually earthquake was centered under Anderson Island in south Puget Sound. The most extensive damage occurred along the Interstate-5 corridor, where river sediments led to shaking amplification and liquefaction impacts. Some damage was experienced in 300,000 households, many from settling foundations. Buildings built prior to 1950 located in the south downtown area and Pioneer Square in Seattle were the most impacted; structural damage to chimneys, walls, foundations and nonstructural elements accounted for two-thirds of all damage reported.[60] Insured losses were

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[59] EQE International – Seattle Nisqually Washington Earthquake Feb 28, 2001;
http://www.propertyrisk.com/refcentr/seattleeq.pdf
[60] Hazard Mitigation Survey Team Report, Nisqually Earthquake, February 28, 2001, DR-1361-WA, Federal Emergency Management Agency and Washington Military Department, Emergency Management Division.

recorded as $305M with $2B in losses overall. Of those impacted, 21% had earthquake insurance but did not meet the deductible. 75% of retail businesses in Seattle that were impacted closed for some period for cleanup or repairs. The average closure was 4.8 days in Pioneer Square. Of those businesses impacted, 50% were financially threatened with closure. Harbor Island saw 69 businesses impacted for an average of $30,900.

The Nisqually Earthquake led to a new emphasis in Washington, and King County especially, on the importance of retrofitting historic, unreinforced masonry buildings that were the most serious casualties of the event. The loss of historic buildings is not only costly in financial terms but can alter the social fabric of a community and fundamentally change its feel and sense of place.

Seattle-Tacoma Earthquake – April 1965[61] At magnitude 6.5, the earthquake killed seven people and caused $12.5 Million in damage (1965 dollars). Severe shaking was felt in Seattle and as far as Issaquah and beyond. Most damage was in the Pioneer Square area and waterfront. Older masonry buildings were most impacted. Damage patterns experienced in 1949 were repeated. Eight schools were closed for inspections and repairs; two were severely damaged. Areas along the Duwamish River experienced severe settling. Three water mains failed in Seattle.

Olympia Earthquake – April 1949[62] The 7.1 magnitude earthquake was centered along the southern edge of Puget Sound. Eight people were killed and property damage in Olympia-Tacoma-Seattle amounted to about $25 Million in 1949 dollars. In Seattle, a sixty-inch water main ruptured, a radio tower collapsed, power lines and gas lines were broken in over 100 places. Three damaged schools needed to be demolished and one rebuilt.

Scenario Drivers[63]

The Juan de Fuca plate is moving northeastward with respect to the North American plate at a rate of 3 to 4 centimeters per year. [64] The boundary where these two plates converge, the Cascadia Subduction Zone, lies approximately 50 miles offshore and extends nearly 700 miles from Northern Vancouver Island in British Columbia to northern California. The collision of these two tectonic plates produces three types of earthquakes: Subduction Zone Earthquakes, Deep/Benioff Zone Earthquakes, and Shallow Crustal Earthquakes. [65]

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[61] Seattle Earthquake History; http://seattle.about.com/od/localgovernment/a/Seattle-Earthquakes.htm
[62] Earthquake History of Washington. 5 Aug. 2003. U.S. Department of the Interior, U.S. Geological
King County Hazard Identification and Risk Assessment – November 2016 Page 86.
Survey. 5 Oct. 2003 http://earthquake.usgs.gov/earthquakes/states/washington/history.php
[63] Earthquake Hazards in Washington and Oregon – Three Source Zones. U.S. Department of the Interior, U.S.
Geological Survey. 2 Oct. 2003 http://www.ess.washington.edu/SEIS/PNSN/CascadiaEQs.pdf
[64] Understanding plate motions, USGS; http://pubs.usgs.gov/gip/dynamic/understanding.html.
[65] Earthquake Hazards in Washington and Oregon – Three Source Zones. U.S. Department of the Interior, U.S.
Geological Survey. 2 Oct. 2003 http://www.ess.washington.edu/SEIS/PNSN/CascadiaEQs.pdf.
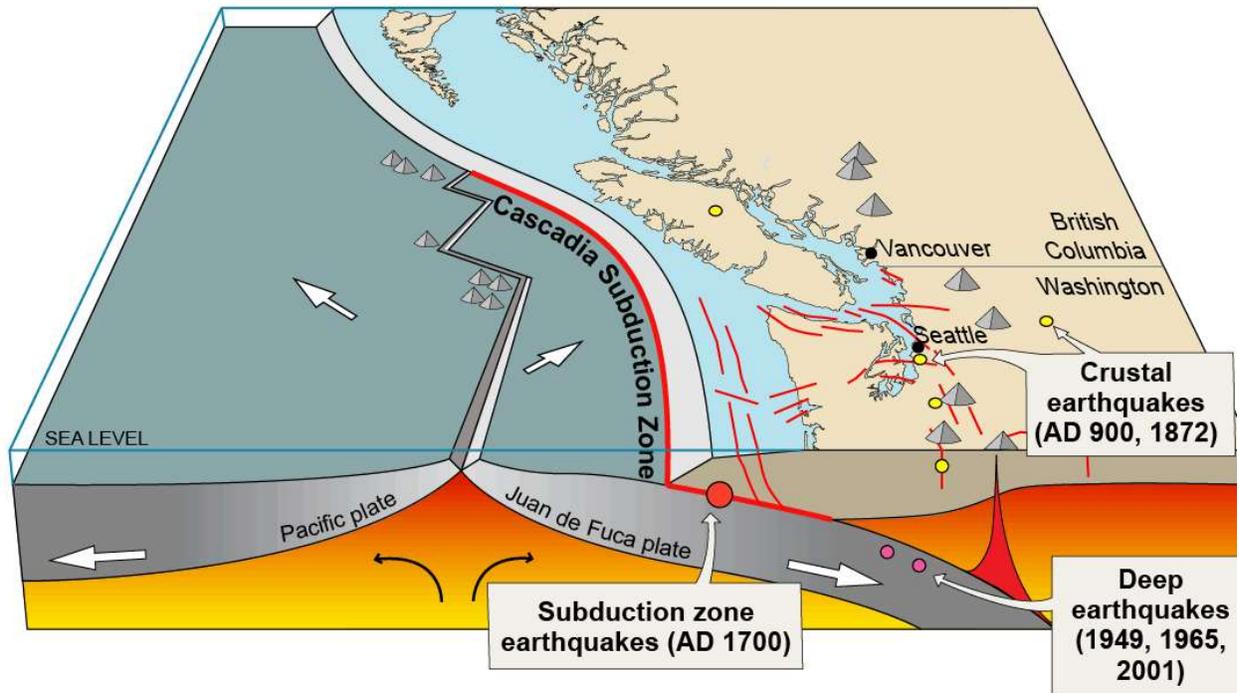
Source	Max. Size	Recurrence
🔴 Subduction zone	M 9+	200–600 years
🔴 Deep Juan de Fuca plate	M 7+	30–50 years
🟡 Crustal faults	M 7+	Hundreds of years?

🔺 Volcano

⌒ Active crustal fault

⌒ Active plate boundary

*figure modified from USGS Cascadia earthquake graphics at http://geomaps.wr.usgs.gov/pacnw/pacnweq/index.html

Cascadia Subduction Zone Earthquakes	A subduction zone earthquake would originate from the Cascadia Subduction zone off the coast of Washington and Oregon. Such earthquakes typically have minutes of strong ground shaking and are quickly followed by damaging tsunamis and numerous large aftershocks. The potential exists for large earthquakes along the Cascadia Subduction Zone, up to an earthquake measuring Magnitude 9 or greater on the Richter scale. This would produce a tsunami all along the fault line from British Columbia to Mendocino, California. Such an earthquake would last several minutes and produce catastrophic damage locally from the earthquake and distantly from the generated tsunami.

Benioff Zone (Deep) Earthquakes (e.g. Nisqually Earthquake)	Deep, or Benioff Zone earthquakes are the most frequent damaging earthquakes occurring within the Puget Sound area. They occur within the Juan De Fuca plate as it sinks into the mantle. These earthquakes occur, 16 to 60 miles in depth. Due to their depth, aftershocks are typically not felt in association with these earthquakes. These earthquakes are caused by mineral changes as the plate moves deeper into the mantle. Minerals that make up the plates are altered to denser, more stable forms as temperature and pressure increase. This compression results in a decrease in the size of the plate, and stresses build up that pull the plate apart. Deep earthquakes generally last 20 to 30 seconds and have the potential of reaching 7.5 on the Richter scale. The last major one in the Puget Sound region was the 6.8 magnitude Nisqually Earthquake on February 28, 2001.
Shallow (Crustal) Earthquakes (e.g. Seattle Fault Earthquake)	Shallow crustal earthquakes occur within the North America plate at depths of 18 miles or fewer. Shallow earthquakes within the North America plate account for most of the earthquakes in the Puget Sound region, though most are small and not felt. The potential exists for major shallow earthquakes as well. Generally, these earthquakes are expected to have magnitudes less than 8 and last from 20 to 60 seconds. Of the three types of earthquake, the timelines and recurrence intervals of crustal events are the least understood. Ongoing research suggests that Magnitude 7 or greater events have occurred on at least eight faults in the Puget Sound basin. FEMA estimates using HAZUS show that events on these faults have the potential to cause greater loss of life and property in King County than any other disaster likely to affect the area. Evidence of a fault running east-west through south Seattle (the Seattle Fault) suggests that a major earthquake with a magnitude of 7 or greater affected the Seattle area about 1,100 years ago.

Priority Vulnerabilities

Unreinforced buildings, especially those built during pre or low-code eras (pre 1973)	Brick and masonry buildings that characterize areas like Pioneer Square in Seattle are extremely susceptible to even minor earthquakes. Unreinforced masonry buildings are likely to collapse or partially collapse and be a leading source of fatalities due to falling debris.
Structures, including roads and bridges, structures, built on vulnerable soils.	Structures on vulnerable or less stable soils are more likely to buckle or collapse. High risk areas cover the region, but are especially common in historic river valleys where sediment has been deposited over time.
Public facilities built to "life safety" codes that	Public facilities, such as city halls, schools, etc. are not required to be built to "immediate occupancy" standards. A major earthquake would render many of these facilities inoperable, leading to difficulties in organizing the recovery in affected jurisdictions.

will be unusable after a major earthquake	
Structures and populations on or near steep slopes	Steep slopes greater than 40% grade are likely to fail in an earthquake. This likelihood increases when the ground is saturated. Buildings on or below these slopes will be damaged or destroyed in these events.
Dams, especially older, less regulated dams	Dams are responsible for most of the region's electricity and are extremely important to any future recovery. A major event may damage these dams and require repair before they can resume electricity generation. Total failure of the major dams is unlikely. In addition to the large dams, however, there are many lower-priority dams that nevertheless meet the standards of high-hazard. These dams are scattered throughout King County and may not even be recognized by the jurisdictions in which they are located. A failure of some of these dams would likely result in numerous fatalities and the inundation of property and infrastructure.
Hazardous materials sites, especially those in aging warehouses or with weakened containment systems	Hazardous materials, or Hazmat, sites dot the region and FEMA has recognized hazardous materials as a community lifeline due to experiences dealing with recovery after recent disasters. Hazmat releases are likely to occur at industrial facilities, on pipelines, and elsewhere around the region. The cocktail of potential contaminants is likely to threaten the public, responders, and the environment, and to delay recovery in parts of the region for years.
Port facilities built on unstable soils	Ports, are almost always built on fill and other extremely unstable soils. Major earthquakes will damage and potentially destroy port facilities. Any seiche or tsunami will also have a greater impact on port facilities than inland facilities.
Rail systems	Rail systems require tracks to be perfectly aligned and will fail during an earthquake as the ground shifts and buckles. Landslides may also deposit material on the tracks. Trains traveling at high speeds during an earthquake have a significantly greater chance of de-railing, potentially injuring passengers, or spilling cargo, which may cause additional hazardous material incidents.
Water and sewer transmission lines, especially those built of cast iron, concrete, or wood	Water lines throughout the region are currently being replaced by ductile iron. Nevertheless, most special purpose districts undertaking this work are decades from completing it. Water systems will likely fail throughout the region and will be difficult to restore due to limitations in transportation

	capacity. Even systems able to complete conversion to ductile iron will experience failures, especially in areas of unstable soils.
Populations without the means to care for themselves over multiple weeks, especially those with Access and Functional Needs	The response and initial recovery following a catastrophic earthquake will take weeks. Homebound populations, those requiring medications, the chronically ill, or others with access and functional needs may need to sustain themselves for an estimated two weeks in some places.
Populations without insurance, especially those without renters insurance or homeowner insurance earthquake riders.	According to the Office of the Insurance Commissioner, which conducted a major earthquake insurance study in 2017, residential earthquake coverage in western Washington is 13.8%. Commercial coverage rates are much higher than residential, with 43.2% of insurance policies having some sort of earthquake coverage. A key finding is that, for both residential and commercial customers, insured properties have a much higher assessed value than uninsured properties, indicating that it is higher-income people that are, in general, purchasing earthquake insurance coverage.

Earthquake insurance coverage rates are a good measure of resilience because insurance is the primary source of disaster recovery funding after an earthquake. Low levels of insurance coverage have stymied recovery efforts in major disasters, such as hurricanes, where hazard coverage is not automatically included in homeowner's policies. |
| Populations communicating in languages other than English | Information from responders, notifications, and other information will likely be communicated predominately in English. Special care will need to be taken to ensure that non-English speakers have access to relief supplies from established points of distribution. |
| Levees, dikes, and other flood control structures | Flood control structures are usually earthen and built on highly unstable soils. An earthquake during the winter months when these systems are running close to capacity could cause major failures and widespread flooding. |

Priority Impact Areas

The severity of an earthquake is different depending on the conditions under which it occurs. Also, different sectors of the population, economy, or government will have different levels of exposure and vulnerability that impact their susceptibility to an earthquake. This risk assessment looks at impacts of various earthquake scenarios to a series of critical sectors. The impact data for physical structures is generated using the Hazus-MH tool for three different Seattle Fault M7.0 scenarios, a Tacoma Fault M 7.1 scenario, and a Cascadia M9.0 scenario. These scenarios are chosen based on their probability and

potential impact. This earthquake model also includes information on liquefaction potential of soils and the age of buildings (as an instrument for building code levels).

This assessment considers impacts to physical and human elements of each of 11 impact areas. For example, for health systems, the locations of key facilities identified by Public Health Seattle – King County will be assessed against data on high hazard areas. The impacts to first the health system overall, including employees and existing patients, will also be examined.

The HAZUS scenarios used in this section were generated by the FEMA RiskMAP team for the 2018 King County Risk Report.[66]

King County residents	The entire population of King County is potentially exposed to the direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of residence, the soil type homes are constructed on, the proximity to the fault, etc. Business interruption could keep people from working, road closures could isolate populations, and loss of utilities could impact populations where no direct damage was experienced. Hazus estimates there are over 600,000 people living in 250,000 households on NEHRP Class D or E soils locally. This represents about 30% of the county population. The population over 65 and the population are the most vulnerable because of their concentration in areas with Class D and E soils. Impacts to the population are not restricted to displacement and sheltering. People may be injured, lose their jobs, schools may be closed from their own damages, government services may be interrupted, health facilities and care may also be interrupted or be completely unavailable. Family members may be separated, including children, institutionalized elderly and the infirm, may be moved to alternate facilities – and unaccounted for. Deaths of homeless and unidentified people may require burial before family can claim their remains. Following the 1995 Kobe, Japan earthquake, the total city population took over 10 years to recover. The population count of New Orleans following Hurricane Katrina still has not recovered to pre-storm levels. King County's population is extremely mobile and many are relatively recent arrivals, drawn by the booming economy. A large earthquake may reverse this growth trend as people lose jobs, face housing recovery costs without insurance, and seek less hazard-prone areas after the trauma of a large earthquake.

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[66] Federal Emergency Management Agency, 2018. King County Risk Report.
https://fortress.wa.gov/ecy/gispublic/AppResources/SEA/RiskMAP/King/KingCounty_RiskReport.pdf

Vulnerable populations	Vulnerable populations are more likely to suffer losses during an earthquake and are likely to take longer to recover after. Factors influencing likelihood of damage include living in higher hazard areas, living in older buildings, being less likely to have emergency supplies, and having a higher rate of persons with disabilities. Slower recovery is exacerbated by poorer populations likelihood of not having access to institutions leading recovery, not having insurance, not having a stable job, wealth, or savings, being more likely to be renters who are ineligible for many federal recovery programs, and having a lower-level of education on average, making it more difficult to find a new job and to navigate the complex post-disaster system. In many catastrophic disasters, most notably Hurricane Katrina, poor communities may never recover.
Property	Lack of damage to structures built since the 1949 and 1965 earthquakes have demonstrated the value of building standards that resist earthquake damages. Overwhelmingly, damages in the Nisqually Earthquake of 2001 were to unreinforced masonry and buildings built before the 1949 earthquake. This held equally true for damages to roads and bridges. The FEMA project team completed an analysis to identify how many buildings were built to specific building codes. In the table below, "pre-code" refers to buildings built before 1950, low-code is 1951-1974, moderate is 1975-2003, and high is after 2003. Countywide, nearly 50% of buildings were built to pre or low code standards. This level of vulnerability is significant, especially for more intense earthquakes, such as the Seattle Fault M7.2.
The economy	King County alone contributes around 50% of Washington's gross domestic product. The county has a diverse economy, which has made it especially resilient to other forms of disruption but is heavily dependent on a high degree of global interconnectedness. Losses to lifeline infrastructure, especially port facilities, communications hubs, and major highway corridors would be crippling if the loss was total and links could not be quickly restored. Some of western Washington's key industries, such as Amazon and Microsoft, may be insulated somewhat from damage due to the highly global nature of their work and redundancy in their systems, while others such as Boeing would be severely impacted as rail and highway routes necessary for the transport of materials is restored. I-5, for example, suffers from limited redundancy and carries over 233,000 vehicles through Seattle, a number that has been steadily growing. Economic risk from a major earthquake is multi-faceted. Economic impacts from an earthquake include immediate loss of facilities and inventories, ongoing loss of

	employees and customers, and loss of businesses. Ongoing impacts will depend on the speed of infrastructure restoration, levels of insurance coverage, international economic conditions, and the ability of jurisdictions to develop and implement a long-term recovery strategy.
The environment	Impacts to the environment from an earthquake include the creation and disposal of large quantities of debris, releases of hazardous materials, the disruption of environmental conservation programs, and the relaxing of environmental programs during the cleanup and recovery. The greatest potential for environmental damage is from hazardous materials releases as fuel and waste pipelines rupture, underground fuel storage tanks fail, trains, including oil trains, may derail, port facilities are damaged by any tsunami or seiche, and other chemicals, including household items, are spilled. The multi-source nature of materials releases, the scale of potential releases, and the lack of resources for cleanup all complicate the scenario. While most common after rain and wind event hazards (approximately 75% of all disaster-triggered releases), hazmat releases after earthquakes are responsible for large releases over a wide area.[67] Earthquake-triggered hazmat releases have included hundreds of gas line ruptures and pipeline breaks, and releases of ammonia, chlorine, and sulfuric acid during the Northridge and Loma Prieta earthquakes.[68]

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[67] Sengul et al, 2012. *Analysis of Hazardous Materials Releases Due to Natural Hazards in the United States.*
[68] Young, Stacy; Balluz, Lina; and Malilay, Josephine, *Natural and Technologic Hazardous Material Releases During and After Natural Disasters: A Review (*2004). Public Health Resources. 90.

| Health systems |

Hazard Mitigation Plan
Hospitals and Pharmacies
with Liquefaction Potential

H Hospitals with Acute Services ● Pharmacies

King County   0   Miles   40   N | Health system impacts from a major disaster include disruptions to emergency services, community health clinics, pharmacies, and hospitals. While new hospitals are required to meet criteria for seismic resilience and may engage in supply-chain and patient evacuation planning, much of the rest of the network is likely to be shut down after a disaster. This is an especially high threat to populations needing regular medical services, such as kidney dialysis and insulin injections (which require refrigeration). In Hurricane Maria in 2017, Puerto Rico was left without power for months and the majority of fatalities recorded due to the storm were from the elevated death rate among medically-fragile populations.

In order to function, hospitals require significant infrastructure inputs, including power and water that are likely to be disrupted after an earthquake. Backup services are available; however, may be insufficient to meet the need if infrastructure recovery takes too long.

Health system impacts therefore include large-scale disruptions to supply chains, disruptions to ongoing care regimens for certain medically-vulnerable populations, disruption of community care networks of pharmacies and local clinics, loss of trained staff, and potential damage to hospitals or loss of hospital functionality due to infrastructure damage. |

Government operations (continuity of operations)	Any damaging earthquake has the potential to impact delivery of essential government services in the days, weeks, months, and even years following the earthquake. The damages to infrastructure and residential or business locations may curtail or even prevent government employees from reaching their work locations or may prevent services from reaching populations in need scattered around the county. Even after initial short term repairs have been made, the impact on the taxable value of properties in the county may cause a revenue shortfall that reduces available services from budgetary impacts. Collection of available tax revenue, the revaluation process (including documentation), and appeals process might produce a further burden on already stretched government obligations. Earthquakes have the possibility of damaging any fixed facility at which services are provided. This may include: adult and juvenile detention facilities, waste water treatment facilities, solid waste disposal systems and facilities, the court system, health and medical institutions and clinics, fire and police stations or equipment, public transportation, schools, and libraries.
Responders	First responders experience personal and professional impacts from an earthquake. Since responders are also local residents, they will be personally impacted by the disaster. Professionally, emergency services will be called upon to help with life safety operations while also seeking to restore day-to-day services.

Hazard Mitigation Plan
Government Facilities--King County
with Liquefaction Potential

Hazard Mitigation Plan
First Responder Facilities
with Liquefaction Potential

Fire Stations   Medic Units   Police Stations

Infrastructure systems	Energy: Dams are the primary source of electricity generation for the region and may be impacted by a major earthquake, even if failure is relatively unlikely. Pipelines cross the region carrying fuel and are susceptible to earthquakes. Since Washington is home to the Northwest's only refineries, damage to this conveyance system will have far reaching, regional consequences. A major concern for maintaining power in facilities while the power grid is down after an earthquake is fuel distribution. With transportation networks seriously impacted, it will be difficult to ensure a supply of fuel is distributed to hospitals, public facilities, and communications centers. Without this fuel, systems are likely to fail after a few days of operation.

Hazard Mitigation Plan
Wastewater Systems
with Liquefaction Potential

Water/Wastewater: Water and wastewater systems are among the most vulnerable to an earthquake of all lifeline infrastructure. Pipelines, especially those over NEHRP class D, E, and F soils, are vulnerable to rupture. King County maintains a wastewater treatment system that is connected to dozens of smaller systems and operates multiple water treatment plants. There are also many separate water systems that operate their own conveyance systems and reservoirs.

Transportation: Transportation lifelines are both state and local responsibility. According to a Regional Resiliency Assessment Program (RRAP) report published by DHS,

WSDOT has operated a seismic retrofit program since 1991 and has been steadily retrofitting bridges through a three-stage process of stabilizing the bridge superstructure, strengthening single-column bridge supports, and reinforcing multi-column piers. In response to the 2012 Resilient Washington State report, WSDOT began a program to completely retrofit three identified lifeline routes for a total cost in excess of $1B (2015 dollars). As of 2019, there are 17 state-responsibility bridges in King County that are in poor condition.

Bridge Seismic Lifeline Routes (green) (WSDOT, 2015)

King County has 177 bridges in its bridge program. At least every two years, those bridges are inspected and recommendations are made for their repair or replacement. Between 2006 and 2016, 32 bridges were replaced and many more repaired. In 2008, the bridge program concluded a 14-year seismic retrofit, improving 115 bridges for $22 million. This retrofitting has substantially improved the survivability (likelihood of collapse) of bridges in the King County inventory.

One category of bridges is fracture critical truss bridges. The average age of these bridges in unincorporated King County is 42 years. Of the 11 bridges in this group, the Miller River Bridge was closed from damages in the January 2011 flood event and the Alvord "T" was closed June 2013. The Stossel Bridge is the lowest rated of those remaining in the inventory. Each carries thousands of vehicles daily.

Bridges, however, are only part of the transportation puzzle. Bridge approaches, and pavement crossing unstable soils, are major threats. The WSDOT Seismic Lifeline route discussed above is only considering bridges, not pavement or approaches.

Railways are another highly-vulnerable piece of transportation infrastructure. Tracks can become misaligned and require repair before train travel is possible. Even in the relatively small 2001 Nisqually Earthquake, rail travel was disrupted for several days.

Port facilities are seriously threatened by a major earthquake due to liquefaction potential of port areas and tsunami threats. It is likely a major earthquake would completely destroy port facilities, requiring years of investment to completely recover. As with the 1995 Kobe, Japan earthquake, port operations may never again reach pre-disaster levels.

Airports are also vulnerable to earthquakes. In the 2001 Nisqually Earthquake, the air traffic control tower at Seattle-Tacoma International Airport was damaged, drastically reducing takeoff and landing capacity. Runway damage is also common as the ground shifts and would require repair before large jets could land. While the region has a number of airports, many of them will also be critical facilities for disaster response, medical patient evacuation, and food and fuel deliveries.

Hazard Mitigation Plan
Transportation—Major Roads
with Liquefaction Potential
∿ Highways

Communications: While the public sector maintains critical radio communications networks, the networks on which most residents depend is privately owned. While cell towers are equipped with backup generators, these generators may only have enough fuel for a few days of continuous operation.

Public confidence in jurisdiction's governance and capabilities	Disasters of the magnitude we can expect from a damaging earthquake have the potential to shake public confidence in government's ability to maintain law and order, provide essential services, repair or replace needed infrastructure for employment, processing of building permits and inspections, clearing of debris and other needs. Restoration efforts may well take longer than the public is willing to accept. Amendments to zoning and building standards may not be embraced by those seeking to rebuild. If rapid restoration is not possible, the area may lose employers and the population may relocate to other areas of the country in search of employment. Earthquake hazards specifically have been the subject of significant reporting in recent years. Articles in the Seattle Times, the New Yorker, and on local television have argued that the Pacific Northwest is unprepared for the level of destruction

	expected following a Cascadia Subduction Zone 9.0 event.[69] These articles have led to both stepped-up state and local action on earthquake preparedness and to more public awareness.

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[69] Schulz, Kathryn, "The Really Big One," The New Yorker (July 20, 2015).

Regional Risk Profile: Flood

Hazard Description

Flooding is King County's most persistent and recurrent natural hazard. Flooding affects tens of thousands of families and properties owners in communities across the county, with life safety, economic, and workplace impacts on tens of thousands more. The communities within King County take flooding seriously; the King County Flood Control District was established in 2007 to regionally manage flood hazards and reduce risk, in partnership with the Department of Natural Resources and Parks' River and Floodplain Management Section. The King County Flood Hazard Management Plan drives much of the work that both the District and King County do to reduce flood risk and manage flood-related hazards.

Flooding is the inundation of normally dry areas by overflowing rivers, increased coastal waves, or other accumulation of surface waters. A number of conditions can cause flooding from too much rainfall in a river's watershed to sustained offshore wind driving a high tide inland, but flooding can also be caused by events such as liquefaction of levees during an earthquake that release water the levees hold back. Other causes of flooding include dam failure, landscape changes after wildfires that exacerbate flooding, rapid snowmelt, channel migration, and debris in streams causing water to backup.

Figure 2. Flooding along the Snoqualmie River in 2015

Typically, King County sees at least minor flooding ever year in the fall and winter and big events are often driven by atmospheric river where moisture is picked up from the Pacific Ocean and brought by the jet stream to drop as prolonged heavy precipitation in western Washington.

A variety of factors affect how flooding occurs and its severity. One main factor for riverine flooding is the "hydrology," which includes how much rain falls, how fast it falls, how fast it reaches the stream, and the amount of water already in the stream. The second main factor for riverine flooding is the "hydraulics" of the watershed, which includes characteristics like the topography, stream channel dynamics, and the overall slope of areas of the watershed.

Flooding is a natural phenomenon and many ecosystems thrive because of the natural floodplain functions that rivers and coastlines provide. Flooding is considered a "problem" when humans construct buildings and infrastructure in the path of floodwater. The many aspects of natural floodplain functions help reduce impacts, slow floodwaters down, and preserve important habitat for endangered species.
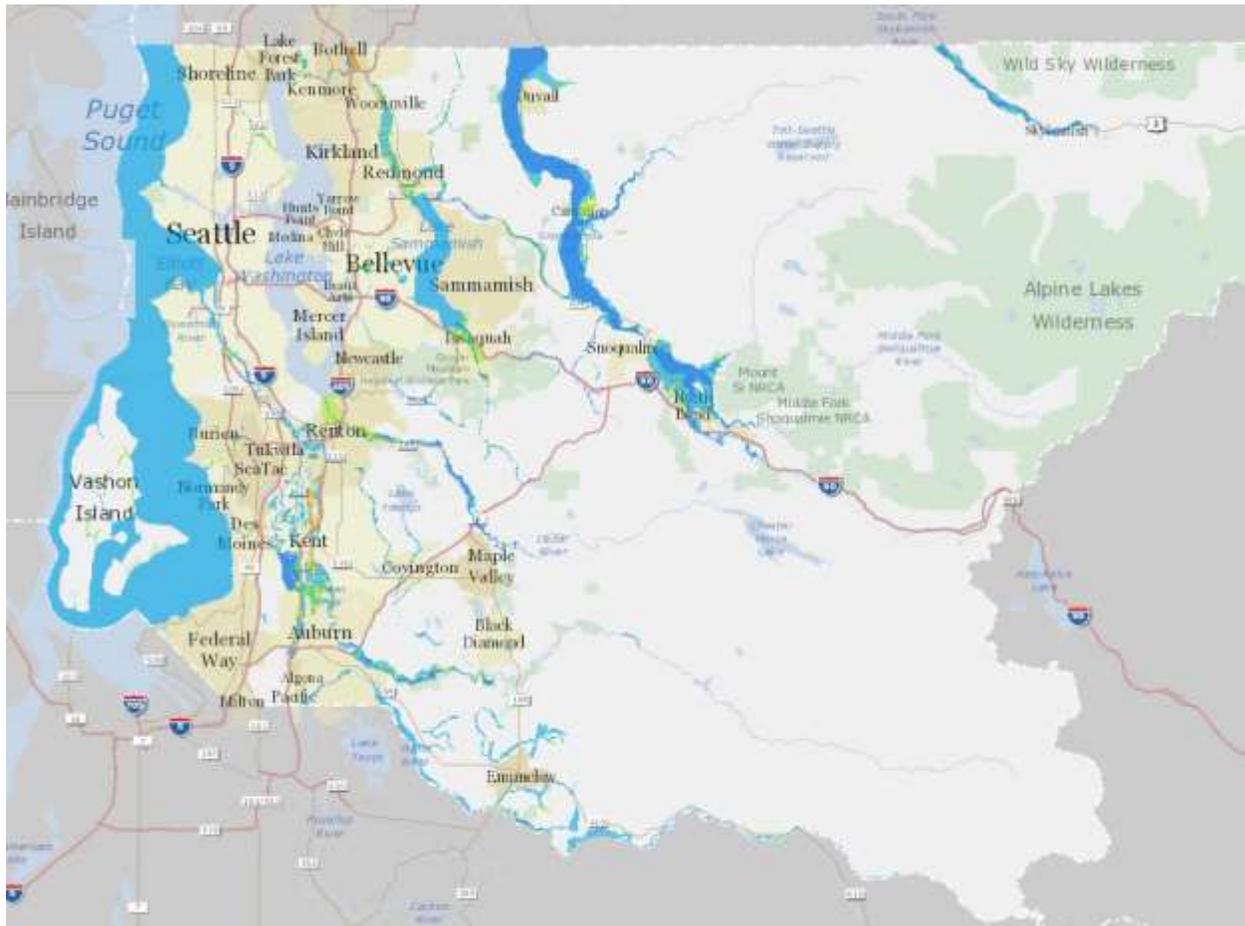
Figure 3. Map showing mapped 1% annual chance floodplains and floodways. Note that Lake Washington does not have an identified floodplain because its levels are controlled by the US Army Corps of Engineers operated Chittenden Locks.

Vulnerability Characteristics and Previous Occurrences

Flooding, no matter the source, causes widespread and long-lasting damage. The force of moving floodwaters can tear homes from their foundations, sweep cars off the road, and destroy public infrastructure. Houses and businesses damaged by flooding can take many months to repair and are often unsuitable to live in during the repairs. Certain types of flooding can leave buildings inundated for several days, which can further worsen property damage. Flood-damaged buildings can pose health risks including mold, contaminated food and drinking water, and mental health stresses from the traumatic experience.

The velocity, depth, and amount of floodwaters impact how dangerous riverine flooding can be. A floodplain where the velocity is more than 3 feet per second and the depth is more than 3 feet is an area dangerous for people to be living or working since those flood conditions can be fatal to someone walking through floodwaters. King County code, for example, prohibits buildings in unincorporated areas to be built in fast-flowing and deep floodplains. Rivers in King County also carry substantial debris, from fallen trees to boulders and sediment, and debris impacts can add to the severity of flooding.

Rivers are dynamic systems and can shift significantly during high flow events or gradually through erosion of streambanks. This risk is called "channel migration hazards," and is a prevalent feature in northwest river systems. The scale of channel migration depends on the severity of the high flow event, geology of the banks and streambed, and characteristics of the surrounding land. King County regularly maps channel migration zones and has applicable development standards for proposals within these zones.

Figure 4. House destroyed due to channel migration along the Raging River.

In coastal floodplains, wave action is the most dangerous aspect of flooding. Buildings are required to be specially designed to withstand powerful wave actions and can only be built on open foundation systems, like piers or posts.

King County covers six large drainage basins and costal flood hazard areas.

1. The South Fork Skykomish River basin lies primarily in the northeast portion of King County and flows into neighboring Snohomish County. The basin drains 234 square miles of mountainous terrain within King County and includes major tributaries such as the Foss, Tye, Miller, and Beckler Rivers. The cities of Skykomish, Baring, and Gold Bar as well as many unincorporated area neighborhoods are located near or on the banks of the rivers and frequently experience impacts from flooding. The basin features steep slopes in the upper portion, so significant runoff can cause major flooding relatively quickly. The rivers in the basin are also very prone to channel migration and it is a significant hazard that communities are focused on.

2. The Snoqualmie River basin drains much of the northeast and north-central part of King County and is typically divided into two areas: the Upper Snoqualmie and the Lower Snoqualmie, above and below Snoqualmie Falls, respectively. The basin also encompasses tributaries such as the Tolt River, the Raging River, Tokul Creek, Griffin Creek, Harris Creek, Patterson Creek, among others. The Upper Snoqualmie River and some of the major tributaries are characterized by steep gradient headwater systems and some lower gradient floodplains near the incorporated communities of North Bend and Snoqualmie. The Lower Snoqualmie River

features wide floodplains along the low gradient channel. The cities of Carnation and Duvall and the unincorporated community of Fall City all lie within the broad Lower Snoqualmie Valley.

3. The Sammamish River basin originates at Lake Sammamish and drains a 240 square mile watershed, including the tributaries of Bear, Little Bear, North, and Swamp Creek basins. The river has been channelized since the construction of the Lake Washington Ship Canal and is partially regulated by a weird outlet downstream of the mouth of the lake, which reduces frequency and severity of flooding.

4. The Cedar River basin stretches from the Cascade Mountains to Lake Washington, where the Cedar River terminates. The basin has been heavily altered from its natural condition, with major projects constructed including Masonry Dam and the Landsburg Diversion, both to serve as water supply infrastructure. Along the Cedar River are many unincorporated community neighborhoods as well as cities like Maple Valley and Renton. Naturally-occurring large wood is a prevalent hazard in the basin.

5. The Green River originates in the Cascade Mountains at an elevation of 4,500 feet and flows through many cities including Auburn, Kent, Renton, Tukwila, and Seattle. The basin is divided into four major sub-basins: the upper watershed above the Howard Hanson Dam, the middle Green below the dam and upstream of Auburn, the lower Green that flows through the incorporated cities, and the Duwamish estuary. The Green River basin features many large structural elements including Howard Hanson Dam, which provides flood control, and large levee and revetment systems on the lower Green River.

6. The White River originates in glaciers on the northeast face of Mount Rainier. The White River drains an area of about 490 square miles, approximately one third of which lies within King County. Major tributaries join the White River along its path like the Greenwater River and Boise Creek. Over one hundred years ago, the White River was diverted to flow into the Puyallup River in Pierce County. Mud Mountain Dam is a major flood control dam that has a significant effect on reducing flooding in the basin. Additionally, water is diverted from the river for hydropower generation near Lake Tapps. Along the river are a number of small unincorporated neighborhoods in addition to the Muckleshoot Indian Tribe Reservation and portions of the city of Auburn.

7. Coastal flood hazard areas pose potential risks to approximately 100 miles of shoreline, about half of which is on Vashon Island in unincorporated King County and the other half is the incorporated shoreline through the cities of Shoreline, Seattle, Burien, Des Moines, and Federal Way. Storm surge and wave action are significant flood hazards facing development along shorelines. Coastal erosion also is a prevalent hazard, including along the steep bluff areas around the shoreline in King County. Many miles of shoreline are variably armored by bulkheads and other structures. Coastal flooding will be exacerbated by sea level rise and other impacts of climate change.

Flooding is a prevalent threat during the fall and winter months due to atmospheric rivers, heavy rain, and king tides. Major floods occur on average every two to five years. Major river flooding has typically not caused fatalities, but rather significant property damage. Flooding along multiple rivers in 2006 and 2009 were the most recent major floods to cause many millions of dollars in damage. Flooding in 1990 is considered the largest flood of record for most of the county except for the Lower Snoqualmie and Tolt Rivers. There have been 28 flooding events since 1965 that have resulted in federal disaster declarations. At least minor flooding occurs every winter. Climate change is likely to have a significant effect in changing the patterns of flooding in the river basins.

Scenario Drivers

Most types of flooding caused by extreme weather are cyclical and are measured by their probability of occurrence in a given year based on the factors that drive flooding. The larger a flood event, the less likely it is to happen in a year. A flood with a 10% chance of occurring in a year is sometimes called a "10-year flood," and that flood event will have less river flow and likely fewer impacts than a 1% annual chance flood event, or a "100-year flood." These flood events can be modeled and maps created to show their extents.

The 1% annual chance flood, or 100-year flood, is the most important scenario because floodplain regulations and federal flood insurance are based on this flood event. This flood event represents the mapped floodplain on FEMA Flood Insurance Rate Maps and forms the basis for community regulations for participating communities in the National Flood Insurance Program. In King County communities, all new or substantially improved buildings must be constructed with their lowest floor at least one foot higher than the expected elevation of the 1% annual chance flood.

While the 1% annual chance flood is scenario most often discussed, the 10%, 2%, and 0.2% annual chance floods are often used for planning and certain regulatory purposes. The extents of the flood events are not consistently mapped throughout the county, but engineering data in flood models can be used in project planning or regulatory compliance.

Typically the recurrence interval floods are driven by cyclical natural factors like atmospheric rivers bringing heavy rain or severe winter storms and king tides. Other factors can drive flooding scenarios in different ways. For example, levee or dam failures may happen due to problems caused by inadequate maintenance. Flooding damage from earthquakes will likely only be seen if an earthquake damages a levee, for example, during times of high water.

King County has a long-established Flood Warning Program that has been monitoring river systems for over 50 years. The King County Department of Natural Resources and Parks' River and Floodplain Management Section operates a Flood Warning Center that opens 24 hours a day when flooding occurs on any of the river systems with gages. For the Flood Warning Program, the rivers are measured by a "flood phase" system based on real-time flow information. When a river reaches flood phase 2, the Center opens, coordinates with local, state, and federal agencies, and accepts calls from the public requesting information about flooding. When a river reaches flood phase 3, patrol teams are sent out to monitor flood protection facilities and any potential flooding impacts. When a river reaches flood phase 4, additional staff are brought in to the Flood Warning Center, sent on flood patrols, and begin to collect damage information in case of a disaster declaration.

FLOOD WARNING PHASE THRESHOLDS

PHASE	SOUTH FORK SKYKOMISH RIVER (at Skykomish)	TOLT RIVER (near Carnation)	SNOQUALMIE (Sum of Forks)	ISSAQUAH CREEK (near Hobart)	CEDAR RIVER (near Landsburg)	GREEN RIVER (Actual or expected flow near Auburn)	WHITE RIVER (Actual or expected flow release from Mud Mountain Dam)
1	6,000 cfs	2,500 cfs	6,000 cfs	6.5 ft	1,800 cfs	5,000 cfs	4,000 cfs
2	10,000 cfs	3,500 cfs	12,000 cfs	7.5 ft	2,800 cfs	7,000 cfs	5,000 cfs
3	18,000 cfs	5,000 cfs	20,000 cfs	8.5 ft	4,200 cfs	9,000 cfs	7,000 cfs
4	27,000 cfs	8,500 cfs	38,000 cfs	9.0 ft	5,000 cfs	12,000 cfs	9,000 cfs

Heavy rain and atmospheric rivers	Most riverine and urban flooding is caused by heavy rain and atmospheric rivers that drive significant weather systems into the Pacific Northwest. Intense rainfall can overwhelm rivers' ability to carry flows in their banks and cause inundation of the adjacent floodplains. These factors not only drive riverine flooding, but also urban flooding issues that can overwhelm local stormwater infrastructure and can cause flood damage.
Severe winter storm, storm surge, king tides	Severe winter storms that have strong winds combined with king tides can cause significant coastal flooding, as seen in the 1982 king tide event that battered much of the shoreline in King County. Intense coastal storms and high tides can cause damage to coastal properties and damage infrastructure like roads and ferry docks.
Sea level rise	As sea level rises in Puget Sound, the stillwater elevation level, or the water level without effect of waves, rises and pushes more water inland during times of severe storms. While the actual increase in flood risk will differ based on the localized geography and wind patterns, sea level rise is certain to worsen flooding along the coastlines in King County.
Channel migration	Rivers natural erode banks and soils due to the energy of moving water. This erosion causes rivers to migrate or move laterally across a floodplain.

	A channel can also move abruptly over a large distance in a single flood event. This can threaten development located in channel migration zones, some of which are mapped.
Dam failure and overtopping	If dams fail, the water held back will rush out quickly, potentially causing catastrophic flooding downstream. Dams both large and small can pose significant impacts. The potential for Howard Hanson Dam's failure in 2009 brought to light the incredible flooding, loss of life, and property damage that could happen if dams fail. Smaller structures that might be in a neighborhood can also lead to deaths and significant property damage. Dam failure can be caused by too much water for a structure to handle or by lack of maintenance that causes the dam to fail.
Levee failure and overtopping	Levees act as flood protection facilities, but only offer protection to a certain recurrence interval. They also are manmade earthen structures that require maintenance. Flooding can exceed a levee system's capacity or flaws in the structure can cause it to fail, and both would cause rapid inundation behind the levee. Water can seep through levees and cause weaknesses that lead to collapse.
Landslide and mudflow	Landslides can rapidly fill in rivers, causing a blockage in the river and immediate overflowing. This threat is particularly present on the Cedar River. Landslides can also add significant material to a river, causing a mudflow and rapid damage to property, similar to the Oso Landslide event in 2014 in Snohomish County.
Earthquake	Earthen levee systems are prone to liquefaction in an earthquake, which can cause major failure of the levee structures. If floodwaters are being held back at the time of an earthquake, the levees can fail and flooding could occur very quickly.
Volcanic eruption	In the event that Mt. Rainier erupts, lahars can fill river valleys and drastically change the course of rivers, streams, and shorelines. The amount of materials brought downstream in a lahar would affect the severity of impacts in future flooding.
Tsunami	Tsunamis are powerful waves that are caused by an earthquake or displacement of water from an underwater land feature collapse. Specific scenarios are outlined in the Tsunami and Seiche Risk Assessment. A tsunami that affects King County would cause significant wave action and likely major damage to properties on the coast.

Humanmade watershed changes	One major factor in understanding flood risk is the underlying land that floodwaters flow over. Harder and more impervious surfaces carry floodwater faster, so as humans continue to build buildings, roads, sidewalks, and other impervious features, floodwaters travel faster to streams, which can increase the severity of flooding.
Climate change	While climate change has an effect and influence on many of the factors already identified, it is a specific scenario driver because of the potential to change flooding in King County. Research is currently ongoing to better analyze, quantify, and understand the effect of certain emissions scenarios that could drive flooding in multiple ways. King County is likely to experience higher intensity rainfall events, which have the potential to cause more impactful flooding.

Priority Vulnerabilities

Families living in floodprone areas	Families with limited budgets are the top concern for flooding. Because flood damage can be very expensive and disruptive, families have a difficult time recovering from the effects of flooding. Without flood insurance, families must take money from savings; and even with flood insurance, flood damaged homes may not be livable for many months. Renters are particularly vulnerable since they often are lower income and do not have flood insurance. Additionally, families that don't speak English as a primary language can be more vulnerable to flooding because most flood warning systems are in English and much of the flood insurance, floodplain regulations, and any mitigation programs are made up of materials in English.
Major roads and sole-access roads	The many bridges, major roads, cross-valley roads, and sole-access neighborhood roads that cross floodplains are a top priority during flooding. Many people in Duvall, Carnation, and other communities in the Snoqualmie valley can be entirely cut off during major flooding since SR 203 and the cross-valley roads are often underwater. During high tide flooding events on Vashon Island, many coastal roads are underwater as well and can limit access via Vashon Highway.
Critical facilities	Schools, hospitals, nursing homes, hazardous materials storage facilities, and other critical facilities operations are threatened during flooding. Schools will be inaccessible and hospital operations and access routes vulnerable. Facilities like nursing homes house populations that cannot easily leave floodprone areas. And hazardous waste, sewage, or animal waste storage facilities threaten water quality and pose health risks during flooding.

Farms	There are many agricultural operations in King County's floodplains including major production areas in the Snoqualmie Valley, Green River Valley, Sammamish River Valley, and parts of the Enumclaw Plateau. Flooding can particularly affect harvest time in October and November as well as making it difficult to start planting in the spring. Farms with livestock faced significant losses in the 1990 floods, but now many dairy or other livestock operations have farm pads that offer refuge for animals in times of flooding.
Linear infrastructure	Linear infrastructure such as water and natural gas pipelines, sewage systems, and utility transmission lines cross rivers, streams, and floodplains. Significant water pipelines take water from protected watersheds down to Seattle, Renton, and other cities and often are threatened by flooding. A major capital project completed in 2019 added flood protection for the Tolt Pipeline, which is part of Seattle's water supply. Additionally, as sea levels rise and worsen coastal flooding,
Flood protection facilities	Levees and revetments are part of the flood protection facility systems in King County. During flood events, levees and revetments are tested by the force of floodwater. Revetments are intended to protect against channel migration, but if the flood is too large, they can fail and rivers can avulse. Levees similarly are put under serious pressure during flood events and a number of issues from seepage to sloughing can undermine levees and cause them to fail.

Priority Impact Areas

King County residents	Flooding can affect anyone who lives in or near floodplains. Most flood hazards are mapped and families living in these mapped 1% annual chance floodplains can expect at least a 26% chance of seeing floodwaters over 30 years, the length of a typical mortgage. Flooding can threaten lives, particular in areas where flooding can happen quickly and with little warning, in addition to those driving on flooded roads. Most deaths occur from people driving through floodwaters and being swept away in their cars.

Flooding also causes significant property damage and, on average, one foot of water in an average size home can cause over $50,000 in damage. Without flood insurance, this level of damage can overwhelm a family's finances. And those without many financial resources will be severely impacted by flood damage to their home and/or belongings.

Flooding also affects those who work in floodplains or commute through them. Many farmworkers are employed on farms in the Snoqualmie or Sammamish Valleys and when flooding inundates or ruins crops, farmworkers can find themselves without jobs. Businesses in floodplains also will shut down during flooding, particularly if buildings and |

access roads are damaged. After the 1993 Midwest Flooding, FEMA found that over 40% of small businesses don't reopen after being flooded.

Vulnerable populations	Flooding is a complicated hazard to understand and accessing flood warning, flood insurance, and other information often requires command of English, understanding of government bureaucracy, and access to financial resources. Populations that don't speak English, don't have access to government resources, and those that cannot afford or don't have flood insurance are particularly vulnerable to the long-term impacts of flooding. Renters can be particularly vulnerable to the impacts of flooding. Families that rent make up over 50% of the households in the floodplain, whereas they make up approximately 37% of households in the entire County. Renters are more often vulnerable because they're far less likely to have a flood insurance policy. Out of the many thousands of families that rent, there are less than 300 renters flood insurance policies, according to data from FEMA, and some of those may be business properties that the data cannot distinguish. Renters often have less wealth or savings to draw from to pay for uninsured losses.
Property	Flooding particularly impacts property and often causes many millions of dollars in property damage in major flooding events. Even a small amount of water inside a building can cause significant property damage and leave building owners with large repair bills. For families, damage to homes may mean difficult financial decisions, displacement for weeks, and lost belongings. For business owners, flood damage may mean lost economic output from shutdowns, destroyed inventory, and inability to pay employees. Throughout King County, there is at least $5 billion of building value in floodplains. Federal flood insurance through the National Flood Insurance Program is the primary way building owners financially protect their property in floodprone areas. As of June 2019, flood insurance policies cover over $2 billion worth of property throughout King County. Many larger commercial or industrial facilities are insured through private contracts, the value of which is not available to government agencies.

Community	Repetitive Loss Properties
Auburn	0
Bellevue	3
Burien	6
Carnation	0
Duvall	2
Issaquah	14
Kent	2
King County	108
Kirkland	1

Mercer Island	1
North Bend	4
Redmond	0
Renton	0
Skykomish	4
Snoqualmie	134
Woodinville	2

Most of these structures are residential. King County attempted to assess the use type of these properties; however, none of the available data sources on RL/SRL properties from the CRS or FEMA contained use types. Even the property-specific forms required to evaluate under CRS did not include use.

| The economy | In 2007, an economic study was conducted to understanding the economic impact of flooding. The study found that 6% of the region's jobs are located in the floodplain and nearly 7% of the county's wages and salaries are generated in the floodplain ($3.7 billion). 20% of the county's manufacturing employment and 30% of the county's aerospace employment are found in floodplains. A major flood that would shut-down economic activity in floodplains would result in at least $46 million per day in lost economic output.

Flooding will affect certain industries like agriculture, aerospace, manufacturing, and distribution more heavily because of their presence and reliance on floodplain locations. In the lower Snoqualmie valley, there are nearly 200 farms that produce a wide range of products from dairy to herbs and row crop vegetables. The Sammamish River valley supports a number of wineries and other small farms. And the Green River valley hosts many large fields of row crops as well as a large County-owned farm leased out by a diverse group of farmers. Flooding can negatively impact these operations, particularly if it occurs before harvest or late into the spring planting season. Farmers cannot sell food products from flood-damaged fields. Flooding, however, also provides nutrients to the soil that supports productive agriculture.

While some agricultural sectors are dependent on natural floodplain functions, other economic sectors have located in the floodplain over decades for other reasons. Large warehouses in the Green River valley, many in the floodplain, make the region one of the largest logistics hubs in the nation. But, the square footage of warehouse and aerospace facilities means that billions of dollars are at risk of flooding every year as well as thousands of jobs. |
|---|---|
| The environment | Flooding is a natural process and supports unique ecosystems and habitats. Many riparian and aquatic ecosystems depend upon some amount of regular flooding or high water events. Various salmonid species use high water events to seek refuge as juveniles or |

	access more favorable habitats, which makes flooding an important part of recovery for the endangered salmon species in Puget Sound. Natural floodplain functions typically result in slower-moving floodwaters with less intense flood height peaks. When upland forest areas are logged or burned, rain and snowmelt reach streams faster, which can cause flooding to be more intense and push water through the floodplain more quickly. King County often incorporates natural functions into the design of projects, which helps reduce flood risk as well as protect and restore ecosystems. Reconnecting rivers and coastlines to their historic floodplains through levee setbacks, creating side channels, and removing obstructions help restore natural functions and bring flood risk reduction benefits as well. The large Countyline project near Auburn restored 121 acres of floodplain along the White River and reduce flood risk for over 200 residential properties.
Health systems	Of the 127 medical facilities throughout King County, only 5 are located in the 0.2% annual chance floodplain (which includes the 1% annual chance floodplain) and of those, only 1 is located in the 1% annual chance floodplain. No hospitals are located in the 0.2% annual chance floodplain. While these 5 facilities are certainly at risk, the risk from flooding to the overall healthcare and medical system is low. One area of concern is the ability of residents in certain areas of the County, in particular sole-access neighborhoods and the lower Snoqualmie Valley, to evacuate for medical reasons during times of flooding. Neighborhoods with roads that are inaccessible during flooding are particularly vulnerable. The lower Snoqualmie Valley can also be isolated when the river reaches beyond a flood phase 4 level.
Government operations (continuity of operations)	Because few government facilities are located in floodprone areas, flooding does not pose a substantial risk to the continuity of government operations. Certain city buildings in Snoqualmie, North Bend, and Carnation are in floodprone areas, but some are elevated and others are outside floodprone areas.
Responders	Police, firefighters, and paramedics play key roles in the response to flooding. Police officers often help shut roads down to prevent people from driving through floodwaters; firefighters often rescue people trapped by flooding; and paramedics transport people hurt by flooding, often from hypothermia or other causes. If any of these first responders' buildings are in the 0.2% annual chance floodplain, their ability to respond is seriously threatened. Of the 64 police stations in King County, 3 are located in the 0.2% annual chance floodplain (in Skykomish, Redmond, and Issaquah). Of the 161 fire stations in King County, 6 are located in the 0.2% annual chance floodplain (in Skykomish, Seattle, North Bend, Renton, Issaquah, and near Enumclaw).

	Additionally, neighborhoods with roads that are inaccessible during flooding pose challenges to first responders. They may not be able to drive to homes and may require helicopters or boats to access.
Infrastructure systems	• Energy systems: most overhead powerlines are not susceptible to impacts from flooding unless the power poles are not resistant to flooding. Buried cables typically aren't affected by flooding very often. • Water/Wastewater: flooding, particularly from king tides and coastal storm systems can damage wastewater infrastructure such as the County's West Point Treatment Plant. Some city wastewater treatment plants are also located in floodprone riverine areas. Where these linear systems cross rivers, flooding can pose issues. The Tolt Pipeline, a water supply line for Seattle, was at risk from the Snoqualmie River migrating further toward its alignment. In 2019, a project was completed to provide some protection from that risk. • Transportation: roads through the Snoqualmie Valley are particularly susceptible to flooding and close regularly during high water events. Valley residents are often isolated. King County Road Services Division closes roads and will be working on an effort to study the impacts of flooding on various county roads. • Communications: most communications infrastructure is not vulnerable to flooding.
Public confidence in jurisdiction's governance and capabilities	Flooding occurs frequently enough in King County that residents often turn to the King County River & Floodplain Management Section for help and information during flooding events. Confidence is high in the government's ability to respond to flooding events. The multiple iterations of the Flood Hazard Management Plan have featured robust stakeholder involvement processes, which has inspired confidence in King County's ability to manage floodplains with higher regulatory standards and other programs to keep people and property safe from flooding.

Regional Risk Profile: Hazardous Materials

Hazard Description

Hazardous materials releases are one of the most common incident types. They can occur due to an accident or also be secondary to other primary hazards like: terrorist attack, earthquake and volcanic activity, severe flooding, and fires. Hazardous materials releases occur from leaking containers or pipelines when corrosion or a puncture occurs, accidental overflow of vessels when being transferred, loading dock and warehouse accidents, careless handling, illegal activities like drug labs, and traffic accidents. The person who dumps paint down a sewer is releasing a hazardous material. The illegal drug lab is using hazardous materials and leaving hazardous waste. The car accident that leaves a pool of fuel, oil, and anti-freeze has left hazardous materials to clean up. A growing source of materials releases is from electronic waste dumping, releasing chemicals like lead, zinc, nickel, flame retardants, barium, and chromium into the environment.

There are nine classes of hazardous materials.

1. Explosives
2. Gases
3. Flammable Liquid and Combustible Liquid
4. Flammable Solid, Spontaneously Combustible, and Dangerous When Wet
5. Oxidizer and Organic Peroxide
6. Poison (Toxic) and Poison Inhalation Hazard
7. Radioactive
8. Corrosive
9. Miscellaneous

Examples of common hazardous materials include anhydrous ammonia (used as a refrigerant), gasoline and diesel (used as transportation fuels), paints and dyes (for homes and clothing), and many corrosives (used in the local aircraft manufacturing industry).[70] Pipelines and rail lines transport crude oil to refineries and finished fuels to homes (natural gas) and retail fueling stations for vehicles.

The risk of a CBRNe event (an attack using chemical, biological, radiological, or nerve agent) is low, if one were to occur this would have widespread impacts. There is little known day-to-day risk of an event, though this is a major focus of federal, state, and local counterterrorism planners. More information on hazardous materials in terrorist events will be provided in the terrorism hazard profile.

Although the likelihood of large numbers of fatalities from a single materials release is low, the effects can be devastating to impacted communities, the economy and the environment. A major oil spill in Puget Sound would destroy the fishery, including $4.5 billion in commercial fishing, plus tourism, and sport fishing. The Puget Sound is also a culturally-sacred and environmentally-critical resource that

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[70] Federal Motor Carrier Safety Administration. Nine Classes of Hazardous Materials. Accessed online on 7/2/19 from https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Nine_Classes_of_Hazardous_Materials-4-2013_508CLN.pdf.

cannot be replaced or valued in dollars. In this way, the hazardous materials incident hazard is one of the most complex. It includes frequent spills and releases from day to day human activities, a threat of a major release from a massive spill or accident, and the threat of an intentional release from an attack. The impacts from hazardous materials are also complex, including slow-acting releases that kill people and the environment over years and catastrophes that kill thousands, such as in Bhopal, India in 1984.
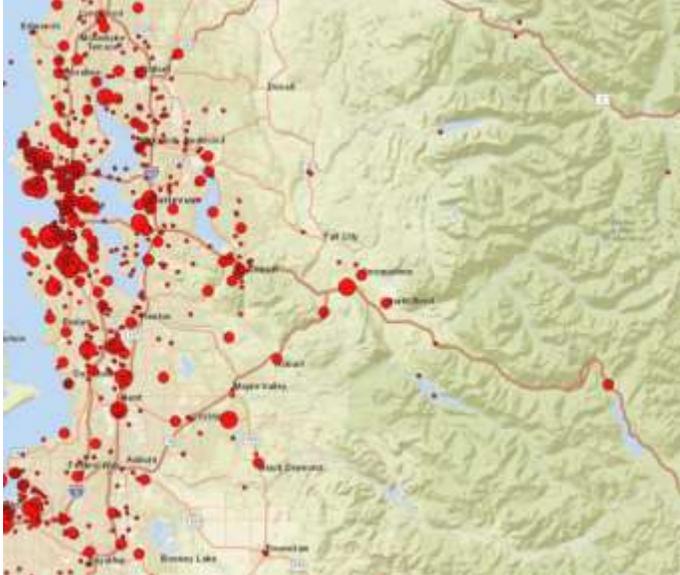
Class 1, 3, and 4 Spills Program-Regulated Facilities (WA ECY)

Between July 1, 2015 and March 31 2019 Washington State Department of Ecology received 748 reports of oil spills of one gallon or more reaching a water source, including both running into storm drains and running directly into a waterway. This only includes reported spills and only includes oil spills. This does not include the uncountable quantity of micro-spills that occur and are later washed into waterways by rain. For example, the rough spot of pavement in a parking lot that is the result of fluids dripping onto the pavement from parked vehicles is an oil spill.[71]

In Washington, the state Department of Ecology is the lead agency for hazardous materials. Local response is led by fire services.

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[71] Washington State Department of Ecology. Coastal Atlas. Accessed online on 7/2/19 from https://fortress.wa.gov/ecy/coastalatlas/storymaps/spills/spills_sm.html.

Vulnerability Characteristics and Previous Occurrences
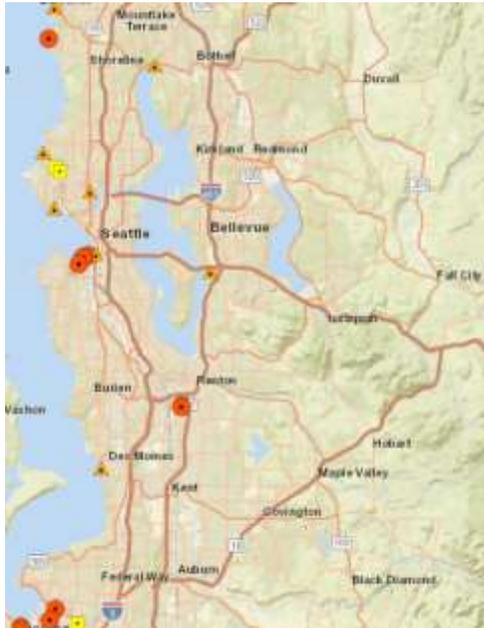
King County hosts a variety of unique transportation and geographic conditions, including one of the largest deep water seaports on the west coast, an International Airport in SeaTac that handles cargo from all over the world, as well as fuel pipelines running south from Whatcom County through King County and down into Portland carrying jet fuels, diesel, gasoline, etc. An estimated 18,833 oil tank cars travel through King County each quarter.[72] Additionally, local highways like Interstate-5, Interstate-90, Interstate 405, US Highway 2, State Route (SR) 18, SR 516, SR 167, US Highway 99 and others transport hazardous materials throughout the region.

In the City of Seattle alone there are thousands of facilities with hazardous materials regulated under the fire code.[73] Other areas with high concentrations of hazardous materials usage include Auburn, Redmond and the Kent Valley.

Business types that commonly use hazardous materials include: hospitals, schools and universities, metal plating and finishing, the aircraft industry, public utilities, cold storage companies, the fuel industries, the communication industry, chemical distributors, research, and high technology firms. Each of these facilities is required to maintain plans for warning, notification, evacuation and site security under various regulations.

While the majority of incidents tend to involve petroleum products, a significant number involve extremely hazardous materials. Extremely hazardous materials include chemicals like chlorine, ammonia, sulfuric acid, nitric acid, some pesticides (EHS is a technical designation, so not pesticides- although the chemistries used as pesticides might be on the EHS list), and other chemicals that can cause immediate death or injury when inhaled, ingested, or come in contact with skin. Approximately 200 local facilities with extremely hazardous materials report to the county under Community Right to Know Act provisions. (plug with time and description of LEPC Seattle and King) These sites report their inventories annually with records being retained in databases in multiple locations.[74]

Though they occur every day, many spills are not reported or go undetected. Some industrial spills from the 1970's and 1980's are still being cleaned up in the Kent Valley, Harbor Island, Duwamish corridor,

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[72] Washington State Department of Ecology. Coastal Atlas. Accessed online on 7/2/19 from https://fortress.wa.gov/ecy/coastalatlas/storymaps/spills/spills_sm.html.

[73] National Fire Protection Association. Materials Management Codes and Standards. Accessed online on 6/25/19 from https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards?mode=code&code=400.

[74] King County Local Emergency Management Planning Committee. 2015. Tier II Reports.

and Seattle/South Park as federal Superfund cleanup sites. There are currently 10 active Superfund cleanup sites in King County.[75] At least five other Superfund sites have completed cleanup and have been closed since the program began. Currently active sites include:

1. Harbor Island – groundwater contains benzene, ethyl benzene, xylene, mercury, cadmium, lead and zinc with poly chlorinated bi-phenols (PCB) sediments. 18
2. Lockheed West Seattle – heavy metal contaminants: arsenic, chromium, copper, lead, silver, and zinc with butyl tins and PCBs.
3. Lower Duwamish Waterway – River sediments are contaminated with mercury, arsenic, PCBs, dioxins, furans, and phthalates.
4. Midway Landfill – Ground water contaminated with heavy metals and volatile organics.
5. Pacific Car and Foundry – Soil is contaminated with heavy metals, PCBs and solvents. Approximately 37,000 obtain drinking water from wells within three miles.
6. Pacific Sound Resources – Soil and ground water contaminated by PCBs and heavy metals from former wood treatment operations.
7. Queen City Farms – the site is a former landfill. Ground water, surface water, and sludge contaminated by volatile organic compounds. Soil contaminated with PCBs and metals.
8. Quendall Terminals – Soil and ground water contaminated with benzene and creosote from former manufacturing plant. Contaminants release to Lake Washington.
9. Seattle Municipal Landfill (Kent Highlands) – Landfill contains volatile organic compounds like toluene, xylene, vinyl chloride, and others – plus heavy metals.
10. Western Processing – former industrial processing facility ground water and sediment contains volatile organic compounds, PCBs, phenols, and heavy metals

An example of the cleanup costs for a Superfund site is illustrated by the Harbor Island Cleanup. The former owner, RSR Corporation agreed to pay $8.5 million in fines toward the cleanup that will cost (when completed) over $32 million.[76] The cost to cleanup an illegal drug lab (in a home) can cost between $5,000 and $100,000 depending on the size of the home. Often the occupants vacate or abandon the sites – leaving a bank or credit union holding the mortgage and cleanup costs.[77]

Scenario Drivers

It is difficult to find a home, school, hospital or place of business that isn't without chemicals, solvents, pesticides, lawn chemicals, cleaners and/or paints.	
Pipeline rupture	Washington State hosts the only oil refineries in the Northwest. Multiple pipelines traverse the state, such as the Olympic Pipeline. Failures or shutdowns in the pipeline can cause fuel shortages and price increases. An explosion on the Olympic Pipeline in 1999 killed three people and cost over $58 million in property damage.

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[75] U.S. Environmental Protection Agency. Superfund Sites Where You Live. Accessed online on 6/25/19 from https://www.epa.gov/superfund/search-superfund-sites-where-you-live

[76] U.S. Department of Justice. 2006. Former Harbor Island Smelter Operator to Pay $8.5 Million in Superfund Cleanup Costs. Accessed online on 6/25/19 from https://www.justice.gov/archive/opa/pr/2006/January/06_enrd_047.html.

[77] Dewan, Shaila and Robbie Brown. July 25, 2009. When an ex-meth lab is home. *The Seattle Times.* Accessed online on 6/25/19 from https://www.seattletimes.com/business/real-estate/when-an-ex-meth-lab-is-a-home/.

Chemical/oil train derailment	An oil spill in 2016 in Moser, Oregon along the Columbia River very nearly caused the destruction of the entire town and an ecological catastrophe in the river. The community was saved by luck of the weather and because most of the oil that spilled flowed into a water treatment plan, where it was safely contained.
Oil tanker spill	An oil tanker spill in the Puget Sound would devastate marine life and potentially cause a permanent shut-down in oil tanker traffic due to public outcry. A major spill would close the fishery economy leading to $4.5 billion in losses for Washington alone and permanent, incalculable damage to tribal cultural resources.
Storage facility failure in a populated area	A facility failure, including an explosion or release of chemicals, could endanger or kill many people. In Waco, Texas in 2013, an ammonium nitrate explosion occurred at a distribution facility, leveling a neighborhood and killing 15 people. A train derailment in 2013 in Lac Megantic in Quebec, Canada killed 60 people and destroyed much of the town.
Vehicle accident on a major roadway	Vehicle accidents that release fuel and oil occur every day on Washington roads. A major incident, especially at an interchange, such as the I-5 and I-405 interchange in Tukwila/Renton would potentially close both freeways for an extended period while cleanup occurs.
CBRNe Attack	Another lower-risk, but high-intensity hazardous materials event is from a chemical, biological, radiological, or nerve agent (CBRNe) attack.

Priority Vulnerabilities

Low-income communities in or around industrial facilities	Low-income communities are more likely to be impacted from major releases due to the proximity of affordable housing to industrial areas and historic environmental injustices.
Individuals with respiratory issues	Individuals with respiratory issues are more likely to succumb quickly to an airborne release of a chemical.
Major transportation facilities such as the Port of Seattle	Major transportation facilities store huge amounts of chemicals and fuel in depots. A failure or fire at one of these facilities could damage or destroy these assets.
Rail facilities	Rail facilities transport chemicals and fuels, including highly combustible crude oil. There have been multiple derailments and spills. In Moser, Oregon

	in 2016, a train derailed causing a fire that nearly destroyed the town and the fuel was prevented from leaking in large quantities into the Columbia River by luck.
Interstate highways	Interstate highways are a major artery carrying chemicals. Accidents happen every day and major chemical spills can shut down a roadway for an extended period of time. (oil slicks contribute to traffic injuries and fatalities when it rains)
Oil tankers in Puget Sound	Oil tankers are expected to traverse Puget Sound in growing numbers due to Canada's approval of a major pipeline and terminal in Vancouver, BC. When this occurs, it will significantly raise the risk a spill that could destroy much of the aquatic life in Puget Sound.

Priority Impact Areas

King County residents	Potential Impacts to the public from a hazardous materials spill can vary widely. Temporary or even permanent displacement through evacuation from an unsafe area can result in relocation/displacement of populations. Employment disruption, school closure, impacts to private and community wellheads and other impacts can change whole communities. Long term exposure to toxic chemicals can cause birth defects and temporary or permanent health problems – especially for the young, old and infirm.[78]
Vulnerable populations	Vulnerable populations often live in closer proximity to facilities with the risk of hazardous materials release. In King County, this includes residences near the Duwamish industrial area, in Kent, Renton, and south Seattle. These are also the locations of the superfund sites in the region. In cases of major releases or system failures, the most impacted populations are frequently lower-income, often ethnic minority communities that live nearby. Populations with respiratory issues are also at a heightened risk of impacts due to an airborne release of chemicals.
Property	Spills of hazardous materials to soil or buildings can result in extensive and costly cleanup efforts. Cleanup standards are established by federal (U.S. EPA), state (Washington State Department of Ecology), and local standards (fire agencies and environmental agencies). Until a site is cleaned up to those standards, residential or business occupancy can be denied under the Health Code. The responsible party (property owner) may be required to pay for the cleanup. Often this can lead to bankruptcy and clean up by state or federal agencies and contractors. Contaminated property can drastically reduce the value of the property and the King County subsequent property taxes available to local and state

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[78] U.S. Centers for Disease Control. Health Effects of Chemical Exposure. Accessed online on 6/25/19 from https://www.atsdr.cdc.gov/emes/public/docs/Health%20Effects%20of%20Chemical%20Exposure%20FS.pdf.

	government. Similar impacts can be expected for transportation accidents with hazardous material spills.
The economy	Small spills can close businesses and rather large impact on employment and land use including the properties of neighbors not responsible for the chemical release. Superfund sites can impact a community for decades until they are cleaned up. The large salmon and fishing fleet that calls King County home may be impacted when some of a year's fish stock – or even the entire run is impacted.
The environment	Any chemical spill on or along rails, roads, pipelines, fixed industrial facilities or illegal drug labs/dumping may impact the natural environment. Wetlands, streams and rivers, lakes, and reservoirs may all be damaged from chemical spills. In some cases these damages may injure the plant and animal life irreparably. Birds, reptiles, amphibians, fish, and mammals may all be impacted. Air pollutants may impact human inhabitants as well as the natural environment. Recreational areas can be closed until a suitable solution can be found to recover the natural environment.
Health systems	Hospitals can be overwhelmed by major releases of hazardous materials as populations, both those exposed and those who feel they may have been, check in at emergency rooms. Hospitals and pharmacies are also sources of hazardous materials, including some radioactive materials such as those associated with cancer treatment.
Government operations (continuity of operations)	King County is the operator of several facilities that are vulnerable to hazardous materials spills. The county has three waste water operations (South Plant, West Point Treatment Plant, and Brightwater). These expensive facilities are vulnerable to the introduction of chemicals (when in large volumes) to the sanitary sewer system. The county also has solid waste (garbage) transfer stations and a major landfill operation at Cedar Hills. While contaminants are avoided, some material may make its way into the landfill and the ground water table. Drinking water facilities including private and community well heads and reservoirs may also be vulnerable to introduction of chemical or biological contaminants. Any chemical spill that impacts a major roadway or rail line may impact public transit routes in the county.
Responders	Hazardous materials make response and recovery activities in all disasters a threat to the health and safety of responders. During local events, such as house fires, stores of chemicals can catch fire and explode, injuring responders. During larger events such as earthquakes, large-scale releases can surprise and overwhelm responders without proper equipment. It can also be extremely difficult to determine the chemical or chemicals that have been released from a given spill, adding to first responder danger.
Infrastructure systems	With hazardous materials being everywhere in our modern community, it is possible to impact almost any critical facility in the county. Any roadway or rail line is vulnerable to the many chemicals transported over them daily. Spills to soils and surface water sources

	can impact drinking water and the environment. Materials dumped into sanitary sewers can contaminate waste water treatment plants. Airborne chemicals can cause the evacuation of the area downwind of the spill, including critical facilities. Damage to road surfaces from chemical spills may require the removal and replacement of the entire road surface and foundational road bed. Transformers used in power transmission contain chemicals called PCB (Poly chlorinated bi-phenols) that can be released during wind storms or lightning strikes and traffic accidents. The impacts to business from interrupted commute/road or railroads closures can last for hours, days, weeks, or longer. White powder incidents have closed postal facilities and government buildings until the substance was identified and removed
Public confidence in jurisdiction's governance and capabilities	The Community Right to Know Act, and other related legislation, resulted from serious breaches in public confidence following massive releases, explosions, or other failures in hazardous materials systems. Any major incident in and of itself seems to offer proof to the public of a regulatory failure. Maintaining Local Emergency Planning Committees and a regular structure to report and analyze hazardous materials releases is critical to maintaining public confidence.

Regional Risk Profile: Health Incident[79]

Hazard Description

Disease has been one of the most influential factors in human history. On many occasions, disease has shaped civilizations and altered the course of history. Throughout the 20th century great strides in medicine have produced many treatments and cures for the deadliest diseases. Many of these medical advances have given us a false sense of security that all diseases can be treated or cured in a timely manner, even though the potential for a devastating disease outbreak continues to threaten our community.

The impact of these diseases varies based on the virulence of the disease, duration of the illness, susceptibility of the population to the disease, and spread within the community.

An outbreak can be characterized by the extent of spread of the disease. Epidemic refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area. Pandemic refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people. More common diseases are classified as endemic, as they are at baseline levels within a community. New or emerging diseases can quickly become an epidemic/pandemic if there is little or no immunity in the population.

Common disease outbreaks include influenza, norovirus, pertussis, hepatitis A, *Salmonella*, and *E. coli.*. Novel strains of influenza are a great risk to King County, because of lack of immunity to a new influenza virus stain, the potential for severe illness, and the high degree of transmissibility from person to person.

For King County, the Communicable Disease Epidemiology & Immunization Section within Public Health – Seattle & King County investigates and coordinates the surveillance of communicable disease cases and outbreaks.

The impact of a disease can be tracked and characterized using several different indicators. These indicators can help Public Health assess and respond to potential disease outbreaks.

- *Incubation period:* The stage of subclinical disease extending from the time of exposure to onset of disease symptoms.
- *Contagious period*: The duration after infection during with the person can transmit the infection to others.
- *Infectivity:* The proportion of exposed persons who become infected.
- *Pathogenicity:* The proportion of infected persons who develop clinically apparent disease.
- *Virulence*: The proportion of clinically apparent cases that are severe or fatal.

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[79] This risk profile was developed for the Seattle and King County Hazard Mitigation Plans by Public Health Seattle & King County.

Vulnerability Characteristics and Previous Occurrences

Epidemics directly affect the health of people who live, work, and visit a community. They have the potential to be one of the deadliest hazards a community can face. Sickness is the most visible consequence of an epidemic, but outbreaks can also severely impact the community as schools, businesses, government agencies and non-profit organizations curtail operations due to employee illness or as countermeasures. The effects of these curtailments grow the longer the disease persists.

In many epidemic and pandemic situations, disease spreads quickly throughout a community. There are many factors that can increase King County's vulnerability to disease spread:

- Rapid population growth, such as is occurring in King County, increases the potential for acquisition and spread of infectious diseases.
- King County's large international air and seaports (including an active cruise ship industry) increase the number of visitors to our area and the risk for importation of infectious diseases. Diseases that are not endemic to Washington have the potential for introduction and spread among our residents. Vaccine preventable diseases (e.g., acute viral hepatitis, measles, and influenza) are significant contributors to morbidity and potential mortality in international travelers and can cause local outbreaks among susceptible persons.
- Persons experiencing homelessness often also have limited access to medical care, so many people living homeless and with health problems have difficulty getting prompt treatment. Living conditions – like crowding and fewer opportunities for personal hygiene – can contribute to the spread of disease. If someone has an underlying medical condition, alcohol or drug use, or weakened immune system, they are even more susceptible. In 2017 and 2018, CD-Imms responded to increases in several infectious diseases among persons experiencing homelessness; new infections and outbreaks in this population continue to be reported and might continue to rise given the increase in persons experiencing homelessness in King County.

Disease often affects those most vulnerable in our communities. Young children, the elderly, the poor and those with underlying health conditions are often the hardest hit by disease.

King County has a large concentration of healthcare resources, but in an epidemic or pandemic these resources can be stretched or overwhelmed by the outbreak situation. The area also provides specialized medical care for a large geographic area, including one of the area's only pediatric hospitals and the only Level 1 Trauma center for Washington, Idaho, Montana, and Alaska. In addition, Airlift Northwest located at Boeing Field is the only life-flight agency serving the same four-state region.

Other resources, such as food and water, are also a concern when planning for disease outbreaks. King County has many open reservoirs that provide water to the city. These reservoirs could become contaminated and be a source of infection for area residents. Food sources can become contaminated by improper food handling practices or ill food workers. Public Health conducts ongoing surveillance for food- and waterborne illnesses to identify and quickly control outbreaks.

Although it is impossible to predict the next disease outbreak, history has shown that outbreaks are not uncommon and can produce devastating effects on a community. While the revolution in medicine in the past century has increased our ability to counteract disease, increases in the number of people without adequate healthcare, the evolution of antibiotic resistant bacteria and globalization help make

outbreaks spread more quickly and increase their magnitude. Disease outbreaks not only cause increased morbidity and mortality in the community, but also put a greater strain on the healthcare and infrastructure system that could prevent the operation of critical services.

Throughout the 20th century several epidemics and pandemics have affected our community.

Influenza. 1918-1919: The influenza pandemic of 1918 was especially virulent, killing a large number of young, otherwise healthy adults. The pandemic caused more than 500,000 deaths in the United States and more than 40 million deaths around the world. The 1918 pandemic first arrived in Seattle in October 1918; over the next six months the virus claimed 1,600 lives.

Influenza. 1957-1958: The influenza pandemic of 1957 was less severe than the 1918 pandemic and caused a total of 70,000 fatalities nation-wide.

Influenza. 1968-1969: The influenza pandemic caused more than 34,000 deaths in the U.S. and cause severe morbidity and mortality around the world.

E. coli. 1993: E. coli-contaminated hamburger meat from a local Jack in the Box caused illness in 400 people and led to the death of two people within one month in the Washington area. Cases were seen in California, Idaho, and Nevada as well.

Pertussis. 2002-2005: Between 2002 and 2003 Public Health reported an 82% increase in the number of Pertussis infections in infants, and a three-fold increase in the number of cases in children <6 months. The occurrence of Pertussis in adolescents and adults has been on the rise since 1990, culminating in a national epidemic in 2005 when 25,616 reported cases nation-wide. Outbreaks within healthcare facilities can occur quickly because the bacterial infection is highly contagious.

Influenza. 2009: Like the 1918 pandemic, the H1N1 outbreak of 2009 affected the young and healthy populations as well as those with chronic diseases. This increase in morbidity caused strain on the local healthcare system. Although the H1N1 virus was not as virulent and there were not nearly as many fatalities as previous pandemics, the outbreak caused a larger than usual amount of disease in the community than seasonal influenza virus does.

Scenario Drivers

The most likely scenario that activates the region's emergency management system would be a disease outbreak that just exceeds our public health system's capacity. We have chosen hepatitis A outbreak for the Most Likely Scenario. In 2017, several state and local health departments responded to hepatitis A outbreaks, spread through person to person contact, that occurred primarily among persons who use injection and non-injection drugs, and/or person who experienced homelessness and their close contacts. Multistate outbreaks of hepatitis A infections have also been linked to food products (i.e.

strawberries in 2016 and pomegranate seeds in 2013).[80] A large outbreak centered in Seattle would cause a strain on the public health system and potentially have strong impacts on local businesses, especially any that the public perceives as responsible for the outbreak.

Hepatitis A Outbreak	Seattle is the center of a hepatitis A outbreak that kills 20 people and makes hundreds severely ill, including hundreds of hospitalizations. The emergency is complicated, and infections are spreading among people who are living homeless who have limited access to adequate hygiene and prompt medical care.
Pandemic Flu	The most severe disease outbreaks would involve pathogens that would infect a large percentage of an exposed population and hospitalize or kill many people. Pandemic influenza has the potential to cause this great a disaster. It poses a great threat to the health of our local community as well as the national/international community. In addition to human morbidity and mortality, pandemic influenza can have many socio-economic consequences. Cancellations of schools, work and public gatherings may be enacted to attempt to halt the spread of disease. Staff absenteeism can create a strain on government and healthcare systems causing limitations of services and care. The 2009 H1N1 flu outbreak showed how potentially easy it is to overwhelm the healthcare system, even though, as it happened, H1N1 was an influenza that caused less severe disease than a typical seasonal flu. A pandemic influenza that caused moderate or severe disease would have a much larger impact on the community. The following table outlines expected disease rates based on Center for Disease Control modeling.

Characteristic	Moderate (1958/68 - like)		Severe (1918 - like)	
	US	King County	US	King county
Illness	90 million	540,000	90 million	540,000
Outpatient Care	45 million	270,000	45 million	270,000
ICU Care	128,750	733	1,485,000	8,910
Mechanical Ventilation	64,875	389	742,500	4,455
Deaths	209,000	1,254	1,903,000	11,418

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[80] Centers for Disease Control. Hepatitis A Outbreaks in the United States. Accessed online on 6/28/19 from https://www.cdc.gov/hepatitis/outbreaks/hepatitisaoutbreaks.htm.

Bioterrorism	Bioterrorism is another potential cause of on a catastrophic disease outbreak. The maximum bioterrorism scenario is estimated by Public Health – Seattle & King County to have impacts similar to the pandemic flu scenario identified above.

Priority Vulnerabilities

Old and young people	People who are either old or young have weaker immune systems and are usually more likely to succumb during an outbreak.
Healthcare staff	Healthcare staff come into regular contact with sick patients and are likely to be exposed both before the illness is identified and during treatment.
People with compromised immune systems	People with compromised immune systems are most likely to become infected and succumb from a serious disease.
People without health insurance	People without health insurance are more likely to delay getting care, allowing the disease to spread farther before it is identified.
Health system	The health system is likely to be overwhelmed in any serious epidemic. In especially serious outbreaks, it may be inadvisable for patients to even come to the hospital and treatment may have to occur outside of hospital facilities.

Priority Impact Areas

King County residents	As many as 11,418 deaths are estimated to occur during the most severe pandemic scenario. Thousands more would be hospitalized, and hundreds of thousands sickened. As of May 4, 2019, there were 45 influenza fatalities in the 2018-2019 flu season.
Vulnerable populations	In 2017-2018 flu season, there were nearly 1,000,000 hospitalizations and 79,400 deaths. The most at-risk group is adults over 65 years of age (70% of hospitalizations).[81] Older adults account for nearly 90% of deaths. During a serious epidemic, older adults, individuals with compromised immune systems, children, people without health insurance, people who speak a language other than English, and people who are recent immigrants to the country are likely to be the most at-risk and suffer the worst impacts.
Property	There are no direct impacts to property.
The economy	The economy may come to a virtual standstill for weeks on end during severe outbreaks as people avoid public places. Many small businesses may lose too much revenue and be

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[81] Centers for Disease Control. Estimated Influenza Illnesses, Medical visits, Hospitalizations, and Deaths in the United States — 2017–2018 influenza season. Accessed online on 6/28/19 from https://www.cdc.gov/flu/about/burden/2017-2018.htm.

	forced to close. Nationally, the economic impact of seasonal influenza has been estimated as high as $166 billion (2012 dollars).[82]
The environment	There are no expected impacts to the environment.
Health systems	Health systems will be overwhelmed and many nurses and doctors potentially sickened. As facilities become unable to take additional patients, it may be possible to treat people in outpatient facilities. During the worst-credible scenario, nearly 300,000 residents of King County would require treatment. This would be far beyond the capacity of the public health system.
Government operations (continuity of operations)	Many government operations may cease to function on a normal basis during the most severe outbreaks. Agencies may have to adopt work from home policies and take other steps to protect employees. Due to employee illness, many non-essential functions may have to be curtailed.
Responders	Emergency services would be severely impacted during a serious outbreak because they are likely to be exposed early due to public contact. As responders become sick, response times and capabilities would be severely limited.
Infrastructure systems	• Energy: There are no direct impacts, outside of employee absenteeism, to the energy sector. • Water/Wastewater: There are no direct impacts to the water and wastewater system from most outbreaks, although this system is a potential target of bioterrorist activities. • Transportation: A disease would not cause any direct damage to the transportation system, but high absenteeism would affect it. Public transit, shipping, and other services may only function at 50% during especially severe outbreaks. • Communications: There are no direct impacts, outside of employee absenteeism, to the communications sector.
Public confidence in jurisdiction's governance and capabilities	The public understands that an outbreak is a severe natural event; however, restrictions on public gatherings are not popular and create frustration. Some people may believe they are not getting enough attention from the medical community. Others may begin to doubt the efficacy of treatment options if the disease worsens. In the most extreme cases, confidence in the medical system can be shaken.

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[82] Mao, Liang, Yang, Yang, Qui, Youliang, and Yan Yang. 2012. Annual economic impacts of seasonal influenza on US counties: Spatial heterogeneity and patterns. *International Journal of Health Geography* vol. 11 no. 16. Accessed online on 6/28/19 from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3479051/.

Regional Risk Profile: Landslide

Hazard Description

The term "landslide" covers a range of geomorphic processes in which masses of soil, rock, debris (a mixture of soil and rock) become detached and move downslope. This mass is usually wet, saturated, or suspended in water. This movement can happen quickly or slowly; displaced material can remain solid or move as a liquid. Landslides can range in size from a few cubic yards to millions of cubic yards. The detailed character of movement is referred to herein as the landslide style. The style of landsliding depends on the local geology, topography, and hydrology in the vicinity of the failure. Five general styles of landslide phenomenon have been identified in King County:[83]

- Deep-seated landslides (including rotational slides, liquefaction spreads, debris flowslides,
- debris avalanches, and rock compound slides),
- Shallow debris slides,
- Processes that build depositional fans (including debris flows and debris floods),
- Rock fall, and
- Rock avalanches.

Landslides are usually a secondary hazard, typically driven by precipitation. Smaller and shallower landslides are often triggered by storm events lasting hours or days. Large deep-seated slides may be triggered by wetter than normal conditions that persist for months. Historical records and geologic evidence also show that large earthquakes, while relatively infrequent can be significant landslide triggers. Landslides can also be triggered by ill-advised clearing, grading, or stormwater discharge. Landslides tend to happen in areas where there is a history of previous occurrences. Another major determinant of landslide risk is local geology. King County's landscape is very young and is largely a product of multiple glacial advances over the last two million years, with the most recent advance approximately 14,000 years ago. Landslides are most common where post-glacial erosion has created steep slopes in glacial deposits, primarily along beach bluffs, ravine slopes, and river valley walls. In addition to areas of steep slope some areas of lower slope are actually old, deep-seated landslides which may be at risk of reactivation. Characteristics of landslide hazard areas include:[84][85]

- A slope greater than 40 percent
- Landslide activity or movement in the last 10,000 years
- Stream or wave action with erosion or bank undercutting

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[83] King County. 2016. Mapping of Potential Landslide Hazards along the River Corridors of King County, Washington. Prepared by River and Floodplain Management Section, Water and Land Resources Division, Department of Natural Resources and Parks. Seattle, WA. August.

[84] Federal Emergency Management Agency. 2018. King County Risk Report: Landslide Exposure Assessment. Page 52.

[85] Washington State Emergency Management Division. 2018. Washington State Enhanced Hazard Mitigation Plan Risk Assessment. Page 308.

- The presence of a depositional fan that may indicate a history of debris flows, debris floods, or rockfall
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel

Landslides are dangerous and unpredictable. Some landslides may show indications of impending or incipient movement; others may happen suddenly without any warning signs. Warning signs of a potential or impending landslide include:[86]

- Rapidly growing cracks in the ground; downslope movement of rock, soil, or vegetation.
- Sudden changes in creek water levels, sometimes with increased sediment, especially during or right after large or protracted storm events
- Sounds of cracking wood, knocking boulders, groaning of the ground, or other unusual sounds, especially if the sound increases
- A hillside that has increased spring and (or) seep activity, or newly saturated ground, especially if it was previously dry
- Formation of cracks or tilting of trees on a hillside
- New or developing cracks, mounds, or bulges in the ground
- Sagging or taut utility lines; leaning telephone poles, deformed fences, or bent trees
- Sticking windows or doors; new and (or) growing cracks in walls, ceilings, or foundations
- Broken or leaking utilities, such as water, septic, or sewer lines
- Separation of structures from their foundation; movement of soil away from foundations
- Changes in water well levels or water wells that suddenly run dry

Vulnerability Characteristics and Previous Occurrences

The most significant landslide risk in King County is during the rainy season from November through January.

Areas in the County most at risk from landsliding include those on or near coastal bluffs, ravine and valley slopes, and in steep mountainous topography. Parcels on slopes greater than 40 percent are at an elevated risk of landsliding compared with more level sites. The landslide risk assessment used WA DNR Landslides and Landforms digital data identifying historic landslide areas, potentially unstable to intermediate-sloped areas, and potential deep-seated landslide areas.

Since 2006, there have been seven disaster declarations impacting the county, including DR-4168 for the SR 530 (Oso) landslide in Snohomish County. Landslides occur during virtually every major storm event and earthquake. Landslides are especially likely in areas where they have been recorded before. A good method of assessing likelihood of a future landslide is to know if the area has had a history of landslides.

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[86] Washington State Department of Natural Resources. 2017. Landslide Hazards in Washington State. Accessed online on 6/7/19 from https://www.dnr.wa.gov/publications/ger_fs_landslide_hazards.pdf?h283k.

- 2001 – DR1361 – Nisqually Earthquake triggers landslides around the state. $66.7M in Public Assistance was authorized.
- 2006 - DR-1737 – Severe storms trigger flooding and landslides. $29.5M in Public Assistance (statewide) was authorized along with $5.4M in Individual Assistance.
- 2007 – DR-1734 – Severe winter storms trigger landslides. $61.3M in Public Assistance was authorized along with $21.2M in Individual Assistance.
- 2009 – DR-1817 – Sever winter storms trigger flooding and landslide.
- 2011 – DR-1963 – Severe winter storms trigger flooding and landslides.
- 2014 – DR-4168 – A slope along SR 530 in Snohomish County fails, bringing with it an entire neighborhood and killing 43 people. This is one of the deadliest disasters in Washington State History. There is a long history of landslides in this area and the tragedy leads the state to invest in a new landslide mapping program.
- 2012 – DR-4056 – Severe winter storms trigger flooding and landslides. $30.1M in Public Assistance was authorized.
- 2017 – DR-4309 – Severe winter storms trigger flooding and landslides. $12.5M in Public Assistance was authorized.
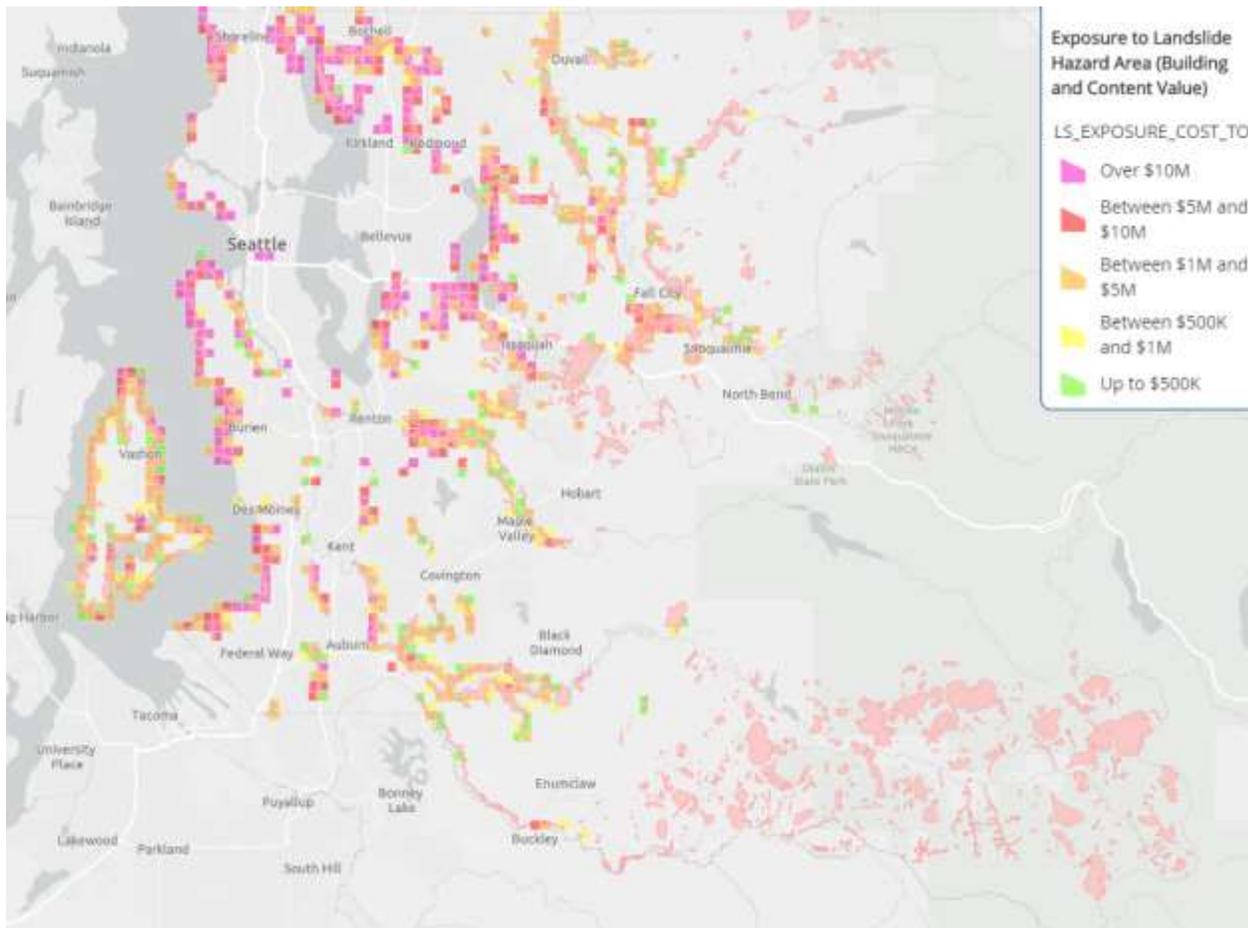
Scenario Drivers[8788]

For planning purposes, King County looks at three common or particularly deadly landslides. These usually result after major weather events or due to human activities or other disturbances such as a major wildfire.

Deep Landslide
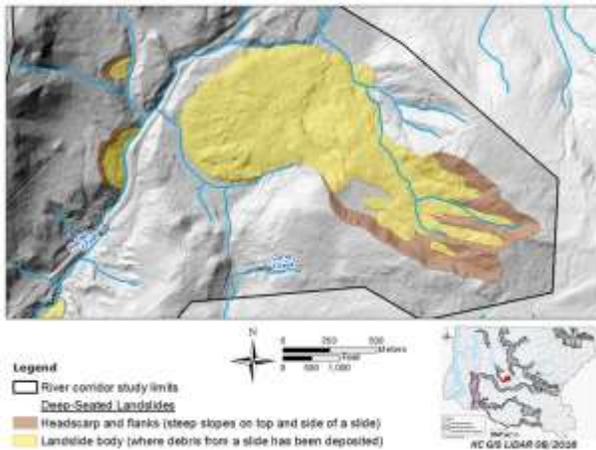
Deep-seated landslides are those that fail below the rooting depth of trees and vegetation. They are often slow moving but can also move rapidly. Deep-seated landslides can cover large areas and devastate infrastructure and housing developments. These landslides usually occur as translational slides, rotational slides, or large block slides. Deep-seated landslides are typically much larger than shallow landslides, in terms of both surface area and volume. A deep-seated landslide may appear stable for years, decades, or even centuries. These long-lived features can be partially or entirely reactivated for a variety of reasons.

Debris Flows
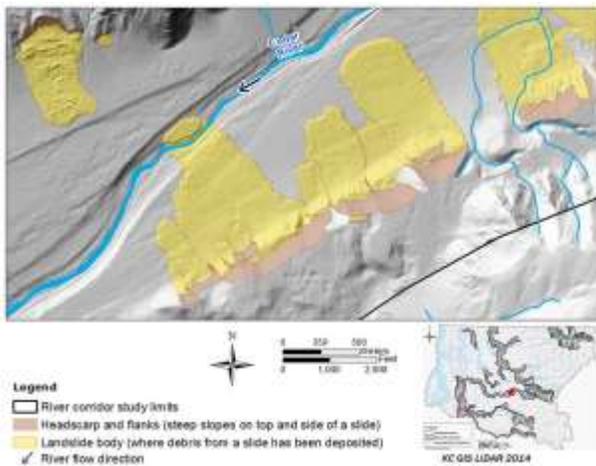
Debris flows usually occur in steep gullies, move very rapidly, and can travel for many miles. Slopes where vegetation has been removed are at greater risk for debris flows and many other types of landslides. The figure shows a series of flows located in the Cedar River Watershed. The ages of these slides are unknown, but they are geologically very young as they overlap (and therefore post-date) the entire suite of river terraces present here. The exact trigger for this assemblage of large, closely spaced landslides is unclear.

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[87] King County Department of Natural Resources and Parks. Landslide Hazards Program website. Accessed online on 6/7/19 from https://www.kingcounty.gov/services/environment/water-and-land/flooding/maps/river-landslide-hazards/landslide-types.aspx#Debris.
[88] Washington State Geologic Survey. Landslide Hazards Program website. Accessed online on 6/7/19 from https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/landslides#types-of-landslides.8

Shallow Landslides

A thin layer of soil and debris moves rapidly down a steep slope.
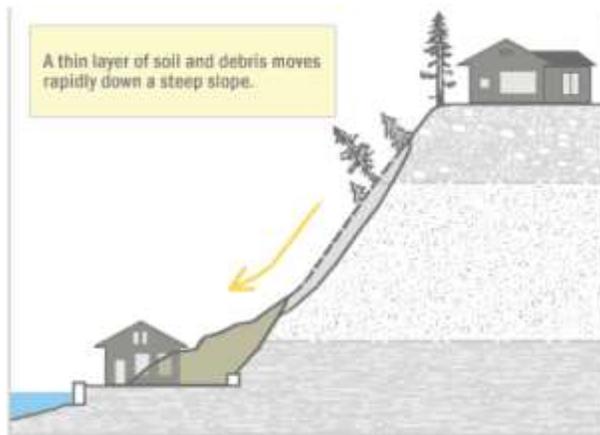
Shallow debris slides (also known as shallow landslides) are a common style of slope movement both in the Puget Lowland and Cascade Mountains. Shallow debris slides are characterized by failure of a relatively shallow layer of soil typically sliding on a surface of more competent material, either bedrock or dense glacial sediments. Shallow debris slides are typically 3 to 6 feet (1 to 2 meters) and translational. Shallow colluvial soils on slopes are formed through a variety of processes, including breaking up of the underlying in-place substrate (either bedrock or Quaternary sediments) by freeze/thaw, wetting/drying, bioturbation, and chemical weathering. Soils on steep slopes in King County vary significantly with respect to soil thickness, soil strength, and hydraulic properties; this variability presents the central challenge in assessing their stability across a landscape.

Priority Vulnerabilities

Homes built above, on, or below bluffs or slopes	Homes built on bluffs or other slopes apply addition weight to a slope and increase the likelihood of slope failure. Homes built below bluffs have also been destroyed by slope failure.
Transportation corridors, including on I-90 and Seattle-Everett BNSF rail line	Transportation routes are often cut through steep areas or travel through valleys with a history of landslides.
Debris flows after vegetation removal	Vegetation removal due to logging, land development, view clearing, or wildfire reduces the root strength that often anchors and reinforces shallow soils. Shallow landslides often increases following vegetation removal and if debris from such a slide enters a hillside swale it may transition into a debris flow that can have devastating impacts far below and distant from the initial failure.
Coseismic Landsliding	This Risk Profile addresses primarily landsliding for which our region has significant collective experience. This includes of landslides triggered by weather events and human disturbance. Geologic evidence is clear that this region is subject to earthquakes from several sources larger than those that have been well documented in the historical record. Widespread landsliding

is likely to be a secondary but significant and potentially catastrophic consequence of a future occurrence of such a large earthquake [xx].

Priority Impact Areas

King County residents	While the total number of people exposed to landslides is relatively small, and the risk of a rapid slope failure has tended to be low, many homeowners do not carry insurance to cover losses from landslide hazards. The total number of people exposed to the landslide hazard is unknown since landslide hazards are spatially limited and do not align with population information in Census data.
Vulnerable populations	No additional impacts to vulnerable populations are expected from this hazard.
Property	In total, 2.6 percent of structures in King County are identified as being within a landslide hazard area, resulting in an estimated $9.8 billion in exposed value. The City of Lake Forest Park has the highest percentage of structures exposed in a landslide hazard area at 16.4 percent. The cities of Bellevue and Seattle and unincorporated King County are estimated to each have over $1 billion of estimated exposed value within landslide hazard areas.[89] The slopes of Magnolia, West Seattle, Burien, Des Moines, Vashon Island, Newcastle, Federal Way and many areas of Bellevue have long been developed for their magnificent views of Mount Rainier, the Cascade and Olympic Mountains, and Puget Sound. Homes with vistas of the Olympic Mountains provide sunsets that are breathe taking – and expose a risk of land movement damages to property build on poor soils.
The economy	There have been direct and indirect impacts to the greater King County community from landslide activity. Residential housing in the greater Puget Sound area that have been built to enjoy the spectacular mountain of the Olympics and Cascade ranges and water views of Lake Washington, Lake Sammamish, and Puget Sound are vulnerable to land movement. Loss of transportation can also have economic impacts. In November 2008, State Road 410 was closed as the result of a debris flow east of Enumclaw. A landslide caused damage to the Green River Bridge on State Route 169 that resulted in the bridge being closed for repairs for eight months. These incidents resulted in SBA loans to

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[89] Federal Emergency Management Agency. 2018. King County Risk Report: Landslide Exposure Assessment. Page 52.

[xx] A scenario study of seismically induced landsliding in Seattle using broadband synthetic seismograms

Allstadt, K., Vidale, J.E., and Frankel, A., 2013, A scenario study of seismically induced landsliding in Seattle using broadband synthetic seismograms, Bull. Seism. Soc. Am., 103(6), 2971-2992

	impacted businesses. The SR 530 Oso landslide caused a complete reroute of the main highway between Everett and Darrington, devastating the local economy and forcing residents to commute several hours longer to work each day.
The environment	Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods of time due to landslides. However, landslides also provide integral resources for many ecosystems. They contribute needed gravel and sediment or wood for building complex in-stream habitats, estuarine marshes, and beaches that are important for fisheries, wildlife and recreation. The Cedar River was partially dammed by slide debris from the Nisqually Earthquake in 2001. Similarly, in March of 2004, a landslide near Renton partially dammed the Cedar River again. All major rivers in King County support salmon and/or steelhead spawning populations.
Health systems	No special impacts to health systems are expected from this hazard.
Government operations (continuity of operations)	Most impacts to King County delivery of essential services are indirect. Roadways closed may impede the county work force from reaching work locations. Transfer stations for solid waste management and sewer lines and lift stations feeding the Metro South Plan, West Point Treatment facility or Brightwater facility may be impacted by slide activity. Only a small number of bus routes use roadways with the potential for impacts by slide activity. Slide activity has resulted in first responder access issues and diverted road and infrastructure maintenance resources. Resulting detours have also impacted the commute of essential workers to their normal work locations. Some slide activity has caused temporary access issues for solid waste transfer stations and to the Cedar Hills Landfill locations.
Responders	Most commonly, homes are isolated and ready access to communities by first responders is impeded by slide activity. Access to schools, businesses, and public services may be impeded by road blockages from slide activity. While no recent deaths or injuries have been reported in King County from land movement, the incident in Snohomish County referred to as the SR 530 Slide or the Oso Slide, 43 people were killed (2014).
Infrastructure systems	• Power: Landslides pose some risk to transmission lines that cross unstable slopes. Otherwise, landslides are not a primary concern for this sector. • Water/Wastewater: Landslides or debris flows in and around reservoirs or waterbodies that support water systems can cause disruptions in water services and the loss of infrastructure. Water supply pipelines may cross unstable areas and be damaged by slope movement. Even if not directly impacted by earth movement, systems that pull water directly from impacted waterbodies will have to deal with increased turbidity or a loss of supply if the water is temporarily cut off by earth damming or rerouting a river. Finally, failures in water system transmission mains can actually saturate a slope and trigger landslides.

- Transportation: Transportation routes can be closed for long periods by landslides and rockslides. The following are some documented incidents. In November 2008, State Road 410 was closed as the result of a debris flow east of Enumclaw. A landslide caused damage to the Green River Bridge on State Route 169 that resulted in the bridge being closed for repairs for eight months. These incidents resulted in SBA loans to impacted businesses. In May 2005, 11 homes were isolated after a small slide on Mercer Island. That September, two lanes of I-90 west of Snoqualmie Pass were closed after a rockslide. A January 15, 1997 slide at Woodward in southern Snohomish County derailed five cars of a freight train. Passenger and cargo rail traffic was interrupted for nine days. Cargo traffic resumed first. Amtrak remained concerned for passenger safety and did not travel on this section of track for several weeks. This type incident can happen almost annually and sometime more than once each year.
- Communications: There is limited risk to communications systems as a whole from landslides. Given the redundancy in systems and proliferation of cell towers, which tend to be less vulnerable, landslides are not a primary concern.

Public confidence in jurisdiction's governance and capabilities	The 2014 SR 530 Oso landslide demonstrated some of the major weaknesses in emergency management capabilities. It also demonstrated a lack of regulation and foresight on the part of government in the permitting of development in the area, which was a known slide area. Local critical areas ordinances do require mitigation for construction in slide hazard areas, but in the Oso slide, this proved to be inadequate. A failure by develops, the government, and residents to properly account for slide risk and protect people from it led to multiple lawsuits and a general lowering of public confidence in government's ability to properly regulate land development.

Regional Risk Profile: Severe Weather

Hazard Description

Severe weather events occur annually in King County, especially between October and April. Severe weather can include heavy rain, snow, and ice; drought; extreme heat and cold; and high winds. Secondary effects of severe weather can include avalanche, flooding, landslides, power outages, and increased demand on medical services such as during extreme heat events. Many of these events are expected to increase in frequency, duration, and/or intensity as the climate changes, and new weather hazards are growing in importance, especially heat and drought. The most frequent impacts from severe weather events are in the rural or suburban parts of the county, where it can take days or weeks to clear roads or restore power; however, events such as extreme cold or heat have a greater impact on urban parts of the county, where there are large unsheltered populations.

The most common source of damaging/severe weather is the Pineapple Express or atmospheric river event. This phenomenon results from moisture picked up by the jet stream over warm areas of the Pacific Ocean that drops as intense precipitation when the moisture-laden air rises over the Olympic and Cascade Mountains. Atmospheric river events are a significant contributor to river flooding in King County.

Vulnerability Characteristics and Previous Occurrences

Though known for being wet, the Seattle metro area has around the same average annual precipitation as Dallas, Texas, and much less than New York City, Houston, Atlanta, or New Orleans. Higher amounts of rainfall occur as you move closer to the Cascades. King County owes its mild climate to the influence of Puget Sound and the Pacific Ocean, which moderate the climate, and to the protective barrier of the Cascade mountain range, which blocks cold air from the interior.
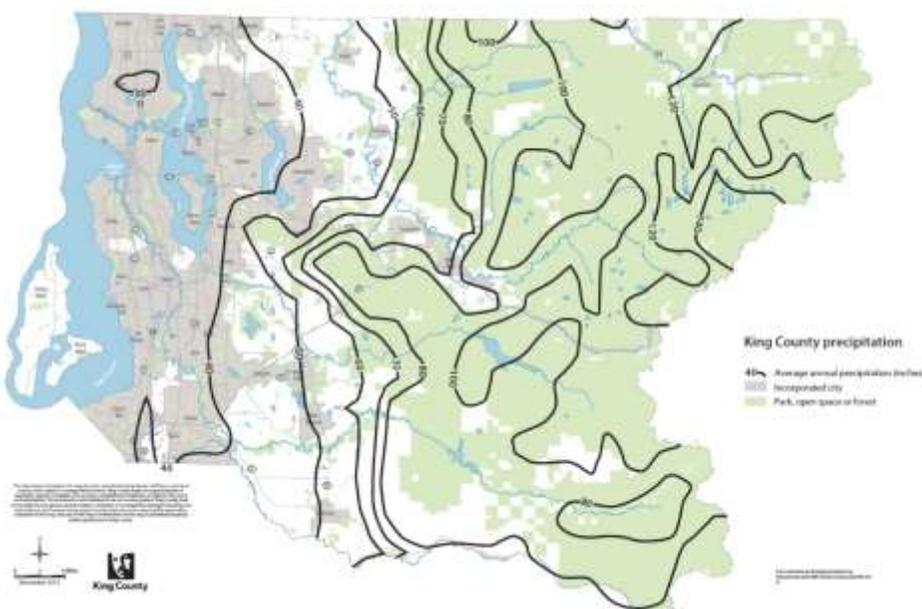
Given the rarity of extreme snow events, King County maintains a relatively low budget for snow removal services. When major incidents do occur, vehicles and drivers can be stranded almost anywhere in the county. Impacts from unusually heavy snowfalls and severe winter weather in King County tend to be short-lived, although there are exceptions. A well-known example is the 2008 winter storm, the largest event since 1996. In the 2008 'Seattle Snowpack,' snow blanketed Seattle and much of King County and remained on the ground from December 13 to December 27 due to a prolonged period of cold temperatures. At the time, Seattle did not use salt to clear roadways, due to environmental concerns. This decision was reversed after the storm event.

Climate change is a major concern for King County. Climate change is projected to lead to drier, hotter summers and more heavy rain events. The consequences of these events can include floods, landslides, avalanches, droughts, and wildfires. The economic consequences can be serious since communities generally are not prepared for extreme weather events, and some events (such as flooding and wildfire) can have widespread impacts on public and private infrastructure. Extreme weather can also affect public health. For example, some climate scenarios project that hundreds of Seattleites could die in each extreme heat event if global temperatures rise 5.4 degrees Fahrenheit over pre-industrial levels.[90]

The majority of disaster declarations in King County are from severe weather events. Disasters are usually declared for a combination of severe storms or winter storms, mudslides, heavy rains, and straight-line winds. The primary impacts and costs triggering these declarations include emergency protective measures for, and damage to, utilities, roads, and bridges, and for costs associated with debris removal.

Major Weather Disaster Declarations Including King County

DECLARATION NUMBER	DESCRIPTION	FEMA-APPROVED DAMAGES (KING COUNTY ONLY)
852	1990, Jan - Flooding	$5,246,411
883	1990, Nov - Flooding	$3,694,824
896	1990, Dec – Flooding	$477,737
981	1993, Jan – Inaugural Day Wind Storm	$1,927,837
1079	1996, Jan – Winter Storm	$3,031,519
1100	1996, Feb – Flooding	$4,226,719

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[90] Bush, Evan. June 14, 2019. Seattle unprepared for deadly heat waves made worse by global warming, researchers say. *The Seattle Times.* Accessed online on 6/17/19 from: https://www.seattletimes.com/seattle-news/environment/heat-waves-could-kill-hundreds-more-in-seattle-as-globe-warms-researchers-say/.

1159	1997, Jan Winter Storm	$3,576,309
1172	1997, April – Flooding	$1,266,446
1499	2003, Nov – Flooding	$4,400,000
1671	2006, Nov Flooding	$16,000,000
1682	2006, Dec – Hanukkah Eve Windstorm	$29,000,000
1734	2007, Dec – Winter Storm	$72,500,000
1817	2009, Jan – Winter Storm	$17,000,000
1825	2009, Mar – Winter Storm	$5,500,000
1963	2011, Feb – Winter Storm	$8,697,563 (Statewide)
4056	2012, Feb – Winter Storm	$32,345,445 (Statewide)
4309	2017, Feb – Winter Storm	$26,612,080 (Statewide)

King County Drought Declarations

YEAR	DESCRIPTION	DESCRIPTION
1919	Water Shortage	Dry summer
1928-30	Statewide drought	Rainfall was 20% of normal
1952-53	Water shortage	Lack of winter precipitation
1977	Severe to Extreme Drought	Low Precipitation
1965-66	Water shortage	Dry throughout state
1967	Water shortage	Dry summer
2001	Moderate to Severe Drought; statewide	Low Precipitation
2005	Water shortage, March – King Co Drought Response Plan Activated	Record Low Precipitation, low snow pack, low river levels

| 2015 | Water shortage record low snowpack | Snow pack at 0 in central Puget Sound by mid-May |

Scenario Drivers

Severe weather can occur in any season. This may include: rain, wind, tornados and funnels clouds, ice, snow, hail, extreme heat, or extreme cold. Climate change is expected to affect extreme weather incidents by changing the frequency, intensity, and/or severity of events.

| Rain and Snow Precipitation | The geographical location of northwestern Washington subjects it to several natural climatic controls: the effects of terrain, the Pacific Ocean, and semi-permanent high- and low-pressure regions located over the North Pacific Ocean combine to produce significantly different weather conditions within short distances. Rainfall in King County varies widely from city to city and area to area. The City of Seattle has an average of 37 inches annually, while Enumclaw has an annual average of 57.9 inches and Snoqualmie/North Bend has 61+ inches of precipitation. The majority of this precipitation occurs as rain in the lowlands between October and early May with substantial snow pack in the Cascades during the same time frames. Precipitation on Snoqualmie Pass in the unincorporated community of Hyak (2800 feet) average 410 inches of snowfall from October to May.

Snow accumulations in King County at elevations below 2,000 feet are uncommon. On average, Seattle will have one or two snow storms during a winter season with appreciable accumulations. Snow accumulation rarely remains two days after such a storm. Heavy local snows and associated cold conditions have resulted in power outages, transportation system impacts, school closures, and adverse impacts to the regional economy. |
| Wind | High wind events in King County are fairly common and are usually experienced as part of a winter weather pattern. Annually, wind gusts of 40-45 miles per hour are recorded locally (NOAA) with severe wind incidents recording speeds of 90 miles per hour and greater. Winter wind incidents often include: widespread power outages, road and bridge closures, tree damage, airport closures/re-routing, hospitalizations or fatalities related to carbon monoxide poisoning, and injuries to utility workers, first responders, and the public. One of the best known wind events was the Inaugural Day Windstorm on January 19, 1993. Winds began mid-morning, lasted five hours and reached over 90 miles per hour in downtown Seattle. The Hanukkah Eve Windstorm of December 15, 2006 heavily damaged the Seattle area power grid, affecting hundreds of thousands in the subsequent weeks. Usually, these damaging winter winds are from the south. |

Tornado	King County and the Puget Sound region do experience tornado activity. Tornados have reached F3 designation within the region, but the slower F0 and F1 class tornados are more common. In September of 2009 the Enumclaw area experienced a class F1 tornado. Though wind speeds of up to 110 mph were estimated, the most substantive damage recorded was the uprooting of trees and damage to roofs, much of which could be attributed to the preceding storm. Tornados are a result of strong weather systems and often times accompany serve wind, rain, and hail. It is not unusual to have funnel clouds spotted during the winter season.
Extreme Cold and Ice	King County's marine climate results in very few extreme cold/ice events. Regionally, temperatures below freezing occur for extended periods for 10-14 consecutive days in January or February each winter. Transportation impacts to buses, trains, roads, bridges include snow routes, shelter needs, and power outages. The December 26, 1996 storm lasted 11 days. Multiple consecutive freezing days can threaten the lives of unsheltered and lower-income individuals, requiring the opening of additional shelter beds or more heating assistance funding.
Extreme Heat	Climate change is expected to lead to warmer winters and hotter summers. Health sensitivity to heat events is higher in the Puget Sound region due to the lack of air conditioning in our region. Public Health Seattle-King County will activate cooling centers and public messaging for multiple days in the mid-80s.
Drought	With the anticipation that higher winter temperatures reduce our snowpack, drought conditions in the summer following low snowpack rises dramatically. Lower snow pack and drier summers can result in lower reservoirs and increased calls for water conservation, reduced water availability and higher mortality for salmon and steelhead runs (due to high water temperature and low river flows), impacts on local crops and livestock, and increased emergency room visits due to heat stress. Some degree of drought conditions exists where precipitation is less than 75% of normal. Drought has become a growing concern in the Northwest both because of variable rainfall patterns and because of observed increases in temperature in the summer. With a higher risk of drought and hotter temperatures, wildfire has become a higher risk for King County.

Priority Vulnerabilities

Unsheltered populations	Populations needing shelter are especially exposed during heat and cold events. Since King County has a moderate climate, many of these populations are unprepared. Cold events may require opening additional shelter spaces and canvassing areas to offer shelter services.
Rural transportation corridors	Rural transportation routes are lower priority and may not even be cleared at all during a snow event.

Immigrant populations and those with limited English proficiency	Populations with limited English proficiency or who are inexperienced with Northwestern climate are more likely to take risky actions, like operating a generator or grill indoors for heat. These populations are also less likely to receive information and warnings about weather systems and to know where to go for help.
Power transmission systems	Power transmission systems, especially power lines, are frequently damaged during storms with high winds by falling trees. During major wind events, it is not uncommon to have hundreds of thousands of residents without power.
Low-income and minimum-wage populations	Populations working in low-wage professions such as extractive industries and service industries can be severely impacted from multi-day weather events that impact transportation systems. These events can trigger a long-term decline in living standards or even homelessness in these populations.
Service industry during peak periods	Many service businesses, especially retail, are heavily dependent on income earned during certain months of the year. A major event around the Christmas holidays, for example, can threaten the viability of many businesses.
People dependent on public transportation	Public transit moved to the most restrictive routes ever recorded during the February 2019 snowstorm. These cutbacks had apparent disproportionate impacts on underserved areas, including some areas with populations dependent on transit. When transit services are cut, it can be impossible for these populations to get to work or appointments.
People with chronic medical conditions	People requiring regular care from doctors are negatively impacted by severe weather events. During heatwaves, people with chronic illnesses, especially heart and respiratory conditions, are also disproportionately impacted.
All residents during multi-day events	Although campaigns recommend having two weeks of food and supplies available, few residents follow this guidance, regardless of income. After more than a few days, many residents will run out of food for themselves and any pets.
Residents down private roads	Private roads are not eligible to be cleared by public snow removal services. Many homeowner's associations contract with the same set of snow removal companies. These companies may become overwhelmed during long-running events.

Water and wastewater systems facilities	Damage to water and wastewater facilities can occur due to a secondary hazard, flooding and tidal surge. These facilities are often built in low-lying areas. The severe damage and release of untreated water that occurred at King County's West Point Treatment Plan occurred during a severe weather event.
Buildings on slopes of greater than 40% grade	Landslides are a major secondary hazard of severe precipitation events. Buildings on or near slopes of greater than 40% grade are most at-risk.
Travelers at airport facilities	Airport facilities are frequently impacted by severe weather events, but often have plans and procedures to contain disruption. During multi-day events, however, passengers can be stranded and there can be a shortage of hotel rooms since many airlines contract with the same hotels.
Waste Management	Garbage pickup can be delayed for weeks. This causes significant public frustration.

Priority Impact Areas

King County residents	Anyone present in King County at the time of a weather incident is subject to the potential impacts of severe weather incidents. While the likelihood of a winter weather incident is high, the likely of direct and significant impacts is Moderate. Impacts to residents may include: personal property damages, interruption of sports and recreation, extension of the daily business commute, impacts to daycare and school closures, injuries, and sheltering needs from power outages. Avalanche control may be needed to reduce the impact to alpine and cross-country skiing enterprises. Injuries and deaths do occur from avalanche impacts to recreational skiers. Impacts from drought take time to materialize as water shortage cause restrictions to water usage and issue of burn bans to reduce the threat of wildfires, especially in suburban areas. Only the most severe weather incidents have an impact on local employment.
Vulnerable populations	Severe weather events, while usually concentrating impacts on infrastructure and agriculture, can seriously threaten the lives of vulnerable people. Cold and hot weather events can lead to an increase in fatalities among the elderly and homeless populations. Immigrant and low-income populations also have been known to succumb by carbon monoxide poisoning that can occur when generators or grills are lit indoors and without proper ventilation. Snow can trap people indoors for days, something especially threatening for people with food insecurity or chronic health conditions that require access to medical services. Any disruption to the economy is also especially threatening to those who are low-income or who work in hourly work or in the service

	sector. When those jobs are not open, they frequently do not pay wages, which can threaten the entire livelihood of a low-income family.
Property	All structures in the county are subject to the direct impacts of severe weather incidents. These same structures are subject to flood impacts where they may be in the flood plain. Structures along the coastline (seawalls) may be eroded. Local urban flooding also occurs from storm debris clogged sewers.
	High winds that accompany winter weather fronts often cause infrastructure damages, power outages, and communications interruptions. Rain saturated soils may cause mudslides that close roadways, damage bridges, and buried rail service interruptions
	Private property damages to homes and vehicles from floods, trees downed from wind and saturated soils are regular occurrences. Private property experiencing repeated flood damages may require elevation of the structure or offers of buy outs (mitigation efforts).
	High winds, snow, and icy conditions can close airports or cause flight delays and rerouting. Mountain pass conditions may be so severe that they are closed to all traffic for days at a time. The floating bridges over Lake Washington (I-90 and SR 520) experience closures for sustained winds over 45 miles per hour. These closures extend the business commute with increased traffic on surface streets and routes around Lake Washington.
	Impacts to emergency medical services from impacts to the roadways of the county can delay response times, restrict emergency room staff and supplies, and result in under staffing EMS and hospitals during severe weather emergencies.
The economy	There are several local ski areas important to King County: Crystal Mountain (Chinook Pass); Alpental, Hyak, and Ski Acres (Snoqualmie Pass); and Steven's Pass (Steven's Pass). Ski area closures can occur from both large snowfalls and where snow is too light or melts off. This can impact seasonal employment at the ski areas.
	Also associated with the passes, as outlined in the avalanche chapter, a WSDOT study claimed that a four-day closure at Snoqualmie Pass in the winter of 2007/2008 cost the state $27.9M in economic output, 170 jobs, and $1.42M in state revenue (2008 dollars).
	Businesses can be severely impacted when weather events impede mobility during high seasons, such as around the holidays. Since a large percentage of

	annual personal spending is spent during the November-December season, negative weather limits access to stores and can cause stores to close. Drought conditions can impact the regional agricultural output of fruits, vegetables, and flowers grown in all the major river basin areas of King County. Regional drought conditions can impact generation of hydroelectric power and drive up electric rates as well as increase usage during hot summers. The most serious and longest-lasting impacts may be to low-income individuals and families who may lose jobs or days of wages due to snow closures. Debt traps caused by missed bills due to lost wages can damage a family for months or years.
The environment	Severe weather can have impacts to the environment through flooding and floodplain damages to salmon and steelhead habitat, wetland impacts to amphibians and reptiles, and bird sanctuaries. Oddly, this can occur from both too much water (flooding or dam failure) or too little snow pack and resulting drought conditions. Hillside destabilization can occur where soil geology and saturation of soils occur. The moisture content of vegetation drops throughout the summer. Dry conditions can result in an increase in the threat of wildfires from lightning strikes, unattended campfires, fireworks, sparks from automobiles, cigarettes thrown from cars on roadways and other heat sources. The dilemma of drought conditions is the balance between human water needs and the protection of the environment including plants, wildlife, and fish that require minimum stream flows to support their annual spawning migrations. Dry conditions also contribute to higher water temperatures, which causes increased salmon mortality.
Health systems	Severe weather disrupts the regular schedule of patient visits and regularly-scheduled appointments for chronic care. Severe weather also can cause more demand on the health system as people are injured or are unable to leave the hospital to return home. Any disruptions to electricity and water supply also can be a threat, though hospitals generally maintain backup generators. During severe cold or warm spells, public health may be required to provide additional patient transport services and to canvass for homeless populations that may be in need of shelter. During the February 2019 snowstorm, hospitals suffered major staffing shortages as doctors and nurses were unable

	to get to work. Staff had to work longer than normal hours and potentially stay temporarily at or near the hospital. Although both requiring the expansion of sheltering services, heat and cold differ because older and less health populations are especially at risk to hot temperatures. One of the most famous examples is the 1995 Chicago heat wave, during with 739 people lost their lives, with the city unprepared to provide support to residents who may be home bound or offer sufficient cooling centers to support residents. In Seattle, where few residents have air conditioners, deaths from heat events is a growing threat.
Government operations (continuity of operations)	During the February 2019 snowstorm, King County took the unprecedented step of closing many government offices to protect employee safety. After two days, due to the growing amount of snow and the need to resume services, offices were reopened. Even with the reopening, many employees chose to telework due to safety concerns. An earlier activation of the EOC for the 1996 snow/ice storm saw activations for 11 days – 2 shifts per day when 16 inches of snow came and stayed for weeks. During that time frame, buses were on snow routes, up to 40% of the employees for King County government were either unable to get to work or arrived very late. A major improvement from 1996 to 2019 is that it is now much easier to telework, meaning that non-public-facing positions can work remotely for days. Hospitals, courts, detention facilities, businesses, law enforcement, fire and emergency medical services were all severely impacted. Search and Rescue volunteers transported medical personnel, emergency management staff, and other essential employees to work and between hospitals for the duration of the incident. During the February 2019 snowstorm, busses were on the most restrictive service routes ever seen. These routes were established in response to previous snow events. Similar impacts were observed for the January 2011 snow storm that impaired King County government operations for 8 days. Some damages were experienced at crucial facilities around the county. See FEMA Disasters 1079 and 1817 above. The recent February 2019 snowstorm did not receive a disaster declaration. During that time frame, most regional public services were impacted by absenteeism, access restrictions to critical facilities, and damage to vehicles like buses, police cruisers, and aid units. Busses and other vehicles that use tire chains are especially vulnerable to breaking down, which can delay a return to full service, even once the snow has melted.
Responders	Portions of the population may be stranded or isolated from the results of severe weather, like roads blocked by trees and power lines, snow- and ice-

	covered roads, water or slides over roadways. Closure of the mountain passes for heavy snow conditions or avalanche control is a fairly common occurrence. Excessive heat that extends over days or weeks or cold conditions for similar timeframes may result in the need for cooling or warming shelters. These especially impact the poor, elderly, young, and infirmed. First responders will be impacted by limited road access, impacts of heat and cold on operations. Conditions will require monitoring efforts during incident response.
Infrastructure systems	• Power: Downed trees caused by high winds and rain saturated soils can damage transmission lines and cause power outages in local areas for hours to days when multiple occurrences are experienced. Utility crews from Puget Sound Energy, Bonneville Power and Seattle City Light work around the clock to restore services. The Inaugural Day Windstorm left 750,000 customers without power. The Hanukkah Eve Windstorm winds and subsequent heavy rains cut electricity to more than 1.8 million customers, hundreds of thousand remained without power for days. Downed power lines pose an electrocution hazard to motorists, pedestrians and any unsuspecting by-standers. During extremely hot temperatures, demands on the power system can increase, especially as more residents install air conditioning. As a winter-peaking system, however, this power demand will still likely be lower than current winter demand. • Water/Wastewater: Water and wastewater systems are vulnerable to a multi-day loss of power as well as to serious flooding. In February 2017, as a result of heavy rains, high tides, and other severe weather, an equipment failure at King County's West Point Wastewater Treatment Plan led to the dumping of over 235 million gallons of untreated wastewater into Puget Sound. Drought can also impact water systems as water levels in reservoirs and groundwater wells drop. • Transportation: Events that impact transportation can include severe snow, ice, wind, and rain. Storms may cause downed trees and snow or ice that temporarily blocks roadways or can cause large floods that can wash out or undermine roads and bridges. For many parts of the state and county, such as around the town of Skykomish, the loss of a single route due flooding can completely cut the community off from the rest of the county. This is especially a problem in the eastern parts of the county that are more rural and have fewer transportation route options. • Communications systems can be knocked out by high winds or loss of power transmission. While the move to cell phones has reduced the vulnerability of telephone lines to outage caused by trees, a multi-day loss of power can still shut down a cell transmission site. Furthermore, high winds can damage or destroy critical equipment

	on cell towers. Most equipment is built to withstand inclement weather; however, especially severe conditions could still lead to outages.
Public confidence in jurisdiction's governance and capabilities	The 2008 and 2011 snowstorms highlighted the shortage of snowplows and the management of the general response to the snow incident in the City of Seattle. The February 2019 event can be regarded by many as much more successful on the public perception front. Successful coordination of a regional call center in the EOC to support other county departments and take snow plowing requests helped ensure the public always had someone to call. The county also maintained substantial engagement with media outlets. The County Executive was fully involved as well, helping to boost awareness and public perception that county government was engaged in the storm recovery effort.

Regional Risk Profile: Terrorism

Hazard Description

Title 18 of the United States Code defines terrorism and lists the crimes associated with terrorism. In Section 2331 of Chapter 113(B), defines terrorism as: "…activities that involve violent… or life-threatening acts… that are a violation of the criminal laws of the United States or of any State and… appear to be intended (i) to intimidate or coerce a civilian population; (ii) to influence the policy of a government by intimidation or coercion; or (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping; and…(C) occur primarily within the territorial jurisdiction of the United States…" . Within the government, combating terrorism is the Federal Bureau of Investigation's top investigative priority. The FBI further defines terrorism as either domestic or international:

- Domestic terrorism: Perpetrated by individuals and/or groups inspired by or associated with primarily U.S.-based movements that espouse extremist ideologies of a political, religious, social, racial, or environmental nature.
- International terrorism: Perpetrated by individuals and/or groups inspired by or associated with designated foreign terrorist organizations or nations (state-sponsored).

The terrorism threat has evolved significantly since the September 11, 2001 series of coordinated attacks by the Islamist terrorist group al-Qaeda against the United States. The threat landscape (referring to identified threats, trends observed, and threat actors) has expanded considerably. Three factors have contributed to the evolution and expansion of the terrorism threat landscape:[91]

- Internet: International and domestic threat actors have developed an extensive presence on the Internet through messaging platforms and online images, videos, and publications, which facilitate the groups' ability to radicalize and recruit individuals receptive to extremist messaging.
- Social Media: Social media has allowed both international and domestic terrorists to gain unprecedented, virtual access to people living in the US in an effort to enable homeland attacks. Islamic State of Iraq and Syria (ISIS), in particular, encourages sympathizers to carry out simple attacks where they are located against targets—in particular, soft targets. This message has resonated with supporters in the US and abroad. Several recent attackers have claimed to be acting on ISIS' behalf.
- Homegrown Violent Extremists (HVEs): The FBI defines HVEs as global-jihad-inspired individuals who are based in the US, have been radicalized primarily in the US, and are not directly collaborating with a foreign terrorist organization (FTO). HVEs may assemble in groups but typically act independently in attacks or other acts of violence.

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[91] Federal Bureau of Investigation. 2019. Terrorism Webpage. Accessed online on 8/26/19 from https://www.fbi.gov/investigate/terrorism.

Domestic terrorists can be 'right-wing' or 'left-wing' extremists such as white supremacists, anti-government militias or anarchists. Domestic terrorists can also be 'single-issue' groups such as animal rights or environmental rights extremists. And, domestic terrorists can also be 'lone wolves' with a personal agenda or grievance and prepares, commits violent acts alone outside of any group support.

According to FBI Director Senate testimony in July 2019, the bureau has recorded about 100 domestic terrorism arrests since December 2018 compared to about 100 international terrorism arrests.[92] The FBI, according to the director's testimony, is most concerned with "lone offender attacks, primarily shootings." Earlier, at a congressional hearing in May 2018, the head of the FBI counterterrorism division testified that the bureau was investigating 850 domestic terrorism cases and of that approximately 350 of the cases involved racially motivated violent extremists[93]. Most in that group, he said, were white supremacists.

In 2015, the Seattle division of the FBI revealed 70-100 active cases possibly linked to terrorism across the state.[94] In the years since revealing the breadth of terrorism investigations in Washington State, domestic terrorism arrests outpaced jihad-inspired terrorism arrests nationwide.[95] The US government acknowledged the problem in its October 2018 'National Strategy for Counterterrorism'. "Notably, domestic terrorism in the United States is on the rise, with an increasing number of fatalities and violent nonlethal acts committed by domestic terrorists against people and property," the strategy paper says.[96]

Vulnerability Characteristics and Previous Occurrences

Terrorism events can be distinguished from other types of man-made hazards by three important considerations:[97]

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[92] Zapotosky, Matt. July 23, 2019. Wray says FBI has recorded about 100 domestic terrorism arrests in fiscal 2019 and many investigations involve white supremacy. *The Washington Post.* Accessed online on 8/26/19 from https://www.washingtonpost.com/national-security/wray-says-fbi-has-recorded-about-100-domestic-terrorism-arrests-in-fiscal-2019-and-most-investigations-involve-white-supremacy/2019/07/23/600d49a6-aca1-11e9-bc5c-e73b603e7f38_story.html.

[93] Zapotosky, Matt. July 23, 2019. Wray says FBI has recorded about 100 domestic terrorism arrests in fiscal 2019 and many investigations involve white supremacy. *The Washington Post.* Accessed online on 8/26/19 from https://www.washingtonpost.com/national-security/wray-says-fbi-has-recorded-about-100-domestic-terrorism-arrests-in-fiscal-2019-and-most-investigations-involve-white-supremacy/2019/07/23/600d49a6-aca1-11e9-bc5c-e73b603e7f38_story.html.

[94] Kim, Hana. December 11, 2015. FBI investigating 70 to 100 cases in Washington State with possible ties to terrorism. *Q13 Fox News.* Accessed online on 8/26/19 from https://q13fox.com/2015/12/11/fbi-investigating-up-to-a-100-cases-possibly-linked-to-terrorism-in-washington/.

[95] Barrett, Devlin. March 9, 2019. Arrests in domestic terror probes outpace those inspired by Islamic extremists. *The Washington Post.* Accessed online on 8/26/19 from https://www.washingtonpost.com/world/national-security/arrests-in-domestic-terror-probes-outpace-those-inspired-by-islamic-extremists/2019/03/08/0bf329b6-392f-11e9-a2cd-307b06d0257b_story.html.

[96] Dilanian, Ken. August 9, 2019. There is no law that covers 'domestic terrorism.' What would one look like? *NBC News.* Accessed online on 8/26/19 from https://www.nbcnews.com/politics/justice-department/there-no-law-covers-domestic-terrorism-what-would-one-look-n1040386.

[97] Mid-America Regional Council. 2015. *Regional Multi-Hazard Mitigation Plan.* Accessed online on 8/26/19 from https://www.marc.org/Emergency-Services-9-1-1/pdf/2015HMPdocs/HMP2015_Sec4-HAZ-Terrorism.aspx.

- In the case of chemical, biological, and radioactive agents, there presence may not be immediately obvious, making it difficult to determine when and where they were released, who was exposed, and what danger is present for first responders.
- Terrorist events evoke very strong emotional reactions, ranging from anxiety, to fear to anger, to despair to depression.
- Even failed attacks have long-term economic impacts for the targeted government and critical infrastructure sector disproportionate to the cost of the attack itself.

The form and locations of many natural hazards are identifiable and, even in some cases, predictable; however, there is no defined geographic boundary for terrorism. Based on previous historical events, it is presumed that critical facilities, services, and large gatherings of people are at higher risk.

King County is the most populous county within Washington State and is ranked 12th most-populous in the US according to the US Census Bureau. King County is geographically diverse characterized by high-density urbanization along the shores of Puget Sound, suburban communities to the east, and rural communities to the southeast. King County is the largest labor market in the state. In 2018, nearly 42 percent of all nonfarm jobs in Washington State were reported from King County-located businesses. Within King County, the Washington State Fusion Center tracks over 800 annual large-gatherings that encompass public assembly and outdoor events. These events include a diverse range of sites that draw large crowds of people for shopping, business, entertainment, sports or lodging, as well as for fireworks, marathons, festivals and parades.

English-language terrorist media continues to identify similar gatherings as "soft targets" and promote them as potential attack sites. For example, Inspire #12 magazine published online by Al Qaeda, suggested targeting locations "flooded with individuals, e.g., sports events . . . election campaigns, festivals, and other gathering [sic]. The important thing is that you target people and not buildings."[98] Attacks targeting these types of events will continue to present security challenges to public safety personnel, because attendees are anonymous and generally unscreened for prohibited items. Violent extremist propaganda continues to urge lone actors to attack soft targets using small arms, knives, and vehicles because they are simple and effective. Foreign terrorist organizations implore followers to kill with whatever means available "whether an explosive device, a bullet, a knife, a car, a rock, or even a boot or a fist."[99]

Prior to the attacks on September 11, 2001, there were less than a dozen major terrorist events in Washington State. Since then, violent extremism has become commonplace, on a global and national

[98] National Counterterrorism Center. 2018. Planning and Preparedness Can Promote an Effective Response to a Terrorist Attack at Open-Access Events. Accessed online on 8/26/19 from https://www.dni.gov/files/NCTC/documents/jcat/firstresponderstoolbox/First-Responders-Toolbox---Planning-Promotes-Effective-Response-to-Open-Access-Events.pdf.
[99] Farivar, Masood. July 18, 2016. New, Low-tech Terror Tactics Simple and Deadly. *Voice of America.* Accessed online on 8/26/19 from https://www.voanews.com/europe/new-low-tech-terror-tactics-simple-and-deadly.

scale, and the number of local terrorism and violent extremism cases continue to rise.[100] Some of the most notorious terror cases in Washington State include the arrest of Ahmed Ressam, the "Millennium Bomber," in December 1999, the Earth Liberation Front (ELF) firebombing of University of Washington's (UW) horticulture center in May 2001, and the foiled Seattle Military Entrance Processing Station attack plot in 2011.

- On March 26, 2018, Thanh Cong Phan from Everett was arrested after mailing at least 11 suspicious packages to multiple military and government facilities in the Washington, D.C. metropolitan area, which contained potential destructive devices. He was charged with shipping of explosive materials, after the packages were found to contain small amounts of black explosive powder.[101]

- On March 31, 2017, Muna Osman Jama of Reston VA and Hinda Osman Dhirane of Kent WA were sentenced to 12 years and 11 years respectively, after being found guilty of conspiracy to provide material support to al-Shabaab. The two reportedly organized an all-female fundraising group, called the "Group of Fifteen," who provided monthly payments to al-Shabaab; facilitating and tracking money sent through conduits in Kenya and Somalia.[102]

- On August 25, 2017, Melvin Neifert from Selah was arrested and charged with receiving incendiary explosive device materials—specifically, potassium nitrate and other materials to make a potassium nitrate-sugar bomb—that were to be used in connection with the 2016 May Day events. Federal authorities seized evidence and questioned Neifert on May 1, the same day anti-capitalist demonstrations took place in Seattle.[103]

- On September 4, 2016, a fire was intentionally set at the Planned Parenthood clinic in Pullman, WA. Authorities recovered a video from inside the clinic showing a flammable object had been thrown through the window. While no injuries were reported, and no suspects identified, there is a history of domestic terrorism against the Pullman clinic.[104]

- On April 9, 2015, Blake Heger was arrested after attempting to place two shrapnel-laden pipe bombs near a high foot-traffic area outside a hardware store in Puyallup, WA. Police were called after a concerned citizen saw him sharpening large knifes in the parking lot. He was found with

[100] United Nations Development Programme. 2016. Prevent Violent Extremism Through Promoting Inclusive Development, Tolerance and Respect for Diversity. Accessed online on 8/26/19 from https://www.undp.org/content/dam/norway/undp-ogc/documents/Discussion%20Paper%20-%20Preventing%20Violent%20Extremism%20by%20Promoting%20Inclusive%20%20Development.pdf.
[101] Shayanian, Sara. March 28, 2018. Man charged with sending explosives to D.C. military sites. *United Press Internationa.* Accessed online on 8/26/19 from https://www.upi.com/Top_News/US/2018/03/28/Man-charged-with-sending-explosives-to-DC-military-sites/5591522255789/.
[102] Department of Justice. Friday, March 31, 2017. Two Women Sentenced for Providing Material Support to Terrorists. Accessed online on 8/26/19 from https://www.justice.gov/opa/pr/two-women-sentenced-providing-material-support-terrorists.
[103] Meyers, Donald W. August 31, 2016. Bail decision delayed in Selah explosives case. *The Seattle Times.* Accessed online on 8/26/19 from https://www.seattletimes.com/seattle-news/crime/bail-decision-delayed-in-selah-explosives-case/.
[104] The Associated Press. September 10, 2015. Video shows object thrown in Planned Parenthood arson. *The Seattle Times.* Accessed online on 8/26/19 from https://www.seattletimes.com/seattle-news/video-shows-object-thrown-in-planned-parenthood-arson-in-pullman/.

two additional pipe-bombs, four large knives, and a screwdriver that he had sharpened into a dagger.[105]

- On January 1, 2014, Musab Masmari attempted to set fire to a gay nightclub on Capitol Hill in Seattle, WA by spilling gasoline down a set of stairs and lighting it, while 750 people packed the club's New Year's Eve event. According to investigative documents, Masmari told a friend that "homosexuals should be exterminated." In July 2014, he was sentenced to ten years in federal prison for arson.[106]

- On July 18, 2014, Ali Muhammad Brown was arrested after killing four people in WA and a college student in NJ, as part of a personal vengeance against the U.S. government for its actions in the Middle East. In 2004, he was arrested and prosecuted for his role in a bank fraud scheme to finance fighters traveling abroad, and had known links to a disrupted terror cell in Seattle, WA and Bly, OR in 1999.[107]

- On October 27, 2012, Abdisalan Hussein Ali, a 22-year old born in Somalia but raised in Seattle and Minnesota, was the third American killed as an al-Shabaab suicide bomber in Mogadishu. Ali was reportedly one of two bombers in an attack that killed "scores of African Union peacekeepers." He arrived in Seattle in 2000 and moved to Minneapolis before being recruited into al-Shabaab and travelling to Somalia in 2008.[108]

- On September 8, 2011, Michael McCright was arrested and charged with second-degree assault for a July 2011 incident where he intentionally swerved his vehicle at a government-plated vehicle occupied by two U.S. Marines in Seattle. Known on the Internet as "Mikhail Jihad," McCright had ties to Abu Khalid Abdul-Latif, a man convicted of plotting to kill federal employees and military recruits in Seattle, WA.[109]

- On June 22, 2011, Abu Khalid Abdul-Latif and Walli Mujahidh were arrested for planning to attack the Military Entrance Processing Station (MEPS) in Seattle with machine guns and grenades after previously planning, but discounting, an attack at Joint Base Lewis McChord (JBLM). According to FBI investigators, "Abdul-Latif said that 'jihad' in America should be a 'physical jihad,' and not just 'media jihad'."[110]

- On May 11, 2011, Joseph Brice of Clarkston WA was arrested for assembling, practicing, and detonating explosive devices after an incident that occurred on April 18, 2010, when an

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[105] McCarty, Kevin. August 10, 2015. Man arrested after 2 bombs discovered outside Pierce County hardware store. *KIRO 7.* Accessed online on 8/26/19 from https://www.kiro7.com/news/man-arrested-after-two-bombs-discovered-outside-pi/28802706.

[106] Carter, Mike. July 31, 2014. Man who set fire in Capitol Hill nightclub sentenced to 10 years. *The Seattle Times.* Accessed online on 8/26/19 from https://www.seattletimes.com/seattle-news/man-who-set-fire-in-capitol-hill-nightclub-sentenced-to-10-years/.

[107] Collins, Laura. September 18, 2014. Revealed, one man's terrifying 'jihad' on U.S. soil: Extremist 'executed four in revenge for American attacks in the Middle East and carried out bank fraud for the Cause'. *Daily Mail Online.* Accessed online on 8/26/19 from https://www.dailymail.co.uk/news/article-2759901/Revealed-terrifying-one-man-jihad-U-S-soil-Extremist-executed-four-revenge-American-attacks-Middle-East-carried-bank-fraud-Cause.html.

[108] Kron, Josh. October 30, 2011. American Identified as Bomber in Attack on African Union in Somalia. *The New York Times.* Accessed online on 8/26/19 from https://www.nytimes.com/2011/10/31/world/africa/shabab-identify-american-as-bomber-in-somalia-attack.html?_r=0.

[109] Carter, Mike. May 29, 2012. Felon admits he tried to run Marines off I-5. *The Seattle Times.* Accessed online on 8/26/19 from https://www.seattletimes.com/seattle-news/felon-admits-he-tried-to-run-marines-off-i-5/.

[110] The Associated Press. June 5, 2012. Seattle terror suspect wants evidence tossed. *Fox News.* Accessed online on 8/26/19 from https://www.foxnews.com/us/seattle-terror-suspect-wants-evidence-tossed#ixzz28jz1MkOE.

explosive device he made prematurely ignited, causing him significant injuries. He had a YouTube channel called "Strength of Allah," where he posted the videos in an attempt to support terrorism.[111]

- On January 17, 2011, Kevin Harpham, an admitted white supremacist, placed a remote-controlled backpack improvised explosive device (IED), with rat-poison coated shrapnel, at a park bench near the marching route on the morning of the Martin Luther King Jr. Day Parade in Spokane, WA. Prosecutors said the device was "constructed with a clear, lethal purpose," and Harpham said it was intended to protest social concepts, such as unity and multiculturalism.[112]

Scenario Drivers

Terrorist attacks continue to take place at open-access events, mass gatherings, and outside the perimeter of secured events, possibly because of a perceived lack of security, the availability of publicized schedules, and largely unrestricted admittance. Examples of open-access events include marathons, parades, protests, rallies, festivals, fireworks displays, farmers markets, and high-profile funerals and vigils or memorials. Terrorists could also target gatherings located close to ticketed events, such as tailgating adjacent to major sporting events or concerts[113]. Judging from previous terrorist plots and attacks, terrorists will likely remain interested in conducting opportunistic attacks against civilian targets, most notably mass gatherings. Techniques used in recent terror attacks have included the use of vehicles as weapons, edged weapons, small arms, and improvised explosive devices (IEDs).

Coordinated Domestic Extremist Attack on Seattle	The radicalization of Pacific Northwest extremist groups has recently been promoted by other national terrorism movements which have called for violent resistance to destroy human life and disable critical infrastructure. Radicalization starts to build in the Winter of 2018. Over the next six months there is an increase in expression of on-line animosity towards the U.S. Government which calls for action on June 24. In recent weeks there has been an increase via social media of on-line extremist groups indicating an intense animosity and a belief of injustice by the U.S. Government. These local online indicators show lone actors, inspired by extremist ideology, have been able to circumvent security measures to take up small arms, make vehicle borne and rudimentary standalone improvised explosive devices (IEDs) with the stated intent to attack the Region. In addition, there are calls for "Leaderless Resistance" making it difficult to locate, mitigate, or prevent their stated intent. Within the Seattle Region, there is increasing concern about a number of these groups starting to influence public opinion, which may lead to violent actions. The on-line information promotes and warns of the need for longer and ongoing

[111] Pignolet, Jennifer. Wednesday, June 12, 2013. Clarkston man convicted of trying to aid terrorists *The Spokane Spokesman-Review.* Accessed online on 8/26/19 from https://www.spokesman.com/stories/2013/jun/12/bomb-maker-sentenced/.

[112] Clouse, Thomas. December 20, 2011. MLK bomb maker gets 32 years in prison. *The Spokane Spokesman-Review.* Accessed online on 8/26/19 from https://www.spokesman.com/stories/2011/dec/20/mlk-parade-bomber-seeks-guilty-plea-withdrawal/.

[113] National Counterterrorism Center. 2018. Planning and Preparedness Can Promote an Effective Response to a Terrorist Attack at Open-Access Events. Accessed online on 8/26/19 from https://www.dni.gov/files/NCTC/documents/jcat/firstresponderstoolbox/First-Responders-Toolbox---Planning-Promotes-Effective-Response-to-Open-Access-Events.pdf.

acts of violence to achieve superiority over current government authority. On July 3, there are several online attacks which a precursor to the July 4th physical attacks on an iconic building are, multiple active shooter events, vehicle borne violence and IEDs, and unattended small items across the City of Seattle and surrounding areas.

Priority Vulnerabilities

Public events	Terrorists have increasingly targeted mass-gatherings in densely populated or high profile areas. Consequently any major urban area in Washington State could be considered at-risk as well as any crowded or high profile critical infrastructure. The specific motivations of terrorists will largely dictate target selection.
Terror tactics used by non-terrorists	A new challenge that is emerging is the increasing use of terror tactics by non-terrorists. A number of evolved weapons, tactics, and targets have emerged through the sheer volume of attacks within the last decade. This normalization of violence has been further exacerbated by extensive media coverage and the ease by which detailed instruction manuals, 'how-to' videos, and online forums dedicated to weapons, explosives, and tactics. It is "essentially shared community content, easily accessible for extremists of all stripes to consume and put into action" including those with no affiliation to foreign or domestic extremism ideologies.[114] Lessons learned from past attempts continue to shape the means by which attackers develop plots—the push for using small arms, edged-weapons and vehicle ramming against soft targets—instead of the often failed large-scale attacks.
Critical infrastructure	Infrastructure systems such as dams, water systems, bridges, and public buildings are high-value targets to terrorists that both stand for government order and, when lost, can cause significant regional harm to people, property, and the economy.

Priority Impact Areas

King County residents	Any King County resident attending a public event could be a victim of a terrorist attack.
Vulnerable populations	Some populations are more likely to be targeted by extremists than others. Terrorist attacks and attempted attacks in the northwest have been motivated by white supremacy (targeting non-white populations), xenophobia (targeting immigrants), homophobia/transphobia (targeting gathering places of gay, lesbian, and transgendered people), and anti-religious attacks against Muslims, Jews, Christians, or other religious groups.

[114] Johnson, Bridget. March 21, 2018. The Austin bomber and our new age of open-source terrorism: How Mark Anthony Conditt likely benefited from Al Qaeda tutorials. *The New York Daily News.* Accessed online on 8/26/19 from http://www.nydailynews.com/opinion/austin-bomber-new-age-open-source-terrorism-article-1.3888244.

Property	Property, including commercial buildings, venues, vehicles, places of worship, or other areas are often damaged or destroyed during terror incidents. Trauma from the incident can prevent the rebuilding of the facility in the same place.
The economy	In addition to the economic costs of stepped-up security, attacks can have a huge impact on a region's economy. Places seen as less safe are less attractive to investors or visitors. Often, terrorist attacks attempt to destroy part of the economy by killing tourists or destroying an important piece of infrastructure.
The environment	A major attack can pollute the environment and poison water and food sources. This can have far-reaching, long-term consequences and damage animal and plant life as well as people.
Health systems	Health systems can be impacted as a target for attacks, by being overwhelmed with patients in the aftermath of attacks, and by personnel being injured or killed from secondary attacks or due to exposure to chemical or biological agents used in the attack.
Government operations (continuity of operations)	Government facilities and employees are a common target for anti-government extremists. These attacks can disrupt day-to-day operations for long periods of time and require additional security measures to protect facilities and employees.
Responders	Responders are often the first on the scene of an incident and therefore can be injured or killed in shootings or due to exposure of chemical or biological agents. Responder facilities, such as police stations, are also potential terrorist targets.
Infrastructure systems	- Energy: Energy facilities, including fuel pipelines, are common targets for terrorists and saboteurs around the world. Many power facilities, such as neighborhood substations, are relatively unguarded and, if lost, can have immediate impacts on people and property in an area. Cyber-attacks are one area where a large-scale attack on the energy system could cause widespread disruption. - Water/Wastewater: Water systems are considered a high-impact potential target. A chemical attack on a water system, if not immediately detected, could injure or kill thousands, depending on the size of the water-system targeted. - Transportation: transportation systems, especially public transit, have been targets around the world, such as in the Madrid Train Bombings or the London Subway Bombings. Attacks on busses are also common. These incidents can cause a loss in public confidence in the transit system. Furthermore, an attack on a tunnel, such as the I-90 tunnel across Lake Washington, can impede mobility in our region over the long-term. - Communications: Communications infrastructure, such as cell towers, are relatively redundant and so somewhat less vulnerable to terrorist attacks. There is a huge vulnerability, however, to cyber-terrorism, which can take multiple facilities offline quickly.

Public confidence in jurisdiction's governance and capabilities	A failure to protect the public from a terrorist attack, even one that is thwarted at the last moment, can cause a total failure in public confidence in government. As seen after 9/11/2001 or after attacks by white supremacists against African-American or Jewish congregations, groups begin to feel isolated, threatened, and isolated from the community. This is especially true in cases where government fails to quickly reassure impacted communities and support them morally and with security resources.

Regional Risk Profile: Tsunami and Seiche

Hazard Description

A tsunami is a series of fast, powerful, and destructive waves that radiate outward in all directions from the source. Tsunamis are usually caused by a displacement of the ocean floor from an earthquake or the collapse of an underwater land feature. Seiches are waves that form in any enclosed or semi-enclosed body of water (i.e. lakes, bays, and rivers) from wind, atmospheric pressure, or seismic waves. Seiche action can also affect harbors and canals.

The primary tsunami threat in King County is from a Seattle fault earthquake, or other events originating in the Puget Sound Lowlands (such as big landslides into the water and possibly other faults). Not all of King County has been modeled for tsunami hazards but scientists are actively working on it. The tsunami inundation (flooding) impacts from a magnitude 7.3 Seattle fault event are shown below in yellow:[115] In addition to the Seattle fault, a Pacific ocean sourced tsunami, like a Cascadia Subduction Zone event, can still affect King County. Wave arrival times for a Seattle fault and Cascadia-derived tsunami are extremely different. In a Seattle fault event, the first wave arrives within minutes, where in a Cascadia event, the first wave will arrive in approximately 2 hours and 20 minutes. In both cases, wave action will persist for multiple hours. An earthquake on the Seattle Fault could generate a seiche in Lake
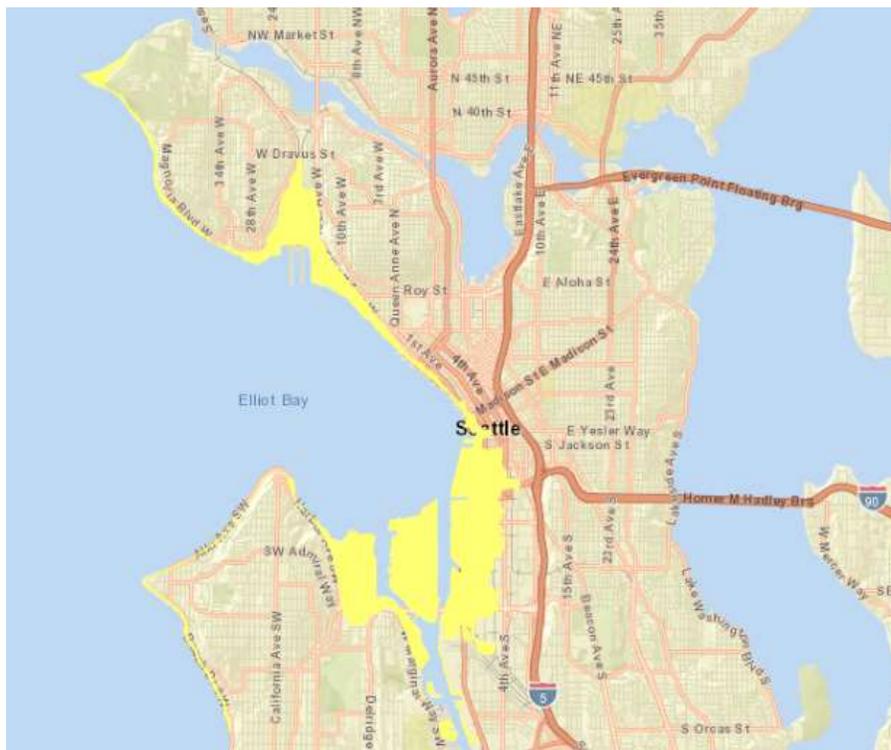
Washington or Lake Sammamish that could impact cities including Sammamish, Kenmore, and Kirkland.

There can also be significant maritime hazard along the western United States' coastlines associated with smaller tsunamis. A tsunami from a local Seattle fault event would cause major damage to port infrastructure and navigational terminals. Additionally, powerful distant tsunamis generated across the Pacific Ocean

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[115] Washington Geologic Survey. Geologic Hazards Information Portal. Accessed online on 6/11/19 from https://geologyportal.dnr.wa.gov/.

can cause maritime hazards in the Puget Sound. Although these distant-sourced events generate relatively smaller tsunamis than local-sourced events, there waves can still cause damage to boats, docks, piers, and aids to navigation (e.g. channel markers, lighthouses, warehouses and port terminals used for loading and unloading cargo ships). Moored boats and vessels underway in the harbor may also be impacted by smaller distant-sourced tsunamis. For example, the 2011 earthquake off the coast of Japan caused a relatively small eight-foot tsunami in Crescent City, California, which led to one hundred million dollars in damaged boats and infrastructure. Anything near the shoreline that has the potential to float or be moved by the wall of water can be carried away – ramming into other structures.

Vulnerability Characteristics and Previous Occurrences

King County includes the deep-water Port of Seattle and several cities that border Puget Sound, including Shoreline, Seattle, Burien, Des Moines, and Federal Way. Together with Vashon Island, unincorporated King County includes a great deal of industry, import/export activity, and commercial and residential real estate that border bodies of water. These key waterfront areas are vulnerable to a tsunami or seiche generated from an earthquake up to hundreds, if not thousands of miles distant from King County.

The most significant documented risks are to port transportation and industrial facilities in the Seattle waterfront and Magnolia. It is likely a tsunami would impact docks, harbors, and other water-dependent facilities in communities such as Des Moines and Burien too. The consequences of a tsunami to the Port of Seattle would likely be catastrophic, causing permanent to semi-permanent harm to the region's economy. As described in the earthquake chapter, damage from the Kobe, Japan earthquake in 1995 led to a permanent reduction in the scale and importance of that port.

The table below summarizes the identified tsunami hazard area, the City of Seattle, following a magnitude 7.3 Seattle fault earthquake. Approximately 0.6 percent of structures within the city are exposed to a Seattle fault earthquake-induced tsunami, totaling an estimated value of $5.1 billion (3.5 percent of the total building value within the city). [116] The modeling to show potential impacts from a Seattle fault tsunami or a Cascadia tsunami for the remaining communities in King County is not yet complete.

City of Seattle Tsunami Exposure Assessment – Seattle Fault Scenario

STRUCTURES EXPOSED	EXPOSED BUILDING AND CONTENT VALUE	PERCENT OF EXPOSED VALUE
969	$5.1 Billion	3.5%

Geologic evidence of previous shallow crustal fault-induced tsunami events has been recorded in the Puget Sound at Cultus Bay on Whidbey Island and at West Point in Seattle.[117] This evidence suggests the last tsunami occurred around 900 AD when the local Seattle fault raised some landmasses around

[116] Federal Emergency Management Agency. 2018. King County Risk Report: Tsunami Exposure Assessment. Page 58.
[117] Moore, Andrew. Looking for paleotsunami evidence: an example from Cultus Bay, Washington. Accessed online on 6/11/19 from https://serc.carleton.edu/integrate/workshops/risk_resilience/activities/82019.html.

the Puget Sound shoreline by as much as 26 feet. A scientific study focused on seismic activity on the Seattle fault within the last 8,000 years found evidence for an additional earthquake that occurred ~6,900 years ago. This suggests a low probability of a large earthquake to occur on the Seattle fault as the recurrence interval could be thousands of years. Since 900 AD, tsunami waves in King County have been less than 18 inches in height and caused little damage to boats and shoreline property.[118] Additional verbal accounts among the Snohomish Tribe reported by Colin Tweddell in 1953 described a great landslide-induced wave caused by the collapse of Camano Head at the south end of Camano Island around the 1820s.[119] No injuries have been reported since the settlement of Seattle in the 18th century. The value and density of property along the waterfront suggests a potential for moderate impacts from such an event.

Multiple seiches have been generated in King County from various local and distant seismic events. Seiche events in the King County have been noted in the following years: 1) In 1891 two earthquakes near Port Angeles caused water in the Puget Sound to surge onto beaches two feet above the high-water mark and an eight-foot seiche in Lake Washington. 2) In 1906 the magnitude 7.9 San Francisco earthquake caused agitated wave activity on the west shore of Lake Washington "so violently that house boats, floats and bathhouses were jammed and tossed about like leaves on the water," reported by the Seattle Post-Intelligencer (4/19/1906). 3) In 1949, a magnitude-7.1 deep earthquake occurred in Olympia that caused seiches within Lake Union and Lake Washington, but no damages were reported. 4) The magnitude 9.2 Great Alaska earthquake of 1964 created global seiches, including in Lake Union that damaged houseboats, buckled moorings, and broke water and sewer lines. 5) In 1965, a magnitude 6.5 deep earthquake occurred in the Puget Sound which caused a seiche where water "sloshing back and forth like soup in a shallow bowl" was observed at Green Lake, North Seattle (reported by the Seattle Times, 4/30/1965). 6) Lastly, in 2002 a magnitude 7.9 Denali earthquake caused seiches in Lake Union that damaged houseboats, buckled moorings, and broke water and sewer lines.

Tsunamis generated along the Pacific Rim have a hard time reaching Puget Sound with any destructive force. The tsunamis generated by the 2011 magnitude 9.0 earthquake in Japan and the 1964 magnitude 9.2 earthquake in Alaska did reach Puget Sound, but the maximum wave height recorded was only 0.04 meters (~2 inches) and 0.12 meters, respectively in (~5 inches) in King County.

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[118] National Geophysical Data Center / World Data Service (NGDC/WDS): Global Historical Tsunami Database. National Geophysical Data Center, NOAA. doi:10.7289/V5PN93H7 [accessed online on 09/11/2019 from https://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=70&d=7]

[119] Koshimura, Shunichi and Harold O. Mofjeld. 2001. Inundation modeling of local tsunamis in Puget Sound, Washington due to potential earthquakes. ITS 2001 Proceedings, Session 7, Number 7-18. Accessed online on 6/11/19 from https://www.pmel.noaa.gov/pubs/docs/ITS2001/7-18_Koshimura.pdf.

Tsunami Scenario Drivers[120][121]

There are four likely triggers for a tsunami in King County. These include an earthquake on the Seattle Fault, an earthquake on the Cascadia Subduction Zone, a tsunami caused by a major landslide into Puget Sound or another major body of water, and an earthquake on the Alaska-Aleutian Subduction Zone.

Seattle Fault Tsunami	A tsunami triggered by a rupture of the Seattle Fault would compound damage caused by the initial earthquake. It would devastate low-lying areas of Puget Sound, but especially the port and industrial facilities around the Port of Seattle and Magnolia. Preliminary modeling suggests the first wave arrives within 2 and a half minutes after the earthquake starts at the Magnolia Bluff area of Seattle and all coastlines within Elliott Bay experience an average of 20 feet (6 meters) of inundation above Mean High Water during the first 10 minutes. Harbor Island also experiences major flooding with at least 13 feet (4 meters) of flow depth above the ground level. South of Elliott Bay has milder flooding compared to Seattle, but strong currents are prevalent at Portage Bay.
Cascadia Subduction Zone Tsunami	A Cascadia Subduction Zone tsunami would devastate the outer coast and seriously impact low-lying areas around Everett and the San Juan Islands. The islands and the strait of Juan de Fuca protect King County from the worst flooding impacts. Preliminary modeling suggests that little inundation would occur along the coastline of South King county, though some flooding may be expected in areas of Seattle SODO and Port. The worst flooding is expected to occur at Portage Bay with estimated wave amplitudes up to 13 feet (4 meters) above Mean High Water. Strong currents are also estimated at Portage Bay near spits of land and in the narrows, which can be hazardous to the maritime community. The first wave is expected to reach Seattle at approximately 2 hours and 20 minutes. Statewide, this tsunami is expected to cause over 15,000 fatalities, primarily in coastal communities in the outer coast counties.
Landslide Tsunami	Verbal accounts among the Snohomish Tribe reported by Colin Tweddell in 1953 describe a great landslide-induced wave caused by the collapse of Camano Head at the south end of Camano Island around the 1820s. The slide itself is said to have buried a small village, and the resulting tsunami drowned people who were clamming on Hat

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[120] King County Department of Natural Resources and Parks. Landslide Hazards Program website. Accessed online on 6/7/19 from https://www.kingcounty.gov/services/environment/water-and-land/flooding/maps/river-landslide-hazards/landslide-types.aspx#Debris.
[121] King County Department of Natural Resources and Parks. Landslide Hazards Program website. Accessed online on 6/7/19 from https://www.kingcounty.gov/services/environment/water-and-land/flooding/maps/river-landslide-hazards/landslide-types.aspx#Debris.

	(Gedney) Island, 2 miles to the south. Bathymetry between Camano Head and Hat Island could have contributed to the size and destructive power of the wave.[122]
Alaska-Aleutian Distant Source Tsunami	An Alaskan-Aleutian subduction zone earthquake can be as large as a magnitude 9.2 event, as experienced in 1964. A tsunami generated from Alaska is a distant-sourced tsunami for Washington state. The preliminary tsunami modeling results for a potential worst-case scenario magnitude 9.2 Alaska earthquake to King County is estimated to be somewhat similar to the Cascadia Subduction Zone event, but half as strong. The highest wave amplitudes can be up to 7 feet (2 meters) and predicted to occur inside Portage Bay, but not predicted to overtop the northern spit. Additionally, it is probable for some unsafe currents for the maritime community to occur, with the highest risk being at Portage Bay. The first wave is expected to reach Seattle's coastline approximately 6 hours after the earthquake.
Lake Washington or Lake Sammamish Seiche	A Seattle Fault earthquake could generate a seiche on Lake Washington that would impact low-lying areas of cities along the lake, including Sammamish, Kenmore, Kirkland, and others.

Priority Vulnerabilities

Port and harbor facilities	Tsunamis are expected to devastate near-shore port infrastructure, boats, and piers. This is the largest economic consequence of a tsunami.
Low-lying and waterfront homes and businesses	Homes and businesses along the many waterfronts would be damaged or destroyed by a mid-sized tsunami and devastated by a local crustal earthquake and tsunami.
Wastewater treatment facilities	West Point treatment plan is in the inundation zone for a Seattle Fault tsunami. Historical records also suggest tsunamis have impacted this area before.

Priority Impact Areas

King County residents	While it would take a rather sizable tsunami along the shoreline of King County, precautionary evacuations from houseboats, live aboard pleasure craft, cruise ships, and property immediately adjacent to waterfronts of Puget Sound and lakes Washington, Sammamish, and lake Union may be recommended.

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[122] Koshimura, Shunichi and Harold O. Mofjeld. 2001. Inundation modeling of local tsunamis in Puget Sound, Washington due to potential earthquakes. ITS 2001 Proceedings, Session 7, Number 7-18. Accessed online on 6/11/19 from https://www.pmel.noaa.gov/pubs/docs/ITS2001/7-18_Koshimura.pdf.

Vulnerable populations	There are no additional anticipated direct impacts from tsunami to vulnerable populations. As always, any disruption to services, the economy, and infrastructure would cause more harm to lower-income and marginalized communities.
Property	Tsunami and seiche threats were not defined until recently. Most of the early 19th and 20th century structures located near the water were probably not engineered to withstand impacts from a tsunami, seiche, or earthquake. The properties along the entire Seattle Waterfront and those in Shoreline, Des Moines, Federal Way, and Vashon Island are at risk from tsunami activity.
The economy	A tsunami or seiche that impacts port facilities, such as one triggered by the Seattle Fault would have any sizable impact on the economy of the region. Damage would run potentially in the billions and have far-reaching consequences for Washington's export-based economy.
The environment	It is possible for a tsunami or seiche to have an impact on the natural environment immediately adjacent to Puget Sound through the release of fuels and hazardous materials or their storage facilities around the waterfront. This may include fish habitat or natural and farmed shellfish beds, wetlands, estuaries, and marsh areas.
Health systems	There are no major health centers located in the mapped tsunami inundation areas.
Government operations (continuity of operations)	It is possible that Sounder traffic between Everett and Seattle or Tacoma and Seattle could be impacted by any large tsunami in Puget Sound. Otherwise, it is unlikely that King County governmental operations would be directly impacted by a tsunami or seiche.
Responders	Along the shoreline of King County, precautionary evacuations from houseboats, live aboard pleasure crafts, cruise ships, and property immediately adjacent to waterfronts of Puget Sound and lakes Washington, Sammamish, and Lake Union would cause impacts to the public. The volume of search and rescue efforts along waterfronts affected from the tsunami may pose potential issues to first responders (police, fire, EMS).There are only small number of scenarios where this is a likely issue.
Infrastructure systems	- Power: Little to no impact directly from tsunami is expected. - Water/Wastewater: Tsunami may impact the West Point treatment plant. The damage would depend on the height of the tsunami and a significant event would be required. If such an event were to occur, the plan would be rendered inoperable. - Transportation: damage to port facilities and ferry terminals are the primary threat to infrastructure from a tsunami. Even relatively small tsunami surges, such as the aforementioned example from Crescent City, have caused tens of millions

	of dollars. Damage to low-lying rail and roads is also likely, but less of a concern since it would not impact primary transportation routes. • Communications: There is limited risk to communications systems as a whole from tsunami.
Public confidence in jurisdiction's governance and capabilities	Coverage from major news outlets, including the Seattle Times and the New Yorker magazine, have argued that Washington is highly underprepared for a major seismic event large enough to generate a tsunami. Both media coverage and reports from state emergency management has led Washington's governor to convene a Resilient Washington Subcommittee to look into mitigation actions out of concern for the apparent low-level of public confidence in state and local ability to manage major disasters. Data is available from Japan and New Zealand that clearly demonstrate that policy level decisions and direct communication to the public will greatly influence the public confidence in King County government.

Regional Risk Profile: Volcano

Hazard Description

Volcanic eruptions are the result of geological activity, and may include lava, rock fragments, gases, and ash ejected from a vent on the surface. Deposits of rock, lava, and ash create the structures we call volcanoes. Washington State has five active volcanoes, four of which have been classified as "Very high" threat by the U.S. Geological Survey, and one considered "High" threat. Mount Rainier would cause the most significant local disruptions in the event of an eruption, but any of them could cause major disruptions due to ash or impacts on the transportation system.

Volcanoes can lie dormant for hundreds or thousands of years between eruptions. Hazards from eruptions are typically divided into near-volcano hazards, those which impact areas immediately on the slopes of the volcano, and distant hazards, which can put areas miles away from the volcano at risk. Near-volcano hazards include pyroclastic flows (hot avalanches of gas, ash, and rock fragments), lava flows, rock (tephra), debris flows, and landslides. Distant hazards, include Lahars – volcanic mudflows,
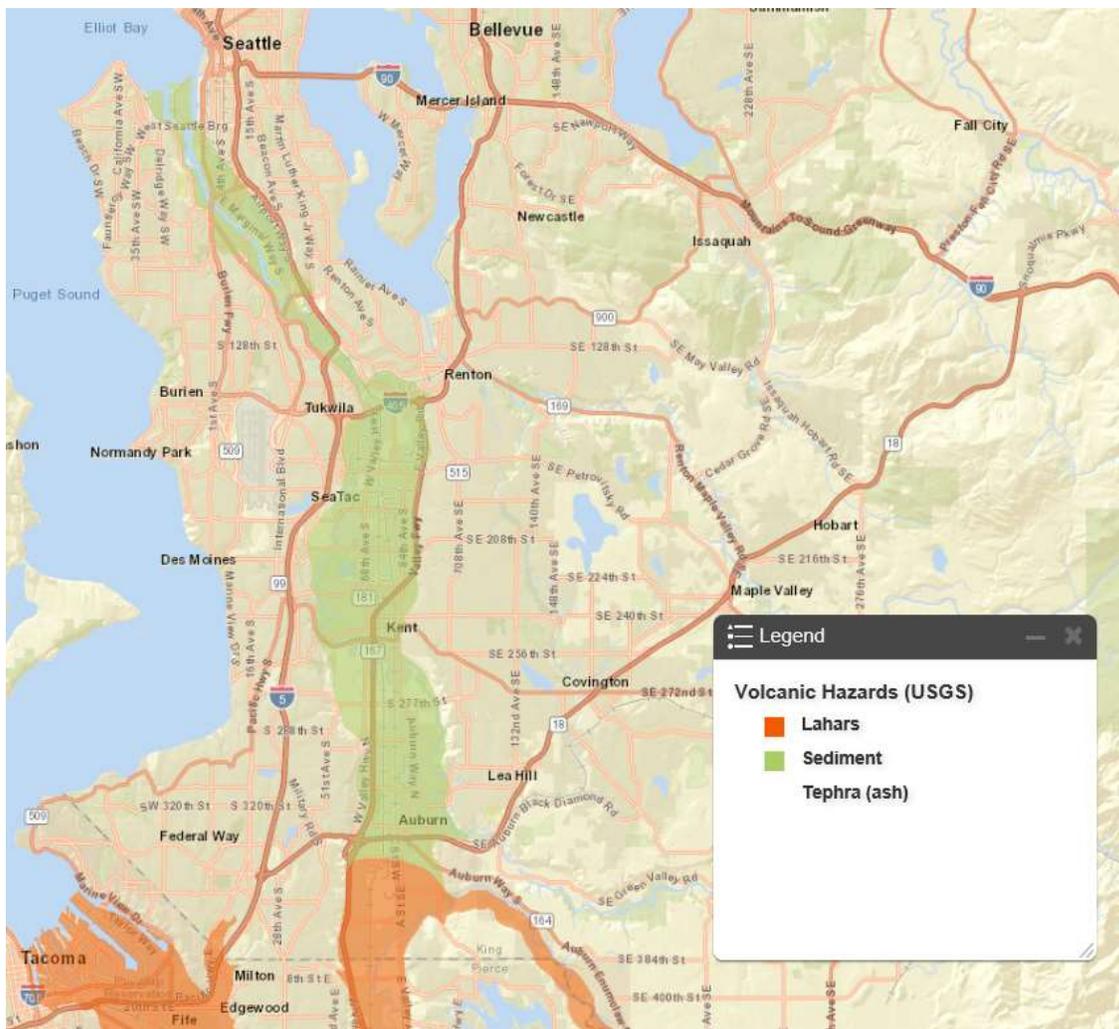
and volcanic ash. Lahars may travel tens of miles down river valleys, picking up debris and inundating floodplains, and leave a cement-like deposit of sediment where they stop. They are a hazard at all five of Washington's volcanoes, and the only personal protective action available to avoid a lahar is evacuation to higher ground. Volcanic ash – made up of tiny particles of glass – may be extremely widespread, as it travels in the direction of the wind. The fine particles may travel hundreds of miles or more downwind. Even in tiny quantities, volcanic ash can be very disruptive, as it lowers air quality, makes roads slippery to drive on, is abrasive, poses risks to aircraft, motor vehicles and electronics, and is extremely difficult to clean up, as it easily remobilizes into the air. Volcanic ash is also dense, and quite heavy when wet – 4 inches of wet volcanic ash is heavy enough to collapse most roofs.

Vulnerability Characteristics and Previous Occurrences

There are multiple hazards from a volcano, including lahars that could impact communities in the south of the county to ash that could impact the entire region and come from any of Washington's five active volcanoes.

Lahars, mudflows that can have the consistency of wet cement, are historically the most damaging element of a volcanic eruption. These flows pick up large and small debris like trees, houses, boulders – anything in its path. Lahars can move 20-40 miles per hour down slopes. They slow down once they reach floodplains, but are still an unstoppable mass of mud and debris, often pushing a flow of water ahead of it. While the lahar risk to King County is limited to a major eruption of Mt. Rainier and impacts primarily the cities of Algona, Pacific, and Auburn, the regional impacts would include a complete disruption of regional transportation routes, including through airport closures, damage to I-5, and damage to the Port of Tacoma.

The best examples of potential local damages from volcanic activity are from the Mt. St. Helens eruption in 1980. This eruption had significant ash-fall over eastern Washington, Oregon, Idaho, and Montana, with trace amounts falling over the Dakotas, Wyoming, Nebraska, Colorado, Oklahoma, and Minnesota as well as Canadian provinces. A long history of volcanic eruptions in the cascades is recorded by the Native Americans in the area. Volcanic activity occurs in geological timelines these events are spaced over hundreds if not thousands of years, during which time the number of exposed inhabitants and inventory of infrastructure has changed greatly. Even the difference between 1980 and today (39 years) has seen a marked increase in population and infrastructure in the possible impact area for volcanic activity. The Mt. St. Helens eruption in 1980 damaged or destroyed 200 buildings, ruined 44 bridges, and buried 17 miles of railway along with 125 miles of roadway. Community water supplies and sewer systems were disabled and reservoirs partly filled with silt and debris.

Mt. Rainier, however, is much closer (60 miles to Seattle) and poses a much more direct threat. Modern Mount Rainier started erupting 500,000 years ago and has had numerous eruptions and mudflows since then. About 5,600 years ago, an eruption created a massive debris avalanche, called the Osceola Mudflow, poured down from the summit of Mount Rainier, picking up sediment and anything else in its path as it traveled down the White River valley and into the Puget Sound. The mudflow filled valleys with up to ~400 feet of sediment and moved at speeds of 40 to 50 miles an hour. Following the Osceola Mudflow, many smaller volcanic eruptions and lahars occurred as the volcano continued to show signs of unrest. The most recent major mudflow, called the Electron Mudflow, began as a part of a crater collapse and traveled down the Puyallup River into Sumner in ~1502. It is estimated that Mount Rainier has generated about 60 of these lahars in the last 10,000 years, with about 10 large enough to reach the Puget Sound. Many communities, including Orting, Puyallup, and Auburn, between Mount Rainier and the Puget Sound are built on top of these deposits. [123]

An eruption of Mt. Rainier, or any other Cascade volcano, is likely to be preceded by warning signs, such as series of earthquakes, and deformation of the volcano. This volcanic "unrest" may last for days before an eruption, or possibly for weeks, to months, to years or more. Monitoring networks are in place to provide advanced warning. This advance warning is critical to communities downstream from the volcanoes, because Even a relatively small eruption could melt glaciers significantly, generating lahars that will reach heavily populated areas.[124]

A lahar should not be seen as a singular event, but a mass movement of sediment requiring significant time to recover from. Deposition of feet to tens of feet of sediment through a watershed and over a floodplain creates long-term changes to the river environment. After a lahar, mitigation measures may be necessary to prevent continued sedimentation over the decades following the eruption, such as the sediment retention structure built following the Mt. St. Helens 1980 eruption. In lieu of this solution, dredging may be required to prevent shipping channels from filling with sediment. Deposition of a large amount of sediment within a floodplain may also change floodplains to a point where floods now occur in areas which were previously safe from flooding.

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[123] Washington State Emergency Management. 2018. Enhanced Hazard Mitigation Plan: Volcano Risk Assessment, page 470-472.

[124] United States Geologic Survey. 2018. USGS Volcano Hazards Program website. Accessed online on 6/12/19 from https://volcanoes.usgs.gov/volcanoes/mount_rainier/geo_hist_future_eruptions.html.

Summary of Hazard Effects

Major types of volcanic hazard, their effects and extents are listed in the table below. The occurrence and scale of volcanic hazards are inversely related, with small events occurring more frequently (10-20 a month), and larger events occurring every hundred years or so.[125]

Hazard	Threat to Life	Threat to Property	Areas Affected
Ash and tephra fall	Low except near vent; high for aviation	Depends on size of particles and amount of ash; can lead to roof collapse, bomb damage, fire	Local, Regional, National, International
Pyroclastic flows	Very high – Near vent and on slopes; low in King County	Very high	Local, Regional, National,
Lava flows	Low except near vent.	Very High	Local
Lahars	High to moderate	High	Local, Regional
Flooding (post-lahar)	Moderate	High	Regional
Gases/acid rain	Low to moderate	Moderate	Local, Regional

Priority Vulnerabilities[126]

Communities in the path of lahar hazards	Communities in the vicinity of Rainier, including the King County communities of Algona, Pacific, and Auburn, are most vulnerable from a large lahar generated by an eruption of Mt. Rainier.
Populations vulnerable to respiratory distress brought on by ash	Ash from any volcanic eruption can lead to disruption of daily life and is a major threat to people with medical vulnerabilities.

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[125] Washington State Emergency Management. 2018. Enhanced Hazard Mitigation Plan: Volcano Risk Assessment, page 463
[126] Clark County Emergency Management. 2007. 2006 Volcanic Ashfall Exercise After Action Report / Improvement Plan.

Populations in the immediate vicinity of a volcano	Populations that use Mt. Rainier National Park or work in the area around the mountain are most susceptible to the immediate impacts. Although advanced warning is likely, it will be impossible to predict the exact moment of eruption. Residents from the town of Orting have approximately 45-minutes to evacuate following activation of their lahar sirens.
Roof collapse caused by ash fall	Buildings can collapse following large ash accumulation.
Electrical systems and the energy sector	Electrical systems may short out due to ashfall and power generation can be curtailed as generation systems are shut off to protect sensitive components.
Communications equipment	Communications equipment has the same vulnerability as general electrical systems and is subject to failure due to ash damage.
Air travel	Airports would likely be closed for the duration of major ash dispersal.
Roads and transportation systems	Traffic signals would likely short out during ashfall. Ash is also creates a very slippery driving surface. Ash can also damage vehicle engines, and scratch windshields when wipers are being used – Driving is not recommended during heavy ashfall.

Priority Impact Areas

King County residents	Cities in the south of the county, including Algona, Pacific, Auburn, and Kent all may be impacted by a lahar. The sedimentation zone spreads throughout the Green River Valley. This area includes some of the largest and fastest-growing cities in the county. The distance from Mt. Rainier makes direct impact of eruption from a pyroclastic event extremely unlikely. Prevailing winds make ash fall in the county unlikely or at least minor. Lava flows and landslide activity would impact Pierce County but are unlikely to reach any portion of inhabited King County. Indirect impacts from a major eruption might include a cooling climate from atmospheric suspended ash clouds but this too is unlikely. Fine ash may cause regional health impacts – especially respiratory for the duration of ash fall. Impact to vehicles and air handling systems in homes and work places may have an employment impact to the King County population.
Vulnerable populations	Impacts to individuals with access and functional needs will be extremely serious. Transportation will be impacted, resulting in difficulty accessing appointments. Individuals with chronic respiratory vulnerabilities will be most negatively impacted by ash. While there are limited numbers of King County residents in the path of the lahar, the communities that are most impacted have higher rates of disability and poverty than the statewide average.

Property	The cities of Algona and Pacific are the most at risk from a Mt. Rainier lahar event, with over 90 percent of their structures exposed to the lahar. While the percentage of structures is not as high, the City of Auburn has the highest potential dollar-value losses. Other damages would include the loss of HVAC and air filtration systems, electrical systems shorting out, and the danger of roof collapse from ash accumulation since ash is heavier than snow. Furthermore, following rains, ash hardens to a concrete-like consistency, which can clog gutters and drains and cause them to fail or collapse. Businesses that operate electronic systems will require decontamination rooms to prevent ash from getting inside and damaging electrical equipment.
The economy	Many of the impacts from a Mt. Rainier eruption to humans and the environment would also impact the economy of King County. Aviation interruption would likely occur from airborne ash. A lahar event would impact rail and port service from direct damages to infrastructure like bridges, rails, and roadways, or from inaccessibility to ports. Ash would cause interruption of all internal combustion engines or vehicles that require filters would impact the workforce and movement of food and supplies as well as repair crews. Abrasion from fine ash on all mechanical parts would cause longer term damages to industrial operations and the ports. Health and respiratory issues would make both indoor and outdoor professions difficult. Medical facilities and the patients that rely on them would have difficulty operating. The cost of debris removal following a lahar would be enormous, even similar to efforts from a major earthquake.
The environment	Any significant volcanic activity on Mt. Rainier would have an impact to the environment. Lava flows, tephra, ash, and lahar activity would directly impact birds, fish, mammals, reptiles, amphibians, trees, and vegetation. Sediment deposition would impact rivers that support salmon and steelhead spawning. Debris and lahar may change the course of rivers entirely. Lahars may cause hazardous materials releases that harm birds, fish and other wildlife. Recreational use of ski areas and hiking trails would also be impacted. It has been four decades, and Mt. St. Helens timber and wildlife have not yet returned to pre-1980 levels.
Health systems	Health systems would be impacted by an expected dramatic rise in demand for services as ash causes people to seek care for respiratory distress. Health systems would also be hindered by transportation system impacts. First responder vehicles should have air filters changed every 35 miles during volcano ash events and there are not enough air filters on hand to meet this requirement.
Government operations (continuity of operations)	Potential impacts to county delivery of services from a Mt. Rainier eruption would be the result of damages to infrastructure, equipment including machinery and vehicles, inaccessibility to service areas, impedance to transportation routes used by the county workforce, and health impacts to residents and the workforce. County services that might be interrupted might include: Medic One response, King County Sheriff's Office services

King County

	like 9-1-1 dispatch, search and rescue and marine or aviation unit response, adult detention, solid waste and waste water services. Services provided by other government agencies and basic service providers might include interruption of: power, phone and cell phone service, emergency medical service, fire and law enforcement, water systems, and health/medical facilities.
Responders	Responder vehicles need regular air filter changes during ashfall. Air filters in the quantity required are likely not available. Responders will also be taxed by high numbers of calls and dangerous roads caused by slick ash.
Infrastructure systems	• Power: Ash can short out electrical systems and cause widespread power failure. Ash accumulation may also cause issues with power generation dams. Generation facilities may be shut down to prevent damage to sensitive components. • Water/Wastewater: Water systems, including reservoirs, could quickly clog with ash, potentially polluting water supply. • Transportation: volcanic ash is very slick and roadways would become treacherous. Vehicles would need regular air filter replacements and there are not sufficient air filters in the region to offset the need. Airports in the region would have to close, potentially for months. Any lahar could potentially destroy major transportation routes, including I-5. Traffic signal systems and communications systems could short out due to ashfall.[127] • Communications: Electrical and communication impact can be severely impacted during ashfall. Ash getting into electrical systems can cause systems to short out.
Public confidence in jurisdiction's governance and capabilities	The 1980 Mt. St. Helens eruption revealed that even heavy monitoring of a volcano, while effective, cannot predict exactly how the volcano will behave. Since that time, investments and public information have created confidence that USGS and local emergency management is capable of providing public warnings and evacuations in time to save lives. Continued investment in risk assessment and warning systems, for example, around Orting, WA, continue to build public confidence. An event could either undermine or strengthen this confidence, depending on losses and the speed of warning. A potential public confidence issue is from false positives that trigger evacuations. There have been numerous cases outside of the US where communities are evacuated, only for the volcano not to erupt at that time. Communities can become inured to warnings. When this happens, and an event does occur, there are much higher losses. A false alert is unlikely in the USGS monitoring system for Mt. Rainier as the danger of a false alert has been a central consideration in the design of the system.

[127] Clark County Emergency Management. 2007. 2006 Volcanic Ashfall Exercise After Action Report / Improvement Plan.

A period of unrest, leading to heightened monitoring and public awareness could last days or years before anything (or nothing) happens. Sharing information with the public on the uncertainty of volcanoes and the potential for long-term monitoring is important. Additionally, in the event of unrest and a potential lahar, the local jurisdiction are the only ones who can actually order the evacuation and so much be prepared to assess risk, inform the public, and act when needed.

Regional Risk Profile: Wildfire

Hazard Description

King County and Western Washington in general have historically been at a low risk from major wildland and wildland-urban interface fires. The historic return period for the heavily forested areas of the slopes of the Cascades in eastern King County is between 200 and 300 years. Western Washington fires are not unheard of, however – in 1902, dozens of wildfires burned nearly 239,000 acres in what is
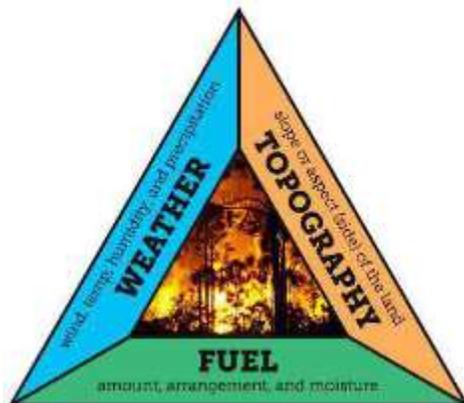
now the Yacolt Burn State Forest, causing 38 deaths. This occurred after an extended period of hot, dry weather, high wind, and an over-accumulation of timber harvest slash.[128] Climate change is shortening this interval, though it is still unknown by how much. By 2040, a four-fold increase in the annual area burned by fires in Washington is projected.[129] Of a more immediate concern is the amount of new development in areas close to the wildland-urban interface. This new exposure is the primary driver of risk in the short and medium term.

Wildfires can occur when the necessary combination of weather (low humidity, low precipitation, high temperatures, high wind), topography (steeper slopes, gulches, canyons, and ridges), and fuel (higher amounts, higher concentration, continuous across the landscape, low in moisture) are brought together with an ignition source (lightening or human-caused). In the western United States, we have seen an increase in large wildfires due to more than a century of fire prevention efforts, rising temperatures, declining forest health, and increased development.

Wildfires can spread quickly when burning in areas with dense, dry, uninterrupted fuels. This is particularly true in areas with steep slopes and ridges and in windy weather with high temperatures and low humidity. This mix of requirements has meant that there have been very few serious fires in King County.

The wildland fire season in Washington usually runs from July through September. Drought, low snow pack, and local weather conditions can lengthen the fire season. Many of the worst fire years on record have occurred in the past decade. Suppression costs alone cost $60 million for the Carlton Complex fire. Economic costs were estimated at $98 million for that fire.[130]

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[128] Washington State Department of Natural Resources. Yacolt Burn State Forest website. Accessed online on 6/19/19 from https://www.dnr.wa.gov/Yacolt.
[129] King County. 2018. King County Strategic Climate Action Plan 2018 Biennial Report.
[130] Washington State Emergency Management. 2018. Washington State Enhanced Hazard Mitigation Plan Risk Assessment. Pp. 493-495.

Washington State Department of Natural Resources lays out the scale of the problem in the new, 10-year strategic plan.[131] "In 2018, wildland fires burned more than 350,000 acres in Washington state and cost more than $112 million dollars to suppress—all before the end of August….Yet, 2018 was not the state's worst for fire. In recent years, hotter, drier summers and longer fire seasons have led to a trend in increased fire starts and area burned. Fires in 2014 and 2015 burned approximately 425,300 and 1,064,100 acres and cost state and federal agencies nearly $182 million and $345 million in firefighting expenses, respectively. In addition to the significant structural and economic losses, three firefighter lives were lost in 2015."

The largest fires in Washington State are usually sparked by lightning in wilderness areas. Small fires (often ignited due to human activity) can also be damaging, however. For example, a small 400-acre fire in Thurston County in 2017 led to the evacuation of nearly 100 homes and the loss of four homes. Human-caused ignition sources may include chains dragging behind trucks, cigarettes, arson, or the loss of control of fires set for recreational purposes.

Washington State Department of Natural Resources is leading an effort including King County to complete a statewide map of all wildland-urban interface areas. Once the mapping is complete, RCW 19.27.560 will take effect, adopting the ICC's 2018 International WUI Code. The following map is a draft map developed using United States Forest Service land cover data and King County parcel data. Interface areas are at the boundary of urban and vegetated areas. Intermix areas are areas where structures and vegetation are mingled.

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[131] Washington State Department of Natural Resources. 2018. Washington State Wildland Fire Protection 10-Year Strategic Plan. Accessed online on 8/26/19 from https://www.dnr.wa.gov/publications/rp_wildfire_strategic_plan.pdf?ivvzxs.

MAP SUBJECT TO CHANGE BASED ON CONTINUED WORK BY WA DNR
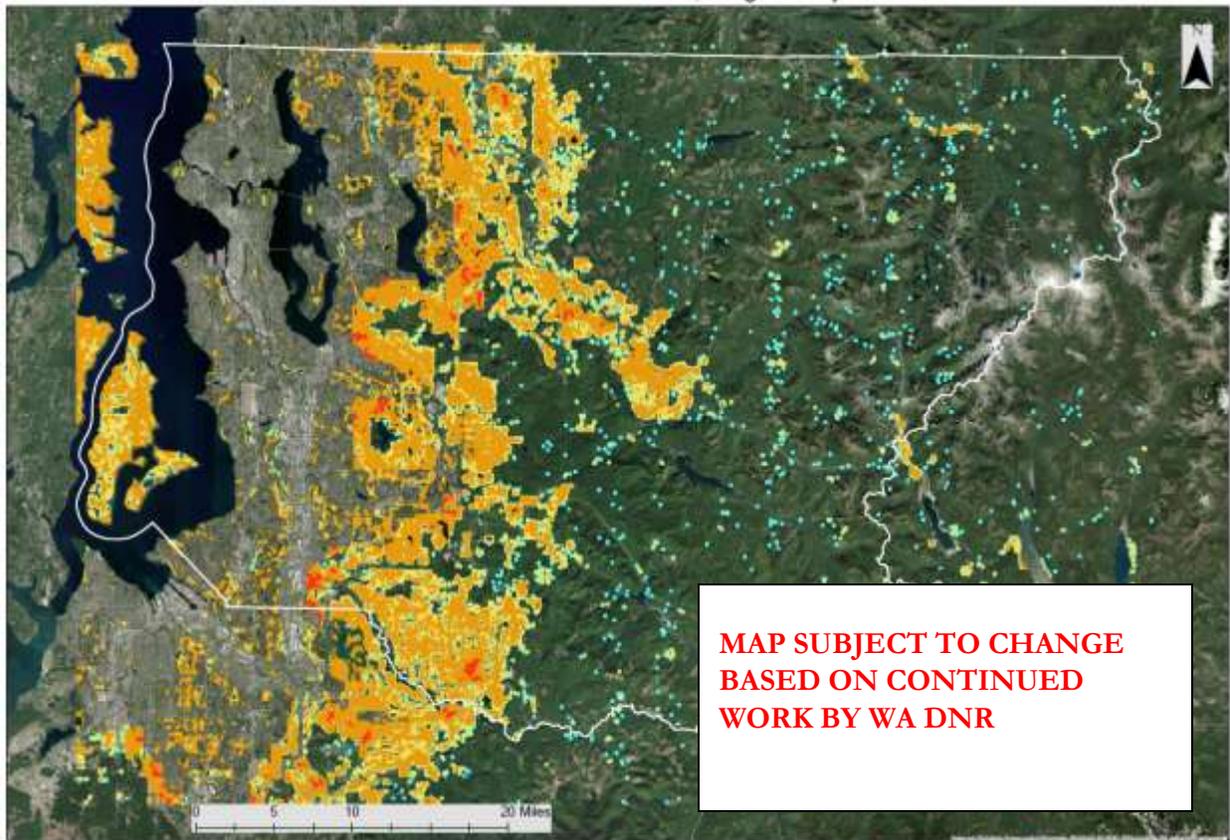
Draft Wildland-Urban Interface Areas: red = interface/intermix areas with high structure density (Source: DNR WUI Mapping Program, 2018)

Wildfire hazards include the fire itself, but also smoke and post-wildfire erosion and flooding. Wildfire smoke is made up of particulate matter, carbon monoxide and other harmful pollutants from burning trees, plant materials, and combustion of plastics and other chemicals released from burning structures and furnishings. Exposure to fine particulate matter (2.5 micrometers and smaller) is a significant health concern, because the small size of the particle allows people to inhale it deep in the lungs where the particles can directly enter the blood stream. The effects of smoke exposure range from eye and respiratory tract irritation to more serious health problems including reduced lung function, bronchitis, and exacerbation of asthma, heart failure, and premature death. People with existing heart and lung diseases, older adults, children and pregnant women are especially at risk of smoke-related health problems.[132]

Post-wildfire flooding, landslides, and mudslides is a deadly secondary hazard to extreme wildfires in areas with steep slopes. Soils in areas burned by fire not only lose their stabilizing vegetation but can also become hydrophobic (water repelling), leading to massive water runoff that carries debris down slopes and into nearby waterways. In Montecito, CA more than 17 people died, 100 homes were destroyed, and hundreds of people were rescued from a series of mudslides and mudflows that hit following heavy rains that drenched areas burned over earlier that summer.[133] Mudslides were a serious

threat in Eastern Washington following the 2014 and 2015 wildfires, and destroyed irrigation systems, roads, and bridges.

One aspect of post-fire flooding is that it can be predicted. King County would likely have weeks to months to prepare and plan for flooding events resulting from a major fire. The Department of Ecology maintains a post-fire flooding calculator to estimate runoff and prepare communities for flooding. In Montecito, for example, emergency managers had already evacuated thousands of people and it was those who chose to not heed the warnings that were most likely to be impacted by the mudslides.

Vulnerability Characteristics and Previous Occurrences

King County communities are rarely threatened by major wildfires, though roadside brush fires can still threaten even the most urbanized areas.[134][135] This has meant that land use and building codes in King County are not adapted to current and future wildfire risk. As the climate changes, there is a greater likelihood that high temperature and dry conditions will be present along with the already-existing topographic, wind, and fuel conditions necessary to support a large fire

Smoke has received the bulk of recent attention in King County due to multiple years of wildfire smoke in the Puget Sound region from wildfires in British Columbia, Oregon, and Eastern Washington. Air quality deteriorated to hazardous conditions in some parts of King County in 2017 and 2018. Recent studies of wildfire smoke exposure in Washington found a significant relationship between exposure to PM2.5 from wildfire smoke and an increase in emergency room and outpatient visits for asthma. Especially impacted were those with pediatric asthma and other childhood respiratory and chest symptoms, as well as Chronic Obstructive Pulmonary Disease across all age groups, and all respiratory outcomes.[136] Smoke will likely be an ongoing concern for the region and may represent a "new normal" though it will not occur every year.

Post-fire flooding is a serious threat to King County. A fire in one of the foothills communities could cause major mudflows and devastating flooding in communities in the watershed impacted by the fire and through which rivers and creeks pass. Communities with existing flood risk, such as along the Snoqualmie River, are especially vulnerable. Damage to homes caused by debris flows is typically not covered by regular homeowner's insurance.

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[132] Washington State Emergency Management. 2018. Washington State Enhanced Hazard Mitigation Plan Risk Assessment. Pp. 493-495.

[133] Queally, James, Etehad, Melissa, and Brittny Mejia. Jan 10, 2018. Death toll rises to 17 in Montecito; 100 homes destroyed by mudslides. *The Las Angeles Times.* Accessed online on 6/18/19 from https://www.latimes.com/local/lanow/la-me-ln-montecito-storm-mudflow-20180110-htmlstory.html.

[134] Headwater Economics. 2018. Communities Across the US Are Experiencing Threats from Wildfires. Accessed online on 6/18/19 from https://headwaterseconomics.org/dataviz/communities-wildfire-threat/.

[135] KIRO 7 News Staff. July 27, 2011. Brush fires shut down portion of SR 509. *KIRO 7.* Accessed online on 8/27/19 from https://www.kiro7.com/news/local/brush-fires-shut-down-portion-of-sr-509/970676697.

[136] For more information, see Washington State Department of Health/Chelan-Douglas, Grant, Kittitas and Okanogan Counties (2015), Surveillance Investigation of the Cardiopulmonary Health Effects of the 2012 Wildfires in North Central Washington State; Gan, R. W., B. Ford, W. Lassman, G. Pfister, A. Vaidyanathan, E. Fischer, J. Volckens, J. R.

Scenario Drivers[137][138]

Wildland-Urban Interface Fire

Although fires are currently rare in Western Washington, they are not unheard of and are expected to increase as climate change leads to warmer temperatures. Prolonged summer heat, combined with high density forests and areas of poor forest health, is increasing fire risk at the same time that people are building more and more into the wildland-urban interface. The building patterns in these areas are not in accordance with FireWise principles and many communities have limited ingress and egress routes.

Smoke

Source: Greg Gilbert, Seattle Times

In 2017, and especially 2018, smoke from wildfires inundated Seattle, causing unhealthy air quality. This was due to wind patterns that blew smoke from fires in British Columbia, Oregon, and Eastern Washington. Warmer summers will increase the number of fires and with more fires, more smoky days are likely.[139]

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[137] King County Department of Natural Resources and Parks. Landslide Hazards Program website. Accessed online on 6/7/19 from https://www.kingcounty.gov/services/environment/water-and-land/flooding/maps/river-landslide-hazards/landslide-types.aspx#Debris.

[138] Washington State Geologic Survey. Landslide Hazards Program website. Accessed online on 6/7/19 from https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/landslides#types-of-landslides.8

[139] Gilbert, Greg. August 14, 2018. Smoky Seattle summers: expect more of them, scientists say. *The Seattle Times*. Accessed online on 6/19/19 from https://www.seattletimes.com/seattle-news/smoky-seattle-summers-expect-more-of-them-scientists-say/.

Post-fire flooding and debris flows
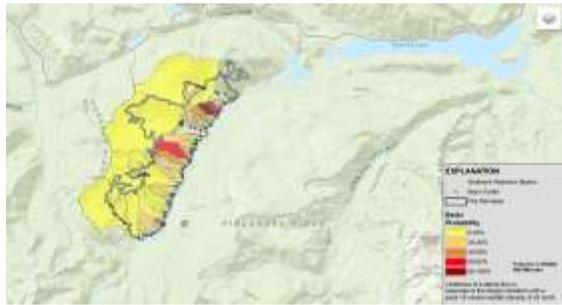
Wildfires burn vegetation on steep slopes, not only destabilizing the slopes but also making the soil hydrophobic in high-intensity fires. This can lead to large debris flows and mudslides when heavy rains occur that damage infrastructure and communities downstream for several years after a fire. USGS can conduct assessments on burned areas to determine the likelihood of major debris flows from a burned area.[140]

Priority Vulnerabilities

Structures built in interface or intermix areas	Structures built in interface or intermix areas are more susceptible to fires, including from spotting and embers ahead of a fire. This is especially true for buildings with less than 100 feet of defensible space.
Foothills and interface communities	Communities in or around areas at a higher risk of fire, such as those in the foothills of the Cascades, are more susceptible to fire.
Communities in or near the floodplain, downstream of potential burn areas	Major wildfires can cause the soil to become hydrophobic. When rains come, large quantities of water and debris and rush down hillsides and destroy homes and infrastructure while causing flooding in downstream communities.
Communities built without multiple ingress and egress routes	Communities with a single ingress and egress route are much more difficult to protect and evacuate. Roads that are less than 24 feet wide, especially those less than 20 feet wide, and those driveways without a turnaround are highest risk.
Buildings built with flammable materials and with vegetation close to the structure	Buildings not meeting FireWise principles, including defensible space, are most at risk to wildfire. This includes proximity of dense brush or timber, flammable composition of structure roof, and siding.
Communities on slopes or hills	Fires tend to burn up slopes and ridges, endangering structures in those areas. Buildings less than 30 feet from a slope of greater than 30% grade are most vulnerable.

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[140] USGS. 2018. Miriam Fire Preliminary Hazard Assessment. Accessed online on 6/19/19 from https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=224.

| Areas with more frequent severe fire weather days and winds | Fire weather, including low humidity and wind, is a major predictor for when ignitions, which are common, will spread and become a major fire. Areas prone to this weather are expected to expand due to climate change. |
| Areas greater than five miles from a fire station and with limited water source availability | Buildings more than five miles away from fire services and with limited pressurized fire hydrant access are more vulnerable. |

Priority Impact Areas

King County residents	King County residents are most likely to experience fire impacts from smoke. Smoke can cause respiratory issues and prevent people from taking part in outdoor activities. There are limited populations exposed to wildfire hazard in interface areas, though this risk is growing due to climate change and new development.
Vulnerable populations	Populations suffering from respiratory ailments are at the greatest risk from wildfire since smoke from fire. People with existing heart and lung diseases, older adults, children and pregnant women are especially at risk of smoke-related health problems.
Property	The level of exposure of property and potential impacts to property from wildfire is not yet known in detail. The communities with the highest levels of exposure include Snoqualmie, North Bend, and unincorporated areas of the county in the foothills of the Cascades. King County is working on a better estimate of overall risk to property and will update this plan with that information when it is available. Likely impacts to property include smoke damage to total loss of facilities. Communities built with many homes close together and constructed of flammable materials can be completely burned in a short time, as seen in Fort McMurray, Canada, Paradise California, and Santa Rosa, California.
The economy	At present, there is relatively little economic impact from wildfires in most of King County. The fires are predominately a risk in the more rural parts of the county. There is some impact from smoke and fire to transportation systems; however, it is likely to be limited and temporary. The largest impacts are likely to be indirect, including losses in work days because of poor air quality, loss of capital required for suppression efforts, interrupted access, and losses in tourist income.
The environment	While fires are often beneficial to the landscape when regular and not intense, a major wildfire can be damaging in the near term. Fires can pollute water systems and destroy old growth habitat. They can burn over springs and increase evaporation. Following extreme fires, hydrophobic soils make it difficult for plants to regrow in and the runoff over these soils increases the turbidity of local streams, endangering fish and other water animal populations.

Health systems	Exposure to fine particulate matter (parts per million 2.5) is a significant health concern, because the small size of the particle allows people to inhale it deep in the lungs where the particles can directly enter the blood stream. The effects of smoke exposure range from eye and respiratory tract irritation to more serious health problems including reduced lung function, bronchitis, exacerbation of asthma and heart failure, and premature death.[141] During extreme smoke pollution events, public health systems are likely to be overburdened by populations suffering respiratory distress.
Government operations (continuity of operations)	Most King County operations and facilities are in the more urban areas of the county and unlikely to be directly impacted by wildfires. Smoke, however, can cause an increase in employee absenteeism as employees may need to stay home to avoid smoke exposure. Another risk is that a wildfire might occupy most of the region's firefighting capabilities, leaving less capability to continue regular structure fire and emergency medical missions.
Responders	Growing numbers of wildfires will increase risk to firefighters. Firefighters in the Puget Sound mostly respond to structure fires. With an increase in wildland or WUI fires, firefighting becomes more complex and dangerous. Also, communities without proper ingress/egress routes further increase risk to firefighters who may be called upon to attempt evacuations in such communities. According to the Washington State Enhanced Hazard Mitigation Plan, there are less than five first responder facilities exposed to wildfire.[142]
Infrastructure systems	- Energy: Washington's transmission lines run through wildland areas. Wildfires in King County could damage or destroy these systems, although brush is usually kept clear of the largest transmission facilities. Rural and other interface power lines would be burned in any fire, as has been seen in numerous communities in Eastern Washington. Utilities in California are increasingly powering down transmission systems during "red flag" fire conditions, affecting energy customers. - Water/Wastewater: Many water reservoirs are in forested areas and could be impacted by wildfire that may burn power supplies to pump stations or the pump stations themselves. Furthermore, post-fire flooding could damage or pollute reservoirs. - Transportation: Fire can cause road closures due to visibility concerns. A greater risk, however, is post-fire flooding and debris flows that can damage or destroy roads and bridges downstream or downslope from a burned area after a rain. Additionally, SeaTac Airport was forced to cancel flights in 2018 due to poor visibility during smoke events.

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[141] Washington State Emergency Management. 2018. Washington State Enhanced Hazard Mitigation Plan Risk Assessment. Pp. 493-495.
[142] Washington State Emergency Management. 2018. Washington State Enhanced Hazard Mitigation Plan: Wildfire Risk Assessment. Page 533.

	• Communications: Cellular communications sites can lose power or be damaged by wildfire. During these events, it may be necessary to deploy cellular on wheels capabilities.
Public confidence in jurisdiction's governance and capabilities	Wildfire hazards have gained renewed importance in recent years due to the smoke problems of 2017 and 2018. Numerous articles in the Seattle Times and other media describe a "new normal" of smoke and fire danger in the Northwest. State and local jurisdictions have been working to prepare public information messaging due to health concerns and public interest. Government will need to be proactive in managing this hazard in order to maintain public confidence.

Hazard Mitigation Strategies

The primary focus of this plan update was the development of comprehensive, operationally viable hazard mitigation strategies and the establishment of a capability to supervise and promote their implementation. Plan strategies were developed using the following structure:

Mitigation Plan Goals	• These match the 14 Determinants of Equity, from King County's Equity and Social Justice Program • Support community resilience.	
Mitigation Plan Strategies	• These are broad approaches to address a problem and support the Plan goals. • These may live on from plan to plan.	
Mitigation Projects	• These are the specific actions to be taken in support of the Plan Strategies. • These are on either a 2 year or 5 year timeline.	

Hazard mitigation strategies were developed by each participating jurisdiction, supported by a series of workshops, described in the planning partner engagement section of the introduction. The workshops were hosted by King County Emergency Management and included state and FEMA staff associated with the RiskMAP program.

The half-day workshop series took participants from developing risk problem statements (December 2018), through identifying community assets and strategies to protect those assets (July 2019), to funding projects (August 2019). Using problem statements developed in the first workshop, participants identified assets and then developed strategies that could protect their assets in workshop 2. Participants were also guided through a strategy prioritization exercise using the King County method described below. They left the second workshop with a list of strategies drafted and prioritized. For the third workshop, participants learned about potential funding sources and how to seek funding for high-priority strategies and eligible projects that they could not fund internally.

For those unable to attend workshops in-person, the planning team provided handouts and met in-person over through Skype to walk jurisdictions through the same process. Unless indicated otherwise, this is the method planning partners used to develop and prioritize hazard mitigation strategies.

Each planning partner also convened those internal stakeholders who were responsible for projects or programs that supported or implemented mitigation along with those stakeholders with funding available or funding needs. In King County, the primary hazard mitigation agencies include:

- Department of Natural Resources and Parks – Water and Land Resources
- Department of Natural Resources and Parks – Wastewater Treatment
- Department of Local Services – Permitting
- Department of Local Services – Roads
- King County Information Technology
- Department of Executive Services - King County International Airport
- Department of Executive Services – Facilities Management Division
- Public Health Seattle – King County

The planning team met with each department individually, with each developing and submitting a list of potential hazard mitigation strategies and projects.

Departments attended the July Mitigation Strategy Workshop and August Mitigation Funding Workshop along with the local jurisdiction partners.

Mitigation Plan Goals:

Goals are broad policy statements of the community's vision for the future. They help describe the contribution each strategy makes toward major objectives that reach beyond any individual department or discipline. In alignment of this and with the Plan's purpose, King County's Regional Hazard Mitigation Steering Committee adopted King County's Determinants of Equity[143] as Mitigation Plan Goals:

Mitigation Plan Goals - 14 Determinants of Equity

1. Access to Affordable, Healthy Food
2. Access to Health and Human Services
3. Access to Parks and Natural Resources
4. Access to Safe and Efficient Transportation
5. Affordable, Safe, Quality Housing
6. Community and Public Safety
7. Early Childhood Development
8. Economic Development
9. Equitable Law and Justice System
10. Equity in Government Practices
11. Family Wage Jobs and Job Training
12. Healthy Built and Natural Environments
13. Quality Education

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[143] Office of the King County Executive. 2016. Equity and Social Justice Strategic Plan. Accessed online on 7/24/19 from https://kingcounty.gov/elected/executive/equity-social-justice/strategic-plan.aspx.

14. Strong, Vibrant Neighborhoods

Supplemental Goals:

15. Resilient and safe high and significant-hazard dams
16. Proactive and innovative floodplain management to reduce Repetitive Loss and Severe Repetitive Loss properties

Mitigation strategies will be categorized according to these 16 factors.

Mitigation Plan Strategies

Mitigation Plan Strategies will be developed based on threats to essential assets and capabilities from hazards within cities and unincorporated areas of King County. In the past these have included strategies for risks such as land movement and flood impacts and projects such as bridge seismic retrofits and generators for critical facilities. For this plan, hazard mitigation strategies are sets of coordinated actions that, taken together, address a risk or vulnerability. They are comprehensive, long-term, and designed to be regularly updated as actions are completed.

The updated strategy format will be used going forward in order to better support long-term tracking of mitigation actions and strategies. The updated strategy template is displayed below.

Lead Points of Contact (Title)	Partner Points of Contact (Title) *Who else outside your jurisdiction benefits from the strategy or will help implement the strategy?*	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
Strategy Vision/Objective *Long-term objective and vision for the strategy*			
Mitigation Strategy *Describe the program/proposed program*			
2-Year Objectives	5-Year Objectives		Long-Term Objectives

Implementation Plan/Actions *This can provide a timeline, indicate partners, discuss implementation stages, etc. Use this to discuss how the strategy/program will be implemented over the long term.*
Performance Measures

This template will be built into a database where strategies can be entered, updated, and projects can be prioritized consistently and effectively. The goal is for strategies to remain in place through future plan updates, while implementation plan actions are changed.

Mitigation Plan Projects

Mitigation Plan Projects represent the specific work to be done and actions to be taken to mitigate a risk or hazard. Candidate projects will be developed and considered for and by each participating jurisdiction, with a process to engage the public in the prioritization of projects. Projects will be prioritized using the scoring method established by the Steering Committee to ensure alignment with the Plan Strategies and Goals and in keeping with the following values:

➢ Equity, Social Justice, and Vulnerability
➢ Collaborative
➢ Adaptation and Sustainability
➢ Multiple-Benefit
➢ Effectiveness
➢ Urgent
➢ Shovel-Ready

Prioritizing Hazard Mitigation Projects

King County developed a prioritization process based on criteria taken from national best practices[144] and priorities identified by the King County Executive. These criteria are used to prioritize projects within strategies. Strategies are also prioritized in this way to identify those areas of emphasis for KCEM and the mitigation steering committee, though this may not impact which strategies are implemented since many depend on exclusive funding sources. The below criteria will be used to establish priorities. These priorities will be applied to projects annually for submission to the FEMA BRIC program.

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[144] Washington, District of Columbia Homeland Security and Emergency Management Agency. 2018. District Hazard Mitigation Plan, Discussion Draft.

King County uses the below matrix, scoring each factor from 0 (unsatisfactory) to 4 (outstanding) with the option of a score of -4 (actively harms the factor). Identifying projects that harm, and giving harmful factors more weight in the formula, is designed to encourage project proponents to modify their proposed design to better resolve any issues.

- -4 Project actively harms or is detrimental to this factor.
- 0 Unsatisfactory for this factor
- 1 Minimal level of standards for this factor
- 2 Satisfactory level of standards for this factor
- 3 High level of standards for this factor
- 4 Outstanding or beyond expectations for this factor.

Strategy:				
Factors for Consideration	Project 1	Project 2	Project 3	Project 4
Equity, Social Justice, and Vulnerability (project is designed to benefit, account for, and include vulnerable populations, especially those in the community most likely to suffer harm from a disaster and those likely to take longest to recover after a disaster)				
Collaborative (project is supported by multiple jurisdictions or agencies)				
Multiple-Benefit (project has benefits beyond hazard risk reduction, including environmental, social, or economic benefits)				
Adaptation and Sustainability (project helps people, property, and the environment become more resilient to the effects of climate change, regional growth, and development)				
Effectiveness (project is designed to attain the best-possible benefit-cost ratio)				

Urgent (project is urgently needed to reduce risk to lives and property)				
Shovel-Ready (project is largely ready to go, with few remaining roadblocks that could derail it)				
Total Scores				

Process Note: Once a jurisdiction has prioritized projects within that jurisdiction, those projects will be advanced to the regional plan. If ever there is competition between projects advanced from different jurisdictions, the RHMP Steering Committee, consisting of representatives from county departments and jurisdiction partners, will establish the order of priorities based on the values identified above. The Steering Committee will also organize priority projects with corresponding strategies. It should be noted that while prioritized projects will be included in the plan, they may not all receive funding. The Steering Committee may also seek to promote a diversity of projects so that all plan goals receive some benefits. In the case of a tie between projects during scoring, the higher prioritization may go to the less-represented mitigation strategy.

In addition to regular ranking of mitigation projects, the steering committee ranked mitigation strategies using the above tool to identify the highest priority strategy within each department and then the highest priority strategies for the county overall. These priorities are reported in the mitigation strategy section of this plan.

Crosswalk with the Strategic Climate Action Plan

Several strategies appear in some form in both the SCAP and this plan. This was done to ensure multiple avenues of implementation and monitoring and to help relevant actions gain a higher profile with other departments. Below are strategies that appear in some form in both plans.

Regional Hazard Mitigation Plan Strategy	Strategic Climate Action Plan Action
Wildfire Preparedness and Risk Reduction	Wildfire Preparedness and Risk Reduction
Accelerate Floodplain Acquisitions	Accelerate Floodplain Acquisitions
Public Information Flood Activities	Increase Technical Assistance to Property Owners for Flood Risk Reduction
Flood Risk Mapping	Flood Risk Mapping

Reduce Flood Impacts to King County Roads	Maintain Quick Response Budget for Emergency Repairs
Stormwater and Surface Water Risk Reduction	Stormwater and Surface Water Risk Reduction
Climate Integration Training	Engage Partners on Climate Preparedness Opportunities
Sea-Level Rise Resilience in Wastewater Facilities	Sea-Level Rise Resilience in Wastewater Facilities

Ongoing Plan Maintenance and Strategy Updates

King County leads the mitigation plan monitoring and update process and schedules annual plan check-ins and bi-annual mitigation strategy updates. Updates on mitigation projects are solicited by the county for inclusion in the countywide annual report. As part of participating in the 2020 update to the Regional Hazard Mitigation Plan, every jurisdiction agrees to convene their internal planning team at least annually. Partners will convene at least biannually to update hazard mitigation strategies. For the 2020 plan, progress updates will be due in 2022 and 2024, in advance of plan expiration in 2025.

In addition to the biannual strategy updates and annual planning check-ins, mitigation strategies that address flooding will be reviewed, revised, and updated annually. Special focus is warranted for flood hazards since flooding has historically been the most damaging hazard and the majority of Federal Disaster Declarations including the county are due to flooding.

Given the emphasis on plan integration described in the introduction, plan check-ins for all planning partners will include updates on integrating comprehensive, capital improvement, and other local and regional plans with hazard mitigation plans and data. This effort is already beginning with the integration of hazard risk and vulnerability information into the 2020 update of the countywide planning processes.

As part of leading a countywide planning effort, King County Emergency Management will send to planning partner any federal notices of funding opportunity for the Hazard Mitigation Assistance Grant Program. Proposals from partners will be assessed according the prioritization process identified in this plan and the county will, where possible, support those partners submitting grant proposals. This will be a key strategy to implement the plan.

The next plan update is expected to be due in April 2025. All jurisdictions will submit letters of intent by 2023, at least two years prior to plan expiration. The county will lead the next regional planning effort, beginning at least 18 months before the expiration of the 2020 plan.

To update and maintain the mitigation strategies, KC EM has worked with the King County Risk Management Services department to develop a reporting tool that will allow for easier updates on 2 and 5-year objective progress. These updates will be collected electronically and feed into a program that can track progress over time for each mitigation strategy. The strategy progress can then be reported out.

Alternatively, progress made on strategies can be organized according to mitigation plan goals. This will be done to show how projects undertaken by agencies and jurisdictions are supporting the 14 Determinants of Equity. Data parsed both in terms of the mitigation plan goals and by strategy will be reported to the County Executive and Council biannually in the annual report of the department.

In addition to the updates for mitigation strategies, the expected publication of data from several programs may trigger an update.

- Publication of the Department of Homeland Security Regional Resiliency Assessment Program report
- Publication of the countywide landslide susceptibility map from Washington Department of Natural Resources
- Publication of the Wildland Urban Interface wildfire risk map from Washington Department of Natural Resources
- Publication of tsunami inundation data from Washington Department of Natural Resources

| Introduction | Add a strategy | Assess projects | Review | | Submit | Reset form |

Jurisdiction:

Strategy name:

Vision/purpose:

Lead contacts:

Description:

Partner contacts:

Hazards	Goals	2-year objectives:
Avalanche	Affordable, healthy food	
Civil disturbance	Affordable, safe, quality housing	
Cyber incident	Community and public safety	
Dam Failure	Early childhood development	5-year objectives:
Earthquake	Economic development	
Flood	Equitable law and justice system	
Hazardous materials	Equity in government practices	
Health incident	Family wage jobs and job training	Long term objectives:
Landslide	Health and human services	
Severe weather	Healthy built and natural environments	
Terrorism	Parks and natural resources	
Tsunami	Proactive and innovative floodplain management	Performance measures:
Volcano	Quality education	
Wildfire	Resilient and safe high and significant-hazard dams	
	Safe and efficient transportation	
	Strong, vibrant neighborhoods	

Projects within this strategy

Name/description	Owner	Timeline	Score	Status

Funding   Total estimated cost:

Source	Amount ($)	Type

| Introduction | Add a strategy | Assess projects | Review |

Jurisdiction:	
Strategy:	
Project:	

Submit

Reset form

Assessment

Equity, social justice, and vulnerability	Designed to benefit, account for, and include vulnerable populations, especially those in the community most likely to suffer harm from a disaster and those likely to take longest to recover after a disaster
Collaboration	Supported by multiple jurisdictions, agencies, or the impacted community
Multiple-benefit	Benefits beyond hazard risk reduction, including environmental, social, or economic benefits
Adaptability and sustainability	Helps people, property, and the environment become more resilient to the effects of climate change, regional growth, and development
Effectiveness	Designed to attain the best-possible benefit-cost ratio
Urgency	Urgently needed to reduce risk to lives and property
Shovel-readiness	Largely ready to go, with few remaining roadblocks that could derail it

Total score:

Scoring

Determination	Meaning	Score
Outstanding	Outstanding or beyond expectations for this factor	4
High	High level of standards for this factor	3
Satisfactory	Satisfactory level of standards for this factor	2
Minimal	Minimal level of standards for this factor	1
Unsatisfactory	Unsatisfactory for this factor	0
Detrimental	Project actively harms or is detrimental to this factor	-4

Plan Approval and Adoption

The King County Regional Hazard Mitigation Plan is submitted first to Washington State Emergency Management for review and then to FEMA for final review and preliminary approval. Each jurisdiction, along with the base plan, must meet all FEMA requirements outlined in the FEMA Local Hazard Mitigation Plan Review Guide. If requirements are found to not be met, the jurisdiction involved must revise the plan and resubmit. Once preliminary approval is secured, FEMA will send a notice of Approval – Pending Adoption.

The RHMP is adopted by each participating jurisdiction, primarily through a resolution passed by the council or commission responsible. The King County Council adopted this plan on **DATE**, following notice of approval, pending adoption from FEMA and Washington State Emergency Management. This plan is effective upon adoption and will expire 5 years to the day after adoption.

Mitigation Strategy Status Updates from the 2015 Plan

The format for hazard mitigation strategies has been completely changed in the 2020 plan update. All actions previously identified have been removed and/or incorporated into new mitigation strategies. The updated strategy format will better support tracking and implementation of mitigation strategies and their constituent actions. Strategies that are preparedness focused have been removed, as well as those that are ongoing in nature and do not have specific targets or responsible entities.

The following tables are taken from the 2018 annual progress report for the 2015 King County Regional Hazard Mitigation Plan. This list only includes strategies submitted by King County departments and countywide strategies. Individual jurisdiction action progress reports are included in each annex. The new statuses for strategies include:

- Removed – Strategy is not carried forward into the new plan
- Complete – Strategy is complete and not carried forward into the new plan
- Updated – Strategy is updated and carried forward into the new mitigation plan.

CURRENT PROGRESS ON 2015 ACTION PLAN INITIATIVES				
Progress (Yes/No)	Timeline	Update Status	Comment (Describe progress or changed priority)	2018 Status
CW-1—Continue to participate in and support the "Resilient King County" initiative.				
Yes	Long-Term	Removed	King County is continuing work towards developing a Regional Recovery Framework. Recent efforts to vet content with King County's Department Directors and Executive Office have been made to start to formulate a governance structure.	Ongoing
CW-2—Continue to maintain a website that will house the regional hazard mitigation plan, its progress reports and all components of the plan's maintenance strategy to provide the planning partners and public ongoing access to the plan and its implementation.				
Yes	Long Term	Removed	King County's Regional Hazard Mitigation plan and all updated documents will continue to be posted to the website.	Ongoing
CW-3—Continue to leverage/support/enhance ongoing, regional public education and awareness programs (such as "Take Winter by Storm" and "Make it Through") as a method to educate the public on risk, risk reduction and community resilience.				
Yes	Long Term	Removed	We continue to enhance public education campaigns and have now added climate resilience as part of our educational presentations.	Ongoing
CW-4—Continue to support the use, development and enhancement of a regional alert and notification system.				
Yes	Short Term	Removed	King County deployed a new Regional Alert and Notification System. Many King County departments and cities have signed on.	Complete
CW-5—Strive to capture time-sensitive, perishable data—such as high-water marks, extent and location of hazard, and loss information—following hazard events to support future updates to the risk assessment.				
Yes	Long Term	Removed	KC DNRP has updated landslide hazard maps (see DNRP – WLR 3 & DNRP – WLR 4)	Ongoing
CW-6—Encourage signatories for the regional coordination framework for disasters and planned events.				
Yes	Long Term	Removed	New signatories were added in 2016.	Ongoing
CW-7—Continue ongoing communication and coordination in the implementation of the King County Regional Hazard Mitigation Plan and the 2013 King County Flood Hazard Management Plan.				

Yes	Long Term	Removed	Ongoing communication and coordination was completed through the linkage process of Lake Forest Park and Kenmore, grants coordination for various applications, and ongoing communication for progress reporting.	Ongoing

DNRP-SWD-1—Seismic Design Standards. Continue to design and build facilities to meet or exceed seismic standards, including redundant essential equipment. Apply current seismic standards to all renovation or replacement of existing facilities and/or equipment.

Yes	Short-term	Removed	Design standards exist and we will continue to design and build facilities to meet or exceed seismic standards, including redundant essential equipment. Apply current seismic standards to all renovation or replacement of existing facilities and/or equipment.	Complete

DNRP-SWD-2—Vulnerability Assessment of Cedar Hills Landfills Structures. Conduct a vulnerability assessment of buildings at the Cedar Hills Landfill to ascertain readiness.

Yes	Long-term	Removed	Structural integrity to be addressed through seismic design standards; to be removed as part of standard work. Additional work completed to reduce vulnerability at the landfill includes: completed Emergency Action Plan, Dam Break Analysis, Potential Inundation Area Mapping for the Contaminated Stormwater (CSW) Pond dam and the SW Stormwater Pond dam (both state registered dams at Cedar Hills Regional Landfill). The SCADA system is being updated to monitor and automate operation adjustments for pumping at the CSW facility. The area 8 stockpile slope was regraded Q3 2018 in response to a Q4 2017 slope failure (a.k.a., landslide or land movement) and to mitigate future failure prior to the rainy season. Coordination between SWD and OEM enhanced, including use of mass notification system for incident response, support and community notification.	Complete

DNRP-WLR-1—Flood Insurance Program. Continue to maintain compliance and good standing under the National Flood Insurance Program. This will be accomplished through the implementation of floodplain management programs, at a minimum, will meet the minimum requirements of the NFIP, which include the following:
- Enforcing the adopted flood damage prevention ordinance.
- Participating in floodplain identification and mapping updates.
- Providing public assistance and information on floodplain requirements and impacts.

Yes	Long-term	Removed	Met minimum requirements of the NFIP by providing public assistance and information on	Ongoing

floodplain requirements, enforcing the adopted flood damage reduction ordinance and participating in floodplain mapping updates. Maintain a CRS Class 2 rating, which verifies that King County meets and exceeds FEMA NFIP minimum requirements.

DNRP-WLR-2—Landslide Hazard Coordination. Form an interdepartmental landslide hazard committee that includes DNRP, DPER, DOT, and OEM. The committee will address broad policy issues, including capital projects, communication, code changes, etc.

| No | Long-term | Updated | Form an interdepartmental landslide hazard committee that includes DNRP, DPER, DOT and OEM. The committee will address broad policy issues, including capital projects, communication, code changes, etc. | Ongoing |

DNRP-WLR-3—Proposed Hazard Mapping Phase I. Update the current landslide hazard map with information that has been collected to date.

| Yes | Short-term | Removed | Low priority now that map is complete.

Status: Complete for areas within major river corridors and Vashon-Maury Island.

Comment: A Phase 1 map was completed in October 2014. Phase I mapping along river corridors was completed by Water Land Resources Division as the service provider to the King County Flood Control District and Phase 1 mapping for Vashon-Maury Island was provided by KC DPER. Areas outside of major river corridors were not included in this map. | Complete |

DNRP-WLR-4—Proposed Hazard Mapping Phase II. Create a geo-database with detailed information on landslide types, run out, landslide dams, etc. Database will be searchable and updatable as new information is acquired.

| Yes | Short-term | Removed | Phase II mapping along river corridors was completed by Water Land Resources Division as the service provider to the King County Flood Control District (KCFCD). Areas outside of the major river corridors (including Vashon-Maury Island) are not included in the geo-database. This mapping along river corridors includes five general landslide types, each of these were mapped separately to illustrate potential hazard areas. This mapping has been completed along with a supporting technical report, database and a user- | Complete |

friendly web tool. It is anticipated that this mapping will be publicly available in August 2016. This mapping will be available in a GIS format. No suitable methodology was identified to predict future landslide runout beyond area of current landslide debris deposition. Therefore, neither such landslide runout, nor the resulting formation of landslide dams was mapped. At this time funding has not been secured for ongoing database management or further updates to the river corridor landslide mapping information.

DPER completed a separate landslide hazard mapping project covering unincorporated King County largely outside of the forest production zone. This was an expansion of the Phase 1 mapping and was needed to identify areas for further geotechnical investigation during building and land use permit application reviews. This mapping does not distinguish between different landslide processes. The DPER mapping is complete to current specifications and is presently undergoing internal review. DPER's map of potential landslide hazards will be available in a GIS format. It will be updated at appropriate intervals as needed following receipt of new data.

Landslide hazards in incorporated areas outside of major river corridors are not included in the Phase I or Phase II products. At this time no work is funded or planned to conduct landslide hazard mapping for incorporated areas that are outside of the major river corridors.

DNRP-WLR-5—Flood Protection Facility Maintenance. Maintain and repair damaged structural elements for King County's extensive inventory of flood protection facilities.

Yes	Long-term	Updated	County staff completed 421 inspections on 332 levees and revetments during the reporting period. Of these, 143 were routine inspections and 279 were post-flood inspections following the 2015-2016 flood season. Resulting in identification of damages to flood protection facilities and repairs or emergency management plan.	Ongoing

Maintenance of more than 70 sites included irrigation, signage, hazard tree mitigation, debris removal, planting, mulching, mowing and installation of a device to prevent beavers from blocking two large culverts which could result in flooding homes and roads in the North Bend area.

Resulting in reduced potential for flooding.

DNRP-WLR-6—River Corridor Restoration. Remove, slope back, or set back County-owned flood protection facilities and other structural features to allow for improved riparian habitat, greater channel diversity and migration, reclaimed flood storage and enhanced open space or recreational/ interpretive uses.				
Yes	Long-term	Updated	Completed projects allowing for river corridor restoration include the Sinnema Quaale Revetment project on the Snoqualmie River. This revetment repair was completed in the summer of 2016 and has significantly decreased the risks to the Snoqualmie Valley Trail, regionally significant fiber optic lines and SR203. The Countyline to A Street levee setback on the White River is currently under construction. Additional setback projects are planned for construction in 2017.	Ongoing

DNRP-WLR-7—Flood Hazard Mitigation. Acquire repetitively damaged homes, purchase underdeveloped land to prevent future development in flood prone areas, and, where cost-effective and feasible, elevate residential homes that sustain recurring deep, low-velocity flooding.				
Yes	Long-term	Updated	Non-structural mitigation efforts are ongoing in flood prone areas. Eleven at-risk homes were elevated in the Snoqualmie basin during the reporting period; another 13 home elevations are underway. Elevating homes eliminates flood damage to living space, resulting in a more resilient community. Acquisition of the last at-risk parcel in the San Souci neighborhood along the Tolt River completed 20 years of effort to acquire 18 parcels from willing landowners. These actions have completely eliminated flood risks to the entire neighborhood and eliminated emergency monitoring and response to the neighborhood.	Ongoing

DNRP-WLR-8—Critical Facility Retrofit. Retrofit the Black River Pump Station by updating the fuel pumps to meet seismic requirements. Currently, the fuel supply tanks for King County flood facilities cannot withstand a moderate to major quake.				
Yes	Long-term	Updated	Recent improvements include: • Replacing the single-walled fuel system with double-walled tanks and lines to handle all diesel fuel in accordance with current code requirements • Replacing the pumphouse roof • Installing safety rails on the roof Sediment had accumulated in the pump inlet bays, hindering operation of pump screen systems. Accumulated sediment was emptied from the bays and inlet apron in 2016 to allow continued operation of the screens and pumps. This improves the certainty of flood protection the station provides too much of Renton and parts of Tukwila and Kent. Staff have completed update of Emergency Action Plans for 10 state registered dams in compliance with Washington Dam Safety Office. Improvements to these plans include automated notification applying King County Alert and King County Inform emergency notification platforms; upgrades to dam break analysis and Potential Inundation Area mapping; and enhanced coordination between operations and emergency planning.	Ongoing
DNRP-WLR-9—Flood Hazard Reduction Programs. Conduct activities that are vital to the mitigation of the natural hazards impacting King County, such as hazard identification, warning, information dissemination and public outreach.				
Yes	Long-term	Updated	Expansion of the King County Flood Warning System to include the South Fork Skykomish River. A four-phase warning system is being developed in time for the 2016–2017 flood season, following review and approval by the District. This system is expected to provide flood warnings to people who live, work or travel through the town of Skykomish and the surrounding area.	Ongoing

In October, the annual flood warning brochure was mailed to 19,222 addresses in the King County river floodplain.

Significant outreach efforts during the reporting period include preparation for flood season, outreach about multiple construction projects, as well as outreach about floodplain planning, technical studies and maps, and other public engagement efforts.

			DNRP-WLR-10—Critical Facility Upgrade. Continue to update flood warning telemetry and gauging, computers, software applications, emergency power, and other response facilities.	
Yes	Long-term	Updated	Updates to the King County Flood App for iOS, Android, and Windows phones were completed for release by October 2015. All King County websites were migrated to a new "mobile responsive" template which adapts to a wide range of screen sizes, from small smartphone displays to big screen desktop displays. In addition, improvements were made to the back-end systems that manage the flood data used on the websites, apps and automated phone systems.	Ongoing
			DNRP-WTD-1— Seismic Design Standards. Continue to design and build facilities to meet or exceed seismic standards, including essential equipment. Apply current seismic standards to all renovation or replacement of existing facilities and/or equipment.	
Yes	Long-term	Updated	This is an ongoing process- we apply current seismic standards to all renovation and/or replacement of existing facilities or equipment.	Ongoing

DNRP-WTD-2—Vulnerability Assessments. Conduct vulnerability assessments of WTD treatment plant facilities and conveyance system structures for flooding, earthquakes, large-scale power outages, and hazardous material spills into the conveyance system (accidental or deliberate, i.e. terrorist action). The assessments should include the following:				

- Review existing earthquake vulnerability assessments and identify facilities and structures that need further assessments.
- Review existing emergency power generation capacities at treatment plants, offsite facilities and interceptors (pipelines) to identify vulnerabilities and response & restoration protocol enhancements.
- Review existing spill response procedures and protocols for hazardous materials spills (both accidental and intentional releases) that impact flows into the WTD system. Update and coordinate emergency procedures with key fire departments and the Office of Emergency Management.

Yes	Short-term	Removed	Request for Proposal issued on 7/12/2016	Ongoing

DNRP-WTD-3—Modification of Existing Facilities. Use the data gathered by the earthquake vulnerability assessments to identify capital projects that increase the resistance of the division's structures and conveyances to damage or that allow a rapid recovery from damage. Projects may include seismic bracing of equipment and piping, removal of z-beam structures, access road reinforcement for the West Point Treatment Plant, or seismic upgrade of underwater interceptors.				
No	Long-term	Updated	This task is driven by the results of the above vulnerability assessments which have yet to be conducted. See item 2 above	Ongoing

DNRP-WTD-4—Sea Level Rise Vulnerability Assessments. Implement cost-effective measures to address, through capital improvement and asset management programs, the vulnerability of 20 facilities at risk of saltwater inflow. The facilities were identified by a WTD analysis of the wastewater system to identify facilities at risk for saltwater inflow from future sea level rise, existing and predicted high tides, and storm surges.				
Yes	Long-term	Updated		Ongoing

DNRP-WTD-5—Control System/ Cyber Security Vulnerability Assessment and Procedure Audit. Implement the Ovation project—a multi-year, multi-million-dollar upgrade of the Wastewater Treatment Division's legacy control systems. WTD is in the process of updating its control systems. Vulnerability assessments are designed into the Ovation project. When the system is operational, a security audit would be conducted to ensure that policies and procedures are in place to protect the system.				
No	Long-term	Updated	This assessment will be conducted when the system is operational	Ongoing

DNRP-WTD-6—Emergency Communications Vulnerability Assessment. Perform an assessment to determine the number of radios necessary to support operational readiness in the event of a widespread telecommunications failure. Currently all key operational facilities and offsite operation and maintenance vehicles are equipped with 800 MHz radios, constituting WTD's core emergency communications method. The analog equipment currently deployed is first generation and is being sunsetted as the system is converted to a digital format. All the division's analog radios will need to be replaced in the next 3 to 5 years. Perform a further assessment of the reliability and deployment of other communications devices: cell phones, smart phones, iPads, text messaging, and the emergency notification system (MyState/AlertSense).				
No	Long-term	Updated		Ongoing
DNRP-WTD-7—GIS Emergency Response Mapping and Real-Time Flow Data. Update the WTD/DNRP Emergency Response map with the current priority roads, bridges, earthquake liquefaction, inundation and landslide zones and gas/petroleum pipelines, under-laid with WTD facilities and conveyance lines and emergency outfalls to facilitate emergency response and continuity of operations. Make this information available through a password-protected website for select users. Explore connecting the map to real-time flow data.				
Yes	Short-term	Updated	A GIS emergency mapping site is now operational on the WTD intranet that shows facilities and conveyance system. Working on moving it to an internet site so that it can be accessed 24/7 by off duty personnel.	Ongoing
DNRP-WTD-8—Emergency Event Management System. Determine the best method for WTD to manage and share emergency response and continuity of operations activities across the division's five treatment plants and the division headquarters in the King Street Center. Determine if the Regional Information System can fulfill this function and, if not, what alternative systems are available (WebEOC, CodeRed, etc.).				
No	Long-term	Updated	Tested the KC OEM SharePoint site during the CSZ exercise. Assessing the need for a separate WTD system	Ongoing
DNRP-WTD-9—Emergency Response/ Damage Assessment/FEMA Cost Tracking. To ensure maximum FEMA reimbursement for disaster repair/mitigation, implement a system to capture and track emergency response activities and expenses form the beginning of incidents through damage assessment and restoration. Use this tracking system for all out-of-the-ordinary emergency events. Include labor, equipment, mileage, supplies, expendables, and outside contracting associated with response and repair.				
No	Short-term	Updated		Ongoing

Action				
DOT-1—Updated response plans to address terrorism preparedness, including the following: • Improve existing systems to address new technologies that are available for early weapons-of-mass-destruction detection. • Leverage existing resources and partnerships (Securitas, King County Sheriff's Office, Seattle Police Department, Seattle Fire Department) to train and exercise together for continuity during real-world events.				
Yes	Long-term	Removed		Ongoing
DOT-2—Update messaging, response plans, and procedures to address winter weather, including the following: • Outreach to vulnerable and at-risk populations for transportation for individuals who need to get to life-saving medical appointments (dialysis, chemotherapy). • Coordination with healthcare and transportation partners to ensure access to medical care.				
Yes	Long-term	Removed		Complete
DOT-3—Update and improve plans to address continuity of transportation services, provision of medical care, and infrastructure resiliency, including the following: • Plans and procedures for workforce continuity and service provision. • Coordination with local partners on evacuation and responder routes, lifeline routes, and transportation routes. • Technical systems and IT infrastructure (e.g. computer programs, SCADA systems).				
Yes	Long-term	Removed		Ongoing
DOT-4—Install security cameras on public buses to deter crime associated with civil unrest and terrorist acts.				
Yes	Short-term	Removed	Metro will have at or near 100% of their fleet equipped with cameras by the end of 2018.	Complete
DPER-1—Continue inspection of existing and new construction.				
Yes	Long-term	Updated	Inspection to ensure code compliance of both new and existing building and sites are conducted for all permit work.	Ongoing
DPER-2—Provide plan reviews for noted construction.				
Yes	Long-term	Updated	Inspection to ensure code compliance of both new and existing building and sites are conducted for all permit work.	Ongoing
DPER-3—Work with schools and fire service public educators to deliver public safety messages.				
Yes	Long-term	Updated	Operational (annual) fire safety inspection of schools was initiated this past year after several years of inaction.	Ongoing

FMD-1—Replace Alder Tower, Alder Wing and Youth Detention Facility with a new modern juvenile justice center meeting all seismic standards. Planning is underway for the new, voter-approved $210 million Children and Family Justice Center. Completion of the new facility is expected in 2019.

Yes	Long-term	Removed	New facility is now expected in 2019 rather than 2018.	Complete

FMD-2—Mitigate structural damage at King County Facilities. This initiative also involves training to determine structural damage during and after hazard events.

Yes	Long-term	Updated	The Facilities Management Division has undertaken replacement of some fire protection systems which as a result, will reduce fire damage during hazard events.	Ongoing

FMD-3—Mitigate non-structural facility damage at King County facilities. This initiative also involves training to determine non-structural damage during and after hazard events.

Was an action taken?	Short-term	Updated	The Facilities Management Division recently received a report about serious deficiencies at the King County Courthouse. We will be updating the response to this issue outside of the cycle of this report.	Ongoing

KCIT-1—Enterprise Server Optimization Project. Implement a standard virtual environment at the King County Data Center to set the foundation for the King County Public Cloud Services to expand infr2astructure service offerings.

Yes	Short-term	Removed		Complete

KCIT-2—King County TV High-Definition Upgrade. Replace obsolete station infrastructure with industry standard high-definition and digital equipment, allowing for delivery of the highest level of service to the citizens of King County.

Yes	Short-term	Removed		Complete

KCIT-3—Countywide Telephone System Replacement. Replace obsolete telephony infrastructure and telephone systems with a modern and feature-rich communications solution.

Yes	Short-term	Removed	Complete by end of 2010.	Ongoing

KCIT-4—Business Empowerment and User Mobility. Improve the King County wide area network to meet business requirements and provide a solid foundation for growth within a resilient and stable network.

Yes	Short-term	Removed		Complete

KCIT-5—Administration Building Rewire. Upgrade network cabling in King County Administration Building to meet infrastructure standards, provide a more robust network connecti2vity to the services provided at the facility, and take advantage of technological advancements.

Yes	Short-term	Removed		Complete

PH-1— Inform the public on risk-reduction techniques for a communicable disease event. "Stop Germs, Stay Healthy" public education campaign increases awareness of healthy behaviors, including hand washing and "cover your cough".

Yes	Short-term	Removed	Public Health promotes infection control prevention every day as well as during outbreaks and flu season. Current focus is on fact sheets with pictograms for outbreaks such as hepatitis A and measles as well as guidelines for encampments and homeless service providers. Also actively using social media and blogs to promote messages.	Ongoing

PH-2—Update response plans to address emerging infectious disease outbreaks, including the following:
- The allocation of resources (antivirals, vaccine, personal protective equipment) from the strategic national stockpile.
- Improvements to surveillance systems to address new technologies
- Leverage existing private and public partnerships (CBO, healthcare, pharmacies) to serve as medication centers and increasing access to medications for hard-to-reach communities.
- Risk communications and messaging, including use of social media.

Yes	Short-term	Removed	A number of response plans were updated including medical countermeasures, equity response plan, risk communication plan, and workforce mobilization plan. Tested new systems for surveillance and plans during hepatitis A and measles outbreaks, including easy to understand visual display of cases and vaccination efforts.	Completed

PH-3—Update response plans and procedures to address winter weather, extreme heat, and other climate-related events including the following:
- Outreach to vulnerable and at-risk populations for carbon monoxide poisoning prevention.
- Transportation for individuals who need to get to life-saving medical appointments (dialysis, chemotherapy).
- Coordination with healthcare providers and NW Healthcare Response Network to ensure access to medical care.
- Coordination with shelter providers for first aid teams and access for people to re-charge medical equipment.

Yes	Short-term	Removed	Consolidated weather events into one extreme weather plan, updated winter weather transportation plan and added wildfire smoke protocols. Tested winter weather plans, including medical appointment protocol during 2019 snow events.	Completed

OEM-1—Inform the public on personal and community preparedness actions they can take to lessen their need for immediate response following a disaster. "Take Winter by Storm" and "What to Do to Make It Through" are two outreach campaigns designed to get the message across to the whole community. These campaigns include trainings, presentations, and tools to facilitate increased community preparedness.				
Yes	Long-term	Removed	Strategy is ongoing by nature and preparedness-focused. Removed.	Ongoing
OEM-2—Create a program to facilitate training for small businesses to increase their resilience to all hazards. Training content would include employee preparedness, business continuity, and recovery planning. Methods of training would include workshops, tools, and one-on-one help.				
Yes	Short-term	Removed	Initial steps to create Business EOC and conduct pilot test were taken in June during Cascadia Rising. As a result of early coordination with Seattle and King County, 7 companies representing more than 150,000 employees participated and were able to make faster operational decisions that could protect company resources and staff in a real event. Examples include early evacuation notifications, avoiding traffic disruptions, and setting up alternate modes of communication. Continuing to work with City of Seattle, WAEMD, and FEMA on building a Regional BEOC model.	Ongoing
OEM-3—Manage and facilitate the Resilient King County initiative, a countywide planning process for crafting a comprehensive long-term recovery strategy following an earthquake or major catastrophe. Develop the Resilient King County final report and the long-term recovery plan.				
Yes	Short-term	Updated	Conducted facilitated discussion with Executive Leadership Team as part of Cascadia Rising Exercise. Will vet plan content over summer and fall 2016.	Ongoing
OEM-4—Take advantage of technological and procedural improvements in regional alert and warning systems to provide the most effective, efficient, and cost-effective messaging to residents, businesses, and government, especially during emergencies.				
Yes	Short-term	Removed	Completed launch for new Alert & Notification system in May 2016. As a result, King County not only has the ability to provide alerts to all 2.1 million residents but also, 16 new cities have signed up and have direct ability to message their residents for local events. This allows a reduction in hazard impact as people will have more time to prepare themselves and their property by receiving alerts during an emergency.	Complete

OEM-5—Continue to update and improve the Comprehensive Emergency Management Plan (CEMP) and the Continuity of Operations Plan.				
Yes	Short-term	Removed	The CEMP has been updated in 2018/2019.	Complete
OEM-6—Integrate the hazard mitigation plan into other plans, ordinances or programs to dictate land uses within the jurisdiction.				
Yes	Short-term	Updated	Regional Hazard Mitigation Plan has been incorporated into the King County Strategic Climate Action Plan. Will also serve as a reference for recovery.	Ongoing
OEM-7—Continue to support the countywide initiatives in this plan.				
Yes	Short-term	Removed		Ongoing
OEM-8—Coordinate and actively participate in the plan maintenance strategy of this plan.				
Yes	Short-term	Updated	County is implementing additional support for grant administration and outreach to promote mitigation.	Ongoing
OEM-9—Continue to encourage community participation in incentive-based programs such as CRS, FireWise, and StormReady.				
Yes	Short-term	Removed		Ongoing

2020 King County Hazard Mitigation Strategies

King County identified the following strategies through meetings among county departments. These strategies were scored by each department using the prioritization criteria outlined earlier in this section. The highest priority from each department is highlighted below. From the list of top priorities for each department the highest countywide priorities were selected. These are:

- Integrate equity and social justice into planning, outreach, mitigation, response, and recovery
- Integrate hazards and vulnerability information into comprehensive planning
- Establish a resilient seismic transportation lifeline

STRATEGY	PRIORITY (SCORE)	LEAD AGENCY	KEY OUTCOMES
Reduce Flood Impacts to Unincorporated King County Road System	18	DLS - Roads	Lower road damage from repeated flooding, especially in the Snoqualmie Valley.

Increase Seismic Resilience of Bridges in Unincorporated King County	16	DLS - Roads	Seismic retrofits to King County bridges, especially those supporting the transportation seismic lifeline.
Stormwater Outfall Erosion Hazard Inventory	18	DNPR	Hazard inventory of stormwater outfalls and mapping of those areas in GIS.
Resilience in Design and Build of Critical Water Treatment and Conveyance Facilities	23	DNRP	Improvements, retrofits, and new construction of water treatment facilities that meets seismic resilience needs.
Landslide, Erosion, and Sedimentation Event Mapping	19	DNRP	Mapping of hazard areas and establishment of GIS layers.
Sea Level Rise Resilience in Wastewater Facilities	18	DNRP	Measures to move or reduce risk to wastewater facilities in areas projected to be impacted by sea-level rise.
Stormwater and Surface Water Risk Reduction	18	DNRP	Retrofits to endangered stormwater facilities. Focus on those areas at greatest risk of failure.
Control System Security and Performance	16	DNRP	Protection of wastewater system from cyber-attacks.
GIS Emergency Response Mapping and Real-Time Flow Data	15	DNRP	Real time GIS updates to critical facility information.
Emergency Communications Enhancements	12	DNRP	Improvements to, and resilience of, emergency communications tools.
Emergency Event Management System	12	DNRP	Improvements to WebEOC, including training on it.
Flood Warning Program	18	DNRP - Flood	Flood warning, including public information about warning system.
Post-Flood Recovery Efforts	19	DNRP - Flood	Resilient rebuilding following a flood disaster.

Home Elevations	18	DNRP - Flood	Elevations of homes out of base flood elevation when acquisition is not feasible.
Home Acquisitions and Relocations	19	DNRP - Flood	Prioritize acquisition as a tool of risk reduction and take advantage of post-disaster acquisition opportunities.
Protect and Restore Natural Floodplain Functions	17	DNRP - Flood	Take advantage of natural systems to reduce flood risk and restore flood risk areas to their natural state.
Flood Risk Mapping	16	DNRP - Flood	Improve and update flood risk maps, accounting for climate change.
Public Information Flood Activities	16	DNRP - Flood	Conduct outreach around flood hazard information.
Flood Insurance Promotion	16	DNRP - Flood	Promote flood insurance to all homeowners, renters, and business owners.
Enforce Higher Floodplain Management Regulations	13	DNRP - Flood	Enforce King County's higher standards to prevent the creation of new flood risk.
Manage Flood Protection Facilities	4	DNRP - Flood	Manage flood protection facilities to ensure they will not fail during a major flood or earthquake.
Seismic Evaluation of King County Courthouse and Maleng Regional Justice Center	16	FMD	Evaluate the vulnerability of major King County justice facilities and develop a strategy to address deficiencies.
Integrate ESJ into Mitigation, Response, and Recovery Activities	25	KCEM	Fully account for equity and social justice in all planning and activities to help ensure that disasters do not increase inequity.
Seismic Lifeline Route Resilience	23	KCEM	Establish transportation seismic lifelines and begin retrofitting vulnerable segments to a standard that will enable effective response

			and recovery following an earthquake.
Integrate Hazard Mitigation and Comprehensive Planning	21	KCEM	Integrate hazards and vulnerability information into comprehensive planning policies, mapping, and related activities to prevent the creation of new risk through development in high hazard areas.
Engage Community Organizations in Emergency Management	20	KCEM	Leverage existing community capabilities and engage with communities to promote emergency preparedness and catalogue potential needs.
Climate Integration Training	18	KCEM	Train local jurisdictions on how to integrate climate change information into planning, projects, and emergency management.
Disaster Skills Risk Reduction Training	18	KCEM	Train communities on what to do in a disaster and how to protect themselves and their families.
Dam Failure Risk and Impact Reduction	16	KCEM	Identify and remove or rehabilitate high hazard dams and conduct outreach on dam safety for good condition dams that will not be removed.
Wildfire Preparedness and Risk Reduction	15	KCEM	Convene partners engaged in wildfire planning activities to coordinate community outreach and reactions to new mapping and potential building codes.
Hazard Mitigation Assistance Grant Support	15	KCEM	Support local jurisdictions who have little experience in developing applications for FEMA HMA.
Public Assistance Grant Support	15	KCEM	Support local jurisdictions and county agencies with PA following a disaster declaration and expand the use of PA Mitigation funds.
Language Accessible Video Emergency Messaging	26	PHSKC	Develop video and other emergency messaging that is accessible to non-English speakers

			and those who are blind or hearing impaired.
King County Facilities Indoor Air Quality Monitoring Network	16	PHSKC	Monitor and mitigate air quality in King County facilities.
Medical Gas Seismic Detection & Emergency Shut Off	10	PHSKC	Install automatic gas detection and shutoff systems for hospitals and medical centers.

Reduce Flood Impacts to the Unincorporated King County Road System

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
Jennifer Knauer, King County Department of Local Services, Road Services Division	King County Flood Control District Cities	Flood Goal 4, 6	$500,000 (Snoqualmie Valley study) Additional design, construction costs TBD

Vision

Reduce the impacts of major river flooding to the unincorporated King County Road system within the Snoqualmie Valley and other major river valleys

Description

The Snoqualmie Valley is located approximately 8-10 miles east of Seattle, Washington and chronic localized and larger-scale flooding regularly impacts and closes roads within the floodplain. During major flood events, King County has identified that countywide, eleven roads are frequently closed, of which ten are located in the Snoqualmie River Basin.

During major flood events, cross-Snoqualmie Valley routes are not passable and approximately 15,000+ residents are cut off from emergency services and accessing other critical destinations during a flood event. When cross-valley road closures occur, they impact over 25,000 drivers per day. There is a need for a permanent flood tolerant cross-valley route, in part due to growth in eastern King County cities and increasing traffic volumes on unincorporated King County roads. In addition to selecting, designing and constructing one cross-valley flood tolerant route, there is a vital need for improved resiliency across other unincorporated King County roads in flood prone portions of the Snoqualmie Valley, as well as other unincorporated King County floodplain locations. A joint study is proposed to be completed by the King County Road Services Division and the King County Flood Control District. The purpose of the study is to evaluate a subset of primary cross-valley routes for the purpose of identifying a cost-effective option that can be built to withstand major flood events and provide east-west access across the valley during major flood events.

Improving the flood resiliency of existing county roads, as well as designing and constructing a flood tolerant cross-Snoqualmie Valley route will be complex and costly. King County Road Services Division continues to struggle to meet its preservation service goals for unincorporated King County roads and bridges, due to current and future forecast financial constraints. The activities identified through this strategy are unfunded needs and a funding strategy will need to be prepared and successfully implemented.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Fund cross-valley study • Scope cross-valley study	• Complete cross-valley study • Complete planning level cost estimates for study • Pursue grant opportunities	• Obtain grant funds to design and build a flood tolerant cross-valley route • Construct the route

Implementation Plan/Actions

- Fund study to evaluate options to assess which major roadway across the Snoqualmie River Valley may be improved to withstand chronic river flooding.
- Initiate and complete the study

Performance Measure

- Study completion
- Route selected, as informed by the study

Increase Seismic Resilience of Bridges in Unincorporated King County

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
Jennifer Knauer, King County Department of Local Services, Roads Division	Cities KC EM WSDOT PHSKC	Earthquake Goal 4, 6	$500,000 (study costs) TBD design and construction costs FEMA BRIC Grants

Vision

Improved seismic stability for unincorporated King County lifeline route bridges

Description

Evaluate the seismic stability of unincorporated King County lifeline route bridges and complete seismic retrofits as informed by the results of the study. Seismic improvements to unincorporated King County lifeline route bridges were completed from 1995 through 2008, to retrofit these bridges to level 2 standards, the standard adopted by the King County Council that reflected the contemporary standards of that time. Subsequent to completion of these retrofits, seismic evaluation standards have changed. This strategy involves evaluating all unincorporated King County lifeline bridge routes to a retrofit level 3 (highest level), which reflects the current evaluation standard. Bridges retrofitted to a seismic level 3 would likely withstand a seismic event and still be in serviceable status. Outcomes from this strategy includes a prioritized list of lifeline bridge seismic retrofit needs and total program cost estimates. This strategy also involves securing the funding and completing the seismic retrofits identified within the prioritized needs list. King County Road Services Division continues to struggle to meet its preservation service goals for unincorporated King County roads and bridges due to current and future forecast funding constraints. The activities identified through this strategy are unfunded needs and a funding strategy will need to be prepared and successfully implemented.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Fund UKC bridge seismic assessment study • Complete seismic assessment study	• Secure capital funds	• Complete seismic upgrades to UKC lifeline route bridges

Implementation Plan/Actions

- Secure funds for the study
- Complete the study and produce prioritized list of lifeline route bridge seismic retrofit needs and costs
- Prepare funding strategy
- Secure capital funds in support of seismic retrofits
- Complete seismic retrofits

Performance Measure

- Study completed
- Funding strategy prepared and successfully implemented
- Bridge seismic retrofits completed

![King County]

Stormwater Outfall Erosion Hazard Inventory

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water and Land Resources Division	N/A	Goal 6 Goal 12	SWM Fee; FCD Grant; FEMA Hazard Mitigation

Vision

To minimize risk to public safety, properties, and water quality/aquatic health associated with landslides, severe erosion, and sediment deposition caused or threatened by discharges from stormwater system outfalls, both public and private. There are hundreds of stormwater system outfalls throughout unincorporated King County that discharge onto slopes or into ravines that are prone to landslides or severe erosion, or where sediment deposition is a hazard downstream. Many of these are known from past events but are not inventoried in any organized way. Many others are not known without an inventory effort to identify them.

Description

1. Establish a GIS mapping layer/database to inventory locations where the discharges from stormwater system outfalls have caused or pose a risk of causing landslides, severe erosion, and/or sediment deposition impacts downstream. Include in the inventory a description of the landslide and erosion processes at play if known or determined through geotechnical evaluation. Include potential causal agents such as slope, soil composition, drainage area, and discharge rates. Include descriptions of observed or potential impacts to structures, facilities, roads, driveways, water quality, and fish habitat. Include a description of the potential mitigation improvement (e.g., tightline, channel stabilization, settling facility, etc.) and its approximate cost.
2. Populate the GIS database with known incidents of erosive problems downstream of outfalls. If additional information is needed on an incident, conduct a field investigation to collect it. In addition to known incidents, review existing stormwater system maps, landslide hazard area maps, erosion hazard area maps, and steep slope hazard area maps to identify outfalls that are potentially at risk of causing erosive problems downstream. Conduct field investigations of these outfalls and their drainage path downstream to determine the nature of any hazards that might exist. If hazards do exist, inventory the location and record the information mentioned above in the GIS database.
3. Use the GIS inventory information to identify and prioritize hazard mitigation projects for feasibility analysis to determine an updated cost and other information needed for ranking against other competing projects. This information can also be used to provide technical assistance to affected property owners if funding is not readily available for a mitigation project. In addition, the information would be beneficial to setting mitigation requirements during the County's permit review of new development projects upstream of problematic outfalls.

At this time, funding has not been appropriated for a program that would implement this mitigation strategy. WLRD Stormwater Services is currently developing a strategic plan that will consider this along with other along with other program ideas for minimizing risk and optimizing stormwater management.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Complete Stormwater Services strategic plan to determine support for this program.	If there is support for the program in the strategic plan, seek funding for its implementation.	• N/A

Implementation Plan/Actions
- Establish GIS database as described under mitigation strategy.
- Populate GIS database with outfall locations known to be a problem based on past incidents.
- Populate database with outfall locations that could be a problem based on hazards that exist downstream either mapped or determined in the field.
- Use the GIS database to identify and prioritize mitigation projects for feasibility analysis to determine an updated cost and other information needed for ranking the project against other competing projects.
- Implement the highest priority projects as funding becomes available. Until funding becomes available, implement stop gap measures (e.g., sandbagging) if needed to minimize severity of hazard.
- Where funding is not readily available for a mitigation project, offer technical assistance to affected property owners.

Performance Measure
- Number of problematic outfalls inventoried
- Number of problematic outfalls fixed
- Number of property owners to which technical assistance was provided for private solutions

Resilience in Design and Build of Critical Water Treatment and Conveyance Facilities

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water Treatment Division	Strategic Climate Action Plan	Earthquake Goal 12	Capital Budget, Revenue Backed.

Vision

WTD Treatment Plant Facilities and Conveyance system structures are protected against identified potential vulnerabilities, including but not limited to flooding, earthquakes, large-scale power outages and hazardous materials spills into the conveyance system (whether those spills are accidental or deliberate, e.g. terrorist action).

Description

Design, build, and retrofit facilities to meet or exceed seismic standards, including essential equipment. Apply current seismic standards to all renovation or replacement of existing facilities and/or equipment.

In April 2018 the division completed a Resiliency and Vulnerability Review of its entire conveyance system to identify critical structures and facilities. The project which was conducted by an engineering consultant conducted initial structural earthquake assessments of the key facilities. The report included recommendations for mitigation projects in order of priority. Work is underway on multiple projects.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Vulnerability assessment review. • Emergency power systems review. • Complete retrofit of 3 facilities identified as most critical/vulnerable.	• Implement changes identified in the reviews conducted in the 2-year window. • Update to spill response procedures is completed. • Complete retrofit of 6 additional facilities in order of priority/vulnerability.	• Facilities that are resilient and able to withstand damage from earthquakes or other hazards

Implementation Plan/Actions

- Review existing earthquake vulnerability assessments and identify facilities and structures that need further assessments.
- Review existing emergency power generation capacities at treatment plants, offsite facilities and interceptors (pipelines) to identify vulnerabilities and response & restoration protocol enhancements.
- Review existing spill response procedures and protocols for hazardous materials spills (both accidental and intentional releases) that impact flows into the WTD system. Update and coordinate emergency procedures with key fire departments and the Office of Emergency Management.

Performance Measure

- % of buildings, pipelines and equipment that are built to seismic resilience standards.
- % of identified vulnerabilities and plan priorities addressed with improvements and resolutions.
- % of retrofit projects planned that are completed.

Landslide, Erosion, and Sedimentation Event Mapping

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water and Land Resources Division	Cooperating agencies	Goal 4 Goal 6 Goal 12	SWM Fee; FCD Grant; FEMA Hazard Mitigation

Vision

Develop a GIS mapping layer to establish a record of observed landslide, erosion, and sedimentation events. Include in the record a description of landslide and erosion processes if available from geotechnical evaluation. Identify landslide, erosion, and sedimentation events caused by stormwater discharge. Use this information to identify and prioritize corrections and mitigations to reduce events. These corrections and mitigations would be prioritized as part of the overall WLRD Stormwater Services strategic plan (currently development) to ensure the highest risk areas are addressed first. At this time, funding has not been secured for implementation of a corrective program for stormwater discharges that cause or contribute to landslides, erosion, and sedimentation events.

Description

Mapping of landslide, and high erosion areas and sedimentation events provides current information for development review and infrastructure planning, and utility protection measures to be implemented. Reconnaissance has identified multiple sites of stream ravine slope destabilization due to stormwater discharge from both public and private stormwater conveyance systems. Multiple measures are readily available to relocate discharge outfall, dissipate flow erosion potential, and implement flow control measures to reduce landslide risk and channel erosion. Sediment discharge and debris flow incidences cause increasing cost of sediment management and property damage and environmental impact to receiving stream habitat. This effort will also reduce inform the business risk exposure of assets that drain to locations impacted by past events. This could result in and identify proper use of different maintenance techniques, effective inspection/maintenance intervals, and the priority of improvement projects needed seek to avoid emergency repairs.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Develop mapping to include landslide prone areas, event tracking and include highly erosive process. Identify impact areas and vulnerability to stormwater discharges.	• Develop program to correct stormwater discharges causing landside activation and high erosion processes. Provide assistance to private system owners to correct stormwater discharges to unstable slopes in high impact areas	• Reduce progressive degradation of streams, wetlands and lake habitats and reduced conveyance and flood protection capacity resulting from sediment deposition.

Implementation Plan/Actions

- Establish ArcGIS mapping of landslide and erosion hazard areas that identify documented incidences, type of landslide or erosion processes and impact zones.
- Prioritize local systems with high impacts to community, public infrastructure, and environment.
- Identify corrective actions and mitigation strategies to reduce impacts and emergency response services provided by King County.
- These actions present opportunities to improve system resilience and capacity buffering from the impacts of climate change variability.

Performance Measure
- Mapping area completed in relation to unincorporated area.
- Identification and prioritization of problematic outfalls
- Strategy to address individual sites.
- Technical assistance to citizens to implement corrective actions

Stormwater and Surface Water Infrastructure Risk Reduction

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water and Land Resources Division	N/A	Goal 6 Goal 12	SWM Fee; FCD Grant; FEMA Hazard Mitigation

Vision

To minimize risk to public safety, properties, and water quality/aquatic health resulting from:

1) The failure of existing stormwater and surface water infrastructure due to aging. Growing numbers of stormwater and surface water infrastructure assets operated by or under the purview of the Water and Land Resources Division (WLRD) are at or approaching the end of their effective life where structural failure could cause flooding, erosion, sedimentation, and/or fish habitat damage.

2) More frequent overflow or functional impairment of existing stormwater and surface water infrastructure due to expected increases in rainfall intensities over the next 50 years from climate change. This too could cause flooding, erosion, sedimentation, and/or habitat damage.

3) The lack of stormwater control infrastructure for managing runoff from lands that were developed before stormwater controls were required on new developments. Over two thirds of the developed landscape in King County was built before modern stormwater controls were required on new developments. This lack of runoff quantity and quality control has been linked to degraded water quality and aquatic health in numerous streams and other water bodies throughout King County as documented by a network of monitoring stations. It may also contribute to existing flooding, erosion, sedimentation, and/or habitat damage.

Description

WLRD is planning to do the following to achieve the vision/objective stated above:

1) Proactively manage existing infrastructure through inspections, maintenance, risk assessments, and repair/replacement of the highest risk infrastructure components before they fail to avoid the high cost of emergency repairs and the damages or injuries that can result from component failure. This proactive management program is already in place for WLRD-operated infrastructure assets but needs further policy development for assets managed by private parties. WLRD Stormwater Services is currently developing a strategic plan that should address this policy development need.

2) Develop a methodology and standards for predicting and designing to future runoff quantities that will be generated by the increased rainfall intensities expected from climate change. To ensure new infrastructure is resilient, this methodology and standards will be incorporated into the County's stormwater regulations for new development and redevelopment. It will also be used by the County to assess the need for and design of future infrastructure improvements to reduce risk. Development of this methodology and standards is a priority of the County's Strategic Climate Action Plan (SCAP) and has been started but additional funding will be needed to finish it.

3) Build new and modify existing stormwater control infrastructure to mitigate for the lack of runoff quantity and quality controls on older developed lands. Projects that do this are called "stormwater retrofits" and several pilot projects are currently underway at various locations across King County. WLRD Stormwater Services is currently developing a strategic plan and retrofit prioritization framework that will give direction to future planning and implementation of stormwater retrofits. A formal planning program to identify, prioritize, and steward future retrofits is currently unfunded.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Implement actions to reduce risk on 48 high risk facility assets and continue inspections, maintenance, and risk assessments on remaining inventory of WLRD facility assets. Complete Stormwater Services strategic plan to identify policy direction for assets managed by private parties. • Seek funding to develop methodology/standards	• Implement actions to reduce risk on 120 high risk facility assets and continue inspections, maintenance, and risk assessments on remaining inventory of facility assets. • Develop methodology/standards	• Implement actions to reduce risk on 192 high risk facility assets by 2027 and continue inspections, maintenance, and risk assessments on remaining inventory of facility assets. Implement actions to reduce risk on any newly identified high risk facility assets. • Incorporate new standards into stormwater regulation.

Implementation Plan/Actions

- Implement actions to reduce risk on high risk facility assets.
- Seek funding to further develop a methodology and standards for predicting and designing to future runoff quantities generated by the increased rainfall intensities expected from climate change.
- Continue progress on existing pilot projects to inform future stormwater retrofits. Complete the Stormwater Services strategic plan and retrofit prioritization framework.
- Complete development of the methodology and standards described at left and vet with elected officials and community stakeholders (e.g., developers, NGOs, tribes, etc.)
- Obtain funding for and begin implementing a formal planning program to identify, prioritize, and steward future retrofits.
- Incorporate the new methodology and standards into the County's stormwater regulations for new development and redevelopment. Conduct planning efforts to identify and prioritize predicted infrastructure problems using the new methodology and standards. This can and should be merged with the planning program described below for stormwater retrofits. Implement highest priority projects to address predicted infrastructure problems.
- Conduct planning efforts to identify, prioritize, and steward stormwater retrofits. This can and should be merged with the efforts mentioned above for addressing predicted infrastructure problems resulting from climate change. Implement highest priority retrofits.

Performance Measure

- High risk facility assets mitigated.
- Climate change infrastructure problems solved
- Acres of developed land retrofitted with stormwater controls

Sea Level Rise Resilience in Wastewater Facilities

Lead DNRP WTD	Partners PHSKC	Hazards Mitigated / Goals Addressed Sea Level Rise (Flooding) Goal 4, 12	Funding Sources and Estimated Costs Capital Budget

Vision

Waterfront wastewater treatment facilities and road networks that will be affected by the rise of sea level due to global warming are built and enhanced to improve system resilience to these impacts.

Description

Developing and implementing adaptation strategies for cost-effective measures to address, through capital improvement and asset management programs, the vulnerability of 24 major and 380 minor facilities and 52 miles of conveyance at risk of saltwater inflow and/or inundation. The facilities were identified by a recent update to the WTD analysis of the wastewater system to identify facilities at risk for saltwater inflow and inundation from future sea level rise, existing and predicted high tides, and storm surges. This update was based on recent (2018) local and probabilistic sea level rise projections developed by network of governmental and non-governmental organizations and universities.

A parallel effort is necessary for roadways in unincorporated King County, especially on Vashon Island and with ferry docks that service the islands. This will be addressed through the KC Roads strategy.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Work is ongoing	• Work is ongoing	• Facilities that are resilient and able to remain operational as the sea level rises

Implementation Plan/Actions

- The facilities were identified by a recent update to the WTD analysis of the wastewater system to identify facilities at risk for saltwater inflow and inundation from future sea level rise, existing and predicted high tides, and storm surges.

Performance Measure

- % of identified projects to improve resilience to sea-level rise completed.

Stormwater and Surface Water Infrastructure Risk Reduction

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water and Land Resources Division	N/A	Goal 6 Goal 12	SWM Fee; FCD Grant; FEMA Hazard Mitigation

Vision

To minimize risk to public safety, properties, and water quality/aquatic health resulting from:

4) The failure of existing stormwater and surface water infrastructure due to aging. Growing numbers of stormwater and surface water infrastructure assets operated by or under the purview of the Water and Land Resources Division (WLRD) are at or approaching the end of their effective life where structural failure could cause flooding, erosion, sedimentation, and/or fish habitat damage.

5) More frequent overflow or functional impairment of existing stormwater and surface water infrastructure due to expected increases in rainfall intensities over the next 50 years from climate change. This too could cause flooding, erosion, sedimentation, and/or habitat damage.

6) The lack of stormwater control infrastructure for managing runoff from lands that were developed before stormwater controls were required on new developments. Over two thirds of the developed landscape in King County was built before modern stormwater controls were required on new developments. This lack of runoff quantity and quality control has been linked to degraded water quality and aquatic health in numerous streams and other water bodies throughout King County as documented by a network of monitoring stations. It may also contribute to existing flooding, erosion, sedimentation, and/or habitat damage.

Description

WLRD is planning to do the following to achieve the vision/objective stated above:

4) Proactively manage existing infrastructure through inspections, maintenance, risk assessments, and repair/replacement of the highest risk infrastructure components before they fail to avoid the high cost of emergency repairs and the damages or injuries that can result from component failure. This proactive management program is already in place for WLRD-operated infrastructure assets but needs further policy development for assets managed by private parties. WLRD Stormwater Services is currently developing a strategic plan that should address this policy development need.

5) Develop a methodology and standards for predicting and designing to future runoff quantities that will be generated by the increased rainfall intensities expected from climate change. To ensure new infrastructure is resilient, this methodology and standards will be incorporated into the County's stormwater regulations for new development and redevelopment. It will also be used by the County to assess the need for and design of future infrastructure improvements to reduce risk. Development of this methodology and standards is a priority of the County's Strategic Climate Action Plan (SCAP) and has been started but additional funding will be needed to finish it.

6) Build new and modify existing stormwater control infrastructure to mitigate for the lack of runoff quantity and quality controls on older developed lands. Projects that do this are called "stormwater retrofits" and several pilot projects are currently underway at various locations across King County. WLRD Stormwater Services is currently developing a strategic plan and retrofit prioritization framework that will give direction to future planning and implementation of stormwater retrofits. A formal planning program to identify, prioritize, and steward future retrofits is currently unfunded.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Implement actions to reduce risk on 48 high risk facility assets and continue inspections, maintenance, and risk assessments on remaining inventory of WLRD facility assets. Complete Stormwater Services strategic plan to identify policy direction for assets managed by private parties. • Seek funding to develop methodology/standards	• Implement actions to reduce risk on 120 high risk facility assets and continue inspections, maintenance, and risk assessments on remaining inventory of facility assets. • Develop methodology/standards	• Implement actions to reduce risk on 192 high risk facility assets by 2027 and continue inspections, maintenance, and risk assessments on remaining inventory of facility assets. Implement actions to reduce risk on any newly identified high risk facility assets. • Incorporate new standards into stormwater regulation.

Implementation Plan/Actions

- Implement actions to reduce risk on high risk facility assets.
- Seek funding to further develop a methodology and standards for predicting and designing to future runoff quantities generated by the increased rainfall intensities expected from climate change.
- Continue progress on existing pilot projects to inform future stormwater retrofits. Complete the Stormwater Services strategic plan and retrofit prioritization framework.
- Complete development of the methodology and standards described at left and vet with elected officials and community stakeholders (e.g., developers, NGOs, tribes, etc.)
- Obtain funding for and begin implementing a formal planning program to identify, prioritize, and steward future retrofits.
- Incorporate the new methodology and standards into the County's stormwater regulations for new development and redevelopment. Conduct planning efforts to identify and prioritize predicted infrastructure problems using the new methodology and standards. This can and should be merged with the planning program described below for stormwater retrofits. Implement highest priority projects to address predicted infrastructure problems.
- Conduct planning efforts to identify, prioritize, and steward stormwater retrofits. This can and should be merged with the efforts mentioned above for addressing predicted infrastructure problems resulting from climate change. Implement highest priority retrofits.

Performance Measure

- High risk facility assets mitigated.
- Climate change infrastructure problems solved
- Acres of developed land retrofitted with stormwater controls

Control System Security and Performance

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water Treatment Division	N/A	Cyber Incident Goal 12	Capital Budget General Fund

Vision

The operational control system for Wastewater Treatment Operations is secure from cyber-attack or system failure.

Description

The wastewater treatment system is operated from three control centers which monitor the facilities and conveyance system that flows to the treatment plants. The Ovation project is a multi-year, multi-million-dollar upgrade of the Wastewater Treatment Division's legacy control systems. WTD is in the process of updating its control systems. Vulnerability assessments are designed into the Ovation project. When the system is operational, a security audit would be conducted to ensure that policies and procedures are in place to protect the system

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Project is staged to include in the 2-year timeframe upgrades to system controls in order of priority based on assessed vulnerability. • Upgraded systems will be tested in this time frame.	• All control systems are upgraded and have passed security testing. • Completion of project.	• A secure system.

Implementation Plan/Actions

• This is a multi-year multi-million-dollar project that is being staged by addressing the most vulnerable systems first and working through the system.

Performance Measure

• % of QA/QC system security tests passed.

GIS Emergency Response Mapping and Real-Time Flow Data

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water Treatment Division	KCIT-Geographic Information Systems (GIS) King County Roads Services Division King County Office of Emergency Management Public Health SKC	All Goal 6	Operating Budget

Vision

Critical information conveyed in the WTD/DNRP Emergency response map is available and updated in real time.

Description

Update the King County facilities Emergency Response maps with the current priority roads, bridges, earthquake liquefaction, inundation and landslide zones and gas/petroleum pipelines, under-laid with King County facilities and conveyance lines and emergency outfalls to facilitate emergency response and continuity of operations. Make this information available through a password-protected website for select users. Explore connecting the map to real-time flow data.

A GIS emergency mapping site is now operational on the WTD intranet that shows facilities and conveyance system. Working on moving it to an internet site so that it can be accessed 24/7 by off duty personnel.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Fully deploy the system where it can be accessed remotely without having to log into the KC computer system.	• System is tested and use in activations. • Necessary modifications are made. • Project completion	• Emergency mapping is reliable and accessible.

Implementation Plan/Actions
- Work is ongoing and includes:
- Work with KCIT to consider improvements that include integration with real-time flow data, integration with Roads Emergency updates and migration of mapping tool from intranet to password secured Internet site.
- Testing to ensure access and timeliness and accuracy of information conveyed.
- Use in emergency activations.
- Socialize process and tools with partners such as Public Health Seattle and King County to aid in environmental health emergency response.

Performance Measure
- % of successful attempts to securely access the mapping tool.
- Ratio of accuracy and timeliness as compared to real life in real time.

Emergency Communications Enhancements

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
Allen Alston	PSERN Project King County Radio Services/KCIT	All Goal 6	Operating Budget

Vision

Ability to effectively communicate in large scale emergency situations where the telecommunications may be disrupted.

Description

The division performed an assessment to determine the number of KC 800 MHz radios necessary to support operational readiness in the event of a widespread telecommunications failure. Currently all key operational facilities and offsite operation and maintenance vehicles are equipped with 800 MHz radios, constituting WTD's core emergency communications method.

A regional replacement project is underway to replace the entire 800 MHz system. It is managed by a regional agency Puget Sound Emergency Radio Network. Inventories have been provided to PSERN. The King County Office of Emergency Management has deployed a communications tool called KCInform. It has been incorporated into the division's operational procedures

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Deploy the new radios. • Train and test the radios and other emergency communications. • Analyze benefits and costs of FirstNet	• Continue training and testing of communications to ensure maximum communications reliability in emergencies.	• Redundant emergency communications are reliable.

Implementation Plan/Actions

- Deploy the new radio equipment and incorporate into the day to day communications protocols.
- Regularly test radios and other emergency communications methods, including KCInform and FirstNet (if used).

Performance Measure

- % of successful communications systems tests.

Emergency Event Management System

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water Treatment Division	King County Office of Emergency Management King County Information Technology (KCIT)	All Goal 6	Operating Budget

Vision

WTD manages and shares emergency response and continuity of operations activities across the division's five treatment plants and the division headquarters in the King Street Center using WEBEOC and other systems as necessary.

Description

Assess WEBEOC's ability to manage information and communication within the division and with its 34 component agencies, and especially the discrete tracking of multiple incidents.
Continue working with the WEBEOC team, KCIT and others as necessary to explore alternative or additional solutions if WEBEOC can't meet all requirements.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Test current system for a variety of scenarios. • Identify and work through questions and gaps identified. • Consider alternatives where WEBEOC doesn't fulfill requirements.	• Deploy an operational system or systems. • Document, train to and test the system(s).	• There is a single system or integrated systems (whether manual or not) sufficient to manage emergency events.

Implementation Plan/Actions

- Test use of WEBEOC for a variety of scenarios with multiple contributors.
- Identify and work through questions and gaps.
- Consider alternatives where WEBEOC doesn't fulfill requirements.
- Document progress and final systems approach.
- Communicate systems approach to users and stakeholders.
- Develop and deliver trainings on the use of the system(s).
- Test the system(s).
- Continuously improve the system(s).

Performance Measure

- Post-test system performance ratings.
- Post use (activations) system performance ratings.

Flood Warning Program

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
King County River & Floodplain Management Section, Office of Emergency Management	Cities and special purpose districts, US Army Corps of Engineers, NOAA, FEMA Region 10	Flood Goal 5, 6	Existing resources

Strategy Vision/Objective

When flooding is imminent, having a robust notification system helps people who live, work, or travel through floodprone areas prepare themselves and their property for the impacts of flooding. It can also mean fewer flood losses and less damage.

Mitigation Strategy

The River and Floodplain Management Section operates the Flood Warning Program, which includes a Flood Warning Center that opens when river systems reach specified flows or heights. The Flood Warning Center gives people that live, work, or travel through floodprone areas early notifications and the opportunity to call in and receive information about ongoing flooding issues. The Center also coordinates with local first responders, the Office of Emergency Management, the US Army Corps of Engineers, and other stakeholders to ensure the region is as ready as possible to respond to flooding problems.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Improved outreach efforts.	• Annual exercises are conducted to prepare the region for flooding.	• Smooth operation of the Flood Warning Program and integration with local communities' programs.

Implementation Plan/Actions
 Implementation Plan/Actions

1. Continue monitoring the status of streamgages to ensure they are collecting data accurately. Streamgages provide the underlying data that are used as the basis for Flood Alert notifications and openings of the Flood Warning Center.
2. Review on an annual basis the various components of the Flood Warning Program and make improvements where necessary.
3. Conduct an annual flood response exercise with other agencies to ensure the region is prepared for flood response and recovery actions necessary. Write up an after-action report.
4. Improve public outreach materials such as flood inundation maps and online interactive map applications that show the inundation areas of the four flood phases.

Performance Measure
- Subscribers to the Flood Alert app.
- CRS points for Activity 610.

Post-Flood Recovery Efforts

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water and Land Resources Division; King County Office of Emergency Management; King County Permitting Division	King County Flood Control District; FEMA Region 10; Washington Department of Ecology; Washington Division of Emergency Management	Flood Goal 3, 5, 12, 14	King County Flood Control District; FEMA Hazard Mitigation Assistance Grants; Increased Cost of Compliance; FEMA Public Assistance Section 406 Mitigation

Strategy Vision/Objective

After a major flood event, there are many opportunities to rebuild in a more resilient way. Being prepared to rapidly address them is key to realizing those opportunities.

Many mitigation grants, including the FEMA Hazard Mitigation Assistance grants, can take over 5 years from obligation to a property owner having their house acquired. King County is uniquely positioned to utilize local resources to complete mitigation projects much quicker to help property owners with flood-damaged property.

Mitigation Strategy

While many other flood mitigation strategies referenced in the Hazard Mitigation Plan will be used to reduce future flood risk, a separate mitigation strategy for post-flood actions is necessary. Property owners are often more willing to sell and consider mitigation efforts after a flood. Additionally, conducting substantial damage determinations quickly is important for flood insurance policyholders to be able to access Increased Cost of Compliance coverage funds for rebuilding. King County needs to be prepared before a flood occurs to move mitigation efforts forward quickly.

This strategy should also consider the permitting environment after a major flood and consider short-term rebuilding moratoriums, permit assistance, and substantial damage letters for Increased Cost of Compliance claims. Additionally, an update to the comprehensive plan may be needed to address long-term recovery efforts.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Communications plan prepared. • Substantial damage strategy prepared and deployable.	• Substantial damage assessments have either taken place or have been practiced. • Communication plan reviewed.	• Successful mitigation efforts occur after major flood events.

Implementation Plan/Actions

1. Prepare communications plan prior to a flood event for reaching affected property owner to inform them of mitigation grant opportunities to purchase their damaged property or elevate their home.
2. Ready a set of funds to deploy quickly after a major flood event.
3. Create a deployable substantial damage inspection strategy and team, and prepare the team to rapidly conduct substantial damage determinations after a flood event or other wide-spread natural disaster.
4. Inspect flood protection facilities and other public infrastructure to ensure public safety is protected and to also identify opportunities for applying for FEMA Public Assistance Section 406 mitigation funding.

Performance Measures

• Property owners engaged after flood event.
• Employees trained on substantial damage assessments.

Home Elevations

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
King County River & Floodplain Management Section; Permitting Division	King County Flood Control District, FEMA Region 10; Washington Department of Ecology, Washington Division of Emergency Management	Flood Goal 5, 6	King County Flood Control District; FEMA Hazard Mitigation Assistance grants

Vision

Elevating floodprone homes is an important tool in making buildings safer from flooding. The buildings will be better able to withstand inundation and a family's, or occupant's belongings will be well above the expected level of the 1% annual chance flood. The result will be less risk to people, pets, and property as floodwater remains below the finished floor of elevated homes.

Description

Home elevations are appropriate in areas where floodwaters are slow moving and relatively shallow, offer significant warning time, and are not subject to channel migration hazards. In areas of flash floods, fast-moving floodwaters, and channel migration, the most appropriate mitigation strategy is acquisition.

King County and the King County Flood Control District have a robust home elevation grant program for properties in the Snoqualmie River basin that has elevated nearly 80 homes. Elevation projects, however, are complex and require significant public investments from the County, Flood Control District, or FEMA. Typically, home elevations cost over $200,000. Current standards require homes to be elevated to the higher of 3 feet above the 1% annual chance flood elevation and 1 foot above the 0.2% annual chance flood elevation.

Most homeowners prefer to elevate on enclosed foundations like a crawlspace or full story enclosure. This technique, when done with proper flood openings, can be a safe alternative, but can lead to negative consequences such as future owners converting the lower level to finished living space, thus reducing the benefit of the home elevation. Elevating on post or piling foundation techniques lessens the likelihood of lower level conversion, although to some, results in a visually less desirable home. There is a balance that the public elevation grant program needs to weigh between producing homes that people think look nice and homes that are likely to remain safe from flooding for 50 years.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Have code compliance strategy implemented.	• Home elevations grants are awarded outside of the Snoqualmie Valley.	• All homes in shallow and slow-moving floodplains are elevated at least 3 feet above the 1% annual chance flood elevation.

Implementation Plan/Actions

1. Continue requiring home elevations to have the lowest floor elevated to 3 feet above the 1% annual chance flood elevation or 1 foot above the 0.2% annual chance flood elevation. Continue requiring a nonconversion agreement to protect the lower enclosed levels from being converted to living space.
2. Create a strategy to address potential code compliance issues that make elevated structures more dangerous, including addressing:
    a. Potential to convert enclosed lower level into living space.
    b. Potential to install noncompliant utilities in lower level.
    c. Potential to block flood openings.
    d. Potential to rent out lower level.
3. Complete home elevations in appropriate floodprone areas outside of the Snoqualmie Valley, including in coastal floodplain areas.
4. Encourage grantees to elevate using post or piling foundation techniques rather than full story enclosures.

Performance Measure

*   Repetitive loss properties elevated.
*   Reduced flood insurance claims.
*   Number of homes successfully and compliantly elevated.

Home Acquisitions and Relocations

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
King County River & Floodplain Management Section; Ecological Restoration and Engineering Services Section	Snoqualmie Watershed Forum, Snohomish Basin Salmon Recovery Forum, WRIA 9 Watershed Ecosystem Forum, WRIA 8 Salmon Recovery Council, Puget Sound Partnership, King County Flood Control District	Flood Goal 5, 6	King County Flood Control District, FEMA Hazard Mitigation Assistance grants, Salmon Recovery Board Grants, Floodplains by Design

Strategy Vision/Objective

Acquiring floodprone properties, removing buildings, and restoring the property to a natural state is the most effective strategy to reduce flood risk in perpetuity. Fewer families living in floodprone areas and fewer businesses operating in floodprone areas so the region recovers quicker after a major flood.

Mitigation Strategy

Property acquisitions have been a tool that King County has employed for many decades to reduce flood risk. Acquisitions are done on a willing seller basis and result in the demolition or removal of the building from the property. Sometimes the seller moves the house to a location outside of the floodplain. Acquisitions are mostly fee simple purchases.

While acquisition is the most effective tool to eliminate flood risk, many people perceive downsides, including that acquisitions mean lost tax revenue and that a checkerboard approach leaves neighborhood with missing pieces. Wherever possible, a neighborhood or area-specific strategy is the best approach.

Acquisitions also offer many additional benefits including enhanced natural floodplain functions, floodwater storage, and recreation potential. Because of multiple benefits, acquisitions can be done by various agencies for different primary purposes. Some are done for ecological restoration or salmon habitat protection while others are done primarily for flood risk reduction. An area of new opportunity for flood risk reduction acquisitions is along the unincorporated coast on Vashon-Maury Island. Very few have been completed for flood risk reduction purposes, but as sea levels rise and coastal flooding worsens, King County needs to be prepared for coastal shoreline acquisitions.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Develop prioritized acquisition list.	• Complete acquisitions in coastal areas.	• Acquire as many floodprone properties as possible.

Implementation Plan/Actions

1. Continue proactively purchasing floodprone properties for the purpose of flood risk reduction.
2. Accelerate coastal floodplain acquisitions.
3. Create and maintain a prioritized acquisition list so that properties can be purchased whenever the opportunity arises.
4. Consider other tools to purchase land over time or future development rights, such as a program where a property owner receives an upfront payment with an agreement that the County will fully purchase the property if it's flooded or the owner seeks to sell.\
5. Purchase and remove infrastructure as part of neighborhood-level acquisitions.

Performance Measures

ions per year.

l hazard areas owned by private landowners with buildings.

• Repetitive loss properties mitigated.

Protect and Restore Natural Floodplain Functions

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water and Land Resources Division	Snoqualmie Watershed Forum, Snohomish Basin Salmon Recovery Forum, WRIA 9 Watershed Ecosystem Forum, WRIA 8 Salmon Recovery Council, Puget Sound Partnership, King County Flood Control District	Flood Goal 3, 12	FEMA Hazard Mitigation Assistance Grants, Floodplains by Design, King County Flood Control District

Vision

Flooding is a natural process. Rivers and coastlines evolve and change because of flooding. Encouraging the protection and restoration of natural functions of floodplains is key in creating healthy and resilient systems.

Description

The natural functions of floodplains include storing floodwater and lowering flood heights and velocities, all of which reduces flood risk. Natural coastlines attenuate waves distribute sediment and large wood on beaches, and allow coastal erosion, all of which reduce coastal wave energy on properties in the floodplain. King County has a robust focus on protecting and restoring natural floodplain functions, but progress still needs to be made to accelerate progress and connect restoration projects to flood risk reduction projects.

Additionally, upland forested areas provide a source of natural functions that reduces fast runoff, manages sediment flow, and protects water quality. These upland areas should be considered vital parts of natural floodplain functions.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Incorporate floodplain connectivity and aquatic habitat improvements in majority of flood risk reduction projects in the county.	• Double the amount of spending on floodplain restoration and protection by leveraging local funding to obtain state and federal grants.	• Every floodplain project achieves multiple benefits such as endangered species habitat, salmon rearing habitat, water quality improvements, climate resilience, agricultural resilience, and flood risk reduction.

Implementation Plan/Actions
1. Proactively acquire floodprone properties to utilize for future restoration projects.
2. Complete restoration projects that reconnect rivers to their floodplains, remove bank armoring, create side channels, reconnect oxbows, and encourage natural features such as beaver dams and large wood in channels for increased flood storage and fish habitat. These projects will create places for flood storage, which will reduce downstream flood heights and provide habitat for endangered species.
3. Restore coastal shorelines by removing bulkheads wherever possible, creating pocket estuary habitats, and allowing erosion to nourish beaches. Softening shorelines and creating estuaries will result in reduced wave energy and fewer negative coastal flooding impacts.
4. Incorporate beaver habitat in restoration projects to provide flood storage and keep instream water cooler.
5. Continue enforcing regulations that stop negative impacts on habitat and encourage net ecological benefit. Shoreline management, critical area, and floodplain management regulations that adhere to FEMA's Biological Opinion are among the regulations that seek to improve natural floodplain functions.

Performance Measure
- Acres of floodplain reconnected and/or restored.
- Large wood per mile in large rivers.
- Linear feet of bulkhead removed; and coastal shoreline restored
- Demonstrated losses avoided by increasing flood storage
- Chinook, coho, and steelhead population numbers, including annual adult spawner returns and juvenile outmigrants.

Flood Risk Mapping

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water & Land Resources Division; DLS Permitting Division	FEMA Region X, Washington Department of Ecology, US Army Corps of Engineers	Flood, Dam Failure Goal 3, 5, 6, 12, 14	FEMA Cooperating Technical Partners Program; King County Flood Control District

Vision

Having updated flood risk data helps government agencies, property owners, and other stakeholders make better risk-informed decisions. High quality flood data also more accurately ties regulations to reducing flood risk.

Mitigation Strategy

While updating flood risk maps is an ongoing activity to take into account landscape and hydrology changes, there are many flood hazards that need robust data and maps:

1. Floodplain maps – update the Flood Insurance Rate Maps used for regulatory and mitigation planning purposes, including updating the South Fork Skykomish River and various streams that only have approximate Zone A flood zones with no base flood elevation information. Additionally, King County should work with incorporated urban communities to better study, understand, and map urban flood risk.
2. Climate-influenced flood risk maps – King County and the University of Washington have been collaborating on downscaling global climate models to generate river-basin scale hydrology data based on the effects of climate change scenarios. King County can also evaluate other climate-influenced changes in hydrology such as low summer flows, less snowpack, and other effects to incorporate into maps showing climate-influenced flood risk. These data will be used to generate maps of predicted changes in flood risk that can be used for planning and regulatory purposes.
3. Sea level rise flood risk maps – as part of the coastal flood hazard study, maps were produced showing the effect on base flood elevation of a 2-foot rise in sea level around Vashon-Maury Island. This study shows the broader effects of sea level rise on flood risk. These maps should be updated with different sea level rise scenarios and also the resulting increased flood risk landward of the edge of the 1% annual chance mapped floodplain should be considered.
4. Channel migration zone maps – currently 8 river sections have been mapped on the South Fork Skykomish, Tolt, Cedar, South Fork Snoqualmie, Middle Fork Snoqualmie, North Fork Snoqualmie, Green, and Raging Rivers. In addition to continually updating these maps, new river sections need to be studied and mapped, including the Lower Snoqualmie. Channel migration zone maps will help property owners best understand the risk from channel avulsion and help keep more development safe.
5. Dam failure maps – every owner of a high hazard dam with the potential in a dam failure for loss of life or structures must develop a dam inundation map as part of the Emergency Action Plan. However, many of these inundation maps are out of date and are not accessible to the public.

Levee failure maps – King County will, where possible, study levee failure impacts and produce maps that show areas of levee failure risk. The data and maps should be made available to the public so people who live and work behind levees have an understanding of their flood risk.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Complete detailed flood study on streams with approximate Zone A floodplains. • Complete levee breach analysis.	• Identify a timeline for updated Flood Insurance Rate Maps with FEMA Region 10.	• Flood Insurance Rate Map and other regulatory flood data

• Create plan for integrating flood maps and downscaled climate model data. • Begin sea level rise scenario mapping for coastal shorelines.	• Establish plan for using climate-influenced flood risk data for planning and regulatory purposes.	will be updated on a regular basis. • Highest quality flood risk data that incorporates effects of climate change.

Implementation Plan/Actions
1. Update Flood Insurance Rate Maps to utilize better flood risk data, including the South Fork Skykomish River and streams with Zone A maps. Also identify a strategy and timeline for updating other streams/rivers that need updated flood risk data.
2. Create climate-influenced flood risk maps that can be used for planning purposes.
3. Create sea level rise flood risk maps for various sea level rise scenarios to be used for planning and regulatory purposes.
4. Continue updating channel migration zone maps.
5. Release dam failure maps where appropriate and provide technical assistance to high hazard dam owners to complete updated inundation maps.
6. Complete levee failure maps and release them to the public where appropriate.

Performance Measures
• Stream miles and linear feet of shoreline with updated flood risk, channel migration, and climate-influenced flood risk data.
• Properties covered by updated flood risk, channel migration, and climate-influenced flood risk data.
• Number of dams with updated inundation maps that are publicly available.
• Linear feet of levees with failure analyses publicly available.

Public Information Flood Activities

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
King County River & Floodplain Management Section, Office of Emergency Management	FEMA Region 10; Washington Department of Ecology; Washington Division of Emergency Management; King County Flood Control District	Flood Goal 5, 6	Existing resources

Vision

Flooding is a complicated hazard to understand and a responsibility of floodplain management agencies is to help people understand it well enough to prepare themselves. A more informed public means property owners who make decisions based on flood risk and fewer unexpected losses during flooding.

Description

Effective outreach efforts are a key piece of comprehensive floodplain management. Letters sent annually, outreach events, project-specific meetings, and providing technical assistance are all components of effective outreach. Repetition of messages and continued outreach activities are also important to ensuring that messages are delivered. Engaging as many types of communication mediums as possible will also ensure that outreach efforts are effective.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• New initiatives are implemented.	• Documentation that more floodprone residents are engaged.	• An informed public that is prepared for the effects of major flooding.

Implementation Plan/Actions

The following activities should be conducted on an annual basis as a way to make the public more aware of flood hazards and risks:

1. Flood brochure – sent to every property owner in the floodplain.
2. Repetitive loss letter – sent to properties with known repeated losses.
3. Realtor, insurance agent, and other stakeholder outreach – workshops, meetings, or other outreach to professionals who need flood risk information.
4. News media outreach – coordinated effort to share stories about flood risk with the news media.
5. Annual event – separate or coordinated event every year that focuses on flood risk .

The following activities are not annual occurrences, but should be maintained to help facilitate the availability of flood risk information:

1. Videos demonstrating flood risk, flood preparedness, and property protection measures that can be taken.
2. Technical assistance to property owners on reducing flood risk on their property, including home elevation support and small actions to reduce localized flood risk.
3. Maintaining a robust website, including an interactive map, with flood preparedness, mitigation, regulation, and other flood risk information. The website will be updated at least annually and the interactive map will incorporate new data when available.
- Floodplain management permitting bulletins will be created to help permit applicants understand the regulations and their purpose.

Performance Measures

- Number of stakeholder groups reached
- CRS points for outreach and public information activities

Flood Insurance Promotion

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
King County River & Floodplain Management Section	Floodprone cities; FEMA Region 10, insurance agents, landlords, realtors, mortgage lenders	Flood Goal 5, 12, 14	Existing sources

Strategy Vision/Objective

Flood insurance is the most important financial protection tool for a family against flood damage. Promoting flood insurance is important to help property owners and renters be prepared for flooding and reduce their financial risk.

Mitigation Strategy

Since homeowners and renter's insurance policies do not cover flood damage, helping people understand that flood insurance is the best financial protection tool is an important strategy. Homeowners with a federally-backed mortgage are required to have flood insurance, so those who are required most likely have a policy. Renters and those who own their houses free and clear are far less likely to actively purchase a flood insurance policy. If their homes and apartments are flooded, they may have to drain savings to pay for the damage.

Of all of the families that live in floodplains in King County, over 50% are renters, 14% own their house without a mortgage, and 35% own with a mortgage. Families living in floodplains are much more likely to be renters than those outside of the floodplain (only 40% of families outside of floodplains rent). Additionally, people of color living in the floodplain are even more likely to rent. Census data shows that 83% of African American families and 90% of Native Hawaiian or Pacific Islander families living in the floodplain are renters.

So, promoting flood insurance should be primarily targeted toward renters and those who own their house outright. The strategy should also strive to incorporate concepts of equity and social justice in the approach and content of outreach.

2-Year Objectives	2-Year Objectives	2-Year Objectives
• Outreach plan developed via stakeholder committee. • Technical assistance contact identified.	• Outreach plan developed via stakeholder committee. • Technical assistance contact identified.	• Outreach plan developed via stakeholder committee. • Technical assistance contact identified.

Implementation Plan/Actions

1. Identify and convene stakeholder committee to help assess problem and create strategy for promoting flood insurance.
2. Develop and implement outreach plan that targets renters/tenants and those who own their home with no mortgage.
3. Identify a flood insurance technical assistance contact for King County residents and businesses to be able to ask questions.

Performance Measures

• Number of flood insurance policies in force and percentage of covered buildings.
• CRS points for Activity 370.

Enforce Higher Floodplain Management Regulations

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DLS Permitting Division; DNRP Water & Land Resources Division	FEMA Region X, Washington Department of Ecology	Flood Goal 5, 12, 14	Minimal, on-going • Permit fees • Existing resources

Vision

Higher floodplain management regulations play an important role in ensuring future development in floodplains is as safe from flood risk as possible. For example, requiring that new buildings have their lowest floor elevated 3 feet above the 1% annual chance flood elevation means fewer flood losses and safer buildings.

While instituting a regulation prohibiting development in floodprone areas would ultimately reduce future flood risk potential, the flood portion stakeholder committee decided not to include a development prohibition mitigation action due to likely political and community opposition.

Description

The King County Comprehensive Plan sets out a policy that regulations should follow the concept of "no adverse impact," such that any particular development must not cause any effect to worsen flooding on another property owner. The key higher standards that do this include a requirement that all development in the entire floodplain meet a zero-rise requirement and a compensatory storage requirement for fill and other materials. This approach reduces any potential flood risk from new development. King County also has higher regulations that protect new or substantially improved buildings, including a requirement that the lowest floor be elevated to 3 feet above the 1% annual chance flood elevation.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Demonstrate that King County is enforcing its higher standards by showing full compliance with the FEMA floodplain management audit. • Establish stakeholder committee to review potential higher standards to include in King County Code.	• Submit to King County Council flood code amendments that include other higher standards.	• Ensuring all potential development in floodplains meet flood-safe standards.

Implementation Plan/Actions

- King County agencies will continue to fully enforce the higher regulations currently in King County Code.
- King County will consider the following higher standards in future updates of the King County Code and will establish a stakeholder committee to evaluate the following:
  - Prohibiting hazardous materials storage in the regulated flood hazard area to lessen potential health impacts from flooding.
  - Requiring non-conversion agreement for structures built on crawlspaces or full-story enclosures to ensure fewer structures converted to unsafe and noncompliant conditions.
  - Requiring building restriction agreements for properties that are removed from the floodplain via a Letter of Map Amendment to ensure freeboard standards are extended to properties surrounded by or close to the edge of the mapped floodplain.

- o Establishing a cumulative or lower substantial improvement requirement to encourage more homes to be elevated.
  - o Extending 1% annual chance flood requirements to the edges of the 0.2% annual chance floodplain to account for higher flooding events and the potential for increasing flood risks due to climate change.
  - o Adopting standards to regulate development in areas likely to face increasing flood risks due to sea level rise to protect against future flood risk.
  - o Establishing coastal high hazard area regulations that require permit applicants to demonstrate that their proposed action will not cause adverse impacts on other property owners, including the potential for wave energy reflection on to neighboring shoreline properties.
- The Floodplain Management Plan update will consider higher regulatory standards.
- Adopt the latest version of the International Building Codes.

Performance Measure
- Fewer and less extensive flood damage during a major flooding event.
- More points in the FEMA Community Rating System category for higher regulatory standards.

Manage Flood Protection Facilities

Lead Points of Contact	Partner Points of Contact	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
DNRP Water and Land Resources Division; King County Flood Control District	US Army Corps of Engineers, local governments, levee and dam owners	Flood, Earthquake Goal 5, 12	King County Flood Control District; Floodplains by Design

Strategy Vision/Objective

Flood protection facilities should be managed in a way that foremostly considers residual flood risk. Alternative management practices should also incorporate improving natural floodplain functions.

Mitigation Strategy

Flood protection facilities include levees and revetments that provide some degree of flood and erosion protection depending on their design and maintenance. All flood protection facilities leave residual risk behind them and above their protection level. In certain areas of King County, flood protection facilities have reduced flood damage, but they have also facilitated growth in homes, warehouses, and businesses built behind them. The expanded neighborhoods and business activities are then more at risk of a 0.2% annual chance flood event or flooding from a levee failure, and if climate change increases the severity of flooding events, then the flood risk will grow. Thus, it is important for existing flood protection facilities to be managed well to protect property owners, but also for King County to where possible reduce areas that need to be protected with expensive flood protection facilities.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Updated Floodplain Management Plan that reflects these priorities.	• Flood protection facilities are managed in way that considers multiple benefits. • Fewer people face residual flood risk from being behind a flood protection facility.	• Flood protection facilities are minimally needed for communities to be resilient.

Implementation Plan/Actions

The following are strategies supported by the King County Flood Hazard Management Plan that should continue:

1. Where possible, King County should remove flood protection facilities and allow rivers to reconnect to their floodplains.
2. If flood protection facilities cannot be removed, King County should consider setting the facilities back to allow floodplain storage.
3. Utilize bioengineering in repairs, enhancements, or temporary measures. Bioengineering incorporates live plants and large wood in an effort to reduce flood velocities while protecting aspects of flood protection facilities.
4. Create criteria for when these flood protection facility alternatives would be utilized.
5. Create criteria based on King County Code and the Flood Hazard Management Plan for the conditions to construct a new flood protection facility or a new dam.
6. Ensure levees and dams are designed for earthquakes and are inspected immediately one. Flood protection facilities should also be continually managed considering seismic risks.

Performance Measures

• Number of properties and buildings in the levee-protected areas.
• Linear feet of flood protection facilities set back or removed.
• Flood protection facilities damaged by earthquakes.

Seismic Evaluation of King County Courthouse and Maleng Regional Justice Center

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
Aaron Bert, Deputy Director Jim Burt, Capital Projects Section Manager	N/A	Goal 6 Goal 9	FEMA PDM, KC Capital Budget, $200,000

Vision

Seismic evaluation of the King County Courthouse and Maleng Regional Justice Center, per the current standards of FEMA-178 and ASCE 41-13, Seismic Evaluation and Retrofit of Existing Buildings. An updated assessment of building risks is needed for further seismic hazard mitigation planning and seismic retrofit, to protect and mitigate against potential loss of life, loss of asset, and loss of essential function capabilities during and immediately after an earthquake event.

Description

King County last completed a seismic hazard assessment of its essential facilities in 1993, based on building codes and seismic hazard protection data available at that time. Since then, earthquakes have produced unexpected and major infrastructure damage and loss of life from relatively small seismic events and have contributed to new data supporting major revisions to seismic mitigation strategies and building codes.

An ASCE 41-13 seismic evaluation is the first step toward earthquake hazard mitigation. Evaluation findings will be used to plan, design, fund and construct needed seismic retrofit projects.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Seismic evaluations, per the current standards of FEMA-178 and ASCE 41-13, Seismic Evaluation and Retrofit of Existing Buildings.	• Identify funding for planning, design and construction of all needed seismic retrofit measures.	• Seismic retrofit to meet or exceed current standards of protection.

Implementation Plan/Actions

- Pre-Application submitted to Washington Emergency Management Division for a 2020 FEMA Pre-Disaster Mitigation grant for Advance Assistance.
- Draft and release RFP for complete building seismic evaluation.
- Based on evaluation findings and available funding, plan and budget building retrofit work and/or apply for future FEMA Building Resilient Infrastructure & Communities to fund seismic retrofit.

Performance Measure

- Achievement of Pre-Disaster Mitigation Advance Assistance grant, or feedback from WA EMD on strength of application, achievement of assessment in 2 years, achievement of retrofit project funding in 5 years.

Integrate ESJ into Mitigation, Response, and Recovery Activities

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
Preparedness Senior Manager	Office of Equity and Social Justice, Public Health SKC	All Hazards Goal 2, 6, 10, 14	Existing Funding

Vision

King County Emergency Management considers impacts and benefits to populations more likely to suffer damage or long recovery times during disaster mitigation, response, and recovery activities.

Description

Vulnerable populations, defined here as those more likely to suffer losses during disasters and recover more slowly afterward, should be a primary focus of an emergency management program. This is fully consistent with our charge of identifying and addressing the greatest sources of vulnerability. As part of this strategy, King County Emergency Management will identify vulnerable areas and develop action plans to ensure that populations more likely to suffer damage are prioritized in accordance with need. This includes prioritized mitigation projects to reduce risks, identification and prioritization of resources during response, and additional support and assistance to increase resilience and reduce recovery times after a disaster.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Develop a geospatial tool to ensure that resources are distributed equitably and according to need.	• Implement prioritized mitigation strategies benefitting populations more vulnerable to hazards.	• Emergency management activities are prioritized according to a comprehensive understanding of vulnerability and need.

Implementation Plan/Actions

- Expand identification sources of population vulnerability and likely impacts to vulnerable populations from different hazards.
- Use identified priority languages to expand outreach and notification capabilities.
- Compile a database of infrastructure vulnerability/inequity for use in mitigation, response, and recovery planning activities by working with KC GIS.
- Increase outreach in priority areas with vulnerable populations by engaging with community partners through the preparedness program. Potentially mimic Seattle's Ambassadors program.
- Include insurance information in preparedness outreach.
- Build a geospatial tool to track impacts and resource delivery during disaster response activities and develop ESJ objectives for EOC operations.
- Develop SOPs for use during activations that ensure staff consider population vulnerability with or without requests from communities. Consider creating an ESJ-specific position or ESJ-specific position responsibilities for work within the EOC.
- Work with county agency partners to prioritize projects that reduce risk in areas with vulnerable populations (as defined in this plan), including through planning efforts such as subarea plans.
- Develop an infrastructure equity map.
- Develop a hazard vulnerability component map to use in comprehensive planning.
- Crosswalk climate risk and population vulnerability with SCAP actions.

Performance Measure

- # mitigation projects specifically benefitting vulnerable communities/populations
- KCEM did/did not identify potential needs in vulnerable communities, regardless of resource requests received from those communities.

Seismic Lifeline Route Resilience

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KC EM	DLS PHSKC FMD DNRP	Earthquake / Goal 4	Capital Budget FEMA HMA General Fund

Vision

King County is able to conduct life-safety response and recovery operations throughout the county following a catastrophic Cascadia Subduction Zone or Seattle Fault earthquake.

Description

Following a major earthquake, at least three-quarters of all state-managed bridges will be inoperable for at least one-three months. This threatens the ability of responders to conduct life safety operations, for life saving resources to be distributed, and for communities to begin to transition to recovery. This strategy will build on state and federal assessments of transportation vulnerability to identify regional lifeline routes for King County and prioritize vulnerable segments for mitigation investments.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Convene a multiagency committee to develop a strategy • Identify potential lifeline routes and route vulnerabilities.	• Develop a prioritized list of lifeline routes and submit to the Executive and Council	• Develop, maintain, and expand the resilient transportation lifeline.

Implementation Plan/Actions

- KC EM will work with WSDOT, DLS, and others to review the completed RRAP for critical transportation and to identify potential seismic lifeline routes. Work with UW to verify RRAP results.
- Based on identified lifeline routes, identify necessary mitigation to protect and expand those routes.
- Prioritize investments based in part on population vulnerability and likelihood of self-sustaining for a longer period of time.
- Continue this effort through the strategy identified by King County Roads to retrofit seismically-vulnerable bridges.

Performance Measure

- Lifeline routes are identified
- # projects completed to strengthen the seismic lifeline routes

Integrate Hazard Mitigation and Comprehensive Planning

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KC EM	Office of the Executive DLS PSRC	All / Goal 12 Goal 14	FEMA HMA Grants

Vision

Comprehensive planning and regional initiatives like Vision 2050 account for hazard risk and the role that development patterns and climate change play in increasing hazard risk. These plans adopt policies and land use patterns designed to limit hazard risk.

Description

The most cost-effective mitigation measures are those that prevent the creation of risk through codes and development standards. At present, hazards are barely mentioned in most countywide/region wide planning documents. This strategy seeks to increase the integration between mitigation, response, and recovery concerns and major land-use policies and plans, including the Growth Management Act, PSRC Visions, and the Comprehensive Plan.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Provide comments on Vision 2050 updates. • Provide feedback on 2020 Comp Plan policies	• Fully participate in the next major update of the comprehensive plan, ensuring hazard risk and risk reduction is represented throughout.	• Integrate hazards into desired planning and development outcomes.

Implementation Plan/Actions

- Work with planning agencies to identify a list of areas where hazard information would be helpful in designing good policies.
- Socialize the concept of integrating hazard mitigation and comprehensive planning by attending regional meetings around the GMA and Comprehensive Plan as well as of City Manager and Planning Director groups.
- Look into developing a land-use tool platform similar to Colorado's planningforhazards.com page and that identifies tools that can be used to reduce hazard risk, such as purchase of development rights.
- Add hazard mitigation policies and strategies to the King County countywide planning policies to be updated in 2020.
- Integrate concepts of social vulnerability into comprehensive planning efforts in order to promote the use of comprehensive planning to both reduce hazard risk and build equity.
- Participate in WA Commerce and FEMA-led activities on how to consider hazards in comprehensive planning.

Performance Measure

- # of countywide planning policies addressing natural and manmade hazards.

Engage Community Organizations in Emergency Management

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KC EM	Public Health SKC	All / Goal 12 Goal 14	FEMA HMA Grants

Vision

Increase the participation of communities to identify local preparedness priorities and opportunities to do hazard mitigation, risk prevention, and community preparedness activities through the creation of "community resiliency networks" using a model similar to the Public Health community health networks. Use feedback from these community groups to influence response planning and prioritization, including for catastrophic response and recovery planning.

Description

Emergency planning typically underutilizes existing community capabilities and undervalues the resilience built into many communities, especially those that are marginally represented or of lower-income. Examples from around the country point out that a partnership with individuals and organizations from these communities a can result in better emergency management, reduced risk, aid in more rapid recovery, and even improve day-to-day quality of life indicators. King County Emergency Management will partner with other agencies to work more closely with communities to identify opportunities to strengthen the 14 Determinants of Equity through mitigation, establish response needs, recovery priorities, and account for community capabilities that can be valuable during disasters.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Bring together agencies to identify potential community partners for emergency management. • Complete a community capability map. • Complete an infrastructure equity map.	• Establish community priorities for each mission area and ensure those priorities are executed through plans and actions.	• Sustain a community equity in emergency management coalition.

Implementation Plan/Actions

- Develop tools to identify areas of inequity in emergency management, including for outreach, language support, and the quality of public infrastructure and services that may be damaged during a disaster.
- Investigate developing a community equity committee for emergency management similar to those used by King County Parks and Metro.
- Work with Public Health SKC and other agency partners to expand the Trusted Partners Network identify potential community organization partners with whom KC EM could engage to learn more about capabilities and gaps.
- Record community-identified mitigation and preparedness priorities and invest in them.

Performance Measure

- King County Emergency Management has prioritized/carried out # of community-identified actions.

Climate Integration Training

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KC EM	DNRP Local Jurisdictions	All Hazards	Existing Staff Time

Vision

All jurisdictions consider climate and climate-induced hazard impacts in their planning.

Description

The King County Hazard Regional Hazard Mitigation Plan provides a framework for local and regional action to reduce the impacts of natural and human-caused hazards in King County. Many of the natural hazards covered in the Plan, including flooding, wildfire, and landslides, are exacerbated by climate change. Building from work initiated in the 2019-20 Plan update, the Office of Emergency Management will host trainings with partner jurisdictions on incorporating climate change into hazard mitigation. The trainings will include information on how climate change affects natural hazards in King County; how to evaluate and adjust hazard mitigation strategies to account for climate impacts, including the potential for disproportionate impacts on frontline communities; and best practices for sharing information about climate risks with the public.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Develop training plan/curriculum • Conduct training	• Host periodic trainings and integrate climate considerations into classes or seminars on wildfires, severe weather, and planning.	• N/A

Implementation Plan/Actions

- Work with SCAP team to develop climate planning training curriculum.
- Identify and schedule opportunities to host climate trainings for King County and constituent jurisdictions.
- Host trainings during mitigation plan update meetings, winter weather seminars, wildfire seminars, and other related opportunities that bring local and county staff together to discuss hazards that are impacted by climate change.

Performance Measure

- # trainings hosted

Disaster Skills Risk Reduction Training

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KCEM Public Outreach Program Manager	Community Outreach Workgroup Zone Coordinators King County Libraries PHSKC	All Hazards Goal 6 Goal 14	EMPG, UASI, SHSP

Vision

King County Emergency Management delivers the county's disaster education, and provides year-round free training and education to county employees, residents, and organizations/businesses via several programs and activities aimed at promoting personal and community risk reduction.

Description

Disaster Skills Risk Reduction Training will provide education on natural and man-made hazards that are present and could occur in King County and ways to mitigate and reduce impacts in addition to increase community disaster preparedness, self-sufficiency, and protection of property.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Complete one Basic Disaster Skills Trainings (General Preparedness/Risk Reduction) within each jurisdictions/unincorporated area in King County. • Train at least 1,500 residents through Basic Disaster Skills Trainings and MYN Facilitator Trainings.	• Complete Advanced Disaster Skills Trainings (Fire Safety & Bleeding Control) within each jurisdictions/unincorporated area in King County. • Train at least 2,500 residents in advanced skills such as fire extinguisher and bleeding control • Train at least 50 individuals to serve as instructors for their respective organization, community, department, or jurisdiction.	• Maintain consistent outreach to high-risk communities. • Maintain consistent advanced disaster skills risk reduction trainings.

Implementation Plan/Actions

• Hold two trainings a month at the King County Libraries or with local jurisdictions
• Connect with the Seattle King County Public Health Ethnic-centric boards and ESJ newsletter for trusted partners to support sharing events and training opportunities.
• Hold four quarterly workshops for public educators to provide continuing education for community engagement specialists and public education and outreach coordinators.
• Modify outreach efforts to mirror need so that 80% of outreach goes to the 20% of the population at highest risk.
• Look into partnering with public health to teach post-disaster environmental health risk reduction skills, including emergency drinking water, toxin exposure reduction, etc.

Performance Measure

• Using sign-in sheets, keep track of how many individuals are attending Basic and Advanced trainings
• Social Media hits
• Ethnic social media connections

Dam Failure Risk and Impact Reduction

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KC EM Dam Safety Program Coordinator	DNRP, WLRD DNRP, Rivers WA Depot of Ecology, Dam Safety Office WRIA 8 WRIA 7 Salmon Recovery Funding Board Tribes Local Jurisdictions	Dam Failure / Goal 5 Goal 6 Goal 12 Goal 14 Supplemental Goal 15	FEMA Rehabilitation of High Hazard Potential Dam Grant Program King County Flood Control District FMA PDM Various Salmon & Environment Recovery Grants

Vision

Lower the risk and impacts of dam failure in King County.

Description

Washington State Dam Safety Office will identify high and significant hazard dams that are in poor condition. King County will gather information from other sources about low hazard dams of interest. King County will assist in seeking alternative funding structures to lower the risk of failure. Additionally, King County will seek alternative funding structures to decommission identified dams that threaten environmental resources. Lastly, resources will be sought to strengthen the integrity and security of high and significant hazard dams in the County that are not feasible to remove.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
Identify dams in King County that are assessed to be in poor condition by the Washington State DSO and identify funding structures to mitigate their risk. Begin dam removal projects.	Eliminate the risk associated with all dams in the County assessed to be in poor condition by the Washington State DSO.	Decommission dams that have outlived their functional use, but still remain operational and pose a threat to the County.

Implementation Plan/Actions

- Washington State DSO will identify poor condition dams in the County and rely them to KCEM.
- KCEM will work with DNRP, local jurisdictions, and tribes to identify potential funding/mitigation strategies.
- Ensure vulnerable populations are accounted for in outreach and risk assessments.
- Where applicable, KCEM will assist in grant application development and administration.

Performance Measure

- Number of mitigation actions for high hazard and significant dams that are in poor condition dams.
- Number of dams removed.
- Number of dams with lowered hazard classification through mitigation actions.

Wildfire Preparedness and Risk Reduction

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KC EM, Hazard Mitigation	DNRP, WLRD, DNRP, Parks, DLS, Permitting KC Fire Districts, WA DNR, King Conservation District, Tribes, USFS, KC Climate Preparedness Public Health Seattle-KC	Wildfire / Goal 3 Goal 5 Goal 12	Existing Resources

Vision

As King County grows, and awareness of climate change-driven wildfire risk grows, King County has a coordinated strategy to support individuals and local jurisdictions in identifying and managing wildfire risk, including risk to property and public health.

Description

Partner with King County communities, fire districts, and other organizations to develop an integrated King County strategy for wildfire. The strategy will review current efforts to address wildfire risk in King County and develop recommendations for addressing identified gaps and opportunities. These recommendations will be carried out through a coordinated Firewise technical assistance program, likely led by DNRP. This effort will be coordinated with a SCAP action seeking a similar outcome. This strategy will be based in part on the results of WA DNR effort to map the Wildland Urban Interface in King County.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Convene a multiagency committee to develop a strategy • Request funding for outreach	• Implement the strategy through coordinated technical assistance between the county and local communities	• Maintain consistent outreach to potentially-impacted communities.

Implementation Plan/Actions

- KC EM will work with DNRP, WLRD and the Climate Preparedness team to identify partners.
- Continue to partner with WA DNR and DLS to map WUI areas – ultimately use this map to target strategy priorities.
- Socialize results of WUI mapping efforts with comprehensive plan staff and look into planning policies that could limit density or development in fire-prone areas.
- Convene multiagency committee once WA DNR WUI maps are closer to being finalized
- Identify existing preparedness actions and gaps, including areas that are/are not receiving Firewise outreach and support.
- Develop wildfire preparedness and mitigation coordination strategy and socialize it.
- DNRP to request $150k funding for an additional FTE to support Firewise efforts.
- Look into model codes, ordinances, or other strategies to promote in addition to Firewise.
- Host an annual tabletop at the wildfire workshop held each year by KCEM.

Performance Measure

- KC EM was successful/not successful in convening *all* the necessary partners to establish a unified strategy for community wildfire preparedness and risk reduction.

Hazard Mitigation Assistance Grant Support

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KC EM	WA EMD Local Jurisdictions	All / Goal 10	FEMA HMA Grants

Vision

Hazard Mitigation Assistance grants go to the communities and projects most needed and more effective at reducing risk, regardless of a community's internal capacity to administer federal grants.

Description

With the passage of the Disaster Recovery Reform Act (DRRA) in 2018, the amount of federal grant funding for hazard mitigation will top $300-700 million annually, at least a 3-fold increase over historical averages. For 2019, grants of up to $4 million, federal cost-share, will be available. The experience-barrier to seeking these grants has prevented jurisdictions and county departments from applying. King County Emergency Management is establishing a grant assistance program to lower these barriers by providing support in administering FEMA grants.

To pay for this service, King County will leverage local management costs, provided to grant recipients.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Publish assistance guidelines and implement at least one test case.	• Expand local capacity to administer grants. • Expand KC EM capacity to support on application development	• Communities that need grants consistently are able to seek them, regardless of internal capacity.

Implementation Plan/Actions

- Administer FEMA grants - King County will administer grants, to include submitting reimbursements and documentation, completing quarterly reports, and managing grant kickoff and closeout.
- Provide application technical assistance - King County will, as time allows, provide support and technical assistance in developing applications. Jurisdictions will take the lead in application development. King County may provide more support in the future.
- Establish a process to collect documentation and reimburse expenditures - King County will establish a process to identify and track expenditures, and collect documentation necessary for submission to FEMA and the State. King County will work with partners to ensure this process is clear and straightforward.
- Develop an interlocal agreement process - King County will develop and establish an internal sub-award agreement process that lays out expectations for both parties in successfully administering the grants and completing mitigation projects.
- Look into other fund sources post-disaster and accelerate projects like flooded home buyouts before rebuilding occurs.

Performance Measure

- # Grants administered on behalf of other agencies/communities.

Public Assistance Grant Support

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
KCEM Business & Finance Officer	King County Public Assistance Team membership	All	FEMA 406 Mitigation

Vision

Post-Disaster Recovery following a Presidentially Declared Disaster will include taking full advantage of the utilization of 406 Hazard Mitigation funding made available exclusively to eligible agencies within a qualifying jurisdiction.

Description

The federal Public Assistance (PA) Disaster Recovery Grant Program supports governmental and government-type agencies recovery from major disaster declared by the President. While billions of PA grants are provided and provide significant support to recovering agencies; mitigating future occurrences of similar nature supports and strengthens resiliency on a long-term basis. The recognition of this is carried out through the provision of 406 Hazard Mitigation funds which are only available to agencies to mitigate damages suffered from a Presidentially Declared Disaster. These funds are added to Project Worksheets for PA Grant funds. King County Emergency Management serves as the County's Applicant Agent for PA and oversees the disaster financial recovery efforts for King County government agencies. This strategy seeks to increase the number of 406 Hazard Mitigation projects added to Public Worksheets to increase King County government resilience in all county agencies.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Provide the KC PA Team (KCPAT) education and outreach on the 406 Hazard Mitigation Grant Program. • 50% of all impacted eligible KC government agencies will identify at least one mitigation project for each PA PWs to mitigate/ prevent/eliminate future damage directly attributable to the declared disaster.	• 75% of all impacted eligible KC government agencies will identify at least one mitigation project for each PA Project Worksheet to mitigate/prevent/eliminate future damage directly attributable to the declared disaster.	• 95% of all impacted eligible KC government agencies will identify at least one mitigation project for each PA Project Worksheet to mitigate/prevent/eliminate the damage directly attributable to the declared disaster.

Implementation Plan/Actions

- Prepare training materials on 406 Hazard Mitigation Program
- Conduct trainings for the King County Public Assistance Team
- DNRP will train operations and engineering staff in the assessment of earthquake damaged facilities. A WTD specific ATC-20 class will be conducted in early 2020 for operations and engineering staff. Response guides and ATC-20 placards for post-earthquake inspection and FEMA cost tracking forms are being placed in all offsite facilities.
- Develop a KCPAT Disaster Recovery Financial Management Plan
- Develop KCPAT Disaster Recovery Profiles
- Represent and support each KCPAT agency during post-disaster recovery process

- Work with each impacted agency during a declared disaster to identify eligible 406 HM project(s)

Performance Measure

- \# of KCPAT members receiving training/outreach
- \# of 406 Hazard Mitigation Projects funded
- % of Impacted King County government agencies receiving a 406 Hazard Mitigation Project
- Identify local cost-share opportunities, including the flood control district.

Language Accessible Video Emergency Messaging

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
Risk Communications Specialist Public Health Seattle & King County, Office of the Director	King County OEM	All-Hazards Goal 6	$100,000 +

Vision

Increase the inventory of pre-scripted and translated language accessible materials for public health emergencies to aid in the rapid dissemination of public information and warning for all-hazards. Using audio-video media, increase the reach of emergency messaging for individuals with English as a second-language and persons who use American Sign Language (ASL).

Description

28.5% of King County citizens are speakers of a non-English language and in some local language communities, there is also a low rate of literacy in the spoken language. This mitigation strategy aims to develop language accessible materials in an audio-video format to assist in public information and warning for known hazards within King County. By providing emergency messaging in an audio-video format, King County will be able to provide equitable access to culturally appropriate emergency messaging for individuals who do not read (in English or in their spoken language) and individuals with language access needs (including individuals who speak American Sign Language). This mitigation strategy will aid in the rapid dissemination via web and social media of critical life-safety/risk reduction emergency messaging to all persons present in King County in the event of an emergency.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Secure videographer • Secure and train ASL interpreter service and spokespeople from language communities • Develop language accessible emergency messaging using audio-video format • Conduct trial runs for language accessible emergency messaging	• Implement language accessible emergency messaging for public use • Conduct public awareness campaign to socialize language accessible emergency messaging	• Reduce delays in issuing language accessible/translated emergency messaging

Implementation Plan/Actions

• Identify, script, and translate/transcreate emergency messaging for key hazards
• Issue request for proposals for content videographer and interpreter services (including American Sign Language)
• Film and produce language accessible emergency messaging content
• Engage communities in review and testing of language accessible emergency messaging
• Implement language accessible emergency messaging for public use and dissemination
• Conduct public awareness campaign to socialize language accessible emergency messaging
• Develop a social media strategy to support the accessible video tools.

Performance Measure

• Time for issuance/public broadcasting of language accessible emergency messaging during emergency activation(s)

King County Facilities Indoor Air Quality Monitoring Network

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
Environmental Health Emergency Response Planner Public Health – Seattle & King County	King County Facilities Maintenance Division	Wildfire Smoke Goal 2, 12	$100,000

Vision

Develop and implement network of indoor air quality monitoring devices in King County operated facilities to ensure the health and safety of King County employees during periods of poor air quality due to wildfire smoke inundation.

Description

Procure and deploy 280 Dylos DC1100 true laser particle counters (indoor air quality monitors) across 28 facilities owned and/or managed by King County to aid in continuity of operation decision making during periods of poor air quality during wildfire smoke events. Indoor air quality network would enable the county to make informed decisions regarding the health and safety of employees working in county owned/managed facilities and base facility closure decisions along established state recommended action thresholds for PM2.5 levels. The Dylos DC1100 systems are portable units that run at an estimated cost of $260.99 per unit and have the capability of relaying recorded PM levels to a central computer for active indoor air quality monitoring via integrated system telemetry.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Procurement of Dylos DC1100 indoor air quality monitors • Deployment of Dylos DC 1100 indoor air quality monitors across 28 king county owned/managed facilities • Establishment of centralized computer telemetry system for active monitoring of indoor air quality network • Increase situational awareness regarding indoor air quality of King County facilities during wildfire smoke events	• Assess indoor air quality performance of King County facilities during wildfire smoke events • Identify mitigation strategies to further improve indoor air quality of King County facilities during wildfire smoke events • Improve the overall indoor air quality performance of King County facilities during wildfire smoke events	• Increase situational awareness regarding indoor air quality of King County facilities during wildfire smoke events • Increase the overall air quality performance of King County facilities during wildfire smoke events to aid in maintaining continuity of operations during periods of poor air quality

Implementation Plan/Actions

- Procurement of Dylos DC1100 indoor air quality monitors
- Deployment of Dylos DC1100 indoor air quality monitors across 28 King County Facilities
- Establish centralized computer telemetry system for active monitoring of indoor air quality monitoring network
- Assess the performance of each King County facility during periods of poor air quality due to wildfire smoke
- Determine if facility closures are warranted based upon state recommended air quality action thresholds during periods of wildfire smoke inundation
- Identify subsequent indoor air quality mitigation recommendations for improving facility performance during wildfire smoke events

Performance Measure

- Prioritization of facilities warranting further indoor air quality mitigation actions to improve performance during periods of poor outdoor air quality
- Development of indoor air quality mitigation recommendations for prioritized facilities

Medical Gas Seismic Detection & Emergency Shut Off

Lead	Partners	Hazards Mitigated / Goals Addressed	Funding Sources and Estimated Costs
PHSKC – Environmental Health Services Division, Community Environmental Health Section	Harborview Medical Center	Earthquake Goal 2, 12	≤$500,000

Vision

Reduce the disruption to level 1 trauma centers in King County following the event of a large earthquake by retrofitting level 1 trauma centers with medical gas seismic detection and emergency shut off systems.

Description

Harborview Medical Center is the only level 1 trauma center within King County and the State of Washington. In the event of a large earthquake impacting the Puget Sound region, disruptions to medical gas piping and delivery systems can significantly increase the recovery time to resume operations. This strategy proposes retrofitting the medical gas piping and delivery systems with early warning seismic detection and emergency shut off valves in order to increase the capability of rapid restoration of medical services following the event of a large earthquake in order to expedite the restoration of life saving operational capacity.

2-Year Objectives	5-Year Objectives	Long-Term Objectives
• Fund feasibility study • Select consultants to complete study	• Update medical gas piping and plumbing code to require seismic detection and emergency shut off valves for Level 1 trauma centers.	• Expedite the restoration of critical life-saving operational capacity for trauma centers with a level 1 designation.

Implementation Plan/Actions

- Allocate funding to conduct a feasibility study for seismic detection and emergency shut off valve upgrades for level 1 trauma centers in King County
- Issue Request for Proposal to contract conduct of feasibility study
- Biased upon findings of feasibility study, update medical gas piping and plumbing code to require seismic detection and emergency shut off valves for medical gases for level 1 trauma centers.

Performance Measure

- Completion of a feasibility study assessing cost-benefit outcome for seismic detection and emergency shut off valve system upgrades
- Update medical gas piping and plumbing code to require seismic detection and emergency shut off valves for level 1 trauma centers.