UPPER SNOQUALMIE RESILIENT RIVER CORRIDOR MANAGEMENT PLAN

Snoqualmie Tribe

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Natural Systems Design

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In collaboration with:

HEADWATER PEOPLE

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List of Abbreviations and Key Terms

MF: Middle Fork Snoqualmie River

NF: North Fork Snoqualmie River

Planning Area: the analysis and planning area of this project

SF: South Fork Snoqualmie River

Three Forks: The confluence of the MF, NF, and SF Snoqualmie Rivers

WSE: Water Surface Elevation

Swing Rock: yiʔduʔad

Snoqualmie Prairie: baqʷab

Snoqualmie Falls : š(ə)qaʔɫdaɫ (upper lip of the Falls) and sqʷəd (under part where stream plunges, bottom of the Falls)

Mount Si: q̓əlbč̓

Executive Summary

There are clear areas of overlap between sacred places and areas planned for urban growth in the Snoqualmie River Valley, where good relationships and respectful land and water use management decisions will sustain the long-term health of the river and all residents of the Upper Snoqualmie Valley. The Snoqualmie Tribe's Resilient River Corridor Management Plan shows the state of natural processes of the Upper Snoqualmie River Valley as they were in the past, as they are today and will be in the future and makes recommendations for changes to support a resilient river corridor in the face of climate change. As the technical team gathered data to inform and fill gaps for the report section of this plan, others on the project team engaged and heard from the Snoqualmie Tribal community in particular, and the broader community at large, about what their experiences with the river are, what is important to them and their relationship to the Snoqualmie River, and how they think it will change in the future.

Image of Snoqualmie Falls including, š(ə)qaʔłdał, the upper lip of the Falls, and sqʷəd, the under part where stream plunges at the bottom of the Falls. Image courtesy of Snoqualmie Tribe, 2021.

This Resilient River Corridor Management Plan reports back what was heard from the community and the results of the scientific assessment, as well as communicates to river and city managers, specifically King County and the City of Snoqualmie, that a more holistic approach is needed to respond to the constantly changing river environment, as they own and manage much of the land along the Upper Snoqualmie River.

Over the last several decades, river and city managers have made decisions responding to urgent issues related to the river's effect on streamside and floodplain infrastructure. These decisions were made without the benefit of a broad, long-term vision for the Upper Snoqualmie River valley. In turn, many of these projects focused on slowing or stopping a natural river process to meet a short-term need, without full regard for the natural processes that support water quality, water quantity, and aquatic and terrestrial habitat.

The cumulative result of decision-making in the absence of a cohesive, holistic management approach for the Upper Snoqualmie River valley is the fragmented, disorganized landscape that one sees today. This plan is intended to help to fill a current gap, and to communicate a vision of what could be. It includes suggestions for where to start to take the steps needed to get to a more connected, more resilient river corridor over time.

The Snoqualmie Tribe's relationship with the river valley is a generational commitment that has existed since time immemorial. Outcomes stemming from this plan should use an intergenerational framework to increase access to a clean river for the tribal community, including to Snoqualmie Falls and areas to harvest ancestral and local foods and materials. Many scientists and planners contribute to misinformed decision-making by working from frameworks that support diminished baselines where generational experiences are erased. Twenty-two (22) recommendations for interventions and restoration activities, and suggestions for where planning could start are included in this plan.

The results of the hydraulic assessment indicate that floodplain connectivity varies throughout the Planning Area and that flood risk through the City of Snoqualmie is expected to increase under climate change conditions. The floodplain through the Confluence and Meadowbrook Slough reaches has a high degree of floodplain connectivity and is predicted to inundate at least once every 2 years under both existing and climate change conditions. This indicates that restoration activities within these reaches have a high likelihood of success because the hydraulic/hydrologic conditions already exist for a well-functioning floodplain ecosystem through these areas (Figure 1).

The goal of this plan is to serve as a knowledge source to share across communities to support a richer cultural relationship with the Snoqualmie River, and to promote a collective understanding of a resilient Snoqualmie River for all.

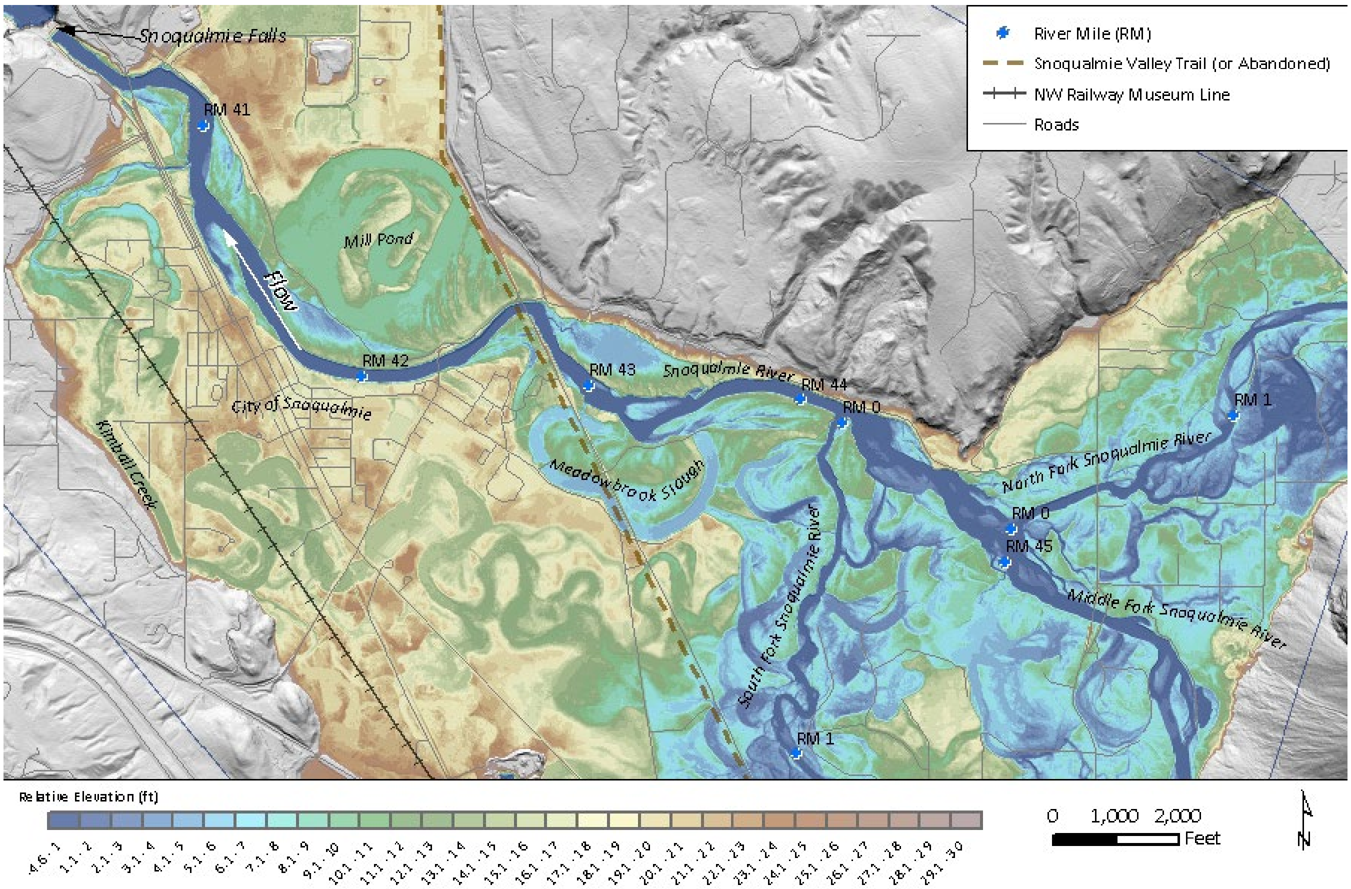


Figure 1. Floodplain elevations relative to the LiDAR water surface are shown, with low-lying areas in blue and higher ground in yellow and brown. This graphic illustrates the dynamic nature of this river and floodplain landscape, which formerly supported a greater degree of river and floodplain connectivity and resiliency compared to current conditions.

Planning Area Description

The Planning Area includes about 3,500 acres of floodplain and 4-miles of the upper Snoqualmie River around the City of Snoqualmie (the City), (Figure 2). It begins just downstream of the confluence of the North Fork (NF), Middle Fork (MF), and South Fork (SF) of the Snoqualmie River, which is protected by the 200-acre Three Forks Natural Area, managed by the City of Snoqualmie. The downstream end of the Planning Area is just above Snoqualmie Falls, a sacred site of the Snoqualmie Tribe (the Tribe) and currently managed by Puget Sound Energy to produce hydroelectricity. Within the Planning Area there four different river morphologies, which are used to define distinct Planning Area river reaches. They are organized from upstream to downstream and characterized as follows:

1. **The Confluence Reach** is a braided river reach where sediment is currently being deposited by the river. It is located between the confluence of the mainstem Snoqualmie River with NF and MF Snoqualmie Rivers, and the confluence of the mainstem Snoqualmie River with the SF Snoqualmie River.
2. **Meadowbrook Slough Reach** is dominated by a slough of the same name, which is a former river oxbow, as well as a portion of the mainstem Snoqualmie River.
3. **The City Reach** is defined by an armored single channel through the City, with the City on the south bank and the proposed Mill Pond development site and Mill Pond (Borst Lake) on the north side of the river. Mill Pond also appears to be a former river oxbow, or a relict channel where the river once flowed.
4. **Kimball Creek Reach** may be a relict channel of the SF Snoqualmie River and extends along the south side of the upper Snoqualmie River valley, passing through the City and meeting the mainstem Snoqualmie River just downstream of the City.

A more detailed description of these different channel morphologies and river processes is described in the **Channel Morphology and Processes** section of this report.

The entire Planning Area is classified as an environmentally sensitive area, including a critical aquifer recharge zone, large wetlands, and floodplain and floodway. Despite this sensitivity, or perhaps because of it, this landscape has a rich history of human use going back to the time that the last glaciers receded.

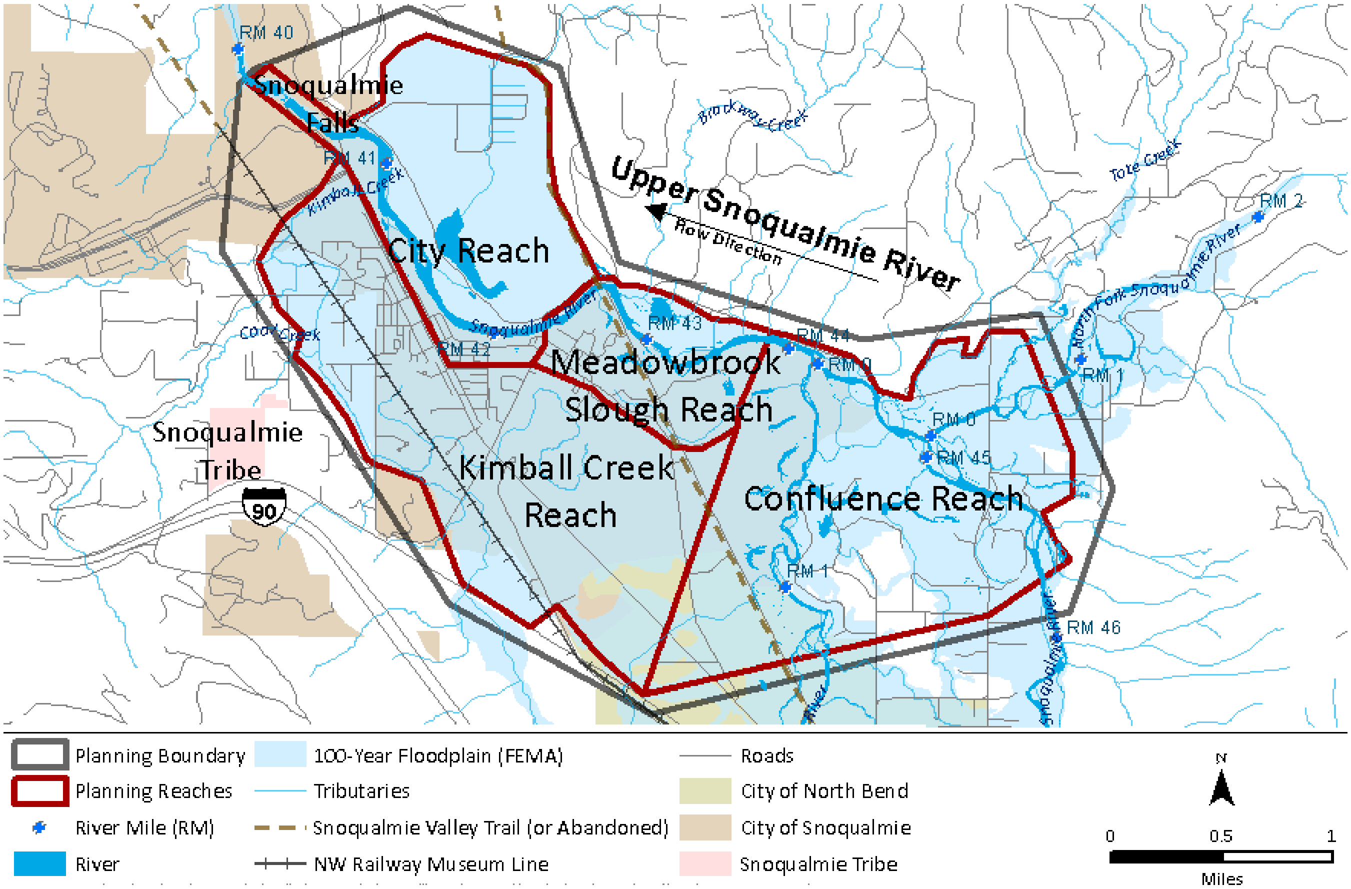


Figure 2 Upper Snoqualmie Resilient River Corridor Management planning area map.

There are clear areas of overlap between sacred places and areas planned for urban growth. Here good relationships and respectful land and water use management decisions will sustain the long-term health of the river and all residents of the upper Snoqualmie Valley (Figure 3).

Snoqualmie Falls (the Falls) and the area around it are a part of the Tribe's creation history. It is the birthplace of Snoqualmie People, who have lived in the Snoqualmie Valley and the greater Salish Sea region since time immemorial. In relation to this sacred place, the conserved property known as "Two Sisters Return" is located adjacent to the Falls. On the eastern or upstream side of the Planning Area, the Tribe maintained a large Snoqualmie Prairie, in the vicinity of the area called Meadowbrook and Tollgate Farms today, which was used for cultivation of edible and medicinal plants, as well as serving as the annual meeting place for trade and commerce. As of 1855, there were an estimated 4,000 Snoqualmie Tribe members living in this valley. Today, the Tribe currently has 650 enrolled members.

Post-European contact settlement brought a different type of trade and commerce. Tribally maintained prairies were some of the first landscapes claimed by new settlers. Snoqualmie Prairie was briefly used as a fort and then as a farm. Today, this former prairie is owned publicly as a scenic buffer between North Bend and Snoqualmie, and it is as wildlife habitat and flood water storage. The valley was also entirely and repeatedly logged.

Today, the Planning Area is a part of the City of Snoqualmie (City) in King County, Washington and is considered part of the upper Snoqualmie Valley. Since 1990, the City has grown close to ten times larger, from 1,500 residents to 14,000 residents, due to the annexation and development of Snoqualmie Ridge for residential housing.

Areas of heightened importance to the Tribe and the City are mapped in Figure 3, including Snoqualmie Falls and the other publicly known sacred sites, as well as past and future development such as Snoqualmie Ridge and the former Mill Site, respectively.

Examples of Protecting and Managing Sacred Sites Today

The transfer of development rights from the planned Falls Crossing development, which would have extended from the eastern edge of the Snoqualmie Ridge development, up to the edge of the Snoqualmie River, the lip of the Falls, and the Snoqualmie Falls Traditional Cultural Property (TCP) around the Falls, led to the creation of the conserved property known as Two Sisters Return. This is a good example of how the City and Tribe can work together to achieve both development and cultural landscape preservation. While the development was originally intended to go right up to the river's edge and the Falls, an innovative transfer of development rights was agreed upon to protect this important landscape from future development, directing the concentration of development away from the sacred site and ecologically sensitive areas.

Snoqualmie Prairie is currently maintained as park and open space at Meadowbrook and Tollgate Farm. It is managed as mowed grassy open space for outdoor events and agriculture by the Meadowbrook Board and a park area with Si View Parks and the Cities of Snoqualmie and North Bend. Prairie restoration is desired by the Tribe and others, but the controlled burns required for restoration are not currently allowed/legal within the King County jurisdiction.

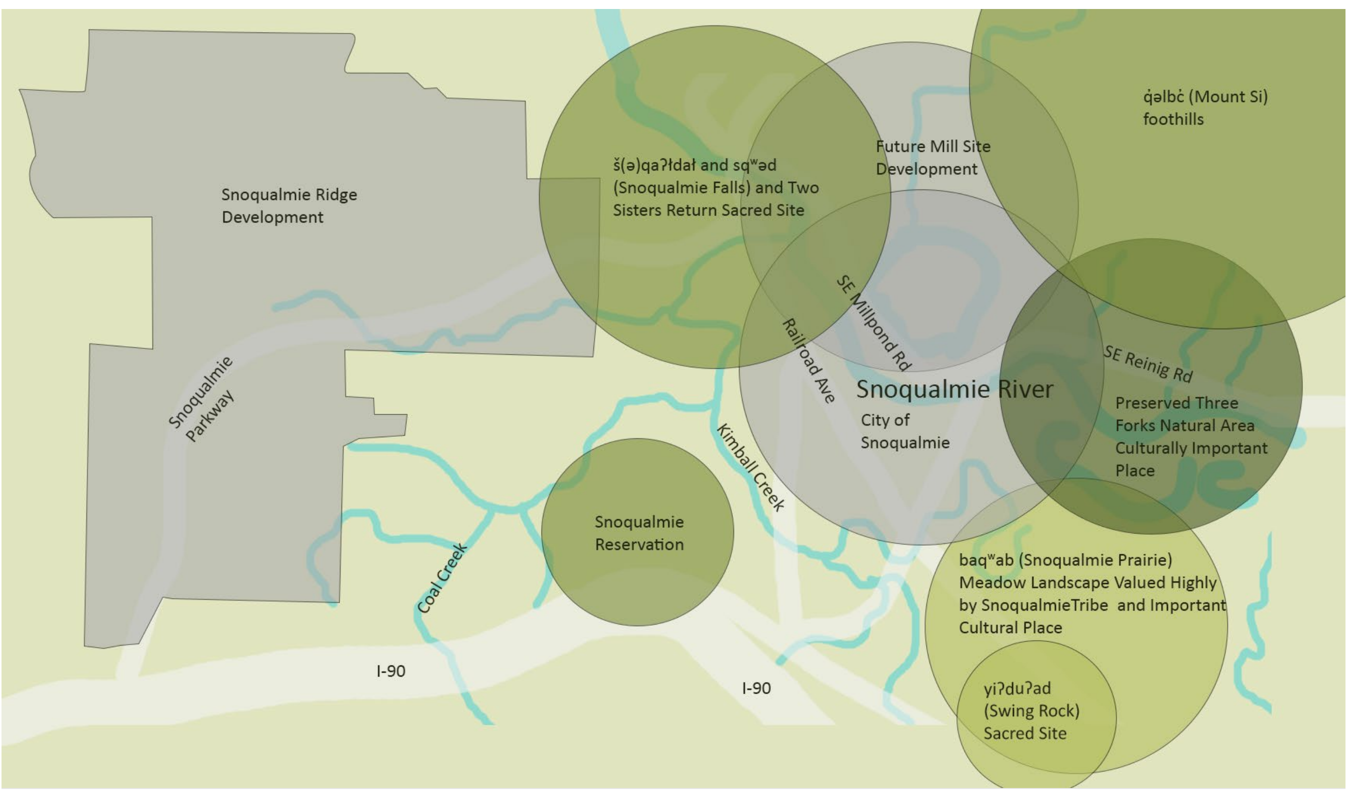


Figure 3 Cultural landscape map, north is at the top of the page with the river flowing from right to left.

Tribal Community Access Experiences

Summarized below are experiences from tribal members and Snoqualmie Cultural Department staff and proposed recommendations for how to increase access in three areas: the Snoqualmie River, the River Valley, and Snoqualmie Falls. The Snoqualmie Tribe asserts that tribal community access is an integral part of a resilient river corridor for continuity with previous generational knowledge being available for future generations.

Snoqualmie River

Based on what we heard, community responses reinforce the Snoqualmie Tribe's Ancestral Lands Movement stating that, "as the Salish Sea region has grown in population, the Snoqualmie Tribe's ancestral lands have been heavily impacted by recreation." Water quality is declining, and people experience the Snoqualmie River as being full of litter and trash. The Ancestral Lands Movement will begin to address the impact of recreation on tribal lands and promoting more respectful uses. For example, the project team heard from tribal community members about the impacts experienced because of poor water quality and trash from local water sports companies in and around the Planning Area.

While the lower Snoqualmie River is significantly affected by decades of litter and trash, the Mill Pond (aka Borst Lake) is a known source of industrial waste pollution (Washington Department of Ecology, 2021). It is likely that addressing toxic sediment deposits, which are close to the river, would improve the health of the greater Snoqualmie River, especially if river restoration and/or climate change were to somehow re-engage Mill Pond with the river. A summary of this pollution and remediation needs, and some initial restoration opportunities are summarized in this plan.

Snoqualmie River Valley

Stewardship and restoration of nearby, accessible locations to harvest ancestral and local foods and materials has been brought up as a desirable resilient river corridor management planning action. Signage installed in these areas acknowledging the Tribal connections would combat the current erasure of the Snoqualmie Tribe's management and relationship with the river since time immemorial. More detail is presented in the planning section at the end of this report. Many local wild foods have been observed to be decreasing in abundance and availability including salmon (sčədadxʷ), steelhead, clams, and wapato. Access to more robust and private harvest locations upstream in the MF and NF Snoqualmie watersheds often requires passes from the local timber companies, creating a cultural conflict between the tribal rights to clean water and food, and having to pay private landowners to exercise those rights.

> "We are Snoqualmie. We are the Spiritual Stewards of Sacred Snoqualmie Falls. We have the duty, responsibility and honor of caring for the great gift of the Creator to the People. It is Snoqualmie Pass, Snoqualmie River, Snoqualmie National Forest, it is the greater Snoqualmie Valley, and it is sacred Snoqualmie Falls. We are literally the Transformer's People. It is our history and our legacy. We pray that we honor it in our lifetimes. Without our connection remaining strong and healthy, we cannot ensure for the next seven generations, which is our teaching. Our teachers, leaders and people prayed and worked to ensure for us. We need to do the same."
>
> - Snoqualmie Tribal Elder Lois Sweet Dorman

Snoqualmie Falls

Tribal access to the river is a challenge, and it is currently limited to public launch areas at some parks and the gated area at the bottom of Snoqualmie Falls (the Falls). The Falls are accessible by tribal members only but requires a key to access the gated area, which can be a barrier as not all tribal members may be aware of this access process. The other side of the Falls is only accessible by purchasing access to the Snoqualmie Falls Forest Theater property. Increasing access for the tribal community to the Falls is another outcome supported in this plan.

Community Survey Results

A community survey was conducted in the fall of 2020 and winter of 2021 where residents and admirers of the upper Snoqualmie River shared **key words, terms, and phrases** to describe their experiences and observations related to the river. In the narrative summary below, the **bolded** key words, terms, and phrases were shared by multiple people in their responses. The key words appear in order from most times repeated to the least.

A top interest for survey responders is the **flow rate** (12) of the Snoqualmie River. Other worries include **flooding affecting homes and communities** (8) and **climate change** (8). Survey responders worried about **development** (8) and want to **minimize development in the flood plain** (7). People are interested in **increasing the buffer around the river** to use this **open space area for public access while also allowing for natural river shifting** (7). There is a shared concern to **preserve and care** for the river (6). **Less water availability** and **wildlife impacts** (6) are of interest along with the **flow timing** of the river (5). They want to **restore habitat and walking paths** (4), along with **restoring floodplain functions** (4). There is an interest to **evaluate the levee system and remove it** (4). **Erosion** is a shared concern and so is **overcrowding** (3). **Drought** and **less fish** are a concern connected to **ecosystem collapse** (3). People are interested in **economic support to move those affected by flooding through relocation and economic opportunities** (3). The **risk to homes** needs to be mitigated (3). There is a sense that it is **overpopulated by the banks** of the Snoqualmie River (2). Some think it is a **bad idea for the Mill Site redevelopment to be built** because the river needs more room to move naturally (2). **Salmon runs** and the protection of them are a concern (2). People want the river protected and maintained to keep watch over the river and wildlife. **Restoring** the Snoqualmie River is a priority, along with supporting **biodiversity** (2).

Single mentions

The following narrative illustrates **bolded key words, terms, and phrases** that were only mentioned by one survey respondent.

There is an **increase in flooding** and instances of **high-water levels** making areas hard to reach. There are **impacts to trout, mussels, and salmon downstream.** These **impacts extend to the trees**, specifically mentioned are **Cedar and Hemlock species**. Impacts noticed by survey respondents also include **loss of biodiversity**, **reduction of water quality**, **less water stored as ice/snowpack**, and **reduction of instream flows for fish and wildlife**. With population growth, there are concerns about **not having enough water for the current and growing human population in Snoqualmie and North Bend, higher water bills,** and **increased traffic on the river.** Related, people have noticed **more trash and pollution** in and around the river. There is a concern that **too much building and construction will limit the water supply for wildlife. Run off pollution** will impact the river corridor due to these increased activities. Some impacts were attributed to **unfortunate political choices**.

People want to see **new designs that allow for flooding**. Someone highlighted they wanted to see **environmental and urban growth management led by the Snoqualmie Tribe and informed by scientific understanding**. There are concerns about current designs, such as **whether the dam will fail** and be able to properly balance the water flows. There is an interest to have **disaster recovery plans**. **There is a reduction of water flows during critical late summer and early fall months** due to **over-extraction of water reservoirs** feeding the river level. People are worried the **recharge of the aquifer is suffering** now and will in the future. Observations include that it is **too hot outside** and **boat access** is a concern.

There is an interest in **responsible farming in the flood plain** and how to support this, of course with buffers to the river. The **soil is rich for farming** in the corridor. In the future, someone is concerned about the **ruined crops** if the management does not respond to needs. There is an interest in **keeping the original prairies open.**

The community knowledge aligns with the data that has been collected, and reinforce the recommendations made at the end of this plan for resiliency.

Snoqualmie 2032

While developing this Upper Snoqualmie Resilient River Corridor Management Plan, land use and development plans were brought up as a concern by community members (see inset text box). Local land use plans are described in the City of Snoqualmie Comprehensive plan, called *Snoqualmie 2032*, which includes a vision statement about supporting a unified community, healthy and diverse economy, distinctive sense of place, and a livable and complete community that includes a healthy environment (Sanders, 2014).

This vision statement is in alignment with the values of this resilient river plan, however while the City's Comprehensive Plan provides a road map for future development, guiding growth and investment, it does not explicitly include either resilient river management recommendations or integration of the values of the Snoqualmie Tribe in the plan. In 2010 the City did adopt the *Snoqualmie Sustainability Strategy* which provided recommendations across twelve sectors, including flooding and climate change hazards, land use, green infrastructure and water, and others.

In the context of the Comprehensive Plan, the Tribe were represented as an organization to consult with regards to preserving natural beauty and ecosystem health, see Vision, Ch. 1, (Sanders, 2014), local economic partners, see Economic Development, Ch. 3, (Sanders, 2014); and descendants of Snoqualmie People , see Community Character, Ch. 5, (Sanders, 2014).

Community Hopes for the Future of Landuse

- *North Bend and Snoqualmie have achieved growth target levels, and it is time that our leaders learn to live within our means without adding further development stressors to our upper valley ecosystem.*
- *The entire river depends on headwaters, protect it.*
- *Protect for future generations.*
- *Smart growth and investment in community.*
- *Additional and maintained parks and trails.*
- *Proper water mitigation plans.*
- *Growth restrictions.*
- *It will be a place that City dwellers can visit and appreciate.*
- *I see more access restrictions coming.*

While it is difficult to measure the successful inclusion of the Tribe in the Comprehensive Plan objectives of preservation of upper Snoqualmie natural beauty and ecosystem health, as well as maintaining or increasing sustainable economic partnerships, there is a need for the City's planning processes to more meaningfully include Tribal participation and incorporate the principles of Free Prior Informed Consent (Washington State Office of the Attorney General, 2019). In either case, the sustainability goals of the City's plan seem to partially align with Tribal values.

Flood Protection Projects Mentioned In City Comprehensive Plan

Natural and engineered-widening of the river channel, as well as a declining riparian forest, have led to increased river water temperatures. Most of the post-European contact settlement is in the floodplain. Floods occur when the river flows exceed 30,000 cubic feet per second on the mainstem Snoqualmie River, generally occurring every 1 to 2 years (Sanders, 2014). Decades of flood control negotiation between US Army Corps of Engineers (USACE), King County, and the City, have resulted in the following flood control measures, completed by 2004 (Sanders, 2014):

- 340 linear feet of right bank widening just above the Falls.
- 500 linear feet of left bank widening just downstream of highway 202 bridge.
- Trestle removed just upstream of SR-202 bridge.

Subsequent updates to the Puget Sound Energy facilities at Snoqualmie Falls included lowering the diversion structure and removing some channel fill. Elevating homes and acquiring flood-prone properties remain a significant part of the comprehensive plan for flood mitigation (Sanders, 2014).

Riparian Forest Restoration Supported by 2014 Urban Forest Strategic Plan

The City has created an Urban Forest Strategic Plan with the following mission statement:

> *“Snoqualmie is dedicated to protecting and managing its vibrant urban forest as a cohesive ecosystem, to enhance its environmental benefits and its contribution to community livability, today and for generations to come”* (Larson et al., 2014)

The City’s goal is to maintain tree canopy cover at 70% or greater, with diverse ages and species. Preservation and enhancement of native vegetation was stated as a City priority, particularly on publicly owned lands, which may be implemented via a stewardship plan, affording community stewardship opportunities for helping with invasive species removal, plantings, and other natural area focused management activities (Larson et al., 2014). Creation of a Forest Stewardship training program, modeled after Master Gardeners was another listed strategy (Larson et al., 2014).

Planned Development

Population growth has been putting increased pressure on water resources in the upper Snoqualmie Valley (Snohomish County Surface Water Management et al., 2015). Known plans for increased development and population growth at the Mill Site on the right bank of the Upper Snoqualmie River and increased tourism and commercial opportunities along the Riverfront or Riverwalk in the City of Snoqualmie on the left bank of the river are summarized below.

Delivery of cold clean water to the lower Snohomish River watershed relies on the upper Snoqualmie River remaining heavily forested and minimally paved (Snohomish County Surface Water Management et al., 2015). The City of Snoqualmie recently won a grant from the State of Washington Department of Ecology Water Resources Streamflow Restoration Program (WRSRP) to investigate the feasibility and pilot test an aquifer storage and recovery program intended to support City water supply. This type of planned infrastructure may affect groundwater and river hydrology, discussed in further detail in the Groundwater and Alluvial Aquifer section of this report.

Mill Site Development Project

The 2012 annexation of the 261-acre Mill Site, on the right bank of the Snoqualmie River, directly across from the City of Snoqualmie, on the left bank, has been proposed by Weyerhaeuser developers as the next area for growth. This site is planned to include industrial, retail, and residential uses (Figure 4).

As of April 2020, the Mill Site Development Project released a Draft Environmental Impact Statement (DEIS) called "Mill Site Planned Commercial/Industrial Plan" for consideration by the WA State Department of Ecology, providing stakeholders at all levels of governance, including tribal governments and the public-at-large, with the opportunity to review various environmental impact alternatives and provide feedback (City of Snoqualmie, 2020a). While this plan sets aside 166 acres for open space and flood storage, the potential impacts of redevelopment on flooding and the protection of wetlands, streams, and terrestrial habitat were among the uncertainties mentioned in the DEIS summary (City of Snoqualmie, 2020a).

Figure 4 Mill Site Development Project Planning Areas (City of Snoqualmie, 2020a).

Mill Site Berm & Fill

To protect the former mill site, Weyerhaeuser constructed a berm along Mill Pond Road with fill later added behind the berm, some without the proper permits; about 93,900 cubic yards of fill were added to the floodplain. The King County Flood Hazard Reduction Plan identified the berm as a hazard that displaced floodwater,potentially impacting conveyance & storage capacity. Weyerhaeuser was issued a permit in 2006 by King County to remove about 49,000 cubic yards of the fill; the berm was breached and most of it removed. The City pursued an action against the County to compel removal of remaining fill. The County prevailed. The Mill property pre-annexation agreement requires removal of floodplain fill as part of future development.

Inset box from Mill Site land use chapter of Snoqualmie 2032 (Nichols, 2014).

Riverfront and Riverwalk

The flood protection projects mentioned earlier, which lowered the base flood elevation at the Falls by 3.8 feet, have had the unintended consequences of increasing erosive forces and decreasing bank stability along the City of Snoqualmie waterfront, particularly in the vicinity of Sandy Cove Park (Edward McCarthy, PhD, 2016). The City of Snoqualmie has been working on a riverfront land acquisition, bank stabilization, and river walk plan to address flood and erosion issues, enhance the downtown business and economic corridor, and increase water access and waterfront views for businesses and the general public (Figure 5).

Several funding sources have been secured to implement this plan, including a funds from King County Conservation Futures, and other ongoing sources of funding (City of Snoqualmie Community Development Committee, 2018). As of 2018, the City had acquired seven of the twenty-five parcels (Figure 6).

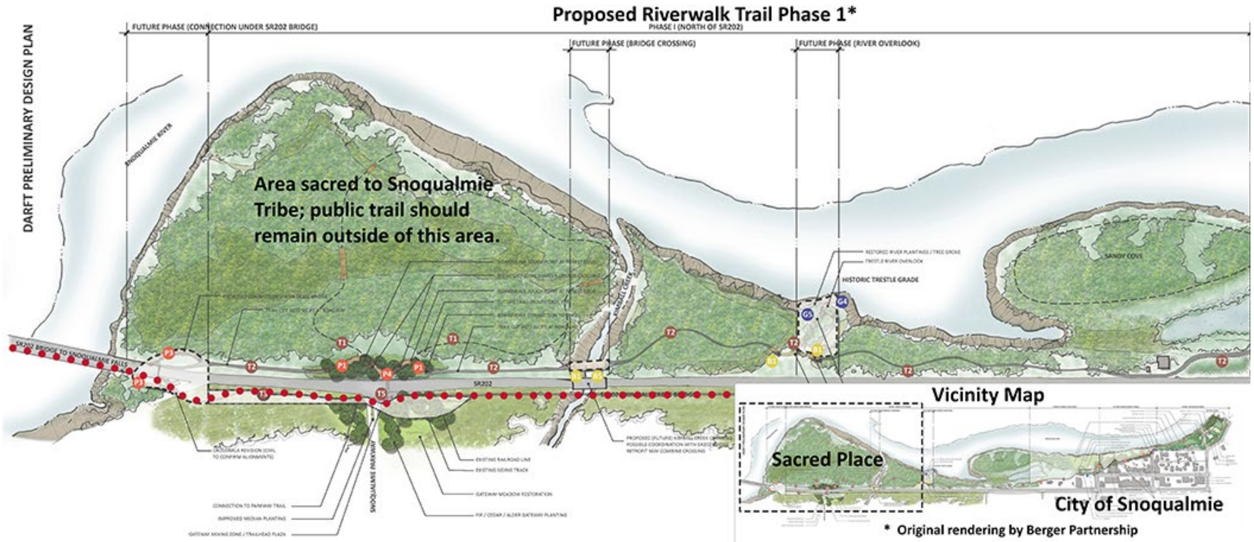
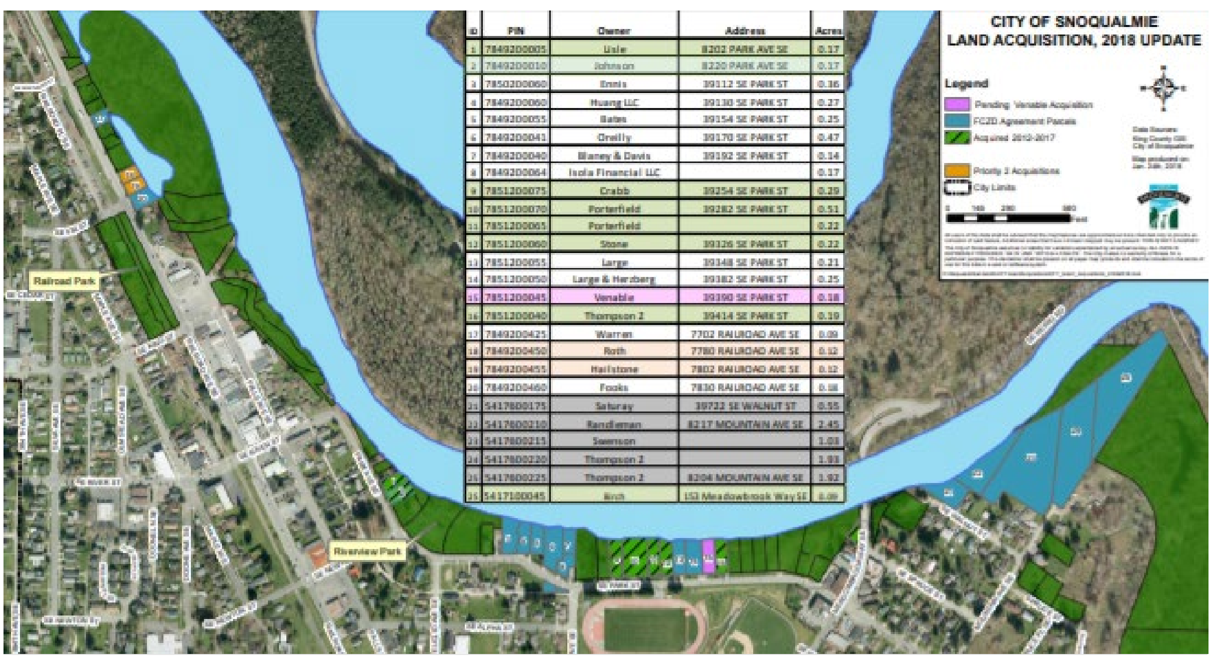


Figure 5 Proposed Snoqualmie Riverwalk Trail Phase 1, illustrating location of sacred area with protective easement and preferred option using existing trails highlighted in red dots. Rendering created by Berger Partnership for City of Snoqualmie, 2016. See https://www.snoqualmiewa.gov/891/Riverwalk for more information.



ID	PIN	Owner	Address	Acres
1	7849200005	Lisle	8202 PARK AVE SE	0.17
2	7849200010	Johnson	8220 PARK AVE SE	0.17
3	7850200060	Ennis	39112 SE PARK ST	0.36
4	7849200060	Huang LLC	39130 SE PARK ST	0.27
5	7849200055	Bates	39154 SE PARK ST	0.25
6	7849200041	Oreilly	39170 SE PARK ST	0.47
7	7849200040	Blaney & Davis	39192 SE PARK ST	0.14
8	7849200064	Isola Financial LLC		0.17
9	7851200075	Crabb	39254 SE PARK ST	0.29
10	7851200070	Porterfield	39282 SE PARK ST	0.51
11	7851200065	Porterfield		0.22
12	7851200060	Stone	39326 SE PARK ST	0.22
13	7851200055	Large	39348 SE PARK ST	0.21
14	7851200050	Large & Herzberg	39382 SE PARK ST	0.25
15	7851200045	Venable	39390 SE PARK ST	0.18
16	7851200040	Thompson 2	39414 SE PARK ST	0.19
17	7849200425	Warren	7702 RAILROAD AVE SE	0.09
18	7849200450	Roth	7780 RAILROAD AVE SE	0.12
19	7849200455	Hailstone	7802 RAILROAD AVE SE	0.12
20	7849200460	Fooks	7830 RAILROAD AVE SE	0.18
21	5417800175	Saturay	39722 SE WALNUT ST	0.55
22	5417800210	Randleman	8217 MOUNTAIN AVE SE	2.45
23	5417800215	Swenson		1.03
24	5417800220	Thompson 2		1.93
25	5417800225	Thompson 2	8204 MOUNTAIN AVE SE	1.92
26	5417100045	Birch	153 Meadowbrook Way SE	0.08

Figure 6 City of Snoqualmie riverfront land acquisition, (City of Snoqualmie Community Development Committee, 2018).

The Snoqualmie Riverwalk project is included in the current comprehensive plan for the City of Snoqualmie and is envisioned as a "destination trail loop" from Snoqualmie Falls to Three Forks Natural Area, along the downtown waterfront of the Snoqualmie River.

A Riverwalk Master Plan was created in 2015 to document all aspects of planning and conceptual design, including:

- Site analysis and planning
- Design and four construction phases
- Development opportunities
- Access points, trail types, parking locations
- Land ownership (tribal for eons)
- Environmental impacts and sustainability
- Respect for historical tribal activities

The State Environmental Policy Act (SEPA) process is used to identify and analyze environmental impacts associated with planning and development. The SEPA process for the first trail phase was determined to have Mitigated Determination of Non-Significance (MDNS), using the following mitigation measures (City of Snoqualmie, 2018):

Mitigation Measures:

1. A 30 (thirty)-foot buffer is required from any identified cultural resources as described in the Cultural Resources Assessment (ESA, 2018).
2. If potential archaeological resources or human remains are discovered during construction, work should immediately cease, the area affected should be flagged with construction tape or other identifying markers, the City should notify the Snoqualmie Tribe and State Historic Preservation Officer, and comply with Chapters 27.44 and/or 27.53 RCW as applicable.
3. Construction shall fully comply with the requirements of all applicable City codes and regulations, including but not limited to:
    a. Flood Hazard Regulations, Chapter 15.12.SMC.
    b. Clearing and Grading Regulations, Chapter 15.20 SMC.
    c. Surface and Storm Water Management Regulations, Chapter 15.18 SMC.
    d. Critical Areas Regulations, Chapter 19.12 SMC.
    e. City of Snoqualmie Shoreline Master Program and Shoreline Management Regulations, Chapter 19.08 SMC.
4. Pursuant to Chapter 19.12 SMC, the applicant shall provide the mitigation identified in the Wetland and Ordinary High Water Mark Delineation and Impacts Assessment (The Watershed Company and KPFF, 2017), to mitigate the Project's potential, significant adverse environmental impacts to critical areas.
5. The applicant shall submit a Temporary erosion and sediment control plan with the Clearing and Grading Permit Application for review and approval with the Clearing and Grading Permit. The plan shall include mitigation, monitoring, and bonds as necessary to ensure the satisfactory performance of the conditions of approval.

The Phase 1 trail is well within a known Snoqualmie Tribe sacred site, Two Sisters Return. The project therefore does not meet Mitigation Measure 1 and is likely not to meet Mitigation Measure 2 either. See figure below. This important cultural resource was not included in the 2015 master planning process and the sacred nature of Snoqualmie Falls was not acknowledged in this planning process either (City of Snoqualmie, 2015). Master plans are the basis of modern development, and this omission is a fatal flaw in this process and remains unaddressed.

If Phase 1 of this project is constructed as planned, it will desecrate this sacred site, violate the Conservation Easement in place to protect the site, and fail to meet identified SEPA requirements. Therefore, we propose using existing pathways and sidewalks in the vicinity of Two Sisters Return, and not increasing human intrusions into the sensitive, protected areas. Fortunately, existing paths and sidewalks can accommodate foot traffic connection from the Falls to the City business district that the City desires, while protecting the sensitive sacred areas that the Tribe has identified. These existing paths and sidewalks could also be improved to afford a more pleasant experience. As planning for this sub-area continues in the future, positive progress can only be made through a collaborative, inclusive process that avoids the clear conflict pointed out here, by initiating early and frequent tribal community involvement.

Current State Of Hydrogeomorphic Processes

Hydrogeomorphic Process Questions

What is the current state of hydrogeomorphic processes in the project reach, and how do these processes affect water quality, water quantity, floodplain function, and in-stream aquatic habitat? How are the conditions and processes expected to change in a warming climate? What places, uses, and conditions within the Snoqualmie River corridor are most valued by the tribal community, and the larger local community?

The current state of river floodplain processes has been studied to answer a variety of scientific questions in and around the Planning Area. The resilient river corridor management planning project used this data and community engagement findings to develop a holistic understanding of river and floodplain hydrogeomorphic processes, and how this dynamic landscape is experienced and stewarded by people.

Overview of Methods

As mentioned in the Approach section of this report, the current state of hydrogeomorphic processes were characterized by reviewing an extensive body of previous work in the area, supplementing that review with field observations and assessment, and conducting additional desktop analyses to quantify effects of hydrogeomorphic processes on water quality, water quantity, floodplain function, and in-stream aquatic habitat. The synthesis of existing conditions presented below integrates relevant pieces of all this work.

Field Observations: Detailed field observations are documented in Appendix and include mapping revetments along the North Fork (NF) and main stem Snoqualmie River, characterization of channel morphology, visual assessment of grain size distributions and functional large wood in the channel, and rapid assessment of riparian forest health in five locations.

Data Sources: Previous work and data sources are summarized in Appendix, and include City planning documents, GIS datasets, geomorphology studies, historical conditions literature, climate change tools, hydrology data, a hydrologic model, well data, various water temperature and water quality studies, Washington Department of Fish and Wildlife (WDFW) fish enhancement plan, and others.

Desktop Analyses: Additional analyses, listed below and described in more detail in Appendix, characterized existing conditions to inform resilient corridor management plan development.

- Aerial photograph analysis to characterize change in channel morphology through time, including mapping of historical channel locations to evaluate channel migration patterns and potential changes in channel morphology and geometry.

- Relative elevation mapping based on high resolution (1 m) LiDAR digital elevation model (DEM) analyzed to identify current and relict floodplain features including channel forms and artificial constraints.
- Tree height mapping based on high resolution (1 m) LiDAR digital surface model (DSM), analyzing distributions of tree heights to estimate forest health, overwater shade presence/absence, and estimate of potential source of large logs as aquatic habitat and large wood recruitment potential in riparian area behind existing bank protection facilities.
- Hydraulic modeling to characterize inundation extents for a range of floods under current and future conditions, and to characterize conditions related to transport and deposition of sediment (detailed method below).
- Groundwater analysis to characterize the current and potential volume of shallow alluvial groundwater that contributes to baseflow and to characterize subsurface hydraulic gradients through the project reach.

Results and Discussion

Existing Reach Hydrogeomorphic Conditions

Different hydrogeomorphic processes and legacy effects influence each of the four zones of the Planning Area, which include the Confluence reach, the Meadowbrook Slough reach, the City reach, and the Kimball Creek reach. Therefore, both the existing conditions and the associated long-term plan elements vary from location to location.

The Confluence reach extends from the confluence of the North Fork (NF) and Middle (MF) Fork Snoqualmie to the Meadowbrook Slough.

- The channel is over-widened in this reach as the result of a highly depositional sediment regime and a lack of robust riparian forest to slow channel widening and create hard points in the fluvial system where forested islands can develop.
- Groundwater gradients inferred from summer water surface elevations indicate primarily down valley flow with some flow into the channels from the floodplain (i.e., streamflow is gaining from groundwater).
- Stream temperature is elevated, with the MF contributing 50-60 % of mainstem Snoqualmie flow with temperatures elevated 2-4 deg C above flows from the NF and SF, and mainstem temperatures at the downstream end of the project reach.
- The riverbank revetments in this reach are primarily along the right bank protecting the road and near the bridge along the NF Snoqualmie River. The road is built along the toe of the hillslope, into which the river would not typically have widened, and we surmise that the armoring is in place as a preventative measure to protect the road from erosion.

The Meadowbrook Slough Reach extends from RM 42.5 to 44, with the abandoned oxbow pond that encircles Meadowbrook Slough as a prominent feature in the left bank floodplain.

- An off-channel wetland is present on the right bank floodplain.
- The river is constrained in this reach with 37% of banks hardened.

- An elevated rails-to-trails trail, called Snoqualmie Valley Trail, bisects Meadowbrook Slough, and crosses the river via an old railroad trestle that ends in a set of stairs.
- Floodplain features indicate that this reach was historically much more dynamic than it is currently. The channel widening that has occurred over a small portion of the reach also supports this historical pattern.
- Riparian forest and shading are sparse on the south side of the channel in this reach, with the slough almost entirely unforested.

The City Reach extends from downstream of Meadowbrook Slough to the Falls.

- The mainstem upper Snoqualmie River is locked into place because of hardened banks, constraining the river in between this infrastructure.
- As a result of this channelization, the river is vertically disconnected from its floodplain due to its relative depth.
- Gravels are uncommon in this reach because sediment transport dynamics in this reach suggest most coarse-grained river sediment is deposited in upstream reaches, channel migration rates capable of recruiting local sediment sources are low due to the almost continuous extent of left bank protection and low gradient, and the river is only capable of transporting sediments that include small gravels and sand (<16mm diameter) during 1-year flows in this reach. There is an indication that gravels are coarsening towards the downstream end of the reach near the Falls, which is sourced from bank sources downstream of Sandy Cove park and is due to channel and slope adjustments from engineered widening and weir lowering.
- The City Reach is strongly gaining, with groundwater gradients pointed across the valley toward the river and resulting lower stream temperatures from the addition of colder groundwater despite extensive clearing of the south bank riparian forest. August stream temperature is 2-3 deg C lower in the City Reach than temperature in the MF Snoqualmie and 0.5-1 deg C lower than the temperature in the main stem Snoqualmie at the confluence of the SF Snoqualmie.

The Kimball Creek Reach includes Kimball Creek and the surrounding floodplain wetlands and waterbodies which drain an 8.7-mile area in the Snoqualmie River watershed.

- Kimball Creek flows through three different land use zones, including low gradient, flat, agricultural wetlands at the downstream end (i.e., west), intermediate gradient, slightly steeper, urbanized areas throughout the City of Snoqualmie and surrounding area, and steeper gradient forested sections at the headwaters, much of which is owned by Department of Natural Resources, and King County Parks.
- The creek channel was dredged up until the 1960s by the now-defunct Kimball Creek Flood District, resulting in deep channel morphology in the urbanized section.
- Kimball Creek has impaired water quality with remarkably high summer temperatures (i.e., > 18-20 deg C), low dissolved oxygen, and signs of pollutants from roadways and the upstream Casino detention pond.
- Beaver dams are present in the Kimball Creek watershed. Although portions of ponded areas have been observed to be seasonally associated with low dissolved oxygen and elevated water temperatures, fish

use has been observed near and upstream of the complexes, and beaver complexes are generally considered beneficial to aquatic and floodplain habitat in the Pacific Northwest (Baerwalde, 2011).

These reaches are used in the report sections below as a categorical framework to describe existing hydrogeomorphic conditions and processes in more detail.

Streamflow

Streamflow was analyzed at the Planning Area scale, rather than reach scale. It is influenced by seasonal snowpack and precipitation from the NF, MF and South Fork (SF) Snoqualmie Rivers, as well as groundwater. Streamflow is monitored at a USGS gage just upstream of Snoqualmie Falls and USGS gages in each of the three forks (Table 1). The MF drains approximately 51% of the total contributing watershed and represents over half of mainstem flow. The South and North Forks each contribute 20-25% of mainstem flow, with the mainstem Snoqualmie gaining flow from groundwater contributions and tributary inflows (e.g., Brockway, Kimball Creeks) from the confluence of the NF, MF, and SF to the Falls.

Table 1. Current streamflow gages for the upper Snoqualmie River Planning Area

Location	USGS Gage Number	Gage Name	DA (sq mi)	Start of Record	End of Record
North Fork Snoqualmie	12142000	North Fork Snoqualmie near Snoqualmie Falls, WA	64	1987	2020
Middle Fork Snoqualmie	12141300	Middle Fork Snoqualmie River near Tanner, WA	154	1961	2020
South Fork Snoqualmie	12144000	South Fork Snoqualmie River near North Bend, WA	81.7	1907	2020
Mainstem Snoqualmie	12144500	Snoqualmie River near Snoqualmie, WA	375	1900	2020

The water year (i.e., Oct 1 – Sep 30) in all three forks begins with low flows. Flows increase with fall and winter rain and rain-on-snow events. Flows recede in the beginning of spring as a larger portion of precipitation is stored as snow; however, a second period of high flow occurs in late spring and early summer associated with snowmelt runoff (Figure 7). Flows then recede through the summer as snowpack and precipitation diminish (Figure 7).

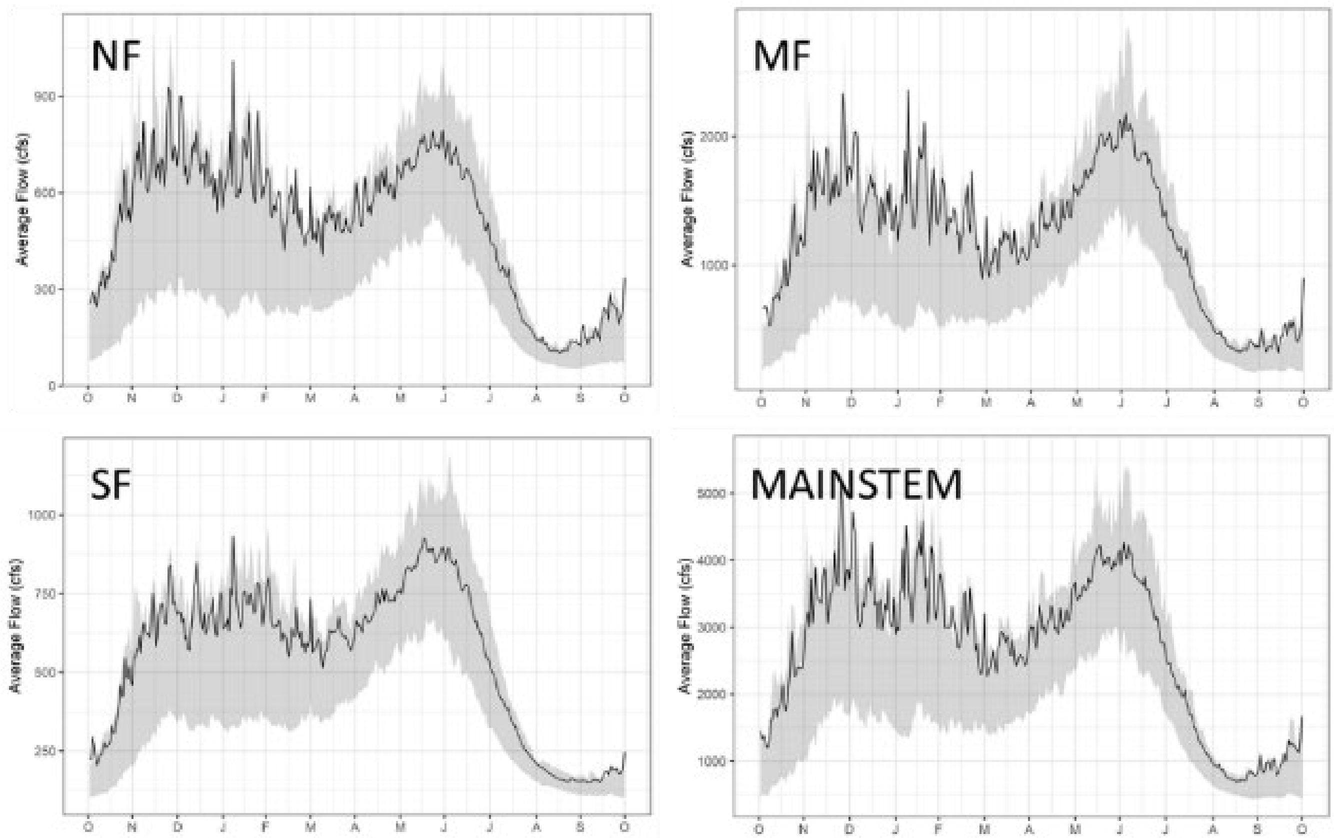


Figure 7. Average discharge for the North, Middle, South, and mainstem Snoqualmie River gages (black lines). Banded area indicates 90th percentile range. Note the y-axes are different for each graph.

Average and median flows in the MF Snoqualmie River are twice those in the North and South Forks of the Snoqualmie River and flows in the mainstem are 20-25% percent greater than the sum of the three forks (Table 2). Streamflow in the upper Snoqualmie River is typically lowest in August when snowpack has disappeared in much of the watershed and rainfall is limited. Summer low flows (i.e., as estimated by the 90% flow exceedance probabilities for daily streamflow, which range from 86 to 253 cubic feet per second (cfs) in the three forks and is approximately 580 cfs in the mainstem Snoqualmie River (Table 2). Low flow in the mainstem is 18% higher than the sum of the three forks, indicating significant groundwater contributions to low summer flow.

Table 2. Streamflow statistics for USGS gage sites

Location	Average Flow Cubic Feet Per Second (cfs)	Median Flow (cfs)	90% Exceedance Summer Low-Flow (cfs)	Contribution (%) To Main Stem Snoqualmie River Low Flow
North Fork Snoqualmie River	509	358	86	15 %
Middle Fork Snoqualmie River	1243	874	253	44 %
South Fork Snoqualmie River	548	429	135	23 %
Mainstem Snoqualmie River	2710	2070	580	

Projected Effects of Climate Change on Streamflow

Snowmelt runoff is a crucial driver of both streamflow volume and stream thermal regimes in the upper Snoqualmie River. Modeling studies in the vicinity of the Planning Area suggest that November through February average streamflow is projected to increase by upwards of 50% by the 2080s due to a combination of more precipitation falling as rain and rain-on-snow and overall increases in winter precipitation (Figure 8, Mauger and Won, 2020). Conversely, May through August average streamflow is projected to decrease by up to 60% by the 2080s due to lower snowmelt runoff (Mauger and Won, 2020). Baerwalde et al. (2020) showed basin-wide increases in winter runoff and basin-wide reductions in summer streamflow (-60%) associated with reduced snowpack, with year-round increases in stream temperature (Figure 9). Combined runoff-temperature models indicate that snowmelt can reduce summer 7-day average of daily maximum temperatures (7 DAD-max) stream temperatures by up to 5.8 ℃ in higher elevation tributaries such as the MF and by 0.5 ℃ at the Snoqualmie confluence with the Snohomish River (Figure 10, Baerwalde et al., 2020). Higher elevation basins where snowpack is a major contributor to overall streamflow and thermal regimes are most susceptible to snowpack losses, whereas lower elevation tributaries are projected to have the least change. This loss of snowmelt contribution to instream flow will further strain water resources in the Planning Area and downstream withdrawals for agriculture, industry, and instream requirements for fish species, while also impairing stream temperature.

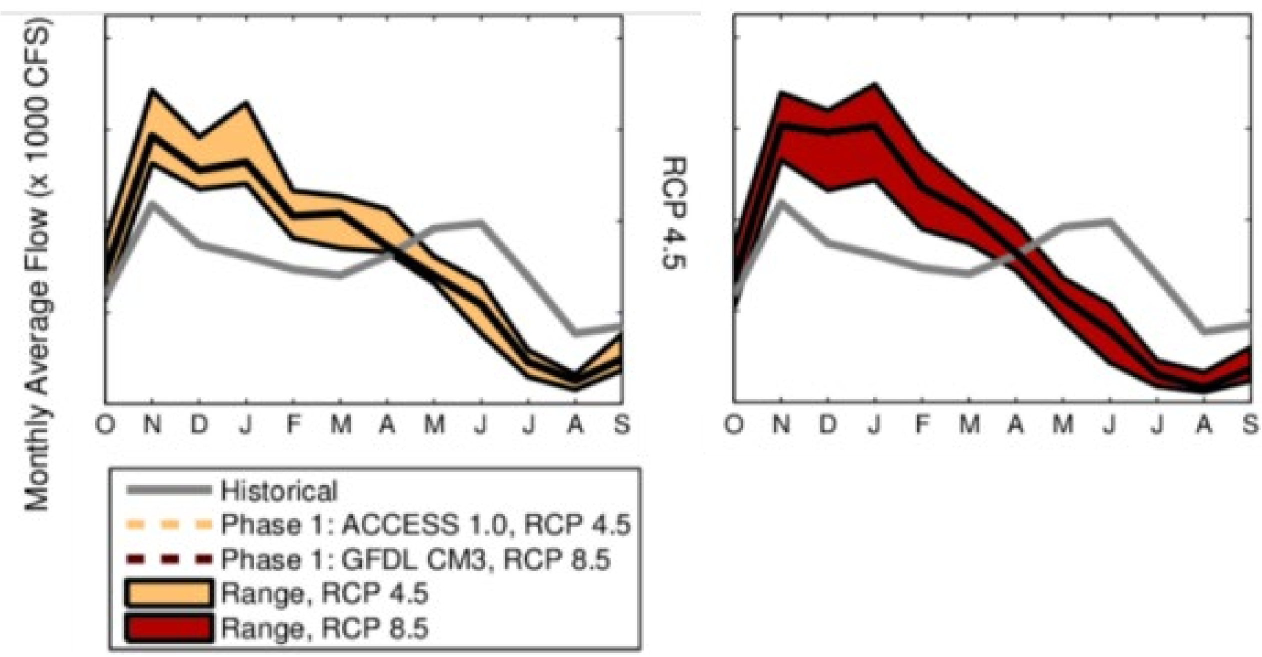


Figure 8. Average streamflow projections for the Snoqualmie River in the 2080s. Modified from Mauger and Won, 2020

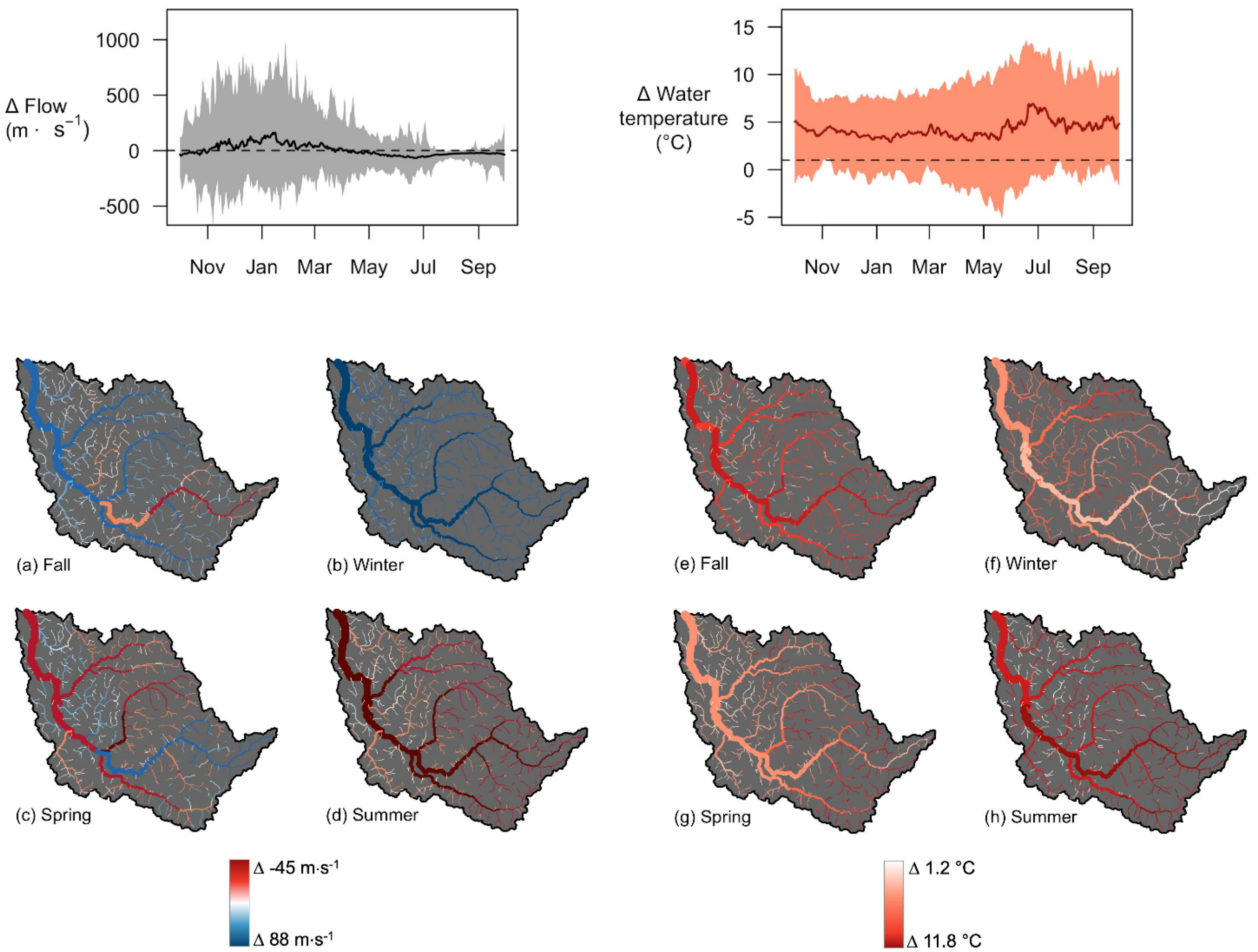


Figure 9. Changes in predicted flow and water temperature from climate change for 2089-2099 versus 1995-2005 from ten global climate models. Banded regions show 95th percentiles at Snoqualmie outlet. Maps display mean change by season. From Baerwalde et al., 2020.

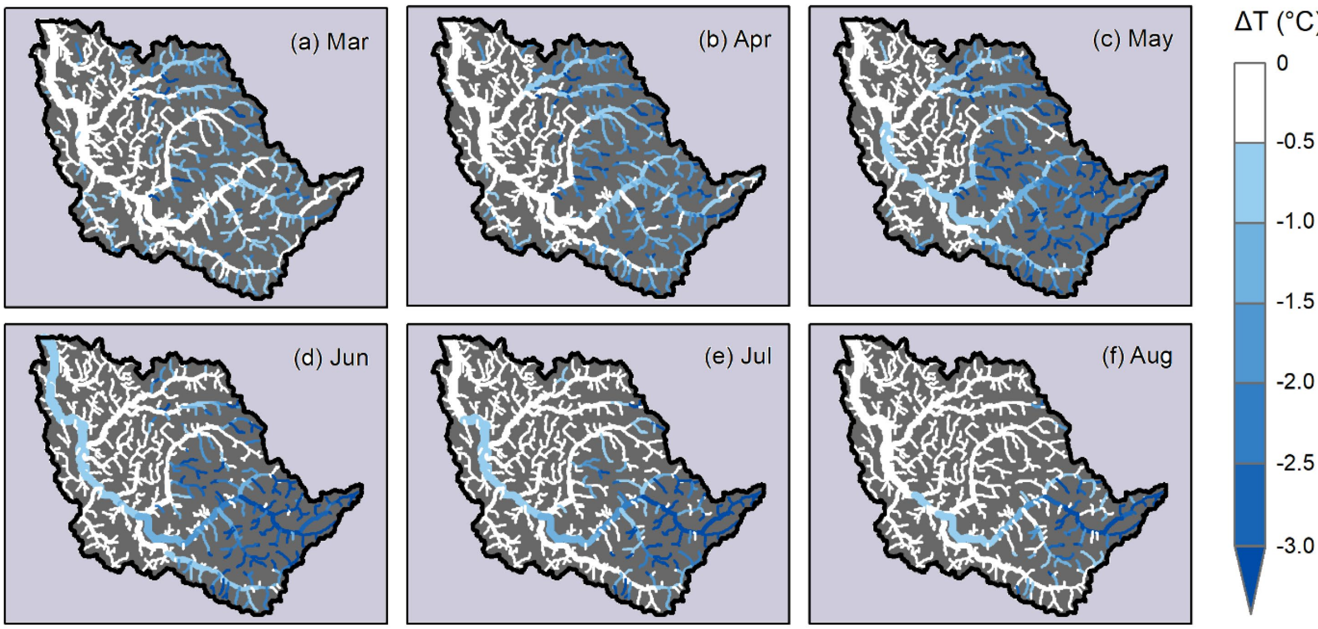


Figure 10. Change in stream temperature with snowmelt from climate change for 2089-2099 versus 1995-2005 from ten global climate models. Maps display mean change by season. From Baerwalde et al., 2020.

Flooding, Peak Flows, and Hydraulics

Flooding in the upper Snoqualmie River valley occurs primarily from late October through January due to heavy rain or rain-on-snow events. Flood recurrence intervals, or peak flows, were estimated for each of the upper Snoqualmie River forks and the upper Snoqualmie River mainstem using a Log Pearson Type III curve and following guidelines in USGS Bulletin #17B (USGS, 1982) and updated with skew and error coefficients from (Mastin et al. 2016). Peak flow estimates for the Snoqualmie River and its forks are provided in Table 3. Peak flows in the NF are disproportional to drainage area, with the 1.01-year flow in the NF 80% higher than the SF, despite a smaller drainage area. This is due to higher precipitation rates and a higher frequency of rain-on-snow events in the NF basin, which sits at higher elevation than the SF.

Table 3. Planning Area peak flow estimates

Snoqualmie River Fork	1.01 yr. Flow (cfs)	2 yr. Flow (cfs)	5 yr. Flow (cfs)	10 yr. Flow (cfs)	100 yr. Flow (cfs)
North	2,650	7,550	10,600	12,560	18,370
Middle	5,390	16,780	23,190	26,990	37,020
South	1,480	5,280	7,910	9,670	15,100
Upper Mainstem Snoqualmie River	9,710	30,340	43,740	52,460	78,770

Peak flow estimates are based on the probability of a flood event occurring in any given year and provide context for the relative magnitude of flood events. For example, a 5-year flow (i.e., Q5) has a 20% chance of occurring in any given year and has an average recurrence interval of five years. However, it is important to note that a 5-year flow, for example, could occur more than once in a water year (e.g., fall 2015, Figure 11). Analysis of discharge data from 1988 – 2020 indicates that the 2-year flow was exceeded in most years in the North and

SF but occurred every 1.6 years in the mainstem. Similarly, 10-year peak flows were exceeded in subsequent years in the three forks, with only three 10-year flows occurring in the mainstem over the 32-year period. These data also highlight years with multiple large (≥ Q2) flood events in 1990, 1995, 2011, and 2015.

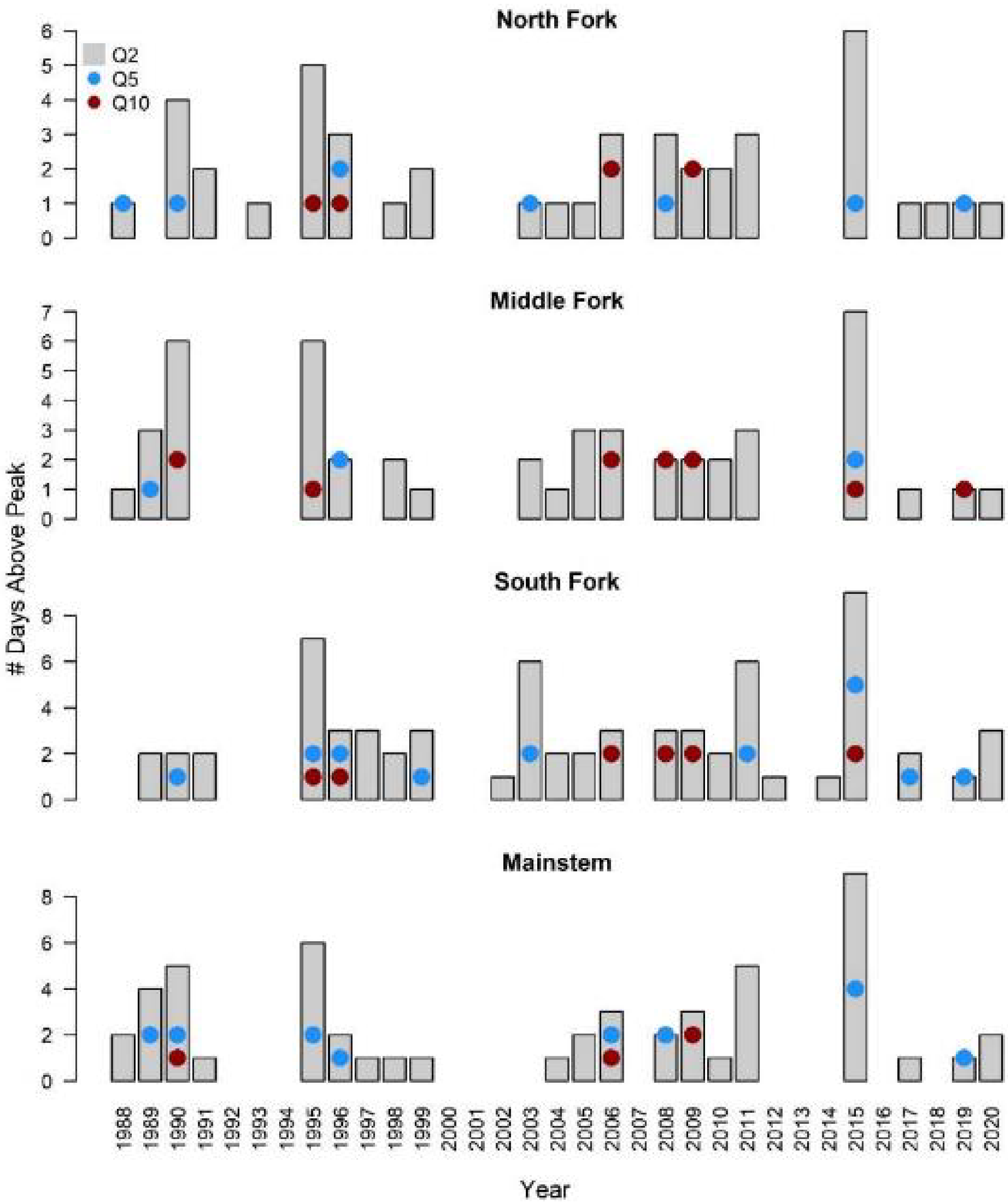


Figure 11. Peak flow frequency for the upper Snoqualmie River and its three forks based on analysis of USGS gage data (see Table 4). Grey bars show the number of days with maximum discharge greater than the 2-year peak flow. Blue and red points show the number of days above the 5- and 10-year peak flows, respectively.

Peak flow timing is similar among the Three forks, with peak flow in the MF occurring 1-2 hours before the North and SF, and the mainstem peaking 12-14 hours after the MF (Figure 12). The rising limb of the flood hydrograph is coincidental in the MF and mainstem and in the North and SF. The falling limb of flood hydrographs in the NF and SF occurs several hours before the MF, which occurs 8 – 12 hours before the mainstem. This translates to longer peak flow events in the MF and mainstem below the forks, with shorter flood peaks in the NF and SF. This pattern is consistent with the relative drainage areas of the forks and mainstem above the gage sites (Table 1), with longer duration peak flows in larger basins.

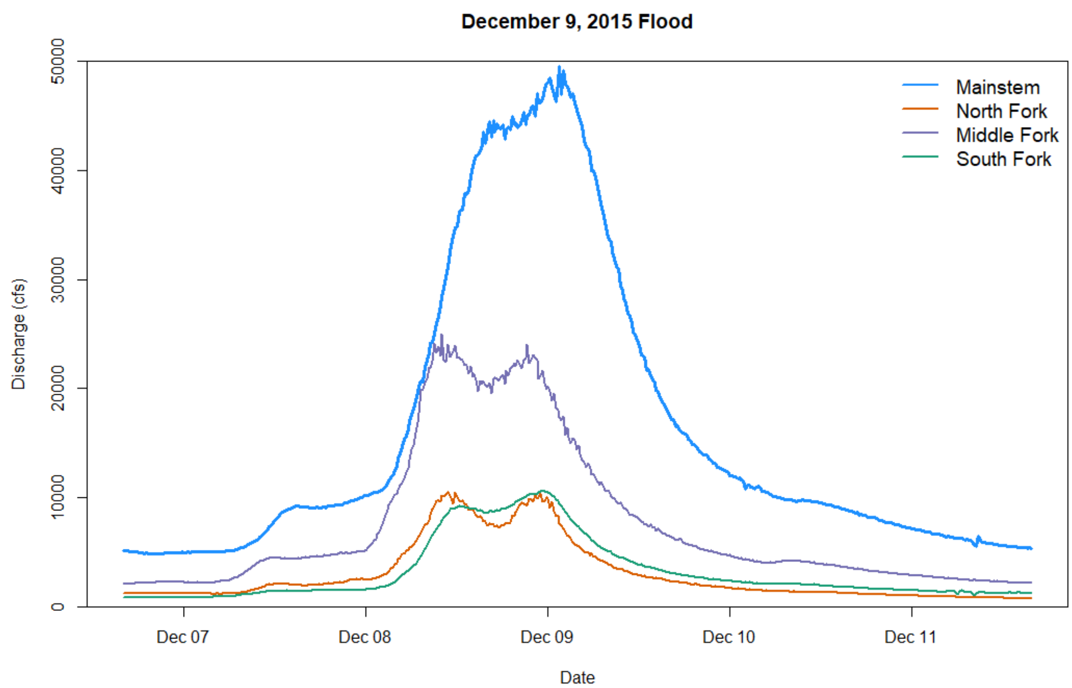


Figure 12. Example peak flow hydrograph for the forks and mainstem. Data are from USGS gages in Table 1.

Flood peak duration and timing is important to understand because the City is located within the Snoqualmie River floodplain and is subject to frequent flooding. Flooding in Snoqualmie is also exacerbated by the natural constriction at Snoqualmie Falls. Analysis by King County and the US Army Corps of Engineers (USACE) in the late 1990s showed that Snoqualmie experiences flooding when discharge exceeds 30,000 cfs (King County Water and Land Resources Division (KCWLRD), 2002). This flow has been exceeded in more than half (32/60) of the water years in the peak flow record for the mainstem Snoqualmie since 1958.

The flood of record in the Snoqualmie (November 24, 1990) inundated more than two thirds of Snoqualmie homes and businesses (King County Water and Land Resources Division (KCWLRD), 2002; Figure 13). This event and repeated flood damages in the City of Snoqualmie led to the Snoqualmie Flood Reduction Project (or Project 205), which was constructed in 2004-2005. The project removed portions of the left and right banks upstream of the Falls and an abandoned railroad bridge 0.8 miles upstream (Figure 14). Widening this area of the Snoqualmie mainstem was intended to reduce the 100-year WSE in the City of Snoqualmie by up to 1.0 ft. The City of Snoqualmie and FEMA also elevated buildings to reduce flood damages following flooding in 1996-1997. FEMA estimated avoided losses of $1.6M during the November 2006 flood for 28 homes elevated through this effort (Federal Emergency Management Agency, 2021). Major flooding occurred most recently in Snoqualmie in January 2009 (Figure 15), which was a 20-year flood event (60,700 cfs at mainstem Snoqualmie gage).

Figure 13. Image of flood of record in Snoqualmie, November 24, 1990 (King County Water and Land Resources Division (KCWLRD), 2002).

Figure 14. Right bank excavation for the Snoqualmie Flood Reduction Project, upstream of Snoqualmie Falls (King County Water and Land Resources Division (KCWLRD), 2002).

Figure 15. Flooding in January 2009 in the City of Snoqualmie (“Northwest Railway Museum Blog: Turning the floods and fires of 2009 into good things,” n.d.).

Geomorphology and Floodplain Connectivity

Patterns of historical and recent channel migration are present on the landscape throughout the Planning Area (Figure 16). Relict channels, oxbows, sloughs, and swales predominate both the undeveloped and developed portions of the valley bottom and indicate that the Snoqualmie river and its forks were likely very dynamic in the pre-European contact world, e.g. (Bethel, 2004). Coarse sediment deposition in the Three-Forks confluence area and the backwatering influence of Snoqualmie Falls have caused the river to actively migrate across its floodplain, creating and re-creating new channels and allowing older channels to develop into floodplain waterbodies such as oxbows. This created a high diversity of aquatic habitats and floodplain landforms which were able to store floodwaters, slowly releasing the cool water throughout the summer dry period. The building of roads, revetments, and levees to protect residences, buildings, farms, and infrastructure have limited channel migration throughout much of the Planning Area. However, these efforts did not encompass the entirety of the Planning Area. Several locations within the Planning Area, such as the Three Forks confluence area, still maintain a degree of active channel migration.

Community Hopes for the Future Geomorphic Character

- *Protect the character and integrity of the river.*
- *Setback levees and reconnect floodplains, restore riparian areas, reconnect side-channels, protect critical areas.*
- *When thinking of permissible activities, the terms 'river' and 'floodplain' should be interchangeable.*
- *Natural channel migration.*
- *Work/lobby towards culvert replacement to re-establish fish run in our creek.*
- *No dams.*
- *The south fork continues to migrate.*
- *Future management is critical.*

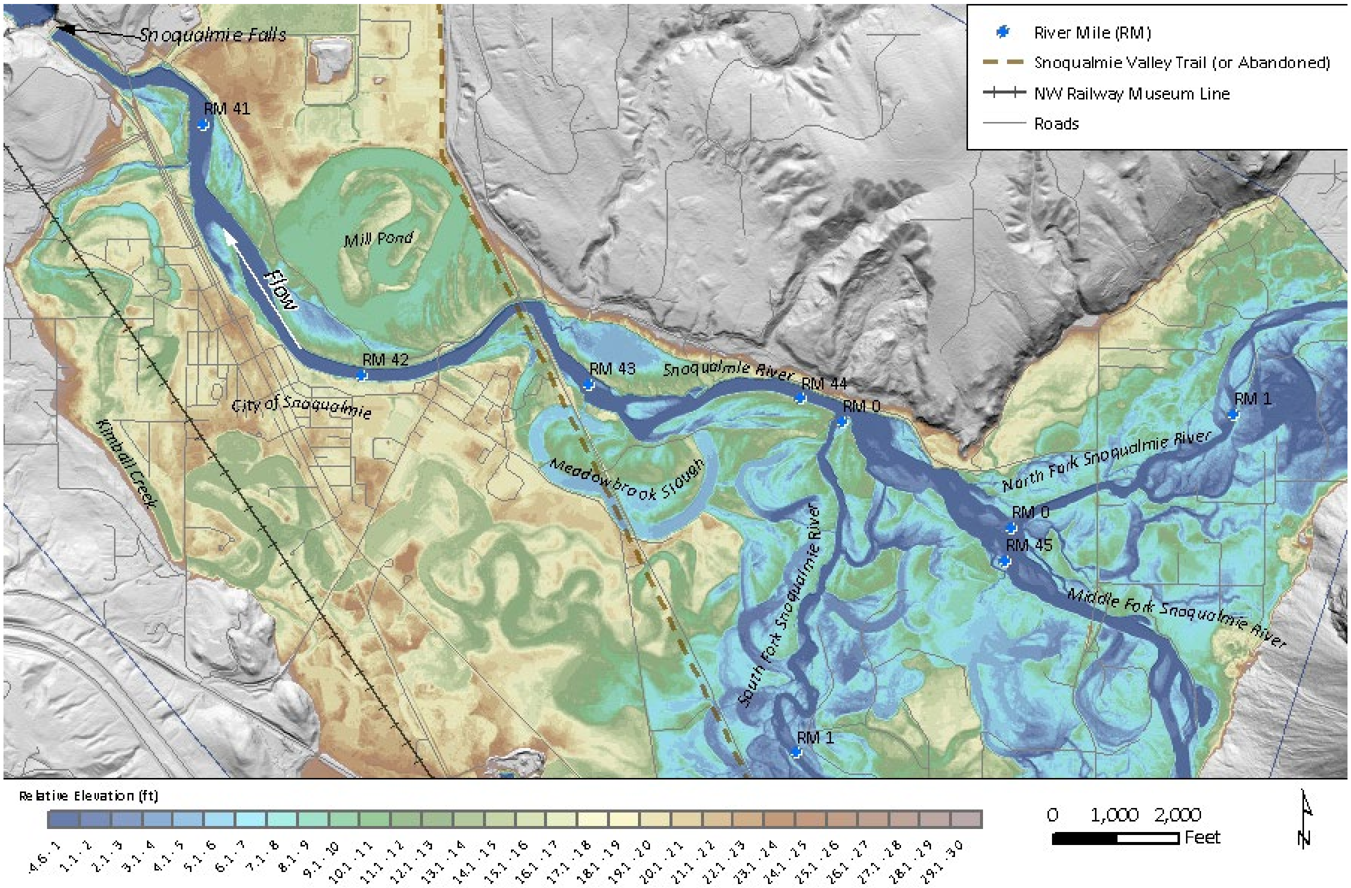


Figure 16. Floodplain elevations relative to the LiDAR water surface are shown, with low-lying areas in blue and higher ground in yellow and brown.

Channel Migration Zones (CMZ) are mapped floodplain areas where a river channel naturally moves over time and are key areas to include in a Resilient River Corridor Management Plan because they represent the highest diversity of aquatic habitats and the riskiest places for infrastructure and development. King County's 1996 CMZ analysis included two different iterations of the CMZ. The first was mapped as the "Unconstrained Migration Hazard" zone which encompassed almost the entirety of the valley bottom through the Planning Area and the second which subdivided that area into "Severe Hazard Areas," "Moderate Hazard Areas," and "Potential Hazard Areas", excluding areas which were likely to be protected from future bank erosion behind roads, levees, and revetments, or developed areas. These excluded areas were assumed to be protected should an erosion threat occur and were called "Mitigated Hazard Zones." Preservation of the built environment within these Mitigated Hazard Zones, by continued maintenance of existing revetments and creation of new revetments by both the City of Snoqualmie and King County, is ongoing and will need to be continued to mitigate erosion hazards in those areas. Most of the Planning Area is in the mapped CMZ (Figure 17). The mitigated hazard zones were not included in the current King County published CMZ maps but are mapped in this study to demonstrate that most areas of the Planning Area are susceptible to erosion, even if they are not mapped in the published CMZ.

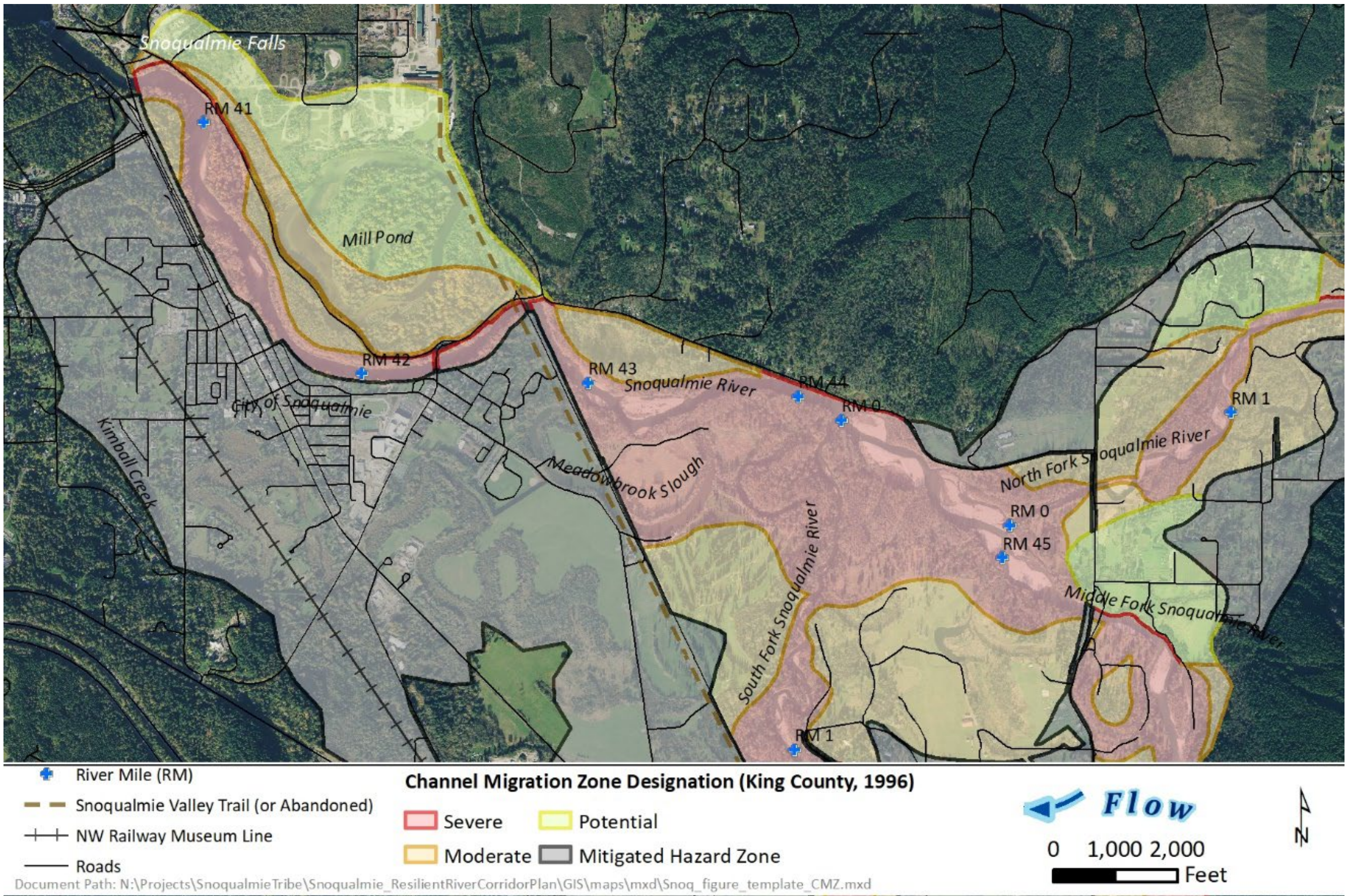


Figure 17. King County mapped the Channel Migration Zone (CMZ) of the Planning Area in 1996 using historical aerial photographs and maps from 1865-1995 (King County Department of Natural Resources Surface Water Management Division River Management Section, 1996).

While the river has freely migrated within portions of the CMZ during recent history, as evidenced by changes to river and floodplain morphology in aerial imagery, analysis of a recent aerial imagery time-series indicated that the river has not migrated outside of the mapped CMZ since the 1996 study. This lack of channel migration is due to the significant degree of bank armoring and other engineered river management measures such as mechanical channel widening and dredging.

Between 1942 and 2019 the active channel corridor of the river between the NF and SF confluences almost doubled in width from 150 feet to 280 feet (Figure 18; Table 5). During this period, the river morphology changed from single thread meandering channel in 1942 to a braided channel in 2019, reducing overall channel length and sinuosity and slowing water velocities. Since the north side, or right bank, of the river is heavily armored adjacent to SE Reinig Rd, the widening has occurred primarily along the south side, or left bank, of the river where it has eroded into early seral forest land. The resulting over widened corridor and lack of stable in-channel wood is contributing to the unstable braided morphology which is degrading aquatic habitat and preventing the

Community River Corridor Observations:

- *North Bend isn't meeting the water mitigation in the summers.*
- *Many days spent kayaking, rafting, and camping.*
- *Scenic car rides with family.*
- *Trout fishing is fun.*

recruitment of riparian vegetation. Furthermore, the prevalence of the unshaded bare mineral substrate is likely contributing to increases in water temperatures downstream (Dugdale et al., 2018; Garner et al., 2017).

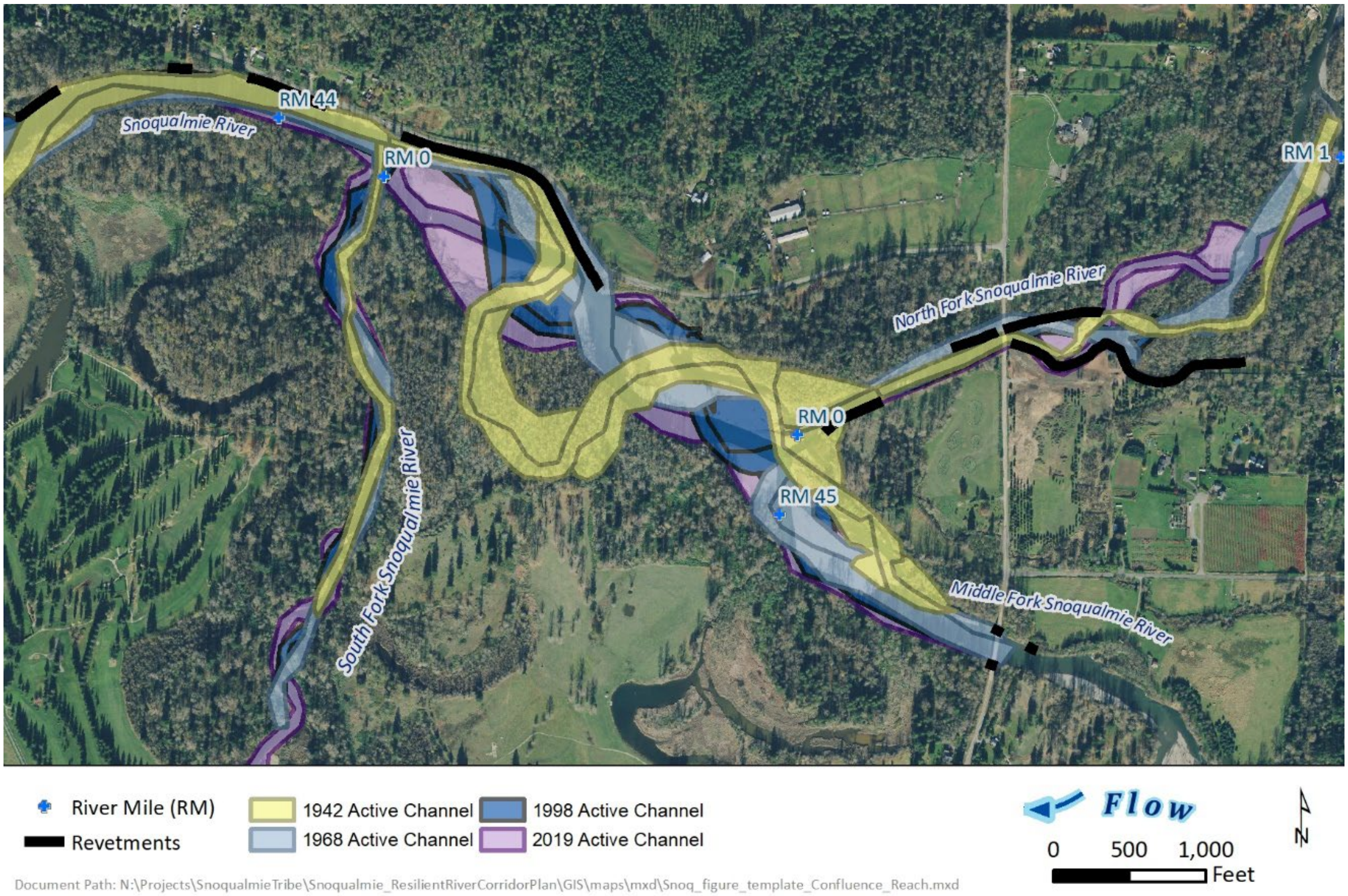


Figure 18. Channel migration history for the Three-Forks confluence reach. The active channel corridor was digitized from available aerial imagery from 1942 - 2019. The background image is 2019 NAIP.

Table 5. Historical aerial imagery measurements of the active channel corridor from 1942 - 2019 for the Planning Area between the North Fork and South Fork Snoqualmie River confluences.

Year	Active Corridor Area (sq ft)	Channel Length (ft)	Average Width (Corridor Area / Channel length; ft)
1942	1,708,000	11,150	153
1968	1,573,000	9,000	175
1998	1,669,000	8,500	196
2019	2,304,000	8,300	278

Widening of the active channel corridor has also occurred in the Meadowbrook Slough reach, between the SF Snoqualmie River Confluence and the Snoqualmie Valley Trail bridge, but to a lesser degree than the Confluence reach. However, the consequences for aquatic habitat, water temperature, and riparian vegetation are the same (Figure 19; Table 6). In this location, widening has occurred between a groin on the right bank and the left bank Pratt Revetment, adjacent to Meadowbrook Slough.

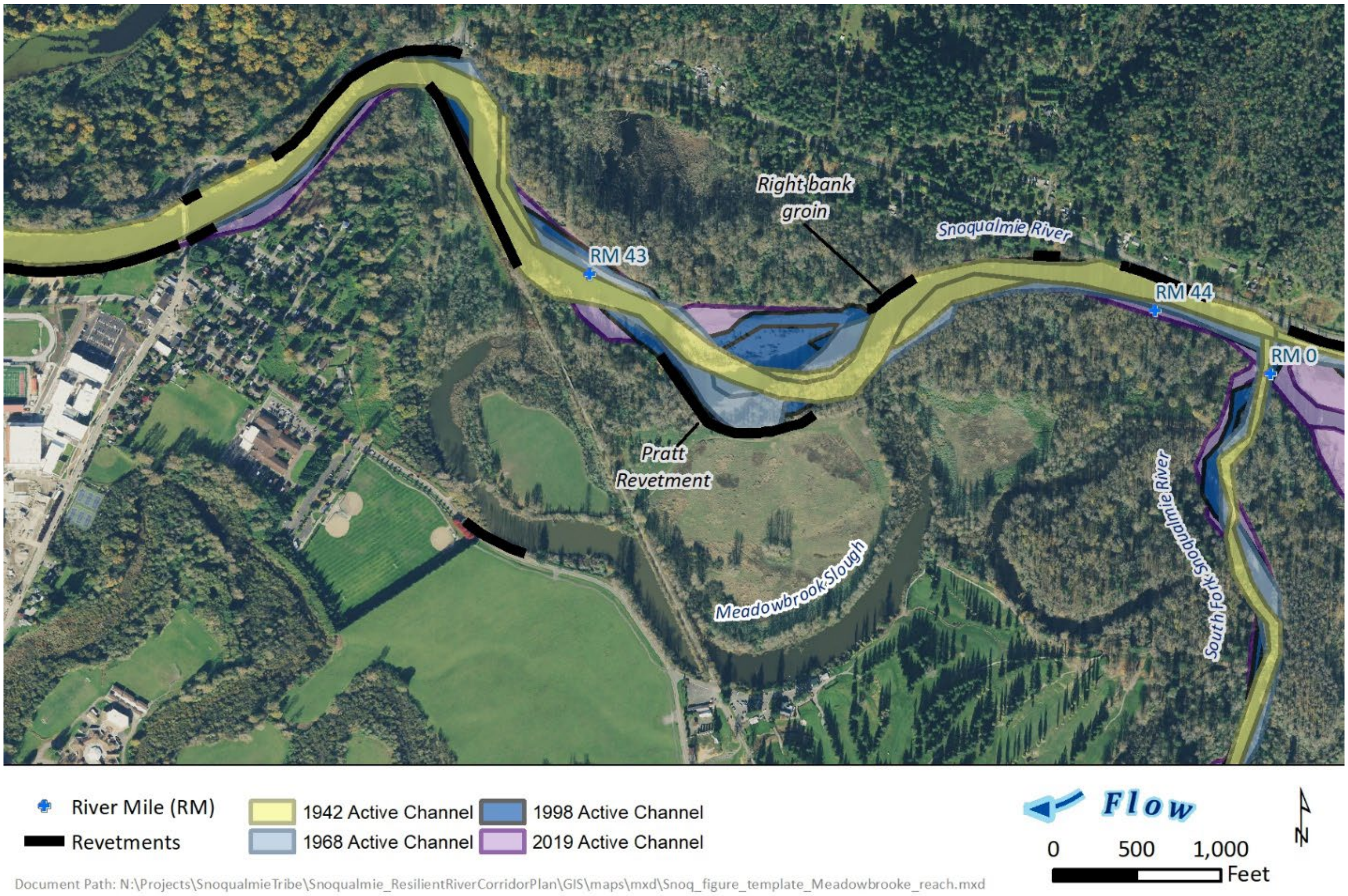


Figure 19. Active channel migration history for the Meadowbrook Slough reach, digitized from available aerial imagery from 1942 - 2019. The background image is the 2019 NAIP.

Table 6. Measurements of the active channel corridor for the Meadowbrook Slough reach, using historical aerial imagery from 1942-2019.

Year	Active Corridor Area (sq ft)	Channel Length (ft)	Average Width (Corridor Area / Channel length; ft)
1942	1,965,000	7,700	255
1968	2,144,000	7,600	282
1998	2,667,000	7,200	370
2019	2,672,000	7,200	371

Community River Corridor Observations:

- *Leave the land alone for off leash dog walking area.*
- *Great river run to run along.*
- *Fishing hasn't been productive over the last few years.*

In the City reach, the river has remained stable since 1942 between the Snoqualmie Valley Trail bridge and Snoqualmie Falls, likely due to the extensive bank protection on the outside of the meander bend next to the city (Figure 20). One of the exceptions is along the left bank near Sandy Cove park which has eroded ~90 ft into bank since 1998. Most of this erosion has occurred since the dam at Snoqualmie Falls was lowered by 2-feet (Edward McCarthy, PhD, 2016). The city is currently planning on building groins at the upstream end of the park to limit the erosion and encourage fine sediment deposition adjacent to the park for public use (Farabee and Johnson, 2014). The river also migrated away from the road directly downstream from the park since 1942 and has formed a forested floodplain in the former channel area. The lack of channel migration due to the presence of channel protection has caused the river to become both vertically and laterally constrained from its surrounding floodplain by concentrating flood flows and stream power within the existing active channel and not allowing the formation of new, well-connected floodplain surfaces.

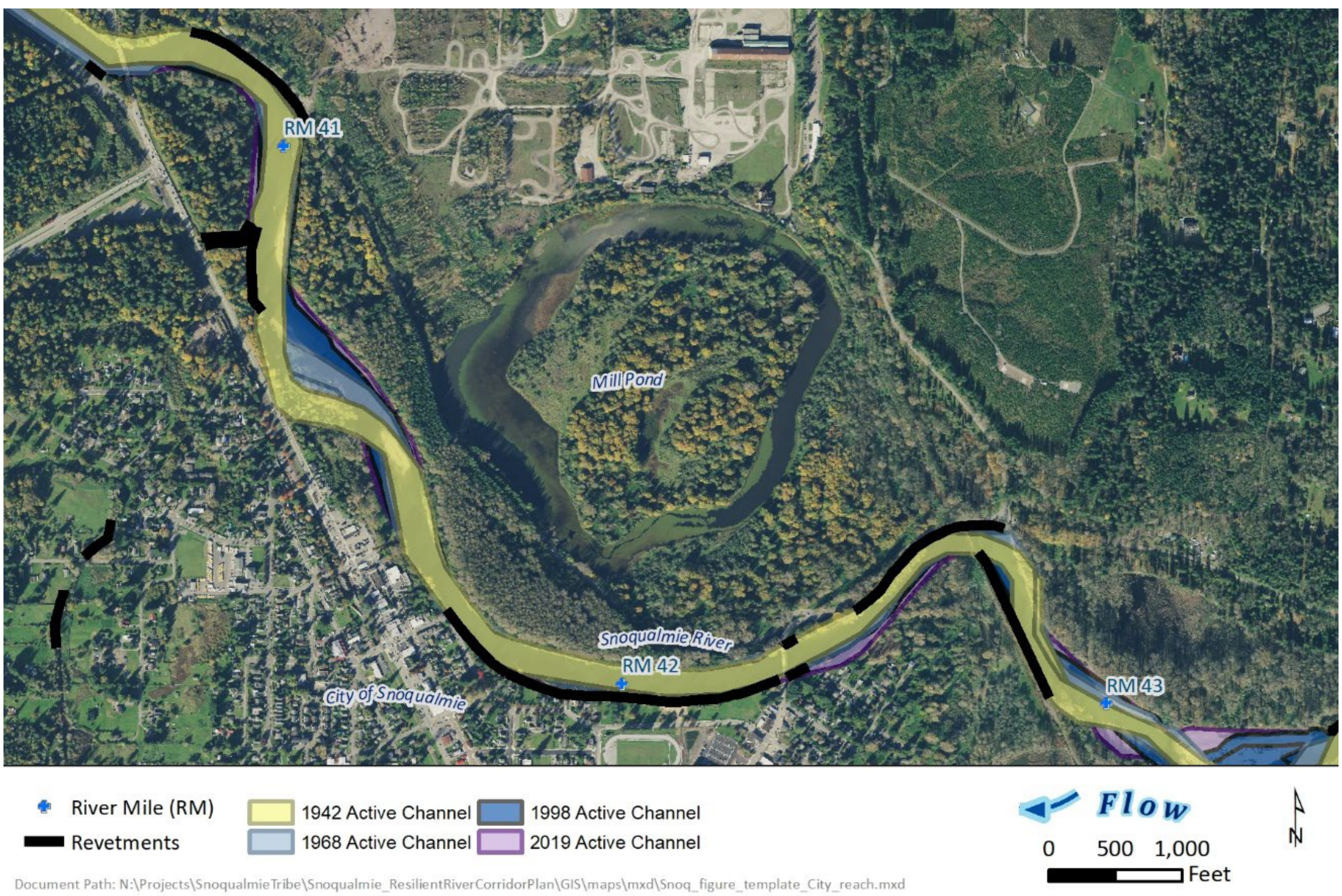


Figure 20. Channel migration history for 1942-2019 in the Planning Area reach through the City of Snoqualmie. The active channel corridor was digitized from available aerial imagery. The background image is the 2019 NAIP.

Sediment Dynamics

To contextualize the ability for future restoration actions to influence geomorphic conditions in the project area, we evaluated the existing sediment transport dynamics by identifying specific areas of deposition and erosion and estimating the size of material that can be transported by the river. In general, the Planning Area acts as a depositional zone for coarse sediments because of the geomorphic conditions created by the confluences with the three forks and backwater created by Snoqualmie Falls (Bethel, 2004). It is one of the first lower-gradient portions of the river after it descends from the steeper headwaters and the abrupt decrease in slope reduces sediment transport capacity, which is the force at which the river transports sediment. This causes coarser material from the steeper headwaters to deposit within the Planning Area.

Community River Corridor Observations:

- *Anytime "outside" growth takes place there is a disruption in traditional access to areas that the Snoqualmie People used to go to gather medicinal plants/food/hunt.*
- *Major access blockage is/was the hydro plant.*
- *We are used to seasonal changes and flooding.*
- *Love the river, do not fear flooding.*

In the late-1960s, the MF Snoqualmie River was predicted to be the largest contributor of sediment to the Planning Area, with an estimated total load of 200,000 tons of suspended sediment. The SF Snoqualmie River was estimated to have a higher load than the NF, 93,000 tons vs. 60,000 tons, respectively (Nelson, 1971).

Results from our more-recent sediment transport dynamic estimate that the area between the NF and SF Snoqualmie River confluences remains a depositional reach. Both the MF and NF were estimated to be capable of transporting coarse material into the Planning Area with grain sizes up to 180 mm in the MF and 50 mm in the NF, making them both a source of gravel and cobbles to the mainstem (Figure 21). This is shown in Figure 22 by the warmer colors (Reds and dark oranges) within both the North and Middle Forks. Once in the mainstem, this material is immediately deposited within the over-widened section of channel between the NF and SF confluences because the river does not have the energy capable of transporting this material further downstream during higher frequency floods (such as the 1-year flow). This is due to the decrease in slope and wide active channel corridor which decreases the concentration of sediment transport capacity within a given part of the channel. The change in sediment transport capacity is shown in Figure 22 as the transition from the warmer colors in the Middle and North Forks (Reds and dark oranges) to the cooler colors (Yellows and Greens) immediately below the North Fork confluence. This depositional tendency is evident in the broad sediment deposits and braided channel morphology that characterize this section of the Planning Area and are represented as green colors in Figure 22. This material could act to increase the development of floodplain surfaces under future restoration scenarios.

Figure 21. Sediment deposit in the braided section of river near the North Fork Confluence. The grain size was visually estimated to range from coarse gravels (32 mm) to medium cobbles (128 mm). The photo was taken on 7/28/20 near RM 44.5 looking downstream.

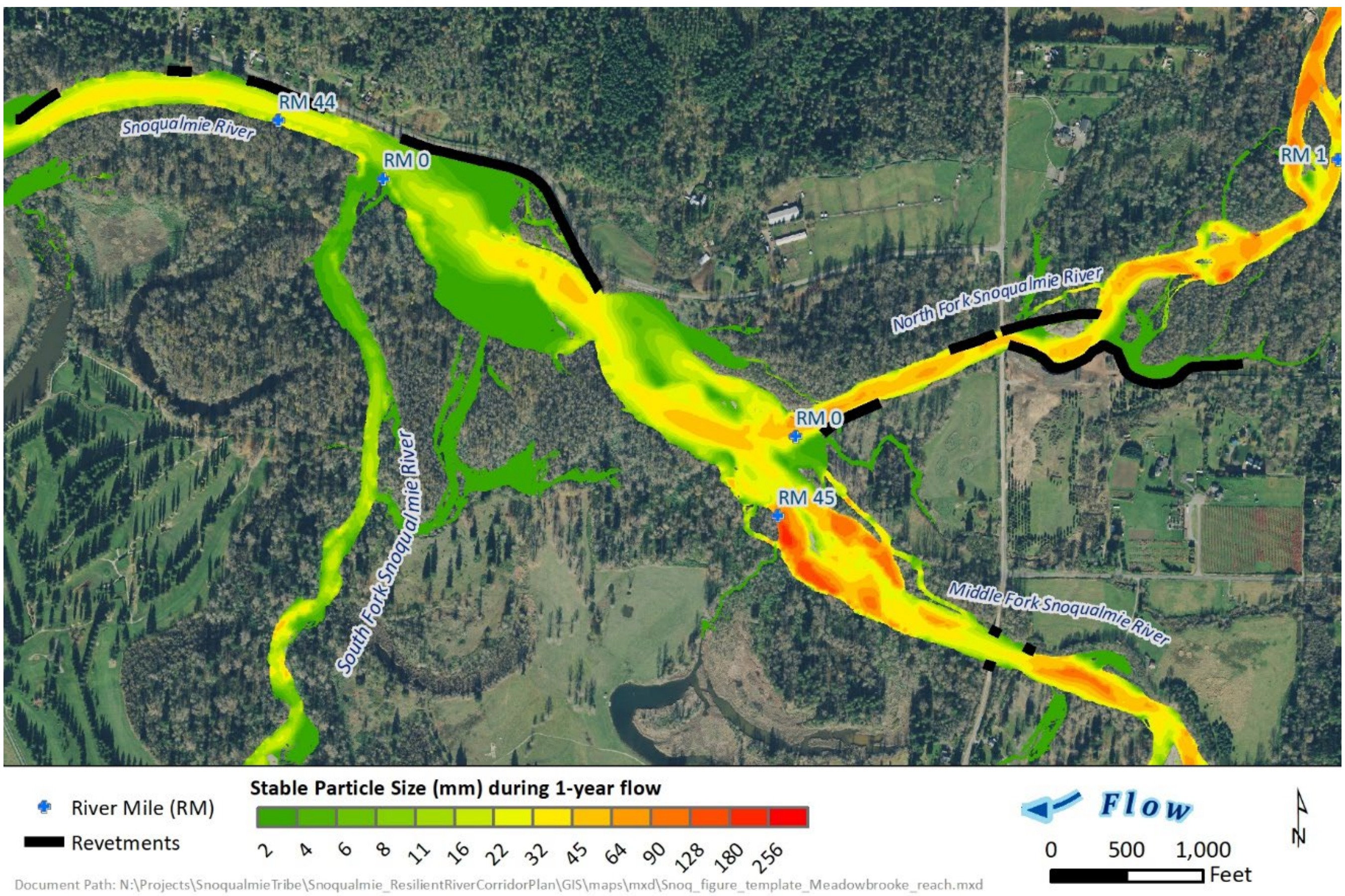


Figure 22. Estimates of the stable particle size for the Planning Area between the North and South Fork confluences. Stable particle size estimates were made using estimates of shear-stress for the 1-year recurrence interval flow from the 2-dimensional hydraulic model coupled with a Shield's stress incipient motion calculation.

Model results also predict that the SF Snoqualmie River is only capable of transporting finer material up to ~16mm to its confluence with the mainstem, which was confirmed by field observations of sediment deposits at this confluence during the field work (Figure 23). This indicates that the SF Snoqualmie River is likely not a major source of coarse sediment to the mainstem and is demonstrated on Figure 22 by the green colors which demonstrate that the South Fork does not have the energy capable of transporting gravels larger than 16mm during the 1-year flow. However, the increase in discharge from the SF, in addition to the narrower channel morphology within the mainstem downstream from the SF confluence, increases the transport capacity of the mainstem directly downstream where grain sizes up to 32mm are predicted to become entrained and transported. This causes the transport of the SF's sediment load which was confirmed by the lack of broad sediment deposits within the mainstem near its confluence.

Figure 23. Sediment deposit at the mouth of the South Fork Snoqualmie River. The grain size was visually estimated to be comprised of small-medium gravels (8-16mm) and was smaller than the coarse sediment deposits in the braided reach directly upstream. This deposit is indicative of the sediment load of the South Fork Snoqualmie River that is transported into the main stem. The photo was taken on 7/28/20 near RM 44 looking towards the South Fork confluence.

The area between the SF confluence and the Snoqualmie Valley Trail bridge is also a depositional area for coarse material because of the low slope and wide active channel corridor (Figure 24). Material up to ~32mm is predicted to be transported directly downstream of the SF confluence and into the widened channel section between the right bank groin and the left bank Pratt revetment. As the channel corridor widens, the flow is spread out over a wider area and the energy for sediment transport decreases, causing deposition of coarse material. This area acts as the last major depositional area before Snoqualmie Falls as the transport capacity decreases directly downstream and is predicted to be capable of transporting material up to 16mm. The change in transport capacity at this location corresponds to a decrease in slope just before the Snoqualmie Valley Trail bridge and is confirmed by observations of bed material change from the field, which noted a decrease in grain size in the downstream direction.

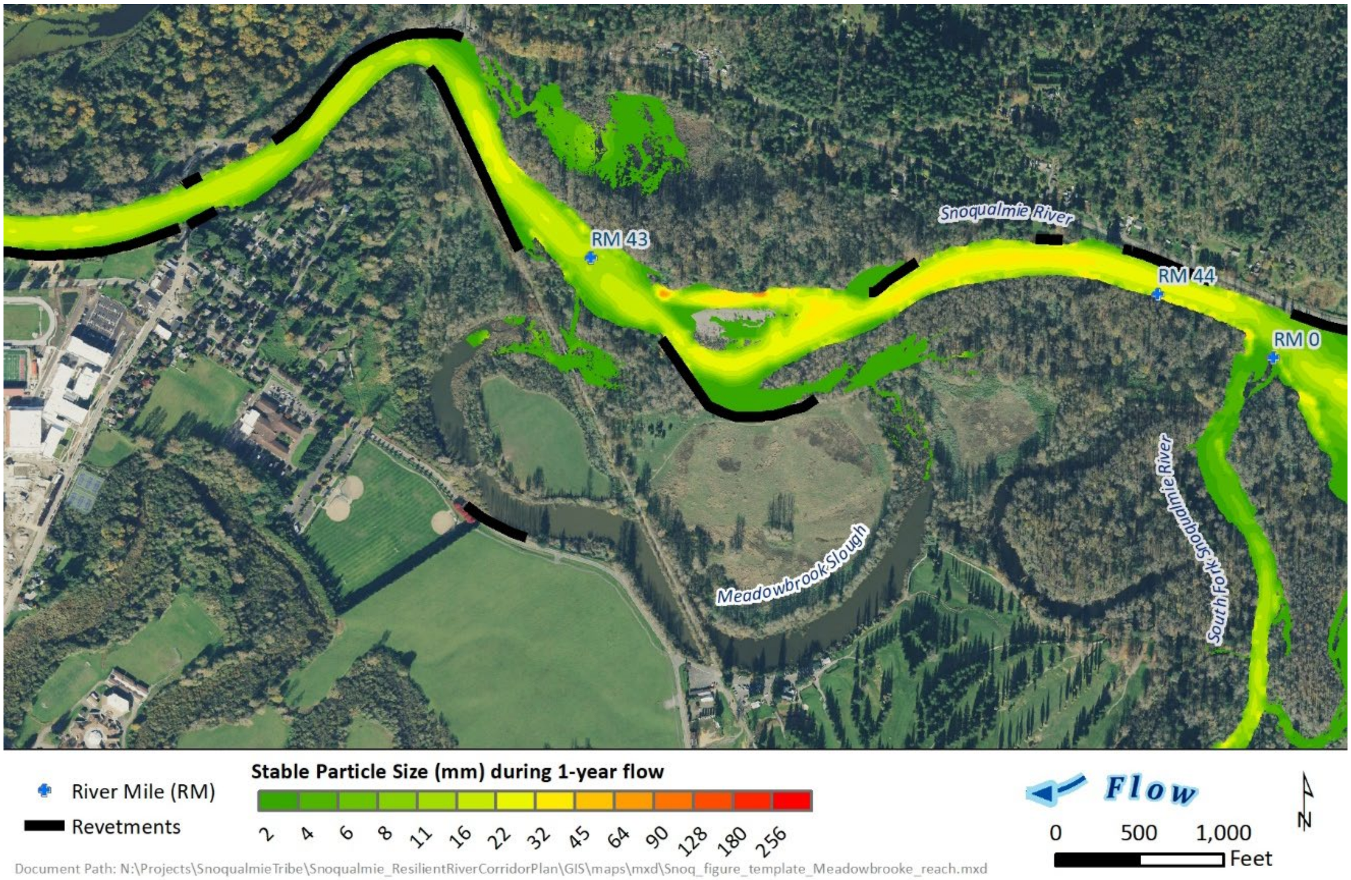


Figure 24. Estimates of the stable particle size for the Planning Area between the South Fork confluence and the Snoqualmie Valley Trail Bridge. Stable particle size estimates were made using estimates of shear-stress for the 1-year recurrence interval flow from the 2-dimensional hydraulic model coupled with a Shield's stress incipient motion calculation.

The sediment transport capacity remains low through the reach adjacent to the City of Snoqualmie where grain sizes up to 16mm are predicted to be transported through the reach to the Falls (Figure 25). Because coarser material is unable to be transported to this section of the Planning Area from upstream sources due to the drop in transport capacity above the Snoqualmie Valley Trail bridge, this reach was characterized as a transport reach for small gravels which were not deposited in the reaches further upstream. This finding is supported by the low amount of gravel deposits present through this portion of the reach. While there are some small areas of gravel deposition such as the mid-channel gravel bar downstream of Sandy Cove Park, we estimate that this material was primarily derived from local bank sources entrained during erosion of the left bank and is not from upstream.

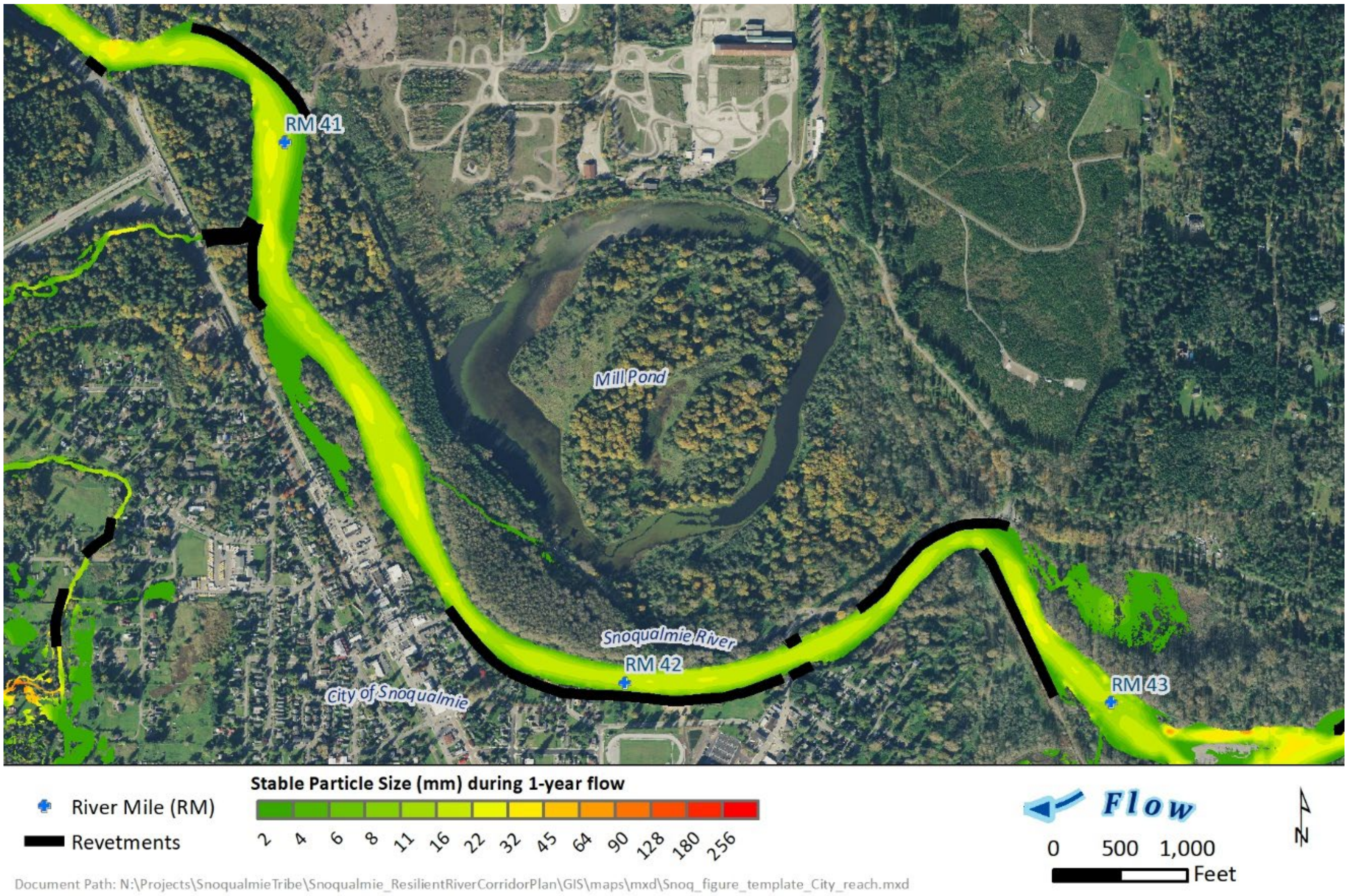


Figure 25. Estimates of the stable particle size for the Planning Area adjacent to the City of Snoqualmie. Stable particle size estimates were made using estimates of shear-stress for the 1-year recurrence interval flow from the 2-dimensional hydraulic model coupled with a Shield's stress incipient motion calculation.

Current Floodplain Connectivity

Floodplain connectivity in the Planning Area has been impacted by roads, trails, railways, levees, berms, revetments, and other floodplain modifications, especially through the City reach. While elevated and armored floodplain features serve their purpose in protecting property and infrastructure from floodwaters, they have adverse impacts on river-floodplain connectivity, river channel migration processes and associated in-channel wood recruitment, and aquatic habitat availability. In some cases, floodplain modifications can amplify or translate flooding to downstream areas or worsen bank erosion in adjacent reaches. Elevated floodplain modifications such as roads, levees, trails, and railways, are visible in the river valley topography. These features were mapped and tabulated for the Planning Area, as well as floodplain elevations relative to the channel water surface, with low-lying channels in blue and green and higher ground in yellow and brown area (Figure 26). In many places, relic channel features are bisected or cutoff from present day channels by elevated roads, berms, or other features. While this mapping effort is not exhaustive, it illustrates the extent of human impacts on the upper Snoqualmie River floodplain.

Water surface elevations as measured by the 4/27/2017 LiDAR acquisition can be used to assess vertical gradients between the Snoqualmie River and adjacent floodplain water bodies. Snoqualmie River discharge (at USGS 12144500 near Snoqualmie) during acquisition was 3,720 cfs. To characterize cross-valley water surface gradients at this flow, we draw a cross section line perpendicular to the Snoqualmie River and compare the water surface elevation (WSE) in the mainstem Snoqualmie to the WSE in Mill Pond and Kimball Creek. The WSE in the mainstem Snoqualmie was 9 ft below the Mill Pond water surface and 12 ft below the Kimball Creek water surface (see Figure 30). This large cross-valley vertical gradient between floodplain water bodies and the mainstem channel suggests the Snoqualmie is vertically disconnected from its floodplain at this location. The vertical offset between the left and right floodplain also suggests the left floodplain may be an older floodplain surface than the right floodplain, or that relic channel features visible in the left floodplain surface are associated with former SF alignments and not the Snoqualmie mainstem.

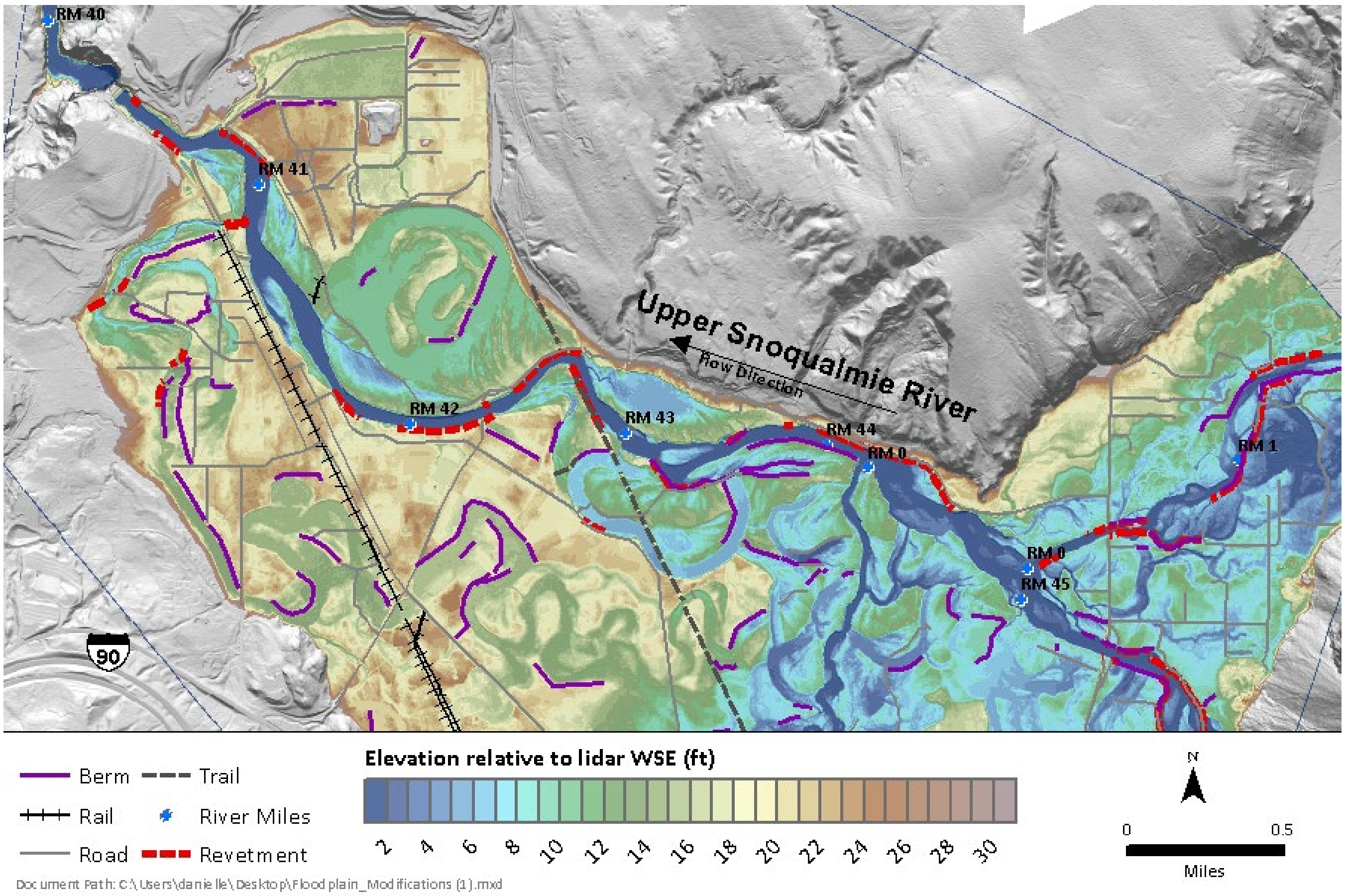


Figure 26. Elevated floodplain modifications mapped from April 2017 LiDAR bare earth data. Floodplain elevations relative to the LiDAR water surface are also shown, with low-lying areas in blue and higher ground in yellow and brown.

Current Floodplain Engagement Patterns

Relative floodplain elevations and modifications are useful in interpreting hydraulic modeling results and to answer questions about how and when the river connects to the floodplain. Hydraulic patterns and frequency of floodplain connectivity within the Planning Area were assessed using a 2-dimensional (2D) unsteady state hydraulic model to characterize current riverine conditions within the Planning Area, to evaluate existing flow patterns, hydraulic parameters, and inundation extents. This model established baseline hydraulic conditions which will enable quantitative comparison to a proposed condition, testing the effects of future restoration or other land use actions. This comparison will be critical to ensure that the design elements meet planning goals without increasing risk to existing habitat, property, and infrastructure. In this planning process, two model scenarios were compared using this hydraulic analysis: 1) Existing Conditions and 2) Climate Change.

River Accessibility:

While 30% of the survey respondents reported feeling like their ability to access to the river has been reduced over time, most of those surveyed, 60%, reported no change in access.

See Appendices for detailed responses.

As expected under current conditions, river flow is contained primarily within the banks under the existing 1-year flow (Q1) levels representing a likely “bankfull” flow level for this region (Castro and Jackson, 2001). Engagement of the floodplain occurs between the Q1 and Q2 flooding several broad floodplain areas at Q2. These areas include the left bank floodplain between the NF Snoqualmie River Confluence and Meadowbrook Slough as well as within both banks of the SF floodplain upstream from the confluence with the mainstem (Figure 27).

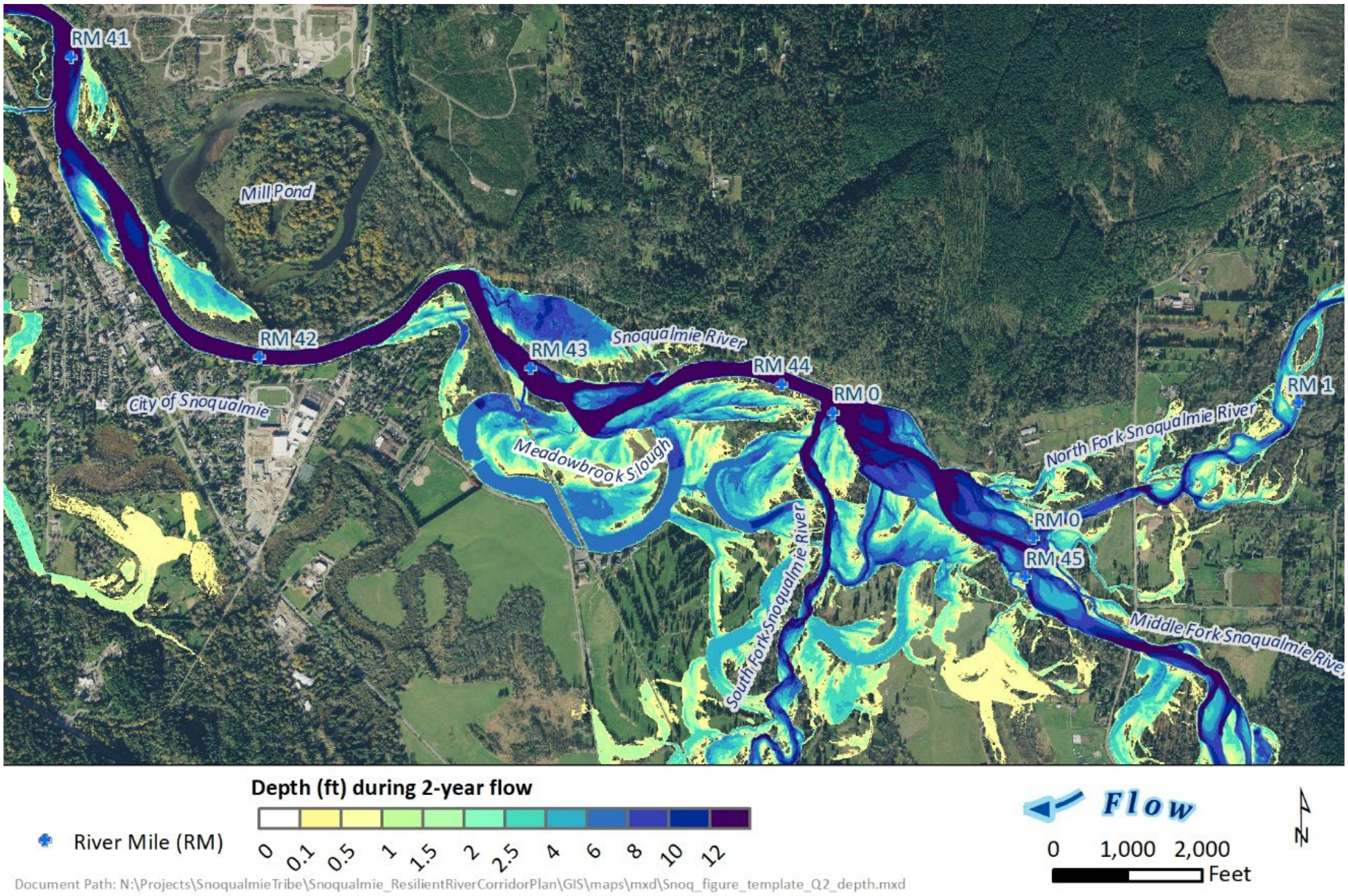


Figure 27. Flood depths under the existing condition 2-year recurrence flow level.

Depths within these floodplain areas range from ~1-8 feet and indicate that the river through this portion of the Planning Area is well engaged with the floodplain due to the frequent nature of the inundation and despite the level of floodplain modifications.

However, river flow inundates only small portions of the inset floodplain through the City reach under Q2, indicating that confinement and bank hardening limit floodplain connectivity. This type of limited connection is detrimental to aquatic and riparian habitat and species because of the importance of frequent floodplain engagement in sustaining riverine ecosystems such as the recruitment and survival of riparian vegetation (Wilcox and Shafroth, 2013), influencing sediment transport dynamics (Wohl et al., 2015), increasing biodiversity (Ward et al., 1999) and facilitating nutrient cycling between the terrestrial and aquatic environments (Ward, 1989) amongst other important processes

During a five-year flood, Q5, floodwaters deepen within engaged floodplain surfaces and expand to the Mill Pond. Flow also begins to engage the floodplain along a relict SF Snoqualmie River channel towards the City of Snoqualmie, although it is not predicted to connect with Kimball Creek until higher discharge levels. Flood depths deepen within the Confluence reach and Meadowbrook Slough under the Q5 flow, with estimated flow as deep as ~14 feet within oxbow and relict channel features, including Meadowbrook Slough itself. The floodplain in and around the Mill Pond also becomes connected under the Q5 flow level.

A simulated twenty-five-year flood shows flood waters beginning to spread out across areas outside of the Confluence and Meadowbrook Slough reaches with flow engaging the floodplain adjacent to Meadowbrook

Slough and the relict SF Snoqualmie River channel, and into the adjacent city parcels between Q5 and Q25. Estimated depths in these areas are between 0.5-2 feet of water, with water predicted to surround portions of the Snoqualmie Elementary School (Figure 28).

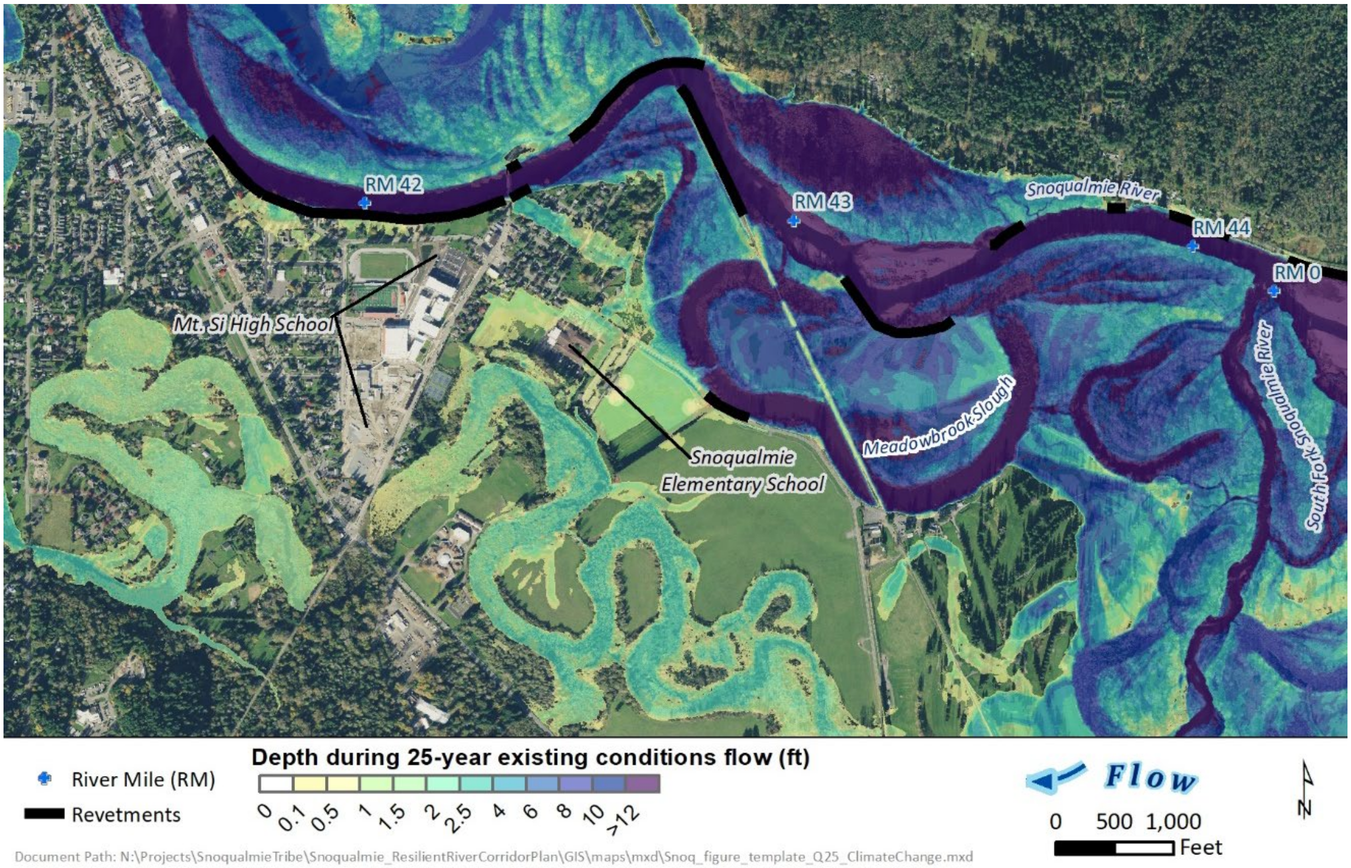


Figure 28. Flood water depths under the existing condition 25-year recurrence interval flow level.

Flood waters are predicted to inundate additional areas of the City of Snoqualmie under the modeled fifty-year flood flow, Q50, with flow engaging the floodplain along the relict SF Snoqualmie River channel and Meadowbrook Slough and across much of the city. Flow also engages the floodplain near the Mill Pond and into the northern portion of the Mill property under Q50.

During a 100-year flood, most of the valley becomes inundated with estimated depths as deep as five feet through the City of Snoqualmie, like what is currently shown in FEMA flood maps.

Between the Q5 and Q25 flow levels, flood waters break out of adjacent low-lying areas (such as Meadowbrook Slough and the relict South Fork Channel that connects with Kimball Creek) and into adjacent areas of the City of Snoqualmie, including Mt. Si High School. It is possible that the elementary school finished floor elevation may be higher than inundated water surface elevations, making the interior of the school free from flooding.

Effects Of Climate Change On Flood Flows

Climate change effects on flood flows may result in an increased frequency and magnitude of floodplain connectivity (See Methods Appendix for detailed information on climate change simulation). Based on these simulations, flood patterns do not change significantly under the 1-year and 2-year climate change flow levels.

The primary differences being deeper depths across the floodplains in the Confluence and Meadowbrook Slough reaches. The 5-year climate change flood waters begin to inundate parcels of the City, including the Elementary School, which did not occur until the 25-year flow level under existing conditions. The 25-year climate change flow, flood waters inundate a good portion of the City of Snoqualmie, including Mt. Si High School and the surrounding neighborhoods (Figure 29). Flow also breaks out from the Mill Pond into the northern portion of the Mill property under the 25-year climate change flow. Most of the valley becomes inundated by Q50 under the climate change scenario and by Q100 depths are as deep as six feet through the City of Snoqualmie.

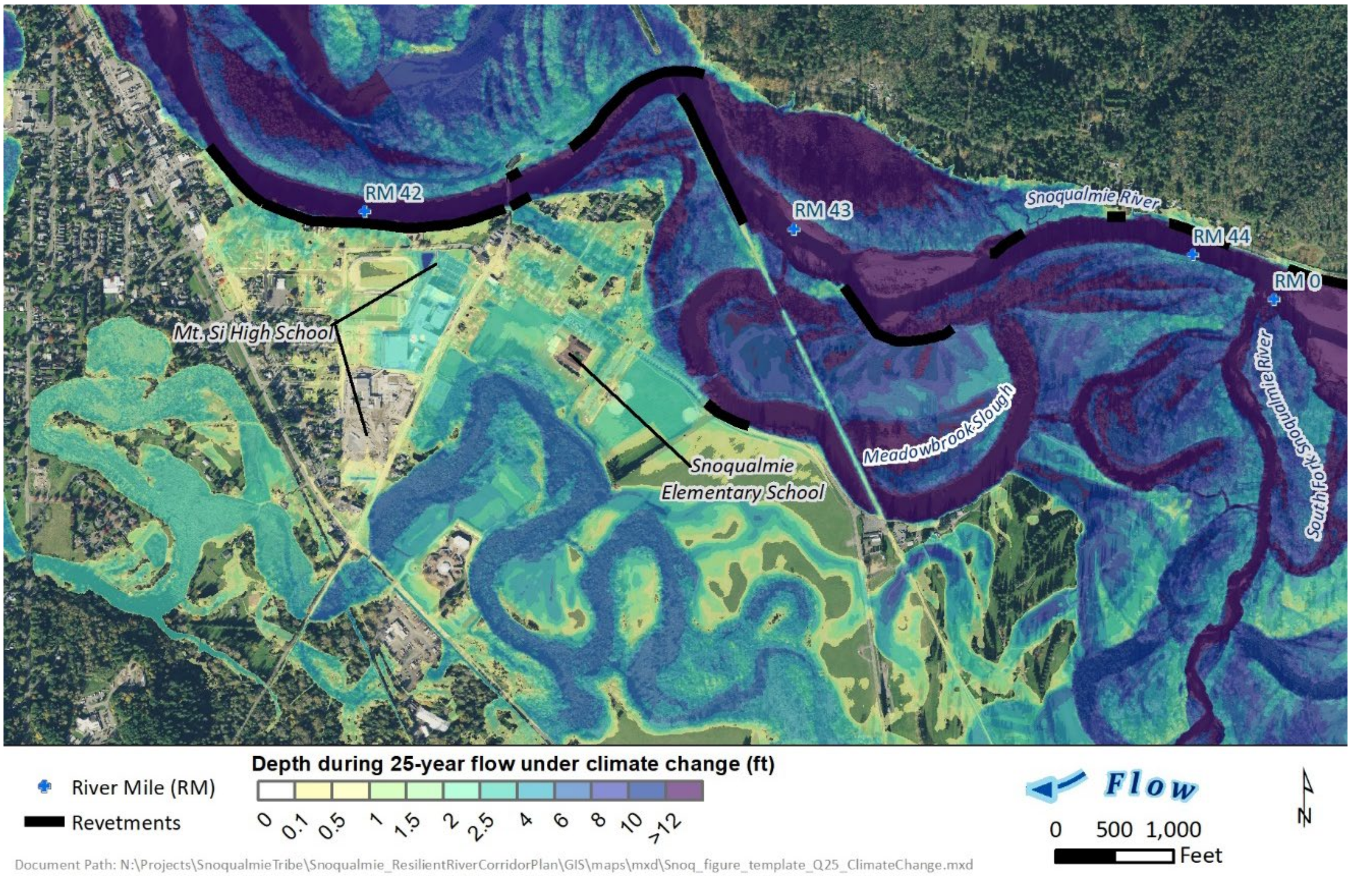


Figure 29. Flood depths under the existing condition 25-year recurrence interval flow level under the predicted climate change scenario. Under this flow level, flood waters inundate portions of the City of Snoqualmie, including Mt. Si High School and Snoqualmie Elementary School, as well as the northern portion of the Mill property.

The results of the hydraulic assessment indicate that floodplain connectivity varies throughout the Planning Area and that flood risk through the City of Snoqualmie is expected to increase under climate change conditions. The floodplain through the Confluence and Meadowbrook Slough reaches has a high degree of floodplain connectivity and is predicted to inundate at least once every 2 years under both existing and climate change conditions. this well-functioning floodplain ecosystem means that restoration activities within these reaches will have a high likelihood of success. There is less frequent connectivity with the floodplain through the City reach due to the existing confinement and flood protection measures, although the Mill Pond is inundated fairly frequently, about once every 5 years. While portions of the City of Snoqualmie, especially in and around the elementary and high schools, are at risk of flooding under the existing 5 year and 25-year flow levels, the flood risk is expected to become greater under predicted climate change conditions with the schools predicted to be inundated more frequently and under greater depths of flood waters.

Groundwater and the Alluvial Aquifer

Community Hopes for the Future of River Water Use:

- *Create catch basin/reservoir holding ponds that can be used for agriculture/drinking water/livestock water*
- *Prepare the banks around the river for climate change and water flows, flooding, and drought, and prepare for capture and use of the water seasonally to prepare for this.*

Approximately 20% of streamflow between the three Snoqualmie River forks and Snoqualmie Falls is gained from groundwater , and as much as 31% of SF Snoqualmie River flow near North Bend is from groundwater inputs (Stohr et al., 1994). As of 2006, the only water withdrawal exceeding 1 cfs within the Planning Area was the Sallal Water Association in North Bend (Stohr et al., 1994). Metering records indicate the district serviced by the Sallal Water Association uses less than the permitted volume, with most of the district relying on well water withdrawals. While significant groundwater withdrawals can reduce the cooling effects of groundwater inflows, the extent of groundwater withdrawals in the Planning Area is not known.

Based on water surface elevations (WSE) in the Snoqualmie River and floodplain water bodies, including Mill Pond (Borst Lake), described in the previous section, we inferred the groundwater table elevations based on the assumption that each surface water body was an expression of the groundwater table, rather than a hydrologically isolated water body.

The interpolated elevations of these floodplain water bodies indicate the hydraulic gradient, or slope, of the groundwater table. The direction of flow at the time that the data was collected can also be estimated with the simplifying assumption that saturated hydraulic conductivity of the underlying sediments and soils are constant. The resulting surface indicates that river within the Planning Area is expected to gain flow from groundwater, with subsurface flow directions pointing toward the river channel, particularly at the downstream end of the Planning Area below the SF Snoqualmie River confluence (Figure 30). However, above the Three-Forks confluence area, within each of the three forks, water surface elevation (WSE) gradients are down-valley, or perpendicular to the channel. Cross section interpretations shown in Figure 31 from the Snoqualmie Aquifer Storage and Recovery Program Development also support the gaining nature of the Planning Area reach with lateral groundwater flow directed toward the Snoqualmie River.

As described in the Methods Section, alluvial groundwater gradient and flux were estimated using a combination of WSE and mapped soil characteristics. Cross section A in Figure 30 illustrates a lateral groundwater gradient of 0.37%, from Kimball Creek to the mainstem Snoqualmie River.

Alluvial groundwater storage potential was estimated for floodplain areas relative to the mainstem WSE and was estimated at 1600-acre feet. This estimate was based on the 'restored' depth or increase in WSE of 4.05 vertical ft to achieve 'bankfull' flow for the Q2. In other words, if the channel were brought up by 4.05 ft everywhere, the 2-year flow would be at top of bank, and the alluvial floodplain would hold an additional ~1686-acre feet of water relative to existing conditions. The upper bound on an estimated mean groundwater flux from the additional groundwater storage to the Snoqualmie River was 4.7 cfs over the first 90 days of the receding hydrograph in summer. **However, note that these estimates are overly simplistic and only intended to provide an upper bound on the function of the shallow alluvial aquifer to store and slowly release ground and flood water to the upper Snoqualmie River.** Key assumptions underlying this estimate are constant soil porosity, specific yield, and hydraulic conductivity across the alluvial aquifer, along with an assumption that the groundwater flows into the river.

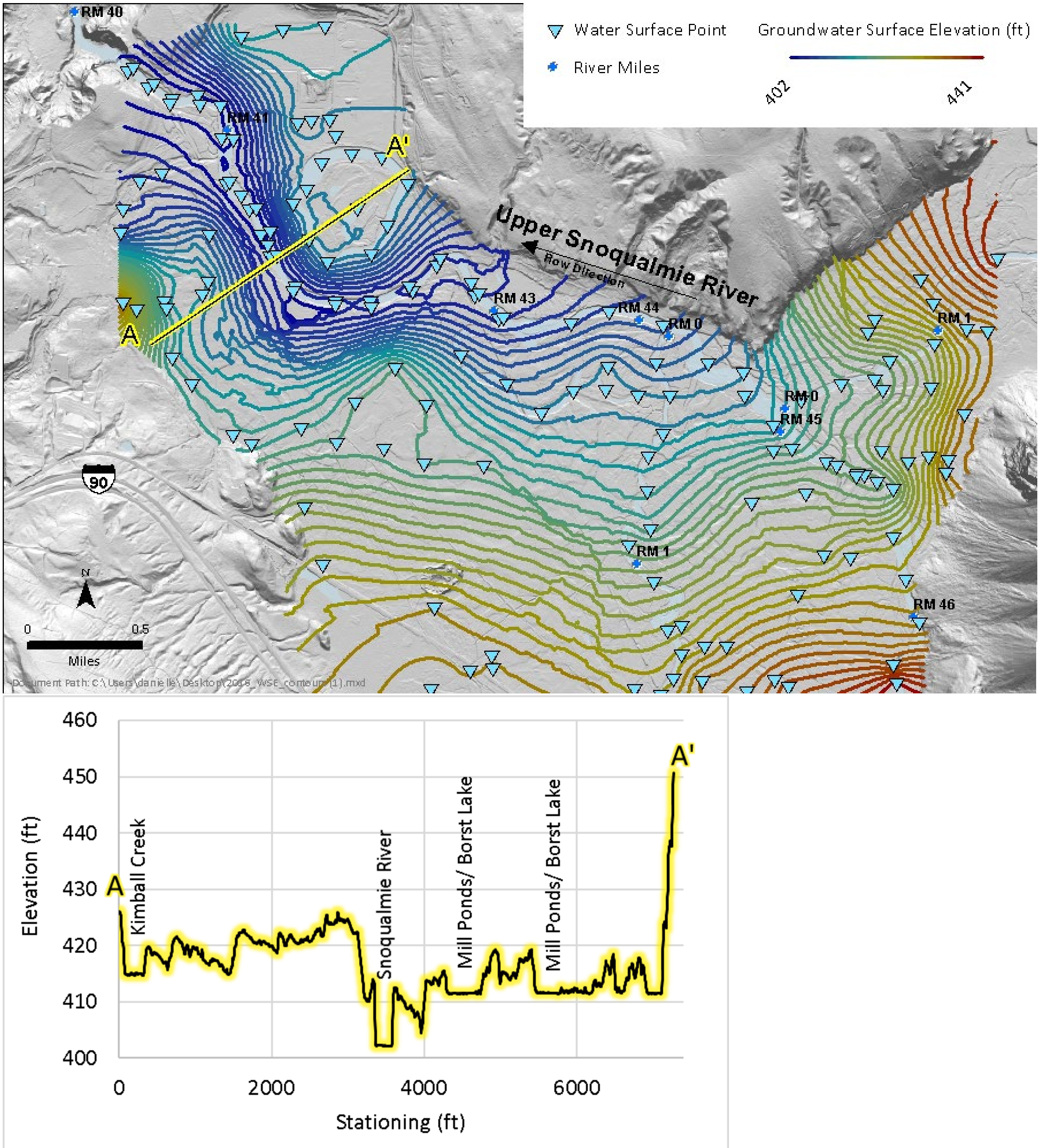


Figure 30. Water surface elevation contours for the upper Snoqualmie River valley, extracted from 2017 LiDAR data, above, with a valley-wide cross section view A-A’ shown below.

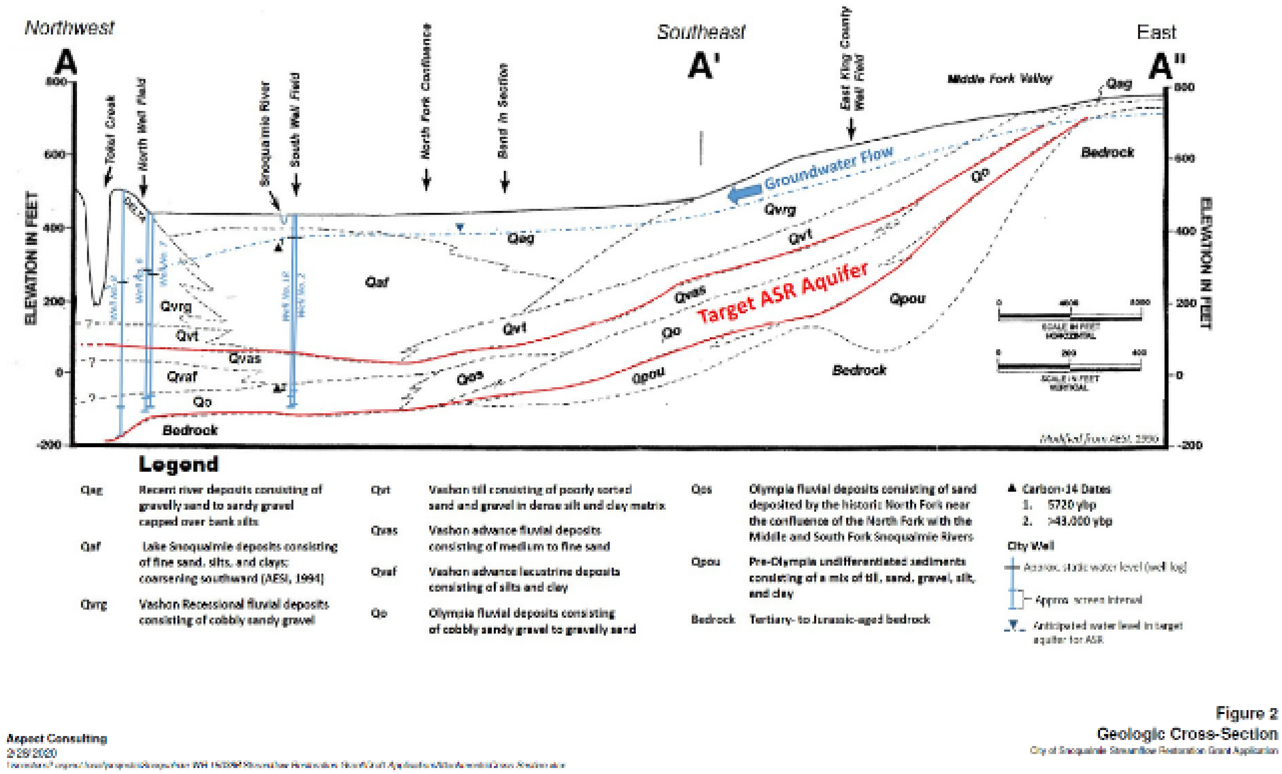


Figure 31. Geologic Cross-Section from City of Snoqualmie Aquifer Storage and Recovery Program Development and Implementation Water Resources Streamflow Restoration Program Grant Application (City of Snoqualmie, 2020b).

Water Quality and Aquatic Habitat

Elevated stream temperatures are a key concern for both water and aquatic habitat quality in the upper Snoqualmie River in general, and in the Planning Area specifically. In 2011, the mainstem and SF were both 303(d) listed for impaired temperature and pH (Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC), 2002) and the mainstem had temperatures in excess of state standards (Kaje, 2009). Effective shade values along the mainstem Snoqualmie River were less than 30% on average (Stohr et al., 1994) (Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC), 2002). Recent temperature TMDL work showed that the planning area is no longer 303(d) listed for impaired temperature (personal communication, M. Baerwalde).

Community Hopes for the Future of River Recreational Use:

- *Keep it as healthy and natural as is possible! Swim in it occasionally, watch it, hear it at night as I fall asleep, experience it rise and fall with the rain.*
- *I would like to see more ceremonies and Salmon Spawning celebrations in Tolt and/or relevant river locations.*
- *Fish, swim, and play.*
- *Create catch basin/reservoir holding ponds that can be used for agriculture/drinking water/livestock water*
- *With stewardship, fly fishing could boom.*

Numerous cold water fishes are present in the Snoqualmie River and are sensitive to different water temperatures at different life stages (Thompson et al., 2011). Although the Planning Area is upstream of Snoqualmie Falls, which is a barrier to upstream migration of anadromous fish, stream temperatures in the Planning Area affect local fishes as well as being a major driver of downstream habitat quality. According to a 2011 study by Thompson et al., coastal cutthroat trout (*Oncorhynchus clarki clarki*), rainbow trout (*O. mykiss*), westslope cutthroat trout (*O. clarki lewisi*), and hybrid or unidentified Pacific trout (*Oncorhynchus sp.*) were found to be the most dominant species in the upper Snoqualmie River watershed. Eastern brook trout (*Salvelinus fontinalis*), mountain whitefish (*Prosopium williamsoni*), largescale sucker (*Catostomus macrocheilus*), longnose dace (*Rhinichthys cataractae*), western brook lamprey (*Lampetra richardsoni*), shorthead sculpin (*Cottus Confuses*), mottled sculpin (*C. bairdi*), torrent sculpin (*C. rhotheus*), Pauite sculpin (*C. Beldingii*), and reticulate sculpin (*C. perplexus*), threespine stickleback (*Gasterosteus aculeatus*), golden trout (*O. aguabonita*), largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), and pumpkinseed (*Lepomis gibbosus*) have also been reported as present. Bull trout (*Salvelinus confluentus*) may be present in the watershed but, neither the Thompson et al. study nor a 2001 study by Berge and Mavros observed this species (Berge and Mavros, 2001; Thompson et al., 2011)(Berge and Mavros, 2001). An eDNA study is planned for summer 20212.

In particular, cutthroat trout, rainbow trout, and mountain whitefish (native salmonid) occupy mainstem MF and some tributaries (Kaje, 2009). Cutthroat has a thermal preference of 10-14 °C, rainbow trout has a thermal preference of 8-18 °C, and Mountain whitefish have a preference for 5.5 – 17 °C, see (Sauter et al., 2001) and references therein. Brook trout are present in mainstem Snoqualmie River above Snoqualmie Falls, and historically there were native char in the upper watershed (Stohr et al., 1994). Brook trout readily colonize new habitat and have a higher thermal tolerance than cutthroat and rainbow. Downstream of Snoqualmie Falls, stream temperature is a critical concern for salmonid habitat, with stream temperature thresholds of 13 °C for spawning, 18 °C for rearing, and 21-22 °C as the lethal limit for migrating adult salmonids (U.S. Environmental Protection Agency (USEPA), 2003).

Stream temperature in the Snoqualmie is generally negatively correlated with elevation and mean daily temperature range is positively correlated with elevation, with overall colder temperatures higher in the watershed but with more diurnal variation (Steel et al., 2016). However, in reaches higher in the watershed, such as the Planning Area, stream temperatures are sensitive to the amount and timing of snowmelt (Lee et al., 2020). Stream temperatures in the Planning Area reach a maximum in late July and August when snowmelt runoff has diminished, and air temperatures are highest. In years with low snowpack (e.g., 2015), July mean weekly maximum temperatures (MWMT) in the MF can be 4 – 5 °C warmer than normal snowpack years, with lesser effects (1.5 – 4 °C) in the SF and NF (Hawkins et al., 2020; Steel et al., 2016). Stream warming also occurred earlier in the summer in 2015 (Hawkins et al., 2020), protracting periods of thermal stress for cold water fish species. Under current conditions stream temperatures exceed the 22 °C lethal limit for salmonids during extreme low flows (i.e., the 7Q10, which is a low flow with a 10-year recurrence interval, or a 10% probability of occurring in any given year). Projections of future stream flows and stream temperatures in the Planning Area indicate high sensitivity to warming air temperatures and diminishing snowmelt contribution to streamflow, with an increase of ~ 8 °C in the main stem Snoqualmie in the Planning Area. Modeling studies have demonstrated that mature riparian canopy protection and restoration of buffers can lower average stream temperatures by 2.0 °C (Stohr et al., 1994) and buffer the warming effects of future climate by 0.5 – 1.0 °C (Fullerton et al., 2022).

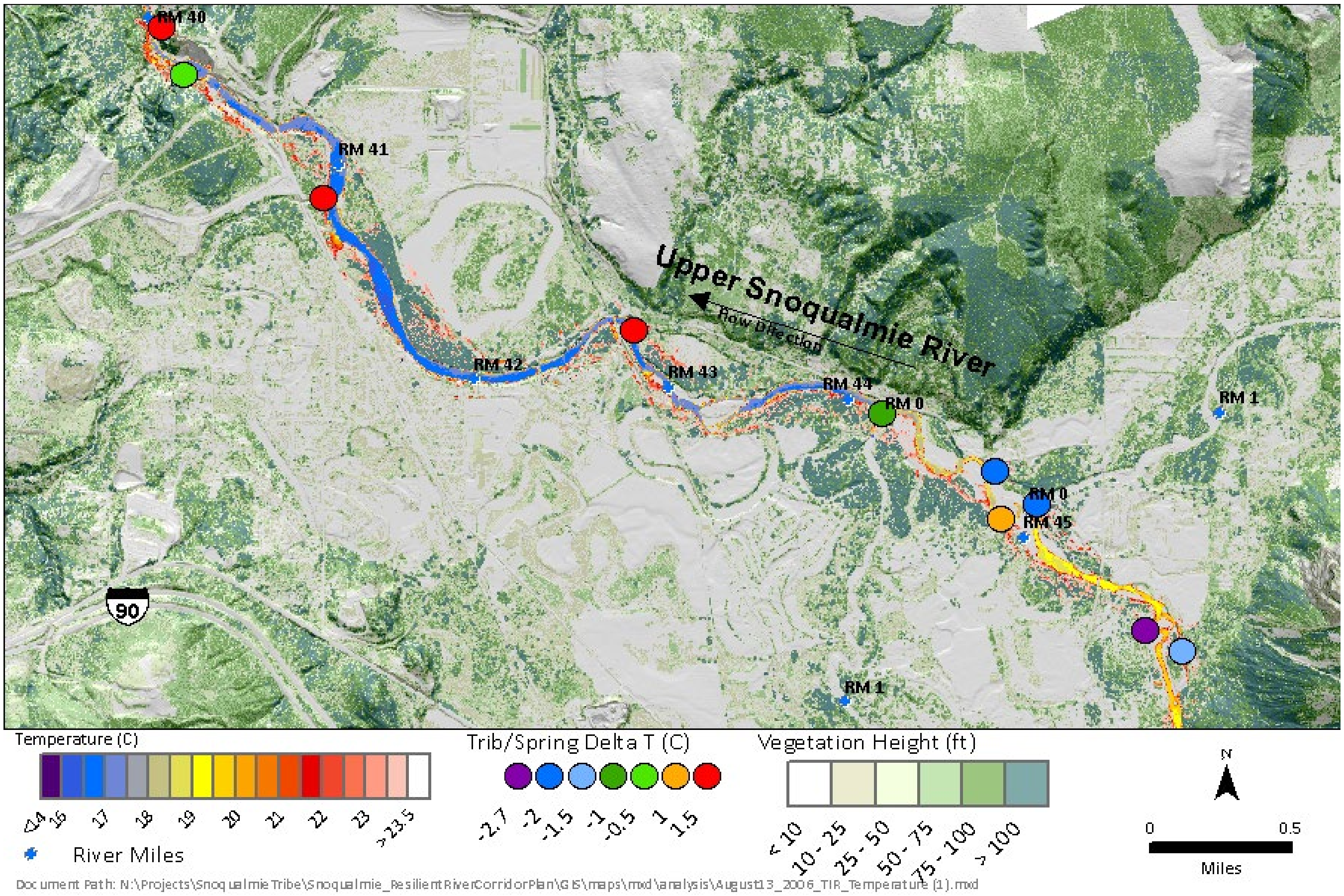


Figure 32. Thermal infrared data from 2006 for the mainstem Snoqualmie, with temperature anomalies for springs and tributaries (colored points) and LiDAR-derived canopy height (2017).

Thermal infrared (TIR) temperature data was collected on August 13, 2006, for the mainstem Snoqualmie River and the Middle Fork (MF) Snoqualmie River by Watershed Sciences, Inc. These data show the MF as 2-4 °C warmer than the mainstem Snoqualmie River. Temperature anomalies for tributaries and springs were derived as the difference in median temperatures and are indicated by colored points in Figure 32. Upstream of the North Fork (NF), the MF has a mean surface temperature of 19 °C. The NF inflow is 17 °C, lowering the mainstem Snoqualmie temperature by roughly 1 °C. Inflow from the SF is cooler still by about 1 °C. Downstream of the SF, surface temperature in the Snoqualmie River is 16.5-17 °C and cools to below 16 °C below the Snoqualmie Valley Trail bridge. This cooling effect despite warm water inflows from both Brockman and Kimball Creeks suggests cool groundwater inflows downstream of the SF. This cooling pattern is also consistent with the strong lateral groundwater gradient inferred from 2017 LiDAR WSE (Figure 30). TIR data were collected in 2020 by the USGS for the Tulalip Tribe via an Ecology grant but, were not available for analysis during the project time frame.

Despite having some of the coolest tributaries and highest forest cover (97%) of the drainages in the Snoqualmie, the MF has impaired summer temperatures in most years (Stohr et al., 1994). Continuous temperature monitoring by Washington Department of Ecology shows temperatures at most locations in the lower MF exceed state standard for roughly 2 months in the summer (Figure 33, (Kaje, 2009)). Historically, the Snoqualmie and its forks contained more wetlands, oxbows, and side channels that were well-shaded by shrubs, vine maple, alder, and dogwood and had greater groundwater and floodplain interaction (Stohr et al., 1994). The loss of these natural features has reduced potential cooling effects of groundwater and thermal refuges.

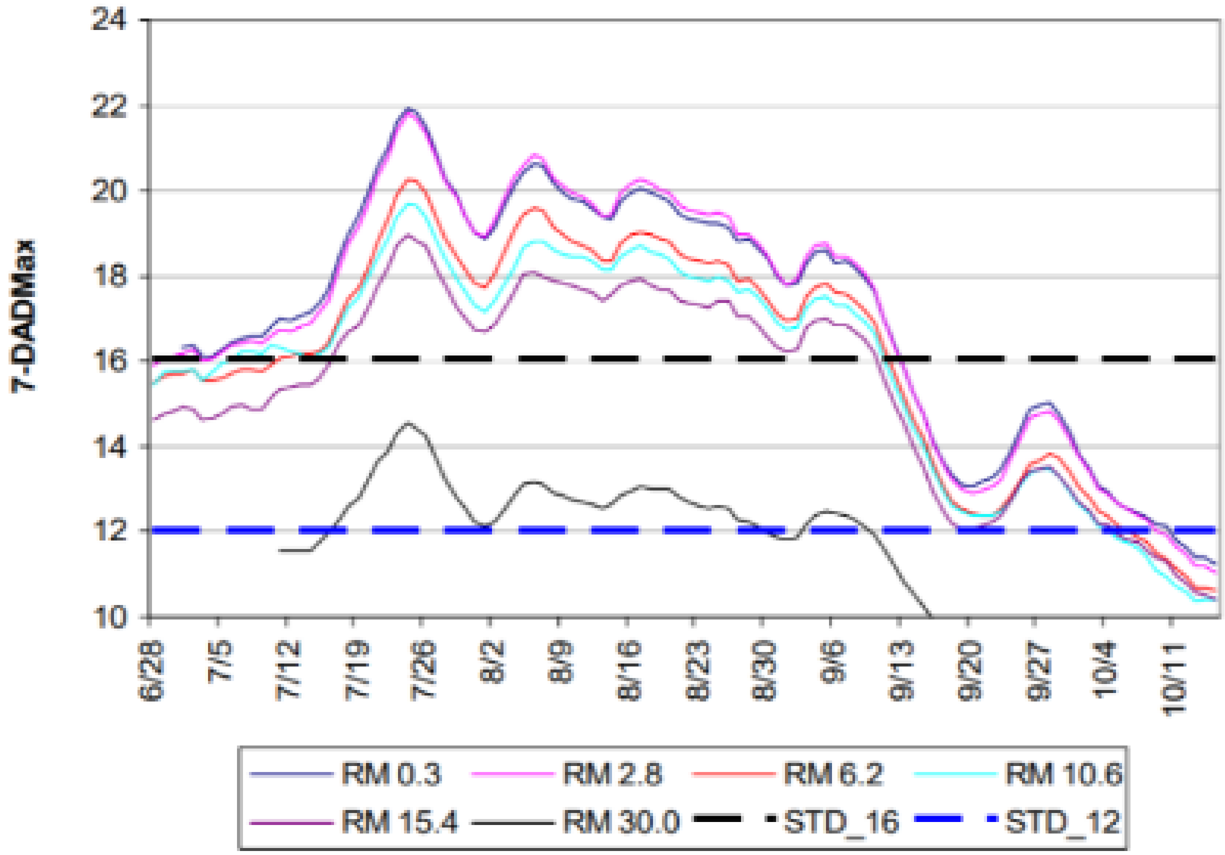


Figure 33. Temperature monitoring by DoE (2006) in the Middle Fork, with state standard temperatures of 12 and 16 °C marked with dashed lines, plot from (Kaje, 2009).

Kimball Creek is the largest tributary to the project reach between the forks and the Falls and is the first tributary to the mainstem Snoqualmie above the Falls. Kimball Creek is broadly divided into suburban, wetland, and forested landcover, each of which has implications for water sources and water quality (Baerwalde, 2011). Low-gradient, broad wetland portions of the Kimball Creek watershed are along the left (south) floodplain between the SF and City of Snoqualmie and are fed primarily with groundwater. Within the City of Snoqualmie Kimball Creek is more confined, with steep banks and a narrow riparian corridor, and receives both ground and surface water. The southern portion of the catchment is forested, higher gradient, and receives mostly surface water. Portions of Kimball Creek have elevated E. coli, temperature, pH, and very low dissolved oxygen, DO, (Baerwalde, 2011). Wetland areas in agricultural portions of Kimball Creek have the most impaired water quality, driven by limited shade, turbidity from bacterial growth, and low DO as a result. Tributaries to Kimball Creek including Coal, Fisher, and two unnamed tributaries (e.g., KT in (Baerwalde, 2011) are better shaded and have cooler water. However, paved areas associated with the Snoqualmie Casino and Interstate 90 (I-90) have adverse impacts on temperature, pH, and salinity. Kimball Creek may also be receiving septic pollution from un-annexed neighborhoods, Snoqualmie Hills East and West, (Sanders, 2014).

Inflow from Brockman Creek near the Snoqualmie Valley Trail bridge during the thermal infrared data acquisition was more than 1.5 °C warmer than the mainstem in that location. A large wetland complex within the alluvial fan of Brockman Creek, on the Snoqualmie River right bank, has limited shade or cover, and water from the tributary warms in this low velocity environment prior to draining into the Snoqualmie River. Variation in temperature of adjacent water bodies provides thermal diversity, which afford important physiological and ecological niches for fishes to utilize, depending on the current metabolic needs at different times of year and life stages (Torgersen et al., 2012). Warmer waters promote increased metabolism and colder waters reduce metabolic rates, growing fish utilize these shifts in temperature to their advantage, feeding on cooler waters and digesting in warmer waters. These thermally diverse areas are important to protect and enhance.

Large Wood Recruitment

Large wood recruitment is currently occurring within some reaches of the Planning Area, although is likely well below historical levels, e.g. (Collins and Sheikh, 2005; Collins and Montgomery, 2002). Active and recent recruitment was observed primarily in areas with active channel migration including between the North and SF confluences, adjacent to Meadowbrook Slough, and just downstream from the City of Snoqualmie (Figure 34 and Appendix B). The recruited wood is from young riparian areas and consists primarily of hardwood species such as cottonwood and alder. Observed in-channel large wood existed as meander jams or as stable snags. While most of the wood was characterized as unstable under large flood conditions, the observed wood was exerting geomorphic influence on the river by forming pools and resisting channel migration. There were limited to non-existent quantities of large wood within reaches with limited to non-existent channel migration activity, such as the City reach.

Figure 34. Examples of large wood within the Planning Area. The left photo was taken near the North Fork Snoqualmie River confluence near RM 44.5 and represents a typical meander jam found within the Planning Area. The right photo was taken downstream of the City of Snoqualmie near RM 41 and was comprised of mobile single pieces of wood, either recruited from local bank erosion or transported from upstream. The photos were taken on 7/28/20 with flow from left to right.

Revetment Removal Wood Recruitment Potential

Locations where larger (i.e., > 100 ft tall) trees are present, such as Meadowbrook Slough reach, may provide good opportunities for re-engaging floodplain to leverage natural in-channel wood loading processes, where natural riverbank erosion recruits trees as downed wood. These areas also afford good riparian shade for restored side channel and off-channel areas. Buffer areas and canopy height are shown in Figure 35. Within each buffer area, the distribution of canopy heights provides insight into wood loading potential if channel migration or bank erosion were restored. Along many revetments, the canopy height is under 10 ft, which includes unvegetated areas. In Figure 35, for example, comparison of the Meadowbrook revetment buffer with the Meadowbrook Bridge (Brg) revetment, shows very few trees above 50 ft in height behind the Meadowbrook revetment.

Locations where larger trees are present, such as the Meadowbrook Bridge facility, may provide better opportunities for re-engaging floodplain to utilize natural wood loading processes and stream shading for side channel and off-channel areas. Whereas other areas do not have mature trees and represent a need for forest restoration and management (Figure 35).

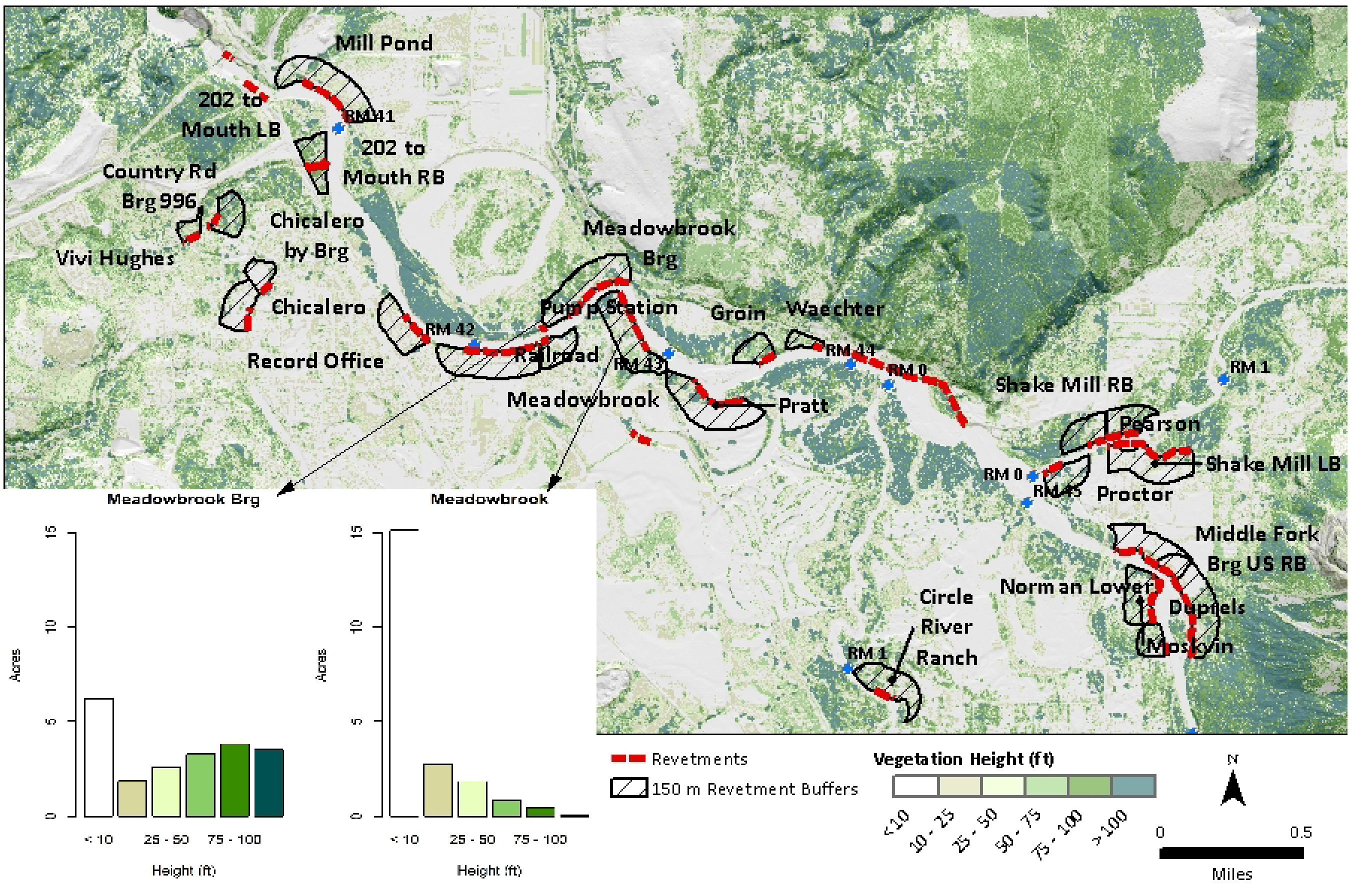


Figure 35. Conceptual analysis of wood recruitment potential with bank de-armoring (revetment removal) for a subset of King County revetment facilities. Buffers extend 150 m from revetment (consistent with riparian restoration in Baerwalde et al., 2020). Canopy heights derived from April 2017 LiDAR data. Example histograms illustrate canopy heights along south side of the river, in the Meadowbrook buffer analysis area, are much lower than along the north side of the River, in the Meadowbrook Brg buffer analysis area.

Riparian and Floodplain Forest

Old growth riparian and floodplain forest was historically cleared throughout the entire Planning Area. Remnants of large conifer stumps can still be found today along the river (Figure 36). While the forest is beginning to come back in some locations, naturally occurring saplings were rarely observed and many undeveloped locations remain unforested. The forest that is recovering is in poor condition, with few large trees and fewer large conifers (see Appendix). These observations combined with the high presence of invasive plant species in the understory and almost non-existent plant recruitment on the river channel gravel bars suggest that regeneration is impaired by invasive species competition and lack of seed source on the banks and floodplain; and plant establishment on gravel bars, which would be typical in this type of river system, is being impeded by high flows due to channel armoring and simplification. Detailed reach-scale forest conditions described below indicate that forest conditions are poor, which has significant implications for river conditions. The lack of shade from south bank riparian forest clearing has contributed to increased water temperatures, increased bacteria and/or algal blooms, declining water quality, lack of wood recruitment, lower dissolved oxygen, and increased fish kills. Each reach is provided a grade based upon a detailed methodology described in Appendix A and in more detail in Rocchio et al (2018).

Community Hopes for the Future of the Riparian and Floodplain Forest:

- *Protect big trees.*
- *Remove black berries.*
- *Volunteer habitat restoration programs.*
- *Preserve traditional gathering lands and enhance them so they produce more abundantly, preserve areas for native wildlife areas in their traditional areas, allow Snoqualmie tribal people the 1st option of "controlling" wildlife populations.*
- *More signage to share stories of the first people who lived there.*

Figure 36 Old growth stump with mature western hemlock tree growing out of it in Two Sisters Return area. Photo taken 7/30/2020 by NSD staff.

Riparian condition of the Meadowbrook Slough reach – C grade

The forest in the vicinity of Meadowbrook Slough was observed to be a mid to late seral North Pacific lowland riparian forest with an understory occupied by blackberry, reed canarygrass, and other invasive species (Figure

37). Large areas of extraordinarily little mature tree cover were observed along the south and west banks, contributing to increased water temperatures due to lack of shade. In areas free of invasive plant species, cottonwood and big leaf maple were the co-dominant tree species, with snowberry as a dominant in shrub layer. In general, there were very few herbs and low conifer density.

Anthropogenic disturbance by railroad/trail, powerlines, and rip rap were also observed to negatively affect forest health, such as biodiversity and canopy cover. On the forest floor, large wood density, both downed wood and standing was extremely low or absent, which is often seen in historically logged areas. This lack of downed wood reduces habitat complexity and biodiversity, particularly in riparian and floodplain forests.

Overall, there was no sign of significant sapling recruitment, due to a combination of invasive species cover, lack of seed source, and other poor sapling establishment conditions. Recent planting efforts were observed to have limited success, which could be due to a variety of reasons including planting methods, species selection, management/establishment care, or the plantings may not have been extensive enough.

Figure 37 Meadowbrook Slough forest conditions. Photo taken 7/30/2020, NSD.

Riparian conditions of the City Reach – D grade

The right bank along the City reach, the riparian and floodplain forest were comprised of even-aged Douglas fir and cottonwood stands. There was sign of elk browse and like the other reaches, large wood density, both downed and standing were low or absent, decreasing habitat complexity and diversity.

Blackberry was the dominant forest understory invasive species, followed by holly. Ivy was present on some trees. The river edge was almost 100% invasive species, including butterfly bush, nightshade, blackberry, thistle, Scotch broom, tansy. The road edge and power line corridor were entirely blackberry and represent ongoing direct anthropogenic disturbance.

Just downstream of the Douglas fir monoculture, the forest transitioned to an early seral deciduous forest without conifers. Even though this forest was more diverse than the Douglas fir stand, just upriver, there was no apparent successional processes due to significant invasive species presence.

Figure 38 Right bank Douglas forest conditions in the City Reach. Photo taken 7/30/2020, NSD.

On the left bank of the City reach, the forest was a mid to late seral North Pacific lowland riparian forest with severely impacted understory. Forest conditions were similar to the Meadowbrook Slough reach where invasive species were limiting species diversity in the shrub and ground layers as well as preventing tree seedling establishment. Like the other reaches, large wood density, both downed wood and standing were extremely low or absent due to logging. However, in this reach, there were also large areas with little to no mature tree cover along on south and west banks due to anthropogenic disturbances such as revetments, city infrastructure, homes, and roads, all of which contribute to increased river water temperatures and other river health impacts.

Just downstream of the City reach, there was a patch of mixed forest along the river in an area referred to as Two Sisters Return by the Tribe. This forest is the only one of its kind observed in the field, with large, >126-150 cm dbh conifers. However, like the other reaches, this forest had a significant invasive species problem, with knotweed and blackberry dominating understory, limiting diversity of native species and tree regeneration/establishment of conifers. Past planting efforts were also observed along Kimball Creek outlet. The overall condition of this unique forest scored a C- grade, this highest in the Planning Area.

Climate Change Benefits of Restored Riparian Forest

Baerwalde et al. (2020) did find that riparian restoration could reduce climate-driven temperature increases by up to 1 ℃ in the summer, while further degradation of riparian conditions would increase warming. For Chinook salmon, projected climate effects accelerated egg emergence, increased juvenile growth and survival (due to metabolic effects of warmer stream temperature), and accelerated outmigration of sub yearling migrants (Baerwalde et al., 2020).

Much of the upstream and north side of the river is currently zoned as open space, with many opportunities for forest restoration. However, a robust riparian and floodplain forest along the south side of the Snoqualmie River, in areas zoned as residential and commercial, would work better for reducing river water temperatures and providing cover and shading aquatic habitat (Sanders, 2014).

Wildfire

The Planning Area is adjacent to managed forests and wildland and fire risk may be higher than most people realize. Fires play an important ecological and cultural phenomena west of the Cascades, albeit with historically longer return intervals than east of the Cascade crest, and wildland fires will need to be carefully and collaboratively managed to allow for low risk and productive events in a future with increasing fire risk due to climate change (Morgan et al., 2019). Fire regimes in the Planning Area are classified as infrequent but with high severity. There are many examples of wildfires promoting the growth of edible plants and increasing meadow habitat and understory biodiversity. Fires are increasing in frequency with climate change and management techniques and the lessons learned have been rapidly evolving in recent decades. For example, due to the different forest species composition and ecology from the east side of the cascades to the west side, the effectiveness of different methods, such as thinning and prescribed burns, differ greatly (Morgan et al., 2019).

The University of Washington's Climate Impacts Group has estimated that very high to extreme fire danger days will increase greatly toward the middle of this century (2040-2069) from an average of 36.5 days to 54 days of very high fire danger per year, and from 11 days to 23.7 days of extreme fire danger per year (Krosby et al., 2018).

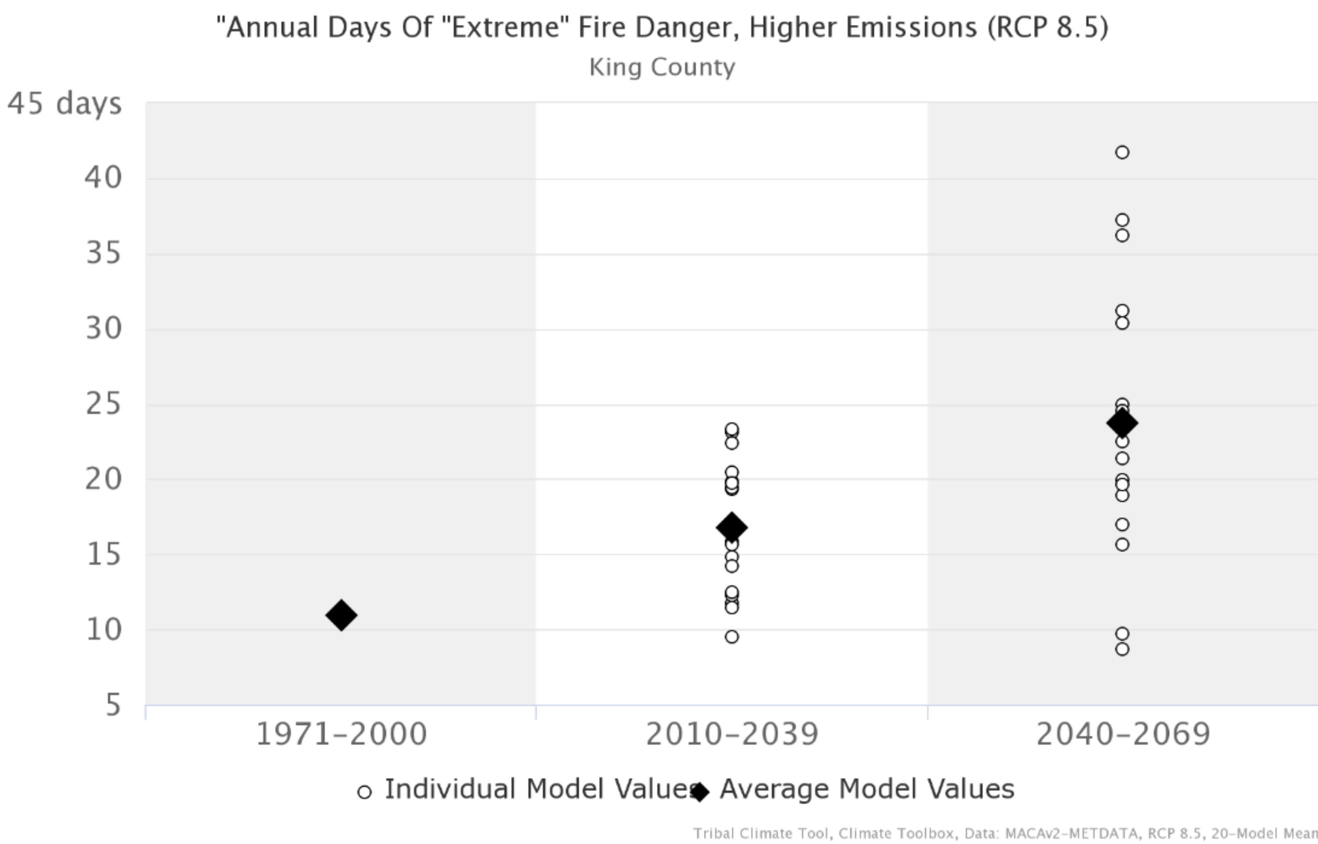


Figure 39 Estimate of increase in annual days of extreme fire danger under higher emissions, 'business as usual', climate change scenario. (Krosby et al., 2018; accessed on 6/21/2021).

All the streamflow changes described previously, such as decreases in summer precipitation and earlier snowmelt will lengthen the fire season and increase the presence of drier fire fuels. Increased areas within the wildland-urban interface will also increase wildfire frequency due to increased fire repression in the short term, and greater opportunity for human ignition of fires.

Wildfires affect aquatic habitats via changes to sediment dynamics, wood input, and increase flood risk. Research into the specific effects of wildfire on western Washington rivers was identified as a need by Morgan et al. (2019).

Despite these climate change and development predictions, quantitative estimates of future fire frequency or area burned are currently unavailable or are very limited (Morgan et al., 2019). Collaborative Community Wildfire Protection Plans are being developed by some western Washington jurisdisctions, such as Snohomish County, in an effort to begin to plan and prepare for wildfire risk (Morgan et al., 2019). Development of a collaborative Community Wildfire Plan, possibly includingtribally-led prescribed burns, is recommended as a resilient river management plan action.

Resilient Corridor Management Plan (RCMP)

Resilient River Corridor Questions

What places, uses, and conditions within the upper Snoqualmie River corridor should be made more resilient and are most valued by the tribal community, and the larger local community? How can this increase in resilience and place-based knowledge be shared to have a richer cultural relationship with the Snoqualmie River and to promote a sense of common stewardship? How might this increased river resiliency be achieved and maintained?

The natural functions of the upper Snoqualmie River are impaired throughout the Planning Area, decreasing water quality and water quantity, and resulting in poor terrestrial and aquatic habitat. Relict channel features are visible in high resolution topographic data, which illustrate that the upper Snoqualmie River historically occupied the entire alluvial valley. This historical landscape included one or more meandering, sinuous channels that migrated over time and a floodplain that flooded every year. Today the river is constrained by rock and wood revetments and roads to a single wider channel, with a resulting loss of river mobility, habitat quality and quantity and a reduction in natural resilience to climate change.

Overarching issues related to this impairment of dynamic natural processes and degradation of natural functions include:

Elevated stream temperature, simplification of the river channel, poor and degraded aquatic habitat, declining forest health, and a lack of conifers and recruitment of stable large wood into the river that has been occurring for decades in a slowly worsening problem. Without a long memory of close connection to the river and its natural processes, many people will not notice or be concerned.

Increased population growth in the Upper Snoqualmie River and climate change are also putting pressure on the river and water supply and may further impact natural river and floodplain processes. Relevant to tribal members, this can mean they may not be able to practice traditional activities in the same ways and in the same places where they used to be able to.

Climate and land use changes in river valleys are manifested in increased flood and erosion risk. Solutions to climate change, including changes in land use, are often politically difficult to coordinate. Collaborative community-based design and planning efforts make this much more feasible and effective, which is a key reason the Tribe is leading the development of a collaborative plan with involvement from tribal members and local community members. Examples of this type of planning process are provided in the Case Studies section. These compromised natural processes and problems arise largely from post-European contact land use values and decision-making processes, such as management decisions being based solely upon economic value. Community impressions of the river confirmed many of the scientific observations and provided specific context for evaluating current planning documents and creating a more holistic plan for a resilient river corridor.

Today, values are shifting to include ecological considerations and broadening even further to accommodate social justice and equity values; all of which are critical to accommodate increasing populations and climate change resiliency. Land use management values are slowly shifting towards those of increased stewardship and landscape regeneration.

The upper Snoqualmie River community's relation to the river and floodplain development, flood inundation, erosion hazards, and summer water availability for out of stream uses were surveyed to gauge support for, and inform, this Resilient River Corridor Management Plan (RCMP, see next section). Enlisting and supporting regenerative community values of stewardship in this plan, will be critical for maintaining and improving river and community health under increased pressures from climate change.

Resilient River Corridor Management Plan Objectives

Based upon the current state of the physical natural processes, which contribute to the quality and quantity of aquatic habitat, and the results of our surveys and interviews with community members the following objectives were identified for the resilient corridor plan:

1. Increase connectivity of mainstem upper Snoqualmie River to cool water tributaries.
2. Restore multi-threaded anabranching channel morphology where appropriate.
3. Restore large wood cycle, where riparian forest is recruited to the river through channel migration and becomes stable in-channel log jams. The log jams help to slow floodwater and resist erosion, eventually becoming forested islands where vegetation is protected from erosion and can mature to sizes capable of being stable in the river when they are eventually recruited. The log jams also provide important aquatic habitat and raise floodwaters – engaging floodplains and side channels.
4. Restore and enhance the health and extent of riparian forests for the purpose of providing riparian shade (improving water quality), increasing bank cohesion and natural resistance to channel widening.
5. Restore natural planform of narrow channels and anabranching patterns by initiating the development of forested islands through construction of engineered log jams for the purpose of riparian shade, habitat complexity and pool development, and flood conveyance. Forested islands and increased instream stable wood also serve to increase GW-SW connectivity with benefits for water quality as well as jump starting the large wood cycle described above.
6. Remove or reduce lateral constraints to channel migration and surface water connectivity, such as derelict bank armoring and groins, to clean up the riverbanks and promote natural channel migration in areas where it can safely occur.
7. Protection and conservation of locations where natural processes are functional.
8. Provide unimpaired, improved, and free river access, prioritizing places where private traditional ceremonies and regular spiritual practices are held near the river, such as the top and bottom of the Falls.
9. Prioritize environmental protection and cleanup of the river and floodplain.

Linking Existing Conditions to Opportunities For Action

Reach-based and project-wide actions were developed to address river and riparian forest health concerns observed in the field and documented in existing studies and literature. These opportunities for action are summarized in Table 8 and mapped in Figure 40.

Each of these have been developed in greater detail in a separate appended “Opportunities Matrix” excel table, which contains information pertaining to the following criteria:

Table 7 List of qualities used to describe Snoqualmie Resilient River Corridor Opportunities, see separate excel file. Letters represent excel file columns.

- Opportunity ID number (see map and Table 8)
- Reach/Zone
- Opportunity/Description
- River mile (if applicable): identifying specific action location, if any.
- Project type: types include infrastructure, engineered log jam (ELJ), forest management, assessment, protection, access, in-stream restoration, BMPs, strategy and implementation plan.
- Next steps: list of any identified next steps.
- Implementation timeframe: near-term, 2-3 years, long term, > 3 years
- Benefit timeframe: immediate, short delay, long delay
- Relative cost: low to high. Low = human powered (e.g., planting trees). Medium = light machinery, minimally designed/engineered. High=big project, good amount of risk, highly engineered
- Physical Benefits/What problem does this address?: lists benefits such as improved habitat complexity, pool creation, solves problem of forest decline, and so forth.
- Bank length affected (feet), if applicable: metric to assist with envisioning action scale and scope
- Floodplain area affected (acres), if applicable: metric to assist with envisioning action scale and scope
- Temperature benefit (none to high): estimated relative water temperature benefits. Low = possible reconnection to a colder water source or groundwater Medium = north side shading. High = south side shading or connection to known cold water source
- Aquatic habitat benefit (low to high): estimated relative aquatic habitat benefits. Low = Improves aquatic habitat conditions (i.e., increases available cover) but does not initiate restored river and floodplain processes; Medium = Initiates some restoration of river and floodplain processes but primarily focused on short term benefits such as improved cover or pools; High = Initiates restored self-sustaining river and floodplain processes
- Terrestrial habitat benefit (low to high): estimated relative terrestrial habitat benefits. Low = Improves terrestrial habitat conditions (i.e., increases forest cover) but does not initiate regenerative forest processes; Medium = Initiates some restoration of forest processes but primarily focused on short term benefits such as improved stem density; High = Initiates restored self-sustaining forest processes
- How will this action affect climate change resiliency benefits? Climate change increase peak flood resiliency benefit. Climate change increased summer drought resiliency benefit. Low = little effect on human impact of increased peak flows or drought resiliency. Medium = some effect on human impact of increased peak flows or drought resiliency. High = significant effect on human impact of increased peak flows
- Risks/issues?: estimated relative risks or issues, if any.

These categories of information are intended to evolve over time, as priorities and latest information becomes available. They may be used to assist with prioritization and implementation. This list of actions may also change over time, as opportunities and needs arise. The table below presents the current list of possible actions, organized by reach. A summary of existing conditions is also provided as context reach-based actions.

Table 8 Summary of reach-based actions to increase resiliency in the upper Snoqualmie River corridor, organized from upstream to downstream.

Study Reach	Existing Condition	Possible Actions
Three Forks Confluence	• Over-widened, extensive unvegetated gravel bars, continuing to widen based on aerial analysis. • Warmest reach – cooling trend toward downstream – MF is a warm water source. • Left bank is well connected hydraulically. • Downstream portions of reach have a mature cottonwood forest and riparian shade. Upstream portions of reach are patchy and provide opportunities for planting/establishment of taller growing tree species. • Depositional reach – historically much more sinuous	**1.** Conduct geomorphic and hydraulic assessment of bridge and road crossings to evaluate site-specific impacts. **2a.** Remove obsolete riprap and groins. **3.** Increase mainstem Snoqualmie River connectivity to cool water tributaries. **4.** Channel and floodplain restoration to encourage multi-threaded channel morphology. Create forested islands using cottonwood and willow planted engineered log jams, and restore riparian forest, prioritizing south riverbank. **5.** Reinforce emerging forested islands with engineered log jams. **6.** Supplemental planting with conifers or early seral deciduous species (cottonwood, big leaf maple) as indicated by existing conditions in stand. **7.** Conservation/protection of well-connected left bank floodplain
Meadowbrook Slough	• Minimal shade at south access point to river and along downstream half of reach on left bank • Snoqualmie Valley Trail limits surface water connectivity of side channels and floodplain • Existing powerline paralleling trail south of Reining Bridge excludes shade trees from this location and provides conditions for dense invasive species monocultures (blackberry, knotweed, ivy)	**2b.** Remove obsolete riprap and groins. **8.** Restoration of floodplain processes within Meadowbrook Slough and adjacent floodplain. Specific actions include: A) Removal of left bank revetment to increase connectivity with Meadowbrook Slough B) Revegetation and invasive species removal in left bank floodplain within Meadowbrook Slough dog park, particularly at 3 open areas at Meadowbrook Slough. C) Re-routing of Snoqualmie Valley trail and removal of elevated rail-road berm from Meadowbrook Slough to the trestle bridge

Study Reach	Existing Condition	Possible Actions
		D) Construction of flood and erosion control measures on edge of floodplain to protect residents, city property, and infrastructure. Examples include ELJs, woody revetments/levees, or other bioengineering approaches. E) Removal or relocation of trestle bridge to improve flood conveyance and safety **9.** Revegetation of left bank at dog park area - wide buffer for shade, resilience to erosion, and large wood recruitment. Existing forest nearest the river requires conifer underplanting and invasive plant species control. **10.** Relocate powerlines and convert to forested buffer. If powerlines cannot be moved, convert blackberry acreage to native shrub community and plant trees along riverbank.
City and Mill Pond	• Horizontally constrained by rip rap and north-bank SE Mill Pond Rd, limiting natural channel migration and complex habitat formation • Limited opportunities to establish forested riparian buffer to provide shade due to extensive human infrastructure along south/right bank. • King Co/Army Corps Snoqualmie Valley Flood Project peeled back banks to increase flood conveyance circa 2004/2005 • Significant invasive species (knotweed, blackberry) threaten forest health and prevent regeneration and natural establishment/recruitment of trees • Environmental contamination of Mill Pond site limits potential habitat restoration and floodplain reconnection opportunities within the site.	**11.** Add more wood to left bank timber revetment to increase structural integrity and improve fish habitat along bank. Utilize bioengineering methods (woody revetment and ELJs) to reduce erosion rates in areas without existing revetments. **12.** Build mid-channel ELJ on bar adjacent to Sandy Cove park to establish flow split, increase shade, and increase pool frequency and complex cover. Enhance side channel habitat along right bank floodplain to add additional habitat complexity. **13.** Vegetation – inside of 100' riparian buffer, control invasives (knotweed, blackberry), plant conifers, willow, dogwood, plant two currently unvegetated bars **14.** Conduct Mill Pond water quality, environmental cleanup, recreational and river connectivity assessment to evaluate potential risks to environmental quality and develop solutions to improve conditions. **15.** Improve tribal access to top and bottom of Snoqualmie Falls
Kimball Creek	• Previous dredging • Lack of riparian shade	**16.** Initiate development of protection strategy, such as creating natural areas like Three Forks, and

Study Reach	Existing Condition	Possible Actions
	• Water quality issues • Agricultural land use • Residential land use and development	implement to protect Coal and Fisher Creeks, which are providing colder, higher DO water to mainstem Kimball Creek. Much of these watersheds is currently forested, but with extensive private property ownership there could be clearing and development actions. **17.** Possible riparian reforestation around Coal Creek where it avulsed into an unforested channel at a location referenced in Baerwalde (2011, p. 10). Exact location and current riparian status need to be assessed. **18.** Riparian reforestation along the Meadowbrook reach of Kimball Creek, see maps showing low canopy cover and high reed canarygrass, and description in Baerwalde (2011, p. 11). **19.** Stream restoration in previously dredged section of Kimball Creek, which could include regrading over-steepened banks, instream wood placements to add complexity and retain gravels that are coming in from Coal and Fisher Creeks. **20.** If not already implemented, use best management practices (BMPs) recommended in Baerwalde (2011) at Casino detention pond and in application of salts to road. Casino detention pond was identified as a source of high pH and warm effluent to tributary "KT", which flows into Kimball Creek.
Project Area	• Declining riparian and floodplain forest • Flood and erosion risk increasing with climate change	**21.** Forest stewardship and management plan **22.** Conduct climate change flood and erosion risk analysis in conjunction with future resilient river corridor action analysis.

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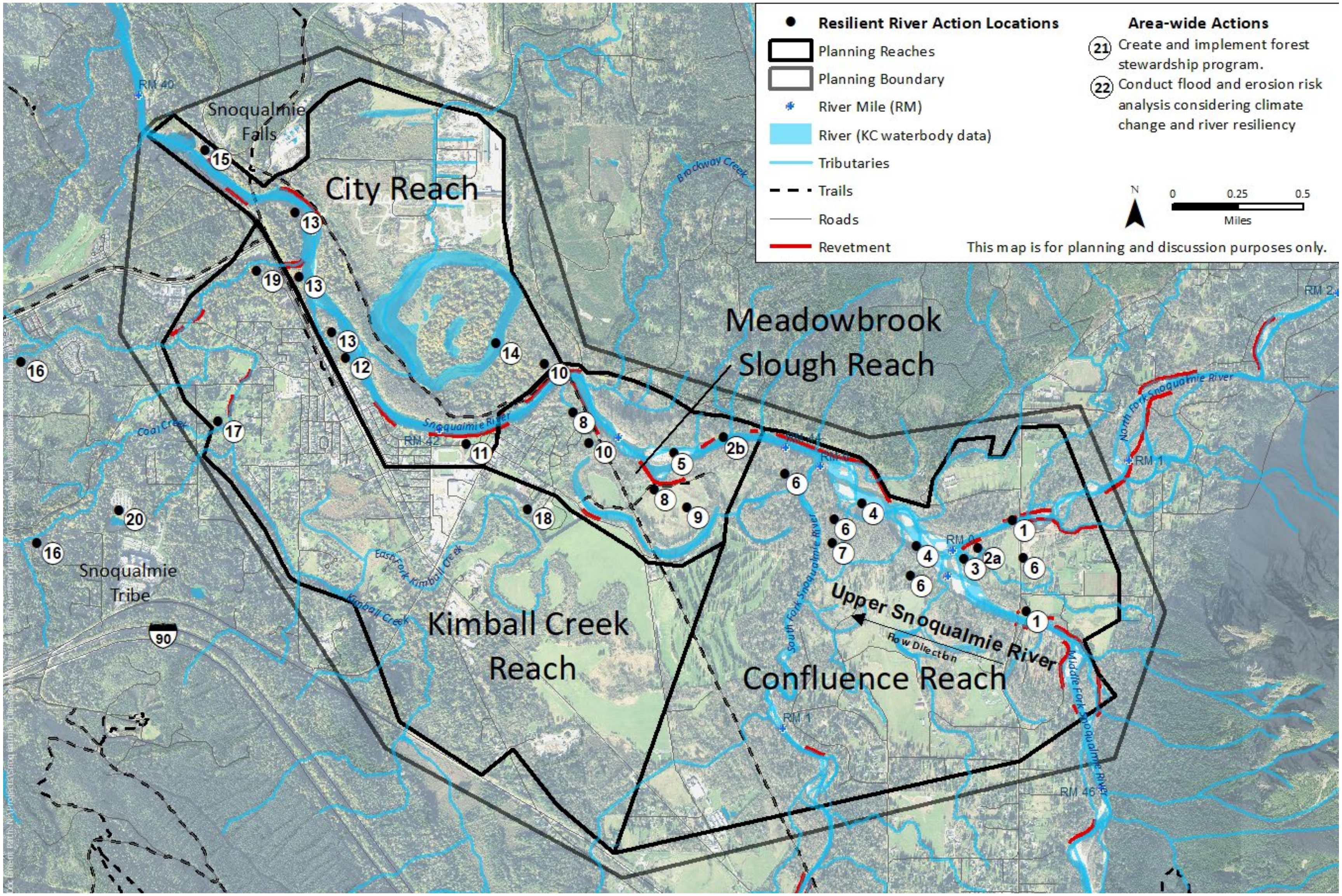

Figure 40 Map of potential resilient river corridor actions.

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These two-dozen, or so, actions provide a list of actionable items to restore natural processes, leverage natural flood protection and groundwater infiltration and habitat benefits, and improve climate change resiliency for the Upper Snoqualmie River. Many of these actions will require more detailed analysis to determine feasibility and benefits. One of the biggest ideas is to move the Snoqualmie Valley Trail crossing at Meadowbrook Slough from the old railroad trestle to the existing road network and a different bridge in the City of Snoqualmie, downriver (Figure 41).

A Note On Unique Considerations For Relocation Of Snoqualmie Valley Trail

The existing railroad grade, crossing the valley in the vicinity of Meadowbrook Slough, has a significant impact on the river. The trail constrains the river and floodplain to the north side of the valley and resulting in the placement of un-natural riprap banks where the river runs alongside. Thus, one of the boldest ideas of the plan is to move the Snoqualmie Valley Trail crossing at Meadowbrook Slough from the old railroad trestle to the existing road network and a different bridge in the City of Snoqualmie, downriver (Figure 41). Removal of this railroad grade is essential to restoring floodplain connectivity, channel morphology, and natural riverbanks.

The current bridge across the river also appears to be a public safety hazard, with several memorials on the bridge deck. The staircase is also a major interruption in bike trail, and it is not ADA compliant. Removing this bridge will eliminate a dangerous river-jumping point and a major constraint on resilient river and floodplain dynamics.

One suggestion would be to design a new multi-modal trail along the terrace surface along a restored river corridor. The new path would be designed to afford a safer, universally accessible, biking and walking route with better access to community facilities. The new route may go over any of the bridges upstream or downstream of Snoqualmie, benefiting local businesses, and rejoin the current route downstream of Mill Pond (Figure 41). The new trail route could also be combined with appropriate flood defenses along the restored floodplain corridor that would maintain or improve flood protection for City of Snoqualmie.

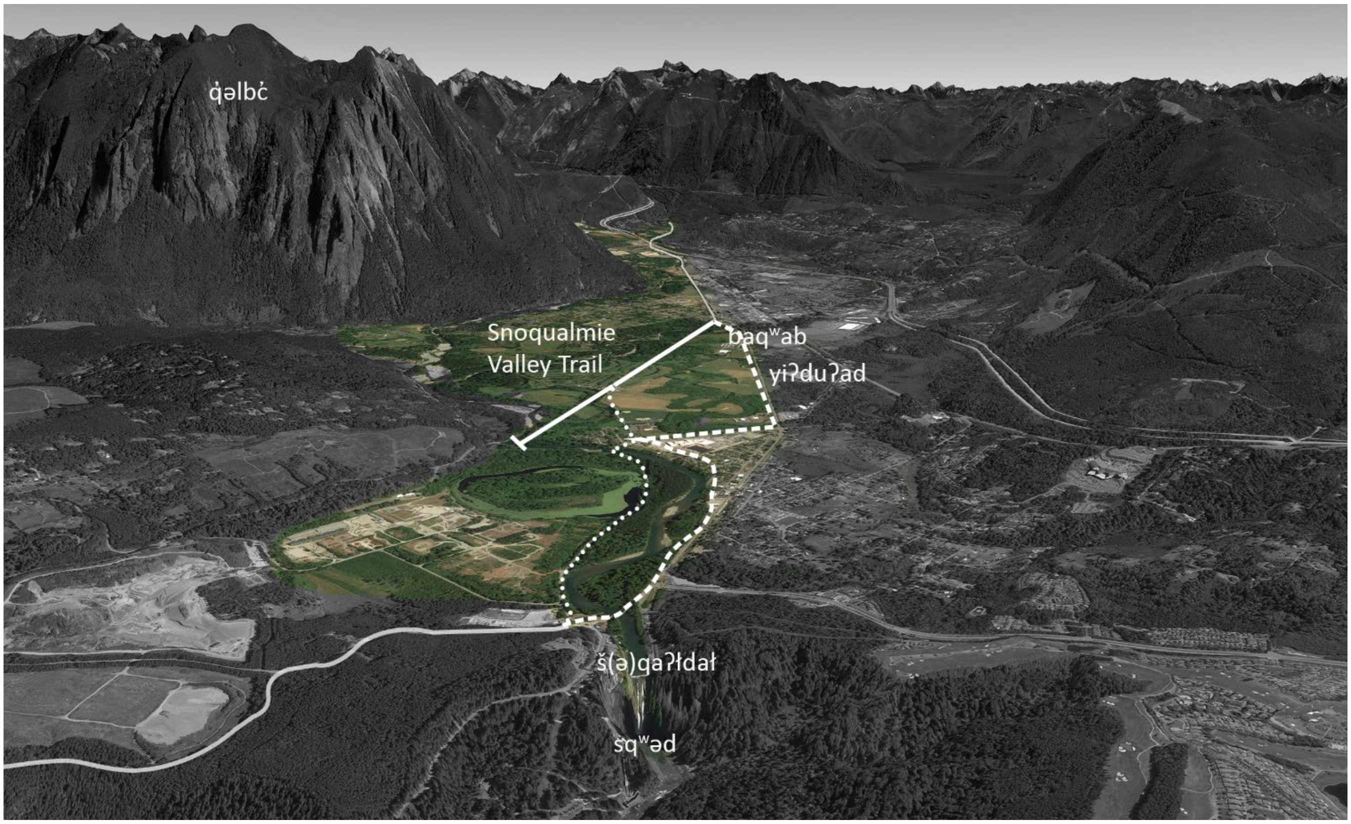

Figure 41 Schematic of two alternative Snoqualmie Valley Trail river crossings over existing bridges (dotted and dashed lines), allowing for removal of railroad berm and trestle from Snoqualmie River and floodplain (middle ground solid line with tick-mark at the end). This idea is part of Action 8 in the map and table above.

Removal of this railroad berm and trestle from the floodplain, and relocating the Snoqualmie Valley Trail, may result in significant river resiliency benefits, however much more analysis and community feedback would need to be conducted to determine specific benefits and to identify any potential risks.

A Note On Unique Considerations For Remediation And Restoration Of The Mill Site And Pond (Borst Lake)

The Weyerhaeuser Snoqualmie Mill Site (Mill Site) occupies almost half of the Snoqualmie River corridor and floodplain within the City Reach. The Mill Site also contains the largest floodplain waterbody (Mill Pond) within the project area and because of that represents a valuable restoration opportunity that could vastly expand the extent of connected floodplain throughout the otherwise constrained city reach. However, the Mill Site has a long history of industrial use and contamination and therefore actions to increase hydrologic connectivity under current conditions is not recommended. In addition, the Mill Site also presents a risk to the Snoqualmie River ecosystem due to existing surface and ground water connections between the Mill Pond and the river corridor – a risk that is likely to increase with climate change.

Surface water from the river interacts with Mill Pond during floods, where flood waters may mobilize polluted sediments and transport them into the adjacent floodplain, river corridor, and eventually downstream where they may negatively impact the food web and ecosystem in general. Under existing conditions, flood waters are predicted to first interact with the pond around the 2-year flood by backwatering into the pond up the outlet. At the 5-year flood, water overtops much of Southeast Mill Pond Road resulting in surface flow between the pond and the river. The frequency of the surface water connection between the pond and the river is predicted to increase under climate change, with water overtopping the road during the projected future 2-year flood. Contaminated groundwater may also flow through the alluvial aquifer into the river due to the lateral hydraulic gradient caused by the vertical offset between the pond and the river. The gradient may be more pronounced during summer low flows when the vertical offset is greatest – a process that may increase with climate change when summer low flows are predicted to be lower. Detailed descriptions of the surface and ground water interactions can be found in the “Current State of Hydrogeomorphic Processes” section above.

While there has been some remediation to clean up historical pollutants within the Mill Site, contamination still exists and would need to be addressed before any meaningful aquatic habitat restoration of the Mill Site could occur. However, floodplain forest restoration could begin immediately. The Mill Site’s proximity to the City of Snoqualmie also represents a constraint to restoration work on the Mill Site, especially if increasing connectivity to an un-remediated Mill Site is considered, because of the inherent risk of pollutants escaping the Mill Site and affecting City residents. The following section provides an overview of the Mill Site, including a summary of the contamination history and associated risks to the Snoqualmie River ecosystem, and outlines some potential restoration strategies that can be considered in the Corridor Plan.

Contamination – Assessment and Remediation

Pollutant Summary

- Groundwater at the upland portion of Mill site is contaminated with PCBs and diesel above Method A (Ecology State cleanup level) levels.
- Sediments in the Mill Pond contain Diesel, VOCs, PAHs, and metals at elevated levels. PCBs have been found in the two former railroad berms, immediately adjacent to Mill Pond.
- Recent (2021) sampling at the Mill Site indicates that the Mill Site is a considerable risk to human health and/or the environment due to contamination from petroleum hydrocarbons, PCBs, PAHs, and phenols.

The Weyerhaeuser Snoqualmie Mill Site has a history of contamination dating back to 1989 when the first documentation of contamination was reported to the Washington Department of Ecology (Ecology), although it likely dates to the early 1900s when the mill was first active. Multiple Ecology programs have worked on the Mill Site during and since mill operations ended in May 1993 and are summarized in the following section (Washington Department of Ecology, 2021).

In 2004, a Level II Environmental Site Assessment (ESA) of the Mill Site was conducted to evaluate the extent of potential pollutants (Delta Environmental Consultants Inc., 2004). Petroleum hydrocarbons (gasoline-, diesel-, and/or heavy oil-range petroleum hydrocarbons), were detected at concentrations above their respective state cleanup levels in multiple areas and source locations within the upland soils of the Mill Site. Diesel contamination in groundwater was also detected at multiple areas. Soil samples collected at the boiler ash fill area also indicated elevated concentrations of arsenic and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) (see Figure 42).

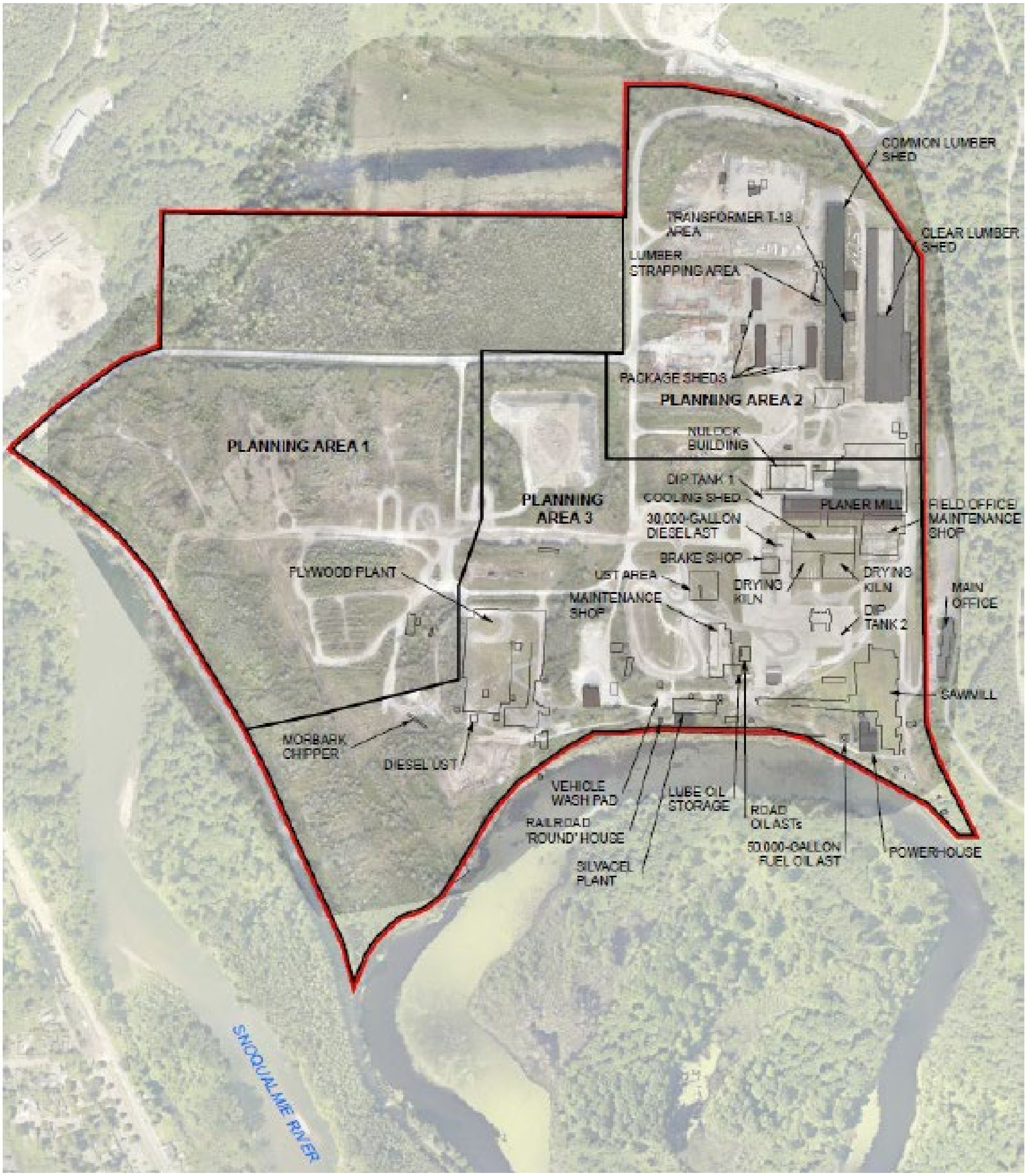

Figure 42. Location of Mill Site structures during mill operations, borrowed from page 30 of (Washington Department of Ecology, 2021). Planning Area designations refer to potential redevelopment. The boiler ash fill area is likely in the southeast corner of the site, adjacent to the powerhouse. Original map created by Farallon Consulting Inc. (2019).

In addition to a Level II ESA, a Level III ESA was conducted to further evaluate the nature and extent of contamination of soil and/or groundwater in areas of the Mill Site where the initial pollutants were measured (Delta Environmental Consultants Inc., 2004). Contamination was identified in either soil or groundwater in most of the areas.

Remediation of petroleum-contaminated soils occurred across much of the Mill Site in 2005 following the completion of the ESAs. Soil from these areas were excavated, stockpiled, and remediated using a bioremediation technique to lower petroleum concentration in the soils. Documentation at the final limits of excavations reported elevated concentrations of both PCBs and benzene, indicating that they remain in the soil and groundwater in one or more locations, primarily concentrated near former underground storage tanks. No further remediation of the Mill Site has been documented to date.

In addition to the documented soil contamination, pollutants have also been measured within the sediments of Mill Pond. Sampling efforts by PES in 2020 describe lithology as black silt and silt with sand, and upper six inches abundant root organics and wood pieces and at time or writing, no record was found of any water samples being collected within the Mill Pond to get a snapshot of current conditions. The upland mill area and plant outflow runoff was discharged to the Mill Pond from 1992 to 2004 under National Pollution Discharge Elimination System (NPDES) Permit No. WA-000173-2, transporting contaminated soils into pond's sediments. While the Mill Site had permission to discharge runoff during this time, it may have also occurred before permit approval. Further assessment is needed to determine if other activities of the Mill operations may have polluted sediments and waters within the pond. Sampling completed by Ecology (1993) and PES Environmental (2020) in the mill pond (Borst Lake) sediments detected the following at elevated levels: diesel, semi volatile organic compounds (including PAHs and benzene, toluene, ethylbenzene, and xylene [BTEX]) and metals. During the 2020 sampling effort, depth to sediment at the sampling locations ranged between 1 and 4 feet below the water surface. Samples were collected from the top 6 inches of the sediment core. Overall, concentrations of the detected chemicals tended to be lower in the samples. No documentation has been found regarding remedial actions at this location.

The Washington State Department of Ecology (Ecology) recently completed an analysis of contamination at the Mill Site by performing a site hazard assessment on 8/20/21 (Washington Department of Ecology, 2021). The Mill Site's hazard ranking, which is an estimation of the potential threat to human health and/or the environment relative to all other Washington State sites assessed at this time was determined to be a one, which represents the highest risk. The Mill Site was determined to be contaminated with petroleum hydrocarbons, PCBs, PAHs, and phenols. It is unknown what the next steps in the remedial process for the Mill Site will be at this time however, a Final Environmental Impact Statement (EIS) for the Mill Site was released by the City of Snoqualmie on December 9, 2021, evaluating over 900 pages of public comments on the Draft EIS, released in April 2020.

Mill Site Restoration Opportunities

The risks to the Snoqualmie River ecosystem posed by the existing contamination at the Mill Site represent a major constraint to potential restoration actions. Any restoration actions that increase surface water or groundwater connectivity with the Mill Pond could in turn increase the risk of introducing contaminants into the Snoqualmie River. Because of this, we consider three categories of restoration actions (Table 9):

(1) restorative actions that could be undertaken immediately, without remediation.

(2) restorative actions that may be taken in the near-term (<5 years) to prepare for potential future remediation and subsequent remediation.

(3) restoration actions that could occur following remediation of the Mill Site.

Given the existing contamination, current proposed restoration actions are focused on areas within the existing forest and surrounding un-polluted upland areas, which could provide ecological uplift and terrestrial habitat improvement. These actions include forest restoration and conversion of the road prism of Southeast Mill Pond Road to a forested levee. Removal of the road prism is excluded from near-term consideration because it currently provides a physical barrier between Mill Pond and the Snoqualmie River during high frequency floods. In addition to actions with immediate ecological benefit, additional near-term actions could support restoration of the Mill Pond site if remediation were to occur. For example, planting and maintaining a forested buffer on the north side of the Mill Pond now would ensure that a mature forested buffer exists, rather than development up to the pond edge, if and when Mill Pond were restored to provide aquatic habitat. Also, because of the central and large-scale significance of the Mill Pond to the City Reach of the Snoqualmie River Resiliency Corridor, if the Mill Site were to be remediated in the future and the contamination risk alleviated, more aggressive actions to increase floodplain connectivity such as the removal of Southeast Mill Pond Road, construction of ELJs, and floodplain grading should be considered and evaluated.

Table 9 Mill Pond restoration actions, organized by timeline and remediation status.

TIMELINE AND REMEDIATION STATUS	RESTORATION ACTIONS	NOTES
Immediately and without remediation	Restore forest within center and along margins of Mill Pond – including invasive species removal – affords immediate ecological uplift for terrestrial habitat. This would also prepare forest surrounding Southeast Mill Pond Road for future barrier removal if remediation of Mill Pond occurs Consider decommissioning Southeast Mill Pond Road and power line corridor and converting road prism to forested levee to maintain barrier between Mill Pond and river but eliminate road and power line corridor as a source for invasion for the forest. This space could also be converted to passive recreation access and provide a space for the Snoqualmie Valley Trail and increased Tribal access to the river on the right bank.	Forest restoration could be conducted in conjunction within the overall Forest stewardship and management plan for the full planning area

TIMELINE AND REMEDIATION STATUS	RESTORATION ACTIONS	NOTES
In preparation for potential remediation	Protect and expand forested buffer to north side of Mill Pond in anticipation of future restoration of Mill Pond. Allowing development up to the pond edge in the near-term will result in degraded/minimal habitat in the long-term if Mill Pond is restored. Conduct feasibility assessment for restoration actions to increase floodplain connectivity to the Mill Pond without increasing flooding in the City of Snoqualmie If feasible, develop restoration designs that can be implemented following site remediation	Feasibility assessment could also evaluate how options may reduce overall flooding in the City of Snoqualmie due to the additional floodplain storage and area provided by the Mill Pond
Following remediation	Remove Southeast Mill Pond Road to increase floodplain connectivity to the Mill Pond Implement restoration actions such as construction ELJs and floodplain grading to increase floodplain connectivity to the Mill Pond Restore emergent marginal vegetation and riparian cover within Mill Pond waterbody	

A Note On Unique Considerations For Restoration Of Sandy Cove Park River Bank

Long-term erosion resiliency at Sandy Cove Park means addressing larger river and floodplain restoration needs, eventually. It is possible to implement a bank protection design which utilizes wood or functions as wood (e.g., dolos) to reduce bank erosion at Sandy Cover Park over the long term (decades). There are several examples of engineered log jams in urbanized rivers, where the ELJ pools are used in the summer as swimming holes (see Eatonville ELJ photo) and river velocities and shear stress are much reduced. Wood longevity approaches centuries in submerged conditions and lasts many decades when exposed to open air. This wood may be replaced from restored riparian forests, nearby. In the Snoqualmie River, it is critical that new bank protection measures are self-settling and deformable. While rock rolls and moves away from eroding riverbanks, wood digs itself in and continues to function as bank protection and aquatic habitat. Furthermore, the Snoqualmie River is a forested system, and river processes and species evolved and respond to wood-based in-channel structures, not rock-based. Protection of Sandy Cove Park is also best done in conjunction with upstream and adjacent river restoration, implementing measures to increase conveyance by dispersing slower flows through restored side channels. Restored side channels would include increased in-channel and floodplain wood placement, enhanced riparian and floodplain forest, and other much needed ecological enhancements.

Figure 43. Example of summer fun in the pool of an engineered log jam at Eatonville city park, image courtesy of the City of Eatonville.

Summary Of Meetings with Cities and King County

In the last week of January 2022, the Snoqualmie Tribe presented the draft Upper Snoqualmie Resilient River Corridor Management Plan to elected officials and staff from the City of Snoqualmie, the City of North Bend, and King County. The purpose of these government-to-government meetings was to introduce the draft Plan with the goal of beginning to craft a common vision of a resilient river for all.

Creating this common vision was intended help to guide conversations with other decision makers. “For example, habitat above Snoqualmie Falls was a focus point, with decreased restoration and protection attention being given to this area due to lack of anadromous access. This project is an attempt to elevate the Upper Snoqualmie River to receive parity in the attention and funding given to salmon-bearing river reaches. This part of the watershed is a critical driver for downstream river conditions, which are affecting habitat productivity for native aquatic species.

At all of the meetings, Matt Baerwalde, Environmental Policy Analyst for the Tribe, and Project Manager for this project, presented on the project outreach process, how data was collected, drafting of the Resilient River

Corridor Management Plan, and finally the outputs and desired outcomes after plan finalization. Matt invited attendees into dialogue during the presentation, but also emphasized that the launching of the final corridor plan is the start of many smaller individual conversations amongst community members and river and land managers regarding the current and future management of the Upper Snoqualmie Resilient River corridor. City and County staff acknowledged the importance and usefulness of having planning documents such as the RCMP available to reference and to integrate into their own future planning efforts.

Summary of Meeting with City of North Bend (Monday, 1/24/2022)

List of Attendees:

Snoqualmie Tribal Council: Chairman Robert de los Angeles **Snoqualmie Tribal Staff:** Matt Baerwalde Cindy Spiry Jaime Martin Michael Ross **Snoqualmie Tribal Consultant:** Danielle Devier	**City of North Bend:** Rob McFarland, Mayor David Miller, City Administrator Rebecca Deming, Community & Economic Development Director Mark Rigos, Public Works Director Danna McCall, Communications Manager

Meeting Summary:

Representatives from the City of North Bend found the presentation of the draft Upper Snoqualmie Resilient River Corridor Management Plan to provide useful information, that it seemed like a proactive body of work, and a great vision for important river and water protection.

There were questions about how the Snoqualmie Tribe sees the Plan meshing with work by other jurisdictions (USACE, FEMA, KC, WRIA, etc.) and how the Plan relates to people and growth. These questions were addressed by reiterating the relationship between healthy recreational access and preserving natural experiences, and the practical long-term benefits of alluvial water storage for improved summer water supply.

The City is interested in further coordination with the Tribe. It was mentioned that there were a number of initiatives that City was working on at the time of this meeting that may be good opportunities for collaboration, especially with regards to water quality. They are particularly interested in hearing more about projects in Three Forks Natural Area.

This Plan is a helpful insertion of unfettered values on River management and City representatives reasserted that they personally support this vision, combining the act of being a good human to resiliently supporting a growing North Bend.

Summary of Meeting with King County Councilmember Sarah Perry (Monday, 1/24/2022)

List of Attendees:

Snoqualmie Tribal Council: Chairman Robert de los Angeles **Snoqualmie Tribal Staff:** Matt Baerwalde Cindy Spiry Jaime Martin Michael Ross **Snoqualmie Tribal Consultant:** Danielle Devier	**King County Council:** Sarah Perry, District 3 King Councilmember Matthew Randazzo V, Senior Advisor to the Commissioner of Public Lands at the Washington State Department of Natural Resources Libby Hollingshead, Chief of Staff to King County Councilmember Sarah Perry

Meeting Summary:

Understanding the physicality of experience of a place is an important part of Councilmember Perry's leadership and decision-making process and that a tour would be extremely helpful to visually understand and experience the landscape first-hand. Just named Chair of the Local Services and Land Use Committee. This Plan is truly relevant to her new role. She would like for the Tribe to consider adding a State of Washington representative or someone from the Department of Ecology to future conversations, especially with regards to recreational impacts. Councilmember Perry mentioned that she is learning a lot about a lot, meeting with City leaders, fire chief, community groups such as the RAC (rural advocates committee), master builders association, etcetera and trying to understand 'sticking points', and intersection with Tribal perspectives and responses. If appropriate, she would like to a more consistent conversation with the Tribe about these topics, within the framework of Free, Prior and Informed Consent

Matt Baerwalde from the Tribe mentioned that while there are many divergent interests, and it will be important to get behind a common vision to support careful decision making. This Plan takes a step back, works across multiple time scales, and creates a common vision for long term co-managed resilient river.

The Tribe supports the creation of a story map of some key locations to help visualize different problems and solutions, this map could also be used as a self-led tour for outreach and education.

This meeting occurred at the perfect time for this conversation, on day twenty-four of the legislative session. This presentation provided context for a wide range of Tribal concerns. The Tribe will work to schedule more meeting time with Councilmember Perry, as well as compile a list of ways to stay connected, such as copying Councilmember Perry on tribal responses on King County projects. Ancestral Snoqualmie Tribe lands are being managed by the committee that Councilmember Perry is leading, and ongoing conversations are important.

Summary of Meeting with City of Snoqualmie (Wednesday, 1/26/2022)

List of Attendees:

Snoqualmie Tribal Council: Deputy Secretary Chris Castleberry **Snoqualmie Tribal Staff:** Matt Baerwalde Cindy Spiry Jaime Martin McKenna Dorman **Snoqualmie Tribal Consultant:** Danielle Devier	**City of Snoqualmie:** Katherine Ross, Mayor Mike Sauerwine, City Administrator Bob Sterbank, City Attorney Jason Rogers, Interim Community Development Director Jeff Hamlin, Public Works Project Engineer

Meeting Summary:

The meeting with the City of Snoqualmie was the last meeting of the week. The first question from the City was about why the Middle Fork Snoqualmie River (MF Snoqualmie) is so much warmer than the other tributaries? And whether it could be due to geothermal influence? The Snoqualmie Tribe have been conducting recent collaborative research Snoqualmie Science Coordination and Advisory Team (SnoSCAT) looking at river water temperature dynamics and they have found that the geothermal influence is not significant in MF Snoqualmie. Lack of forested islands and little riparian shade was stated as the likely culprit.

The City of Snoqualmie were also interested in knowing whether the Tribe planned to present the Plan to the Mill Pond landowner. While the Tribe had not in touch with them prior to the time of this meeting, it was agreed that a meeting with them seemed like a good idea.

The newly elected Mayor, Katherine Ross, stated that she was very much looking forward to final plan and discussing with City staff and the City Administrator requested a copy of the presentation. The City Planner acknowledged the discrepancy in available grant funding above and below falls and that this Plan helps inform the watershed forum conversation about that unreasonable division. Upstream conditions directly affect downstream conditions.

The Tribe agreed to share the slides and the Plan as soon as it is published and reiterated that the idea behind this plan is to build empathy and a common vision between what the Tribe is trying to accomplish and the interests of other residents. At the time of this meeting, several meetings with landowners and watershed forum groups were scheduled. The Tribe appreciates the vision of a corridor-perspective and supports working on this Plan piece by piece.

Summary of Meeting with King County staff from the Department of Natural Resources and Parks Water and Land Resources Division (DNRP/WLRD) River and Floodplain Management Section (RFMS) (Tuesday, 1/25/2022)

List of Attendees:

Snoqualmie Tribal Staff: Matt Baerwalde Heather Minella **Snoqualmie Tribal Consultant:** Danielle Devier	**King County DNRP/WLRD, SF Skykomish/Snoqualmie River Basin Staff:** Chase Barton, Supervising Engineer Gus Kays, Engineer III Chrys Bertolotto, Project/Program manager III John Klochak, Environmental Scientist III **King County DNRP/Parks Staff** Kelly Heintz, Capital Planning and Land Management **King County DNRP/Parks/RRS Staff** Denise Di Santo, Watershed Stewardship **King County DNRP Staff** Joe Hovenkotter, Tribal Relations **King County Local Services Staff** Jesse Reynolds, Sub Area Planner

Meeting Summary:

King County mentioned that they have plans for some of the revetments that were identified for replacement or removal in the Plan, as well as an upcoming update to the flood hazard management plan. As report is finalized, opportunities for integration should be identified. The annual King County check-in meeting with the Tribe was planned for some time in March and may be a good starting point for some collaboration. Additional opportunities for communication or collaboration should also be found.

The Tribe reiterated that this plan is intended to create space for these collaborative conversations and to develop a common community vision for planning and decision making. When asked by King County staff why there were fewer recommendations for South Fork Snoqualmie and Middle Fork Snoqualmie River, the Tribe mentioned the need for a discrete planning area to make the planning and analysis process workable within project budget.

Staff from King County also wanted to hear more about the connection between river restoration and tribal access. The Tribe responded that this Plan is a synthesis of technical work and community vision, which has not been done. The goal of this Plan is to look for common ground and building empathy between different communities. Tribal access and recreational access are excellent ways to build empathy between people and the River, advancing a long-term stewardship agenda. The County found it helpful to understand the vision of the Snoqualmie Tribe, and to have some guidance for land acquisition, and opportunities for trail and landscape improvement.

Denise di Santo mentioned that she met with Ryan Lewis, restoration manager from Tribe, in December 2021 and they developed a map to help Denise allocate some restoration resources and develop near term restoration plan. Furthermore, Kelly Heintz mentioned that King County Parks had worked with the University of Washington on Three Forks Forest Restoration and Stewardship plan. She would like to share it with the Tribe. They may be able to help with a future forest stewardship plan.

When asked whether the Snoqualmie Tribe plans to consult with other tribes on this Plan, the Tribe listed several past and upcoming meetings, some of which were and could be attended by representatives from other tribes. However, no direct tribe to tribe outreach was planned prior to this meeting.

The County also asked about alluvial water storage and what that might look like in this valley. The Tribe re-emphasized that the scientific aspects of the Plan focused on active restoration of floodplain connectivity and natural processes. Jesse Reynolds, a King County planner, was interested in looking at the floodplain with Tribe to look for opportunities to support the Plan. King County's water quality and habitat program may be able to support the Plan as well. Chase Barton will share the final Plan with that group, once it is published.

Resilient River Corridor Management Plan Case Studies

Below is a list of example cities which have implemented a resilient river corridor management plan with economic and ecological success. These examples were selected as relatively local examples for river managers, planners and decision makers to reference going forward, however, resilient river management is happening worldwide and there are many other excellent programs and projects.

Johnson Creek, Portland, Oregon: ongoing restoration of Johnson Creek watershed includes 150 acres of restored floodplain, over 200,000 trees and shrubs planted, over 16,000 feet of streambank restored, a successful willing seller program (since 1997). Additional information about the ongoing restoration of Johnson Creek watershed may be found in the following list of sources:

- http://nrcsolutions.org/johnson-creek-restoration-portland-oregon/ Johnson Creek Report Card ("Johnson Creek Report Card | Report Cards | The City of Portland, Oregon," n.d.)
- Economic Arguments for Protecting the Natural Resources of the East Buttes Area in Southeast Portland. (City of Portland Bureau of Environmental Services, 2009)
- Johnson Creek Watershed Action Plan.(Johnson Creek Watershed Council, n.d.)
- Johnson Creek Restoration Plan. (*Johnson Creek Restoration Plan*, 2001)
- And others (https://www.portlandoregon.gov/bes/33212)

Boulder Creek, Colorado: The Boulder Creek Restoration Master Plan (2015), aims to improve resilience along twenty-four miles of Boulder Creek, from its confluence with Fourmile Creek in Boulder Canyon to the confluence with St. Vrain Creek in Longmont. Strategies include bioswales, green streets, forest stewardship, floodplain restoration, changes to planning and zoning, and others. http://nrcsolutions.org/boulder-creek-floodplain-restoration-boulder-colorado/

Dungeness River, Washington: the Jamestown S'Klallam Tribe has been working on the Olympic Discovery Trail. In 2015, a 750-foot long new bridge was built across the Dungeness River in 10 months and two days in a location where large floods damaged a large old railroad trestle, to the point where it could no longer function as a part of the Olympic Discovery Trail and presented a significant pollution hazard to the river and habitat downstream (Johnson, 2015). The length of the new bridge and the speed at which it was built are not typical for an emergency repair, and this project is a good example of rapid-long-term resilient river management.

Figure 44 Image of 750-foot Olympic Discovery Trail Dungeness River crossing built by Jamestown S’Klallam Tribe (Johnson, 2015). Aerial Photographs provided by John Gussman.

Napa River, California: a multi-jurisdictional collaborative restorative flood mitigation approach, in-progress since 1998, leveraging many different features and techniques to return the river to its natural state and utilize the river’s natural features to prevent flooding. Bridge removal, railroad relocation, land acquisition, were all a part of this plan. Actions are ongoing. http://nrcsolutions.org/the-napa-river-basin-california/

For more examples, Naturally Resilient Communities provides excellent web-based database of resilient river and floodplain solutions and case studies. http://nrcsolutions.org/restoring-floodplains/

Identified Next Steps

Suggested next steps for the Upper Snoqualmie Resilient River Corridor Management Plan (Plan) are*:

1. Follow up on actions identified during January 2022 County and City meetings (see Summary of Meetings with Cities And King County).
2. Snoqualmie Tribe begins to prioritize actions and develop a Tribal plan for next steps. Priorities may vary by department.
3. Integrate and align existing city and county hazard mitigation plans, comprehensive land use plans and other planning initiatives with the Resilient River Corridor Management Plan (the Plan) and Tribal priorities as identified pursuant to the Plan (see #2 above).
4. Continue to get the word out via multiple communication channels (e.g., normal staff and governmental meetings, social media, land use review, etc.). Continue to refine the Plan and the project concepts identified within the Plan.
5. Leverage relationships and communication channels established in the creation of this Plan and elsewhere to build a community river stewardship program and begin to restore the riparian and floodplain forest.

*List is not in a prioritized order.

Image of Upper Snoqualmie River taken by Snoqualmie Tribe, 2019.

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