Agriculture Resilience Plan for Snohomish County

Prepared by:

Snohomish Conservation District

December 2019

COVER PHOTO CREDIT:
Lorenzo Townsend, Snohomish Conservation District, 2019.

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December 2019

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Funding

NOAA Community Based Restoration Program
Stillaguamish River Lead Entity
Estuary and Salmon Restoration Program
EPA National Estuary Program
Floodplains by Design

Recommended Citation

Snohomish Conservation District, 2019. Agriculture Resilience Plan for Snohomish County. Lake Stevens, Washington.

"A bee works its essential magic in the blueberry blossoms, sharing the hope and promise of another summer of organic, antioxidant rich blueberries at Hazel Blue Acres."

Karen Wolden-Fuentes, Hazel Blue Acres Farm, Photovoice 2017

Executive Summary

This Agriculture Resilience Plan is a plan guided by and developed for the local farming community in Snohomish County. The Plan will help build a more resilient agricultural landscape – one that can withstand pressures and changes associated with development, population growth, flooding, shifts in weather and climate change. Through a combination of information gathering and sharing, creation of online planning tools, project scoping and design, project implementation, and farmland protection, the Agriculture Resilience Plan will help ensure local agriculture remains a cornerstone of our way of life and value system in Snohomish County.

"The Agriculture Resilience Plan is an effort to help all of us farmers weather the changes that are coming in the future. It's a way for farmers to raise their voices together and create change to benefit agriculture."

Libby Reed, Orange Star Farm

The goals of the plan are to:

- Provide **information** and project **funding** for farmers to manage for future risk on their farms
- Develop landscape-scale **projects** to improve agricultural resilience
- **Protect** agricultural lands from subdivision or development

Agriculture in Snohomish County

— *Over 63,000 acres of active farmland*

— *1,558 farms*

— *Farms as large as 2,000 acres*

— *Agricultural products selling for over $157 million per year*

Source: United States Department of Agriculture

Agricultural resilience can be improved by helping farmers plan for future challenges and risk, absorb future change, and more quickly recover from stress.

The Agriculture Resilience Plan is linked to the work of the Snohomish County Sustainable Lands Strategy (SLS). SLS, started in 2010, is a collaborative effort of partners working to improve coordination and generate progress for fish, farm, and flood management in the Snohomish and Stillaguamish watersheds. As a participant in SLS, the Snohomish Conservation District identified a gap in the scientific understanding of agricultural needs, particularly as they relate to climate change, as well as an organized planning approach to developing priority landscape-scale projects. This Agriculture Resilience Plan is intended to fill this data gap and identify priority resilience projects that will keep Snohomish County's agricultural lands viable into the future.

Need for Resilience

Despite the increasing importance of and need for local farming in Snohomish County, agriculture is threatened by development and environmental changes. The United States Department of Agriculture noted that farm sector profits declined by $9.8 billion from 2017 to 2018 across the country. This represents 13 percent of the profits from farming. Production expenses are forecast to increase by $11.8 billion due to increases in costs for fuel, feed, and hired labor. Finances are just one of the pressures facing farmers. American Farmland Trust has identified that 175 acres of farm and ranch land in the United States are lost to sprawl and development every hour, while 1.7 billion tons of topsoil are lost to erosion each year. These trends and pressures also affect Snohomish County farms. Everett is one of the fastest growing cities in Washington State, and the rising cost of land makes it difficult for farmers to stay in the county.

In addition to the existing economic and development pressures on agriculture, climate change will present additional challenges into the future. In Snohomish County, sea level rise is expected to lead to saltwater intrusion and rising groundwater tables. A changing climate will cause drier summers, wetter winters with more intense storms, and increased river flooding. Land subsidence and riverbank erosion are expected to continue and increase.

How the Agriculture Resilience Plan was Developed

The Agriculture Resilience Plan is intended to be the farmers' plan – a document that reflects the interests and priorities of farmers in Snohomish County. Therefore, outreach to and engagement with farmers and the farming community has been a key component of developing this plan and will continue to be central to its implementation. Input from farmers has been solicited through the formation of a Steering Committee of local farmers, outreach to existing agricultural groups and individual farmers, and a photo documentation project called PhotoVoice.

Snohomish Conservation District formed a Steering Committee for the Agriculture Resilience Plan in order to ensure that the plan is guided by the input of local farmers. The Committee is comprised of 9 Snohomish County farmers representing various types, sizes, and locations of farms. The Steering Committee met quarterly to provide guidance on the direction and development of the plan.

In addition to soliciting guidance from the Steering Committee, the Conservation District conducted extensive outreach to the local farming community. In fall 2016 and winter 2017, the Conservation District reached out to existing agricultural groups to ask for input into the scope of this project. Groups included the Snohomish Conservation District Board of Supervisors, Focus on Farming attendees, the Sustainable Lands Strategy Agriculture Caucus, the Snohomish County Farm Bureau, Snohomish County Cattlemen, the Snohomish County Agricultural Advisory Board, SnoValley Tilth, the Coordinated Diking Council, the Marshland Flood Control District, the French Slough Flood Control District, and the Stillaguamish Flood Control District.

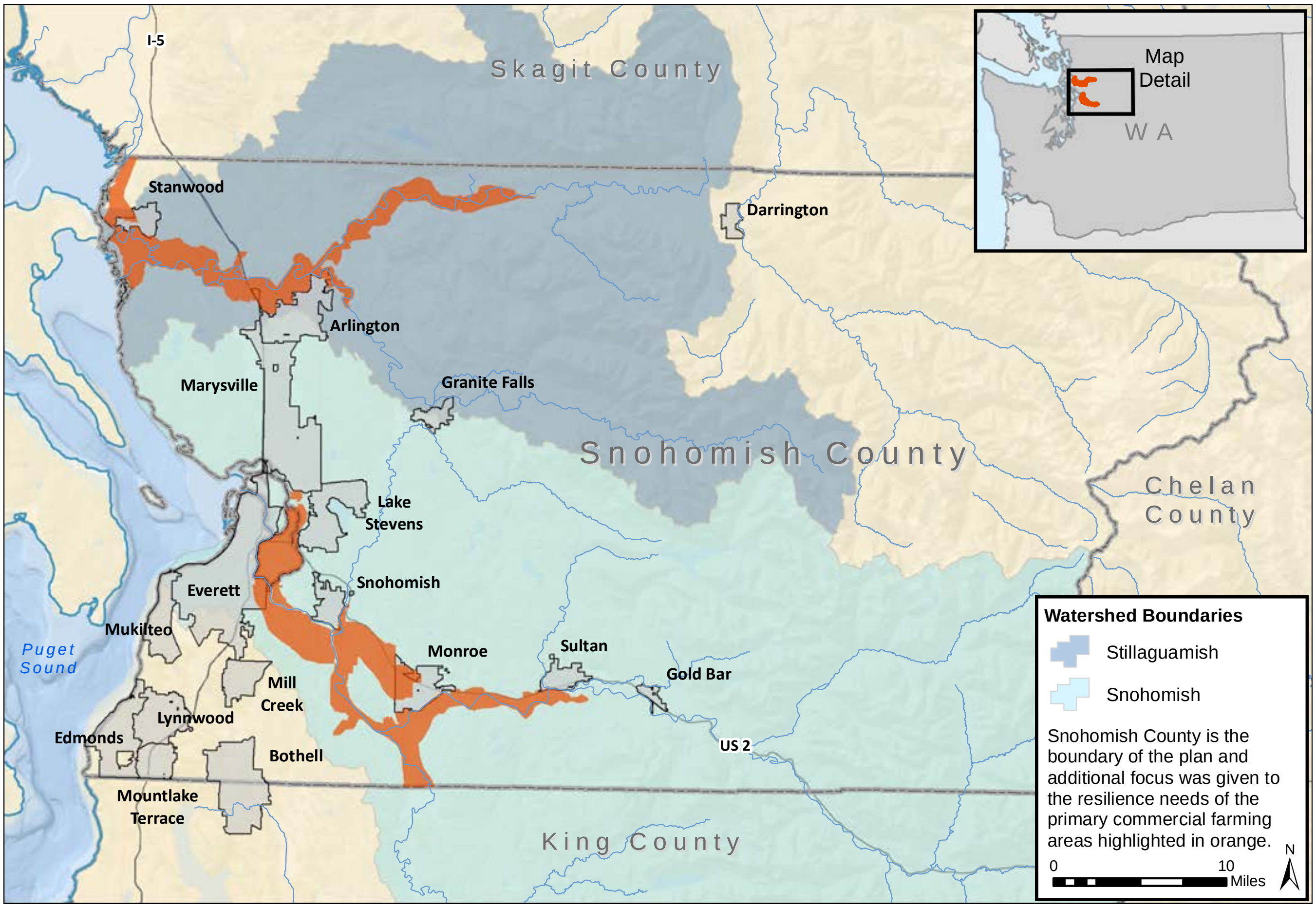

Figure E-1. Plan Study Area. This map shows the study area for the Plan, which includes all of Snohomish County with a focus in the key floodplain agriculture reaches in orange.

In spring 2019, the Conservation District launched a broader community engagement effort, primarily focusing on commercial farmers in the river floodplains. Presentations were given for local diking, drainage, and flood control districts and community meetings were organized outside of these areas. The goals of this effort were to provide localized results from the risk modeling and assessment work and to gather feedback on resilience needs and potential projects. This information was used to create Reach Summaries that were then reviewed and revised by the farming community in summer 2019.

STEERING COMMITTEE MEMBERS

- Andrew Albert, Andrew's Hay
- Dan Bartelheimer, Sno-Valley Farms
- Brian Bookey, Cherry Lane Farms
- Darren Carleton, Carleton Farms
- Jeff Ellingsen, SCD Board Member and Farmer
- Spencer Fuentes, Hazel Blue Acres
- Nick Pate, Raising Cane Ranch
- Libby Reed, Orange Star Farm and SCD Board Member
- Jeremy Visser, dairy farmer

Impacts Assessment

To understand the impacts of climate change on agricultural land in Snohomish County, the Conservation District initiated technical studies on flooding, groundwater levels, saltwater intrusion, land subsidence and aggradation, and crop impacts. Key take-aways from each technical study are listed below. The studies are summarized in Chapter V of this plan, and full studies can be found on the Conservation District website at https://snohomishcd.org/impact-assessment.

FLOODING

Increases in the extent of flooding will put additional farmland at risk of inundation, particularly during more frequent storm events (such as the 2-year and 10-year floods). Thousands of additional acres will be flooded on a 2-year event by mid-century and critical stage heights will be exceeded more frequently each year.

GROUNDWATER

Rising sea levels are anticipated to delay the time when estuary farmers can access their fields in the spring by up to three weeks by the 2050s and up to five weeks by the 2080s.

SALTWATER INTRUSION

Areas closest to the shoreline are at the highest risk of saltwater intrusion. Areas within 5,000 feet of the shoreline are especially vulnerable, and areas within 10,000 feet could also experience increases over time.

Florence Island, in the Stillaguamish River estuary, already experiences saltwater intrusion above crop tolerance thresholds in patches, and those impacts are likely to increase in severity over the next 50 years. Increasing pumping could pull salty water upward in the groundwater table.

SUBSIDENCE AND AGGRADATION

The analysis of farmland subsidence for both the Stillaguamish and the Snohomish River floodplains indicated that some areas may be sinking 2-3 inches per decade due to cultivation of organic soils, although error rates in this study are high.

The Lower Stillaguamish River channel is aggrading, and this trend is likely to continue into the future. The Lower Snohomish River is not aggrading in general, but upper reaches (from the SR-9 bridge to the Skykomish River) show some aggradation.

CROPS

Increasing air temperatures in summer months are projected to negatively impact some existing crops while at the same time providing opportunities for new types of agricultural production. This warming will result in a longer growing season but also an accelerated growing degree day accumulation, which can have a negative impact on yields. Models project a decrease in summer precipitation and an increase in winter precipitation.

By the 2040s, Snohomish County is predicted to have similar growing conditions to Santa Cruz County, CA, just south of San Jose. And by the 2080s, conditions are expected to be most similar to Santa Barbara County, CA, just north of Los Angeles.

Priority Needs

The agricultural community in Snohomish County is facing many current and projected challenges associated with increased development and a changing climate. Through a robust community engagement process, farmers provided priority resilience needs. Addressing these resilience needs will require partnership building, innovative approaches to problem solving, and funding acquisition. Farmers highlighted the need for grant and/or loan funding to address many of these issues described below.

FARMLAND CONSERVATION

Much of Snohomish County's commercial farmland is in the floodplain, where state and local regulations provide partial barriers to conversion of the land. Still, many farms in both the floodplains and upland areas continue to be lost to development, habitat restoration, and other uses. Existing funding sources are insufficient to reach conservation targets or satisfy farmer interest. Potential options for increasing funding available include augmentation of the Transfer of Development Rights program at Snohomish County, as well as additional grants and/or taxes.

DRAINAGE INFRASTRUCTURE IMPROVEMENTS

Diking, Drainage, and Flood Control Districts across the County consistently report insufficient funding to manage current drainage needs, citing runoff from upland areas and increased flooding as major contributors. Climate change projections indicate increased winter flood frequency and scale, highlighting the need for improvements to and increased capacity of drainage systems. Many agricultural areas require a drainage needs assessment to inform projects that would increase capacity of existing culverts, tide gates, and pump stations as well as replace aging infrastructure.

COMPENSATION FOR UPLAND RUNOFF

Development of upland areas has resulted in increased runoff reaching our floodplains, in many cases exacerbating drainage challenges for farmers. Some diking, drainage, and flood control districts have agreements with local jurisdictions to collect stormwater fees to help offset the costs of this increased runoff and sediment, yet most do not. There is a need to work with individual districts and local jurisdictions to help develop these compensation agreements and potentially increase revenue under existing agreements. Projects or initiatives to reduce upland runoff would also greatly benefit farmers. These include use of green stormwater infrastructure, regulatory changes to county and city development codes, and education of or incentives for urban and suburban landowners to reduce runoff from their properties.

Farmers Helping Farmers

"Collaboration is a big part of farming on a small scale. Farmers need opportunities such as the Tilth to work together and learn from each other. Farms might benefit from a grown-in-Snohomish County brand. This would help consumers recognize when they are buying locally."

Anna Caruso, Caruso Farm, Photovoice 2017

FLOOD PROTECTION

While farms in the floodplain are often inundated in winter months, damages are minimized and spring drainage made possible through a system of sea dikes, river levees, and riverbank protection projects. In many places, this flood protection infrastructure is in need of improvements or replacement, and in others, there is a need for additional protection. With flood frequency and severity predicted to increase, impacts to this infrastructure will increase.

ACCESS TO IRRIGATION WATER

Many farms do not have legal water rights yet have a need for irrigation water to maintain their viability. Climate change predictions indicate the need for irrigation water will increase with less precipitation falling in summer months and increasing temperatures. At this time, new water rights are not available for farmers. There is a need for creative approaches to providing access to water. Potential options include on-farm water storage or the coordinated management and leasing of water rights at a landscape scale.

"We may have enough water now but we may not have enough in five years. We need to be looking to the future."

– Jesse Allen, farmer

ASSISTANCE IMPLEMENTING DROUGHT RESILIENCE PRACTICES

There are numerous techniques that can be used to increase a farm's resilience to drought or to reduce the need for irrigation. Existing incentive and grant programs through the state and federal government provide cost-share funding for practices that build soil water holding capacity, hold and/or store water, and increase irrigation efficiency. These programs, however, are often highly competitive or pay low rates. With climate predictions indicating hotter and drier summers, additional funding, research, and on-farm trials are needed to incentivize new practices.

ADDITIONAL GROUNDWATER ANALYSIS

Further study of groundwater levels and saltwater intrusion are recommended in the estuaries of the Stillaguamish and Snohomish Rivers to validate predicted impacts of sea level rise on farmland. In particular, additional data collection and analysis has been recommended for Florence Island and Drainage District 7 in the Lower Stillaguamish River floodplain and Ebey Island and Diking Districts 2 and 4 in the Lower Snohomish River floodplain.

While the intent of this Agriculture Resilience Plan is to focus on needs and actions to make the agricultural land itself more viable and resilient to future change, farmers also provided valuable feedback on other market, research, and education-related needs. These include:

- **Assistance complying with regulations –** The costs of and time associated with complying with county and state regulations puts incredible pressure on farmers, particularly smaller operations.
- **Research into new crop varieties –** The impacts of changing land use, climate, and markets continues to necessitate research into crop varieties that are resilient, drought tolerant, salt tolerant, and/or slower to mature.
- **Flood risk training for new landowners –** New farmers moving into the floodplain could benefit greatly from training on how to minimize flood risk by accessing flood data and predictions available through Snohomish County and preparing for floods.

Next Steps

This Agriculture Resilience Plan for Snohomish County will help ensure the viability of our farmlands into the future. The next step is to continue to work together as an agricultural community to implement the actions included in this Plan. The Steering Committee recognizes that these actions cannot be achieved without collaboration and partnership. The needs represented in this plan, therefore, are a starting point for collaborative thinking with partners, communities and government bodies about how we manage our land and our natural resources in a time of changes and uncertainty.

Implementation of the Agriculture Resilience Plan will involve the following:

- Project scoping and design
- Coordination with SLS partners
- Funding procurement for project implementation and farmland conservation
- Continued education to local farmers
- Partnership building

Growing a Thriving Local Food Culture

"Inspiring and supporting the future generation of farmers and eaters is really what it is all about. The excitement in this kiddo's eyes as she proudly holds up her veggies, fresh from the field, is energizing for us. We want to grow a food culture in our community that shares this excitement and pride in fresh, healthy, local food that tastes great and allows the farming community to thrive here as well."

Chelsea Johansen, Rainy Sunday Ranch, Photovoice 2017

Hands on Farming

"We are a small farm, a husband and wife team. If it needs prepped, seeded, weeded, planted, irrigated, transplanted, harvested, packed, marketed, or sold, we do it, all of it. We do almost all of it by hand, both out of necessity and preference. We enjoy being in close contact with the soil, with our farm, with our customers. We see value in small farms that are dedicated to being sustainable and relevant in our communities."

Chelsea Johansen, Rainy Sunday Ranch, Photovoice 2017

Chapter I
Introduction

Since the early 1800s, agriculture has been a cornerstone of life in Snohomish County. Farms in the county have produced milk, eggs, chickens, hogs, beef, berries, row crops, hay, nursery crops, and vegetables such as corn, peas, and pumpkins.[1] There are over 63,000 acres of active farmland in Snohomish County.[2] These acres support 1,558 farms.[2] While 85 percent of these farms are less than 50 acres, sizes vary and some farms are as large as 2,000 acres.[2] Agricultural products grown on these acres sell for over $157 million per year.[2] Agriculture is an important component of the Snohomish County community, both socially and economically. In recent years, demand for local and sustainable produce has increased at the same time as the population in Snohomish County has gone up by almost 13 percent from the 2010 Census, now reaching over 800,000 residents.[3] As the population continues to increase, the need for locally grown food will also rise. Residents of Snohomish County buy local produce at the county's seven farmers markets, through Community Supported Agriculture (CSA) subscriptions, and at grocery stores like the Sno-Isle Food Co-op. Agricultural producers in the county also provide food to consumers around the Puget Sound region and beyond.

Despite the increasing importance and need for local farming in Snohomish County, agriculture is threatened by development and by environmental changes. The United States Department of Agriculture projected national farm sector profits to decline by $9.8 billion from 2017 to 2018. This represents 13 percent of the profits from farming. Production expenses are forecast to increase by $11.8 billion due to increases in costs for fuel, feed, and hired labor.[4] Finances are just one of the pressures facing farmers. American Farmland Trust has identified that 175 acres of farm and ranch land in the United States are lost to sprawl and development every hour, while 1.7 billion tons of topsoil are lost to erosion each year.[5] These trends and pressures also affect Snohomish County farms. Everett is one of the fastest growing cities in Washington State and the rising cost of land makes it difficult for farmers to stay in the county.[6] Between 2012 and 2017, the acres of farmland in Snohomish County dropped from 70,863 to 63,671.[2]

"Agriculture is part of the social and environmental fabric of Snohomish County. It is emblematic of the enduring values of this community.… [F]armers are stewards of the land and are focused on the continued productivity of the land."

Snohomish County. 2018. Snohomish County Agriculture Action Plan: A Plan to Preserve and Enhance the Agricultural Economy in Snohomish County. March 2005. https://snohomishcountywa.gov/DocumentCenter/View/8152/Snohomish-County-Agriculture-Action-Plan?bidId=

In addition to the existing pressures on agriculture, climate change is expected to present additional challenges into the future. In Snohomish County, sea level rise is projected to lead to saltwater intrusion and rising groundwater tables. A changing climate is expected to cause drier summers, wetter winters with more intense storms, increased river flooding, and impacts to crop viability. The *Puget Sound State of Knowledge: Climate Change in Puget Sound* report prepared by the University of Washington Climate Impacts Group describes anticipated climate impacts at a regional scale. The report includes the following projections for Snohomish County under moderate greenhouse gas emission scenarios:

- The projected streamflow during a 100-year flood event is projected to increase up to 58 percent on the Snohomish River and 76 percent on the Stillaguamish River by the 2080s[8]
- The area inundated by a 10-year flood in the lower Snohomish River floodplain will increase anywhere from 19 to 69 percent by the 2080s[9]
- Spring peak flows in the Snohomish and Stillaguamish rivers are projected to occur 29 to 49 days earlier than under current conditions by the 2080s[8]
- The summer minimum streamflow will decrease by 7 to 32 percent in the Stillaguamish River and by 17 to 33 percent in the Snohomish River by the 2080s[8]
- The length of the growing season will increase, but agriculture will also experience "shifts in crop production, increasing water supply challenges, changing risks from pests, increasing winter flood risk, and an increasing risk of saltwater intrusion."[7]

This **Agriculture Resilience Plan** is intended to help prepare the agricultural community in Snohomish County for changes, whether from development, population growth, erosion, shifts in weather, or climate change. This is a plan that will help farmers in our county plan for future challenges and risk, absorb future change, and more quickly recover from stress. The plan will help build a resilient agricultural community into the future through a combination of information gathering and sharing, creation of online planning tools, project implementation, and farmland protection.

Resilience

Resilience is defined as the ability of something to withstand change or difficulties. Farmers have honed this skill—constantly adapting to changes in markets, regulations, and weather over the years. Now climate change has introduced new difficulties. We have already experienced increased temperatures and higher intensity rainfall events. These and other impacts are expected to continue into the future.

The goals of the plan are to:

- Provide information and project funding for farmers to manage for future risk on their farms
- Develop landscape-scale projects to improve agricultural resilience
- Protect agricultural lands from subdivision or development

The Agricultural Resilience Plan is linked to the work of the Snohomish County **Sustainable Lands Strategy** (SLS). SLS, started in 2010, is a collaborative effort of partners working to improve coordination and to generate progress for fish, farm, and flood interests in the Snohomish and Stillaguamish watersheds. The SLS effort is intended to lead to "a broad set of common understandings about the importance of fish and farms and the need for collaboration to simultaneously protect and enhance both resources while also recognizing and upholding Native American tribes' treaty rights and cultural traditions."[10] SLS members are developing a series of reach-scale plans to identify coordinated sets of multiple-benefit projects to improve natural functions within each reach while generating a net gain for farm, fish, and flood interests.[11] Reach-scale plans for the Lower Skykomish River, Lower Snohomish River and Estuary, and Lower Stillaguamish River have been completed and a plan for the North Fork Stillaguamish River is underway.

As a participant in SLS, the Snohomish Conservation District identified a gap in the scientific understanding of agricultural needs, particularly as they relate to climate change, as well as an organized planning approach to developing priority landscape-scale agricultural viability projects. SLS participants representing fish interests are guided in their efforts by numerous plans and studies, including the *Snohomish River Basin Salmon Conservation Plan* and the *Stillaguamish Watershed Chinook Salmon Recovery Plan*. Meanwhile, the agricultural representatives are farmers that don't have the benefit of completed plans and studies identifying landscape-scale needs or future impacts. Farmers also don't have the staffing capacity to coordinate at the same level as other participants in SLS. This Agriculture Resilience Plan is intended to fill this data gap and identify priority resilience projects that will keep Snohomish County's agricultural lands viable into the future.

This plan includes eight chapters:

- **Chapter I – Introduction** discusses the importance of agriculture in Snohomish County and the purpose of the Agriculture Resilience Plan.
- **Chapter II – Outreach and Engagement** describes how the Agriculture Resilience Plan has been guided by a Steering Committee of farmers and how input has been solicited from local farmers through community meetings and the PhotoVoice project.
- **Chapter III – Farmland Conservation** describes the Snohomish County Farmland Conservation Strategy, a collaborative effort to preserve farmland and reduce conversion and subdivision of farms.
- **Chapter IV – Resilience Practices** describes practices farmers can adopt on their farm to plan for and increase resilience to droughts and floods.
- **Chapter V – Impacts Assessment** describes current and future impacts to agriculture, including climate change impacts to crops and the results of flooding, groundwater, saltwater intrusion, and land subsidence assessments.
- **Chapter VI – Priority Needs** identifies the most important actions needed to create a resilient agricultural system in Snohomish County.
- **Chapter VII – Reach Summaries** includes descriptions of 11 agricultural reaches in the Snohomish and Stillaguamish River floodplains, including information on current and future impacts to agriculture and resilience needs.
- **Chapter VIII – Next Steps** describes how the Agriculture Resilience Plan will be implemented.

The Farmer Does It All

"On many small farms the farmer does it all—both in the field and the office. It can be overwhelming and challenging, but also rewarding. We market to various outlets—farmers markets, CSA, and wholesale. Each requires time, energy, and paperwork. We need an outlet we can count on that would bring more farms to Snohomish County. This could be a specific vegetable or fruit processor or a USDA meat processor."

Anna Caruso, Caruso Farm, Photovoice 2017

1 Snohomish County, 2016. Snohomish County Comprehensive Plan. Land Use Chapter. Amended November 10, 2016.

2 United States Department of Agriculture, 2017. Table 8. Farms, Land in Farms, Value of Land and Buildings, and Land Use: 2017 and 2012. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Washington/st53_2_0008_0008.pdf

3 Office of Financial Management, April 1, 2018 Population of Cities, Towns and Counties Used for Allocation of Selected State Revenues.

4 United States Department of Agriculture, 2018. Highlights from the August 2018 Farm Income Forecast. https://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/highlights-from-the-farm-income-forecast/

5 American Farmland Trust, 2018. No Farms, No Food. https://www.farmland.org/no-farms-no-food?utm_medium=email&utm_source=govdelivery

6 Catchpole, D., 2017. Everett was the 9th fastest growing city in the state last year. Everett Herald. https://www.heraldnet.com/news/everett-was-the-9th-fastest-growing-city-in-the-state-last-year/

7 Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

8 Hamlet, A.F. et al., 2013. An overview of the Columbia Basin Climate Change Scenarios Project: Approach, methods, and summary of key results. Atmosphere-Ocean, 51(4), 392-415, doi: 10.1080/07055900.2013.81955.

9 Mauger, G.S., & Lee, S.-Y., 2014. Climate Change, Sea Level Rise, and Flooding in the Lower Snohomish River Basin. Report prepared for the Nature Conservancy. Climate Impacts Group, University of Washington, Seattle.

10 Snohomish County. Sustainable Lands Strategy website. https://snohomishcountywa.gov/2194/36450/Sustainable-Lands-Strategy

11 Snohomish County, 2018. Lower Skykomish River Reach-scale Plan, July 2017. https://snohomishcountywa.gov/DocumentCenter/View/45061/Lower-Skykomish-Reach-Scale-Plan?bidId=

Chapter II
Outreach and Engagement

The Agriculture Resilience Plan is intended to be the farmers' plan – a document that reflects the interests and priorities of farmers in Snohomish County. Therefore, outreach to and engagement with the farming community has been a key component of developing this plan and will continue to be central to its implementation. Input has been solicited through the formation of a Steering Committee of local farmers, outreach to existing agricultural groups and individual farmers, and the PhotoVoice project. The next phase of plan implementation will involve robust planning conversations with groups of farmers on the landscape to develop and scope landscape-scale projects that improve agricultural viability.

Snohomish Conservation District formed a **Steering Committee** for the Agriculture Resilience Plan in order to ensure that the plan is guided by the input of local farmers. The Committee is comprised of 9 Snohomish County farmers representing various types, sizes, and locations of farms. The Steering Committee meets quarterly and provides guidance to the direction and development of the plan and its implementation. The Committee reviewed the technical information gathered as part of the Impacts Assessment (Chapter V) and assisted in prioritizing the needs of agriculture at the county-wide scale.

Steering Committee Members

Brian Bookey, Cherry Lane Farms

Libby Reed, Orange Star Farm and SCD Board Member

Jeff Ellingsen, SCD Board Member and Farmer

Nick Pate, Raising Cane Ranch

Dan Bartelheimer, Sno Valley Farms

Jeremy Visser, dairy farmer

Darren Carleton, Carleton Farms

Spencer Fuentes, Hazel Blue Acres

Andrew Albert, Andrew's Hay

In addition to soliciting guidance from the Steering Committee, the Conservation District conducted extensive outreach to the local farming community. In fall 2016 and winter 2017, the Conservation District reached out to existing agricultural groups to ask for input into the scope of this project. Groups included the Snohomish Conservation District Board of Supervisors, Focus on Farming attendees, the Sustainable Lands Strategy Agriculture Caucus, the Snohomish County Farm Bureau, Snohomish County Cattlemen, the

Where it Happens

"Prominent in the center of the farm is the barn, which gives a refuge throughout the seasons for family and for visitors who come to pick or buy organic blueberries in this beautiful, peaceful setting."

*Karen Wolden-Fuentes,
Hazel Blue Acres Farm, Photovoice 2017*

Snohomish County Agricultural Advisory Board, SnoValley Tilth, the Coordinated Diking Council, the Marshland Flood Control District, the French Slough Flood Control District, and the Stillaguamish Flood Control District.

In spring 2019, the Conservation District launched a broader **community engagement effort**, primarily focusing on commercial farmers in the river floodplains. Presentations were given for local diking, drainage, and flood control districts and community meetings were organized outside of these areas. The goals of this effort were to provide localized results from the risk modeling and assessment work and gather feedback on resilience needs and potential projects. This information was used to create Reach Summaries (Chapter VII) that were then reviewed and revised by the farming community in summer 2019. In total, eight community meetings or presentations were organized and over 75 farmers provided input into the final recommendations in the plan.

In order to increase engagement of farmers in development of the Agriculture Resilience Plan, the Snohomish Conservation District and The Nature Conservancy conducted a **PhotoVoice** project. Seven farms took part in the project and participated in a series of four photography workshops. Participants were taught photography skills, then each took photographs to respond to two questions – "Why is agriculture important to our community?" and "What are the major challenges facing agriculture?" Themes that emerged in the photographs included farmland protection, increasing resilience to climate change impacts, improving drainage in the face of increased flooding, and the importance of local and sustainable agriculture. The photographs and accompanying captions were the centerpiece of an exhibition event attended by farmers, elected officials, and agency staff. The photos were presented to the Snohomish County Council and have become part of an exhibition that has been shown at venues and events throughout the county. Photographs and captions from the PhotoVoice project are included throughout this Plan.

Chapter III
Farmland Conservation

Across the United States, farmland is being lost to development and conversion to other land uses. American Farmland Trust (AFT) reports that 31 million acres of agricultural land nationally were lost to development between 1992 and 2012. Such losses are usually irreversible. AFT also reports that development disproportionately affects agricultural lands—more than 70 percent of urban development takes place on agricultural land.[1] These trends are reflected in Snohomish County as well. For example, the USDA Census of Agriculture reported that land in farming in Snohomish County shrank from 70,863 acres in 2012 to 63,671 acres in 2007.[2] These numbers don't represent the additional impact of losing larger farms to smaller, often non-commercial, farming uses. Pressures on the agricultural land base are increasing as the population of the county rises—Everett is among the fastest growing cities in Washington State—a population that could be fed by locally grown food if it was available.[3]

In order to protect our local farms, a group of partner organizations and stakeholders have created a collaborative approach to farmland conservation in Snohomish County. Led by PCC Farmland Trust, the **Snohomish Farmland Conservation Working Group** also includes the Snohomish Conservation District, Snohomish County, Forterra, The Nature Conservancy, and the Washington Department of Fish and Wildlife. These organizations are committed to the preservation of farmland for agriculture through increasing the number of voluntary transactions (easements and fee acquisitions)

What is a Conservation Easement?

Agricultural conservation easements are voluntary legal agreements that prevent any future development from occurring on a property by extinguishing development rights. At the time the easement is put in place, the farmer is compensated for the value of the development rights. Easements allow for agriculture and agricultural accessory uses as well as compatible activities such as habitat restoration, recreation, and education. Easements are powerful tools for:

- Protecting priority agricultural resource lands;
- Protecting farms suited for long-term viability due to soils and access to water and markets; and
- Assisting landowners with achieving their goals of honoring a farm legacy while supporting business investments or succession plans.

Farms to Condos

"Snohomish county is beating its plowshares into condos. Once, our living came from the land. Now, we crowd into compact developments, shop at big box stores and work in urban environments. Arable land is disappearing."

Bill Pierce, Soaring Swallow Farm, Photovoice 2017

on priority Snohomish County farmlands. In addition, the group is supported by organizations (including Ducks Unlimited) and farmers (including members from the SLS agriculture caucus) who are critical to implementation of the Farmland Conservation Strategy that was developed by the Working Group.

The purposes of the Strategy are to:

- Develop a roadmap for farmland conservation that supports an integrated multi-benefit landscape approach
- Provide priority information to efforts such as the Snohomish Agriculture Resilience Plan and the Sustainable Lands Strategy reach scale plans
- Better coordinate the partners involved in farmland conservation to maximize opportunities
- Develop a landscape-scale funding strategy
- Create goals and metrics for the key agricultural areas in Snohomish County
- Increase the rate of farmland protection

A key component of the Strategy is **coordination**. Strategic partnerships are instrumental in increasing the pace of farmland conservation in Snohomish County. The Working Group has agreed to establish regular and ongoing communication that allows them to organize outreach efforts to priority parcel landowners and to share timely opportunities with one another. This will encourage partners to identify who the most appropriate lead organization is for both landowner outreach and individual transactions. Coordination helps maximize limited resources and lessen duplication of efforts; reduce confusion and frustration within the farming community; increase the extent of outreach and focus more strategically; and provide a consistent message to achieve multi-benefit efforts.

The Farmland Conservation Working Group participates in **multi-benefit planning**, specifically the Sustainable Lands Strategy (SLS) effort. As many of Snohomish County's prime working lands and large available blocks of farmland are in lowlands and floodplains, the Working Group recognizes the need to work with partners in SLS to develop a balanced multi-benefit approach to floodplain management. In areas of the floodplain where priorities overlap, the Working Group commits to working collaboratively with other floodplain interests and landowners on projects that protect the landowner's future flexibility in determining the best use of the land.

The Strategy also includes **priority mapping**. PCC Farmland Trust, with input from local partners and farmers, developed an analysis and accompanying map to identify and prioritize farmland for conservation. A suitability analysis, or prioritization, ranks properties relative to one another based on a set of criteria that includes metrics that describe the quality of farmland and proximate development threats. Both the criteria and resultant maps were reviewed and approved by farmers on the Steering Committee for the Agriculture Resilience Plan with the expectation that this map would be a working document that is updated and re-prioritized with forthcoming information on potential climate impacts to flooding, groundwater levels, and saltwater intrusion. The resulting GIS data and maps can be used as a decision support tool to assist the Farmland Conservation Working Group in identifying farmland conservation opportunities and conducting community outreach throughout Snohomish County. Figure III-1 shows high priority agricultural areas identified in the priority mapping. Table III-1 shows the acreage of agriculture in Snohomish County in each priority tier for protection.

Table III-1. Farmland Prioritization Acreage

PRIORITY RESULTS	ACREAGE
Very high	15,421
High	25,453
Medium	26,282
Low	34,164
Very low	6,832
Total	**108,152**

The highest priority farmland for protection (ranked Very High and High in the mapping effort) equals a total of approximately 40,000 acres. In the short-term, the Farmland Conservation Working Group has identified a **ten-year voluntary conservation goal of 15,000 acres**. Voluntary conservation includes purchase of agricultural conservation easements or acquisition of the land from willing sellers with an accompanying conservation easement. This short-term acreage goal represents the highest priority lands identified as most suitable for current funding sources. It is important to note that the 15,000-acre goal is a short-term goal and does not represent the full amount of farmland conservation needed to ensure market stability, food security, and the maintenance of critical farming infrastructure. While these lands are suitable for current funding sources, it is not possible to fund the purchase of conservation easements on this volume of land with current funding sources alone within a ten-year period. Achieving this goal will require success in both leveraging current funding sources and in working with decision makers to create new sources of funding.

Existing funding sources for farmland protection include the NRCS Agricultural Conservation Easement Program, the Washington Wildlife and Recreation Program, Snohomish County Conservation Futures, Floodplains by Design, and the local Transfer of Development Rights program. Potential new funding sources include:

Stillaguamish Valley Preservation Initiative

The Stillaguamish Valley Protection Initiative (SVPI) is a focus area effort nested in the overall Snohomish Farmland Conservation Strategy. The main focus of this initiative is to protect farmland and the benefits that the open space associated with farmland provides for local food production, flood storage capacity, water infiltration, and wildlife habitat. The urgency of protecting these lands from development is a shared priority for both agriculture and salmon recovery interests, particularly in the face of forecasted population growth in Snohomish County. Partners in this initiative and the SLS advocate for flexible easements in the valley that prioritize agricultural use but also recognize the value of habitat restoration if conditions change such that farming is no longer viable or if restoration would create a greater public benefit.

- **Private foundations.** Foundations currently fund groups that facilitate voluntary transactions but are not currently paying for easements.
- **Local Transfer of Development Rights.** While a Snohomish County Transfer of Development Rights program exists, improvements that could make it more successful include the adoption of additional receiving areas, reduction of the enrollment fee, and creation of a bank.
- **Regional Transfer of Development Rights.** A regional program exists for Transfer of Development Rights to the South Lake Union area of Seattle. The program is set up to use King County credits first, but the majority of King County credits have been purchased. The program could be used to purchase development rights from Snohomish County farms.

- **Bond.** A bond could be passed to provide funding for protection of agricultural land. This approach has been used in King County.
- **Real Estate Excise Tax 3.** This tax, which would require County Council and public vote, could raise up to $41 million per year through property sales.
- **Conservation Futures.** The rate for this local tax could be increased by the County Council.

"You never forget visiting a farm. Whether it's picking fruit, selecting a family pumpkin, or planting a tree. It's honest work and it connects us with our core values and shared heritage."

Nichlos Pate, Raising Cane Ranch, Photovoice 2017

1 American Farmland Trust, 2018. Farms Under Threat: The State of America's Farmland. May 9, 2018. https://www.farmland.org/initiatives/farms-under-threat

2 United States Department of Agriculture, 2012. Table 8. Farms, Land in Farms, Value of Land and Buildings, and Land Use: 2012 and 2007. https://www.nass.usda.gov/Publications/AgCensus/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Washington/st53_2_008_008.pdf

3 Catchpole, D., 2017. Everett was the 9th fastest growing city in the state last year. Everett Herald. https://www.heraldnet.com/news/everett-was-the-9th-fastest-growing-city-in-the-state-last-year/

Snohomish County Farmland Conservation Priorities

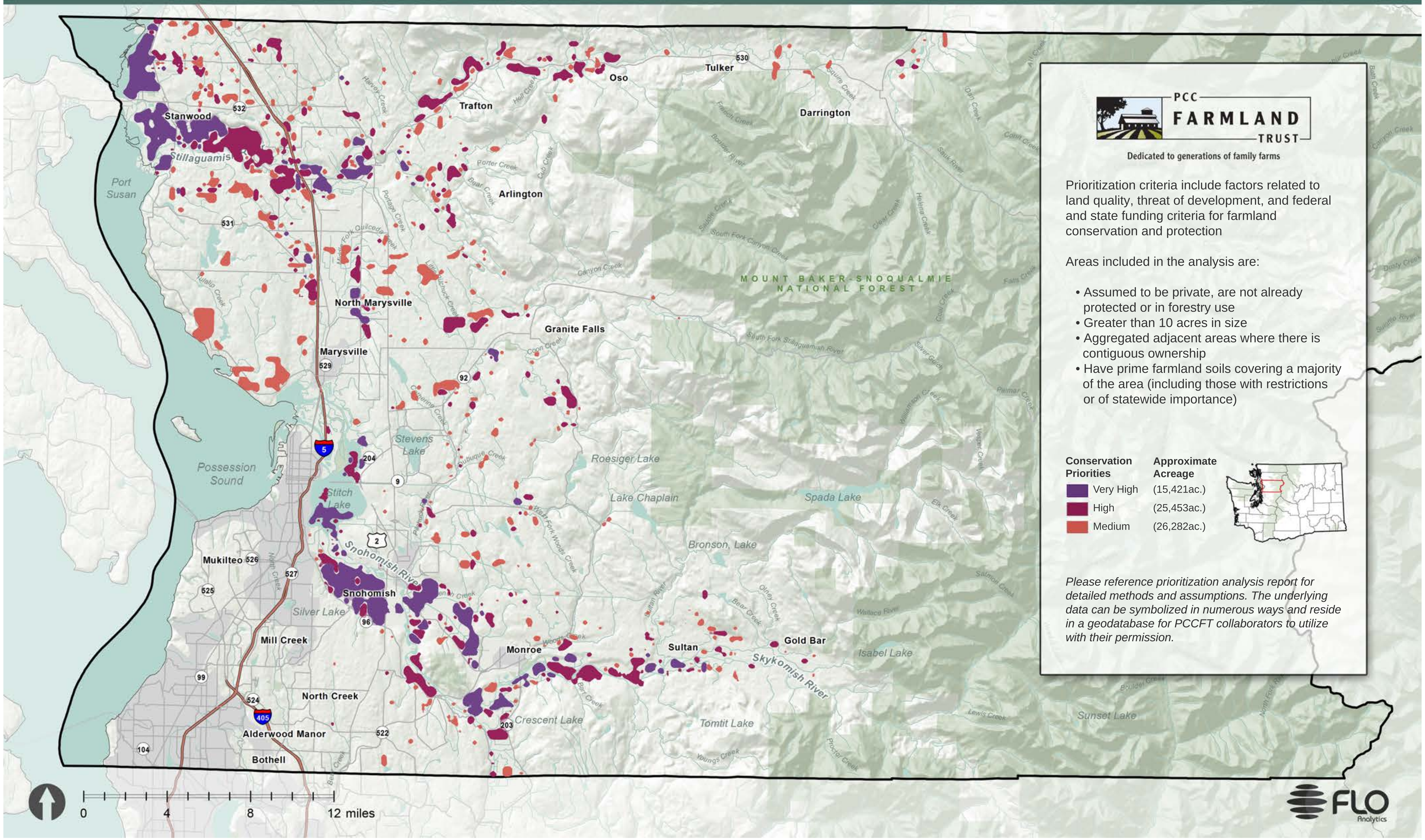

Figure III-1. Snohomish County Farmland Conservation Priorities

Chapter IV
Resilience Practices

Farmers are resilient; as a matter of course, farmers adjust their practices from year to year based on weather, soil conditions, and markets. Climate change impacts, however, are expected to increase pressures on agriculture in Snohomish County and may necessitate added resilience measures or changes in management altogether. Fortunately, there are a variety of tools and approaches that can be adopted to increase agricultural resilience.

Specific climate change impacts that are anticipated in Snohomish County include less rainfall in summer months and more (and higher intensity) rainfall in winter months, higher temperatures overall, decreased water availability, increased flooding, heightened pest pressures, and the potential for saltwater intrusion into groundwater and irrigation ditches. Additional information on anticipated climate change impacts is included in Chapter V. These impacts will put additional burden on Snohomish County farms, which are already under threat from development and other pressures.

By their nature, agricultural activities are highly susceptible to the effects of environmental and social changes. To stay productive and viable, agriculture requires the resilience to adapt to such changes. The Food and Agriculture Organization identifies three key components of agricultural resilience: reducing exposure to shocks (such as a pest outbreak or a flood), reducing sensitivity to shocks, and increasing the ability to adapt. Improving overall productivity, increasing product diversity, enhancing soil resiliency, and increasing land protections are some of the main strategies recommended to address these three components of agricultural resilience.

The practices and management approaches described in this chapter do many things to help build resilience to climate change as well as to changing markets. They promote healthy soils by increasing organic matter content and therefore the soils' ability to hold water during droughts. They build in diversification of products and revenue streams. They help protect livestock health and production. They create alternative sources of water for livestock and irrigation. And they help protect farms from pests, rising flood waters, and other changes we expect to see in the coming years.

As part of the Agriculture Resilience Plan, the Snohomish Conservation District has developed a series of factsheets on resilience practices that can be adopted by Snohomish County farmers. Resilience practices relate to cropping, livestock, soil, and water. When adopted successfully, the practices interact with each other and can most effectively derive benefits if applied in combination. The results of research on nine resilience practices are summarized in this chapter. Full factsheets on each resilience practice are available online at http://snohomishcd.org/ag-resilience/. The full factsheets go into detail about the effectiveness, implementation approach, and potential agricultural benefits of each practice or set of practices.

Viability

"Agricultural viability requires being open to new ideas."

Nichlos Pate, Raising Cane Ranch, Photovoice 2017

Managed grazing is a system that imitates the natural grazing patterns of large herbivores in savannah and prairie environments and eliminates overgrazing, a problem worldwide and in Snohomish County. Animals in a managed grazing system can create landscapes that are highly productive while protecting water quality, sequestering carbon, and creating and maintaining carbon-rich soils. A managed grazing system focuses on two key components: how long livestock graze a specific area and how long the land is able to rest before livestock return. Benefits of managed grazing include increased production of forage, increased soil fertility, reduced soil compaction, increased resistance to drought, better control of forage species, cost savings, and carbon sequestration.

Silvopasture is the practice of incorporating trees into a livestock grazing system with the goal of integrating the management of tree crops, livestock, and forage. Trees are typically selected for their crop value and can include fruit, timber, or nut trees. Trees grow faster and wider in girth in a silvopasture system due to the fertilizer provided by animal manure. Forage stays productive longer into the season and has a better nutritional profile. Livestock show less overall stress, put on weight more easily, and produce more milk than livestock grazed in open pasture alone. Silvopasture offers a multifunctional land use in which production and protection can be achieved on the same parcel of land at the same time.

Agroforestry is a land management system that combines the production of perennial and annual crops with trees. Agroforestry maximizes economic production by producing high value tree crops while maintaining regular income with annual companion crops. Agroforestry practices include alley cropping, forest farming, riparian buffers, silvopasture, and windbreaks. These practices can be used individually or can be combined to create landscape-wide diversity of production and ecological benefit. Benefits of agroforestry can include positive impacts on soil ecology and water holding capacity, decreases in weed competition, increases in farm economic resiliency, access to new and potentially lucrative markets, protection of genetic diversity in food crops, improvements to water quality, and decreases in erosion.

Biochar is a soil amendment with the potential to improve soil tilth, enhance fertility, and decrease fertilizer inputs and irrigation needs. Biochar, which is essentially charcoal, has traditionally been produced by piling wood, covering it with earth, and allowing it to burn in smoldering piles. This approach, however, releases a large amount of carbon into the atmosphere. A new, more efficient method has been developed; known as pyrolysis, this method involves heating organic materials in low oxygen conditions. When added to soil, biochar can increase soil health and water holding capacity, decrease fertilizer and irrigation needs, reduce soil acidity, absorb greenhouse gases, and enhance crop yields.

Conservation Agriculture is a farming system that improves soil resilience and agricultural productivity through a set of soil management practices designed to create an ongoing sustainable system. The three core principles of conservation agriculture are to minimize soil disturbance through no-till or conservation-till methods, to maintain soil cover throughout the year with cover crops, and to manage crop rotations to combat pests and pathogens. No-till or conservation-till methods protect soil structure, soil composition, and biodiversity. Soil cover methods such as cover crops provide organic matter to feed the soil, protect against soil erosion by holding soil in place, and increase soil biodiversity and nutrient availability to crops. Crop rotations protect against pest and disease problems by interrupting the life cycle of certain bacteria, fungi, insects, and weeds. Conservation agriculture produces a constant net increase of soil organic matter rather than a decrease. At the same time, it produces a consistent improvement in soil moisture retention, which can minimize the impact of drought.

Regenerative agriculture is a method of farming the land while at the same time regenerating or improving the natural functions of the farm ecosystem. Regenerative agriculture involves adoption of a number of resilience practices as part of a holistic system. These practices can include no-till and pasture cropping, application of compost and/or biochar, managed grazing, silvopasture, agroforestry, multi-species cover crops, and crop rotations. Regenerative agriculture creates a system that more closely mimics nature's ability to cycle nutrients and eventually reduces the need for costly external resources such as fertilizers and pesticides. This results in increased yields, increased resilience to droughts and floods, and diversification of products.

Integrated pest management is an ecosystem-based approach that aims to keep pest populations below the economic injury level while reducing the use of pesticides and minimizing risks to people and the environment. Specific techniques used in integrated pest management can involve cultural controls, biological controls, and/or mechanical controls. Cultural controls are practices that reduce the initial establishment, reproduction, and overall survival of a pest by creating a less hospitable environment. Biological controls use a pest's natural enemies (such as parasites, predators, or pathogens) to keep pest populations low. This can be accomplished by increasing habitat for desirable species or through timed release of specific predators or pathogens. Mechanical controls directly kill, block, or make the environment inhospitable to pests using physical components, such as temperature, humidity, or light. Examples of mechanical controls include tillage, flaming (burning an area), barriers (such as fine mesh), soil solarization, and plastic mulching for weeds.

Resilience

"Climate change in this region has brought early floods and late floods, drought and, most recently, the highest spring rainfall in recorded history. As farmers we take note of these and other changes in the natural world because it's part of our job. Our livelihoods are born of these natural processes (growing plants, raising livestock) and they are constantly in flux in small and large ways. It is humbling to work amidst the call and response of nature."

Libby Reed, Orange Star Farm, Photovoice 2017

Stormwater harvesting, also known as rainwater collection, is a method of storing rain that falls on roofs. Rainwater tends to have a neutral pH and is therefore gentle on crops and can be stored for agricultural irrigation and watering. Harvesting rainwater from existing roofs is legal in Washington State, and property owners can have up to 5,000 gallons of storage volume onsite without a permit. Permits can be obtained to store larger quantities of stormwater. Storage containers include polyethylene tanks and PVC bladder tanks. Typical systems require gutter work, tank installation, and a pumping system. A 1,000-square-foot roof in Western Washington sheds over 22,000 gallons of water every year that could be stored and used for irrigation purposes.

Waterbreaks are linear systems of forested plantings planned and designed to reduce flooding impacts for lands adjacent to streams and rivers. Forested systems such as waterbreaks can help maintain some of the natural functions of a river system while reducing flood damages to agricultural lands. Waterbreaks can trap and hold debris from floodwaters thus keeping it off of agricultural fields. They also reduce scouring and sand deposition in fields, protect levee systems, reduce soil and bank erosion, and protect water quality. Waterbreaks should be planted parallel to a river or stream as well as along field borders. Plant species used in waterbreaks typically include native plants that can tolerate flood conditions and are adapted to the specific soils and site conditions.

1 Building Resilience for Adaptation to Climate Change in the Agricultural Sector: Proceedings of a Joint FAO/OECD Workshop. 23–24 April 2012. Edited by Alexandre Meybeck, Jussi Lankoski, Suzanne Redfern, Nadine Azzu and Vincent Gitz http://www.fao.org/docrep/017/i3084e/i3084e.pdf

Chapter V
Impacts Assessment

To understand the impacts of climate change on agricultural land in the Snohomish and Stillaguamish River floodplains, the Snohomish Conservation District initiated technical studies on flooding, groundwater levels, saltwater intrusion, land subsidence and aggradation, and crop impacts. This chapter summarizes key findings of these technical studies. The full studies and online tools can be found on the Conservation District website at https://snohomishcd.org/ag-resilience.

The Take-Away: Flooding

Increases in the extent of flooding will put additional farmland at risk of inundation, particularly during more frequent storm events (such as the 2-year and 10-year floods). Tens of thousands of additional acres will be flooded on a 2-year event by mid-century and critical stage heights will be exceeded more frequently each year.

Flooding

Much of the most valuable and productive farmland in Puget Sound is located within floodplains, which provide nutrient rich soils and excellent growing conditions. While floodplains are important areas for agricultural production, the flooding associated with these areas also poses a risk to agriculture. Flood waters and debris can damage structures, fencing and equipment resulting in costly repairs and clean-up efforts. High energy flows cause erosion to banks resulting in loss of land. High waters pose a risk to livestock if not moved to higher ground. In addition, the standing water and associated drainage impacts can result in negative impacts to yields and delayed spring cultivation.

Climate change is expected to lead to more frequent and severe flooding as sea levels rise and as precipitation patterns and loss of snowpack shift toward more intense winter storm events.[1] In order to understand future flood hazard conditions in the Stillaguamish and Snohomish River floodplains, the Conservation District partnered with the University of Washington Climate Impacts Group (CIG) and Fathom to develop future flood hazard maps. CIG and Fathom used a regional flood frequency analysis from historical records of river flows to develop hydraulic models, and then used future climate change projections for the 2050s and 2080s to develop flooding simulations. The approach used is a pilot of a new and less expensive method of flood modeling. The resulting maps are at a coarse scale (10m) and are thus most appropriate for general risk assessment and planning purposes, not for site-level analysis.

Friend and Foe

"Hazel Blue Acres is nestled snugly between stretches of the Stillaguamish River near Silvana, WA. Here, rows of organic blueberries weather the floods and droughts of life on that powerful and changeable river."

*Karen Wolden-Fuentes,
Hazel Blue Acres Farm, Photovoice 2017*

Table V-1. Projected Extent of Flooding

	HISTORIC	2050s		2080s	
	ACRES	ACRES	PERCENT CHANGE	ACRES	PERCENT CHANGE
Stillaguamish River watershed					
2-year flood	9,095	38,575	324%	41,448	356%
10-year flood	37,642	54,288	44%	56,988	51%
100-year flood	65,281	66,527	2%	68,267	5%
Snohomish River watershed					
2-year flood	16,946	40,134	137%	45,511	169%
10-year flood	64,392	72,330	12%	76,111	18%
100-year flood	93,995	94,276	<1%	98,228	5%

Projected increases in discharge and flood stage will increase the amount of land inundated in a flood. The table above shows the acreage flooded and the percent change in area flooded for both watersheds given historic data (closest approximation of current conditions) as well as under projected flooding conditions for the 2050s and the 2080s (RCP 8.5 high emissions scenario).[2]

As shown in Table V-1, increases in the extent of flooding will put additional farmland at risk of inundation. In the Stillaguamish River watershed, current flooding extent for the 2-year flood (50% chance event) is projected to more than quadruple by the middle of the century, going from 9,095 acres inundated to 38,575 acres. In the Snohomish River watershed, projections indicate the acreage inundated in a 2-year flood will more than double, going from 16,946 acres to 40,134 acres. More severe changes are projected for the more frequent 2- and 10-year flood events, while the 100-year event (1% chance) will see smaller increases in the amount of land inundated.

Modeled flood extents for specific locations can be viewed in an online web map that can be accessed from https://snohomishcd.org/ag-resilience. However, it is important to note that the model is at a coarse scale and most appropriate for high-level risk assessment and planning, not site-level analysis.

Agricultural producers in the county have expressed that yearly flood frequency is as important as flood height when assessing the potential for future risk. CIG completed an analysis looking at the change in number of

Table V-2. Projected Days Per Year Stage Thresholds are Exceeded

	STAGE	HISTORIC	2050s RCP 4.5 – LOW (AVG)	2050s RCP 8.5 – HIGH (AVG)	2080s RCP 4.5 – LOW (AVG)	2080s RCP 8.5 – HIGH (AVG)
Stillaguamish River at Arlington	17 ft	1.2	2.9	3.0	3.5	3.5
	19 ft	0.5	1.3	1.4	1.6	1.7
Snohomish River near Monroe	17 ft	1.1	2.6	2.9	3.2	3.9
	23 ft	0.2	0.4	0.4	0.5	0.7

days a year the rivers reach specific flood stages based on farmer input into key flood stage thresholds (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). In the Stillaguamish River floodplain, farmers identified the 17-foot and 19-foot flood stages as critical, which correspond roughly to the 2- and 3-year events. In the Snohomish River floodplain, farmers identified the 17-foot and 23-foot stages, which correspond roughly to the 3- and 13-year flood events.

Table V-2 shows the average number of days per year these stage thresholds are exceeded using historic data alongside projections for the 2050s and the 2080s at the Stillaguamish River at Arlington gauge (#34) and the Snohomish River near Monroe gauge (#12150800).[3] Average estimates are shown here for two climate projection scenarios (low or high greenhouse gas emissions). The modeling indicates increases in flood frequency of all stage heights by the 2050s and again for the 2080s. For example, the models show that the 17-foot stage on both rivers is exceeded for 3 days per year, on average, by the 2050s, whereas historically it has only been exceeded about one day per year, on average. The more extreme stages on both rivers – 19-foot on the Stillaguamish and 23-foot for the Snohomish – also occur more frequently in the future, happening about two to three times as often by the 2050s and three to four times as often by the 2080s.

Groundwater Levels

Groundwater levels are a major variable affecting agricultural operations in the lower Snohomish and Stillaguamish River floodplains. The timing and extent of groundwater saturation affects when farmers can get out on their fields in the spring; accessing when fields are too wet can cause damage to equipment and soils. Wetter years will result in delayed access to fields and drier years may allow earlier access depending on crop types. In the fall, rain and the associated rise in the groundwater table effectively ends the cultivation season.

Climate change is expected to impact groundwater conditions and timing in both watersheds. A rise in relative sea level is expected to raise groundwater levels and extend the period of saturation in the spring, thereby delaying field access. The impact of sea level rise on groundwater levels may also shorten the agricultural season in the fall as groundwater levels return to pre-spring conditions earlier.

Table V-3 shows relative sea level rise projections at the Snohomish River and Stillaguamish River mouths (RCP 8.5 high emissions scenario).

Table V-3. Relative Sea Level Rise Projections

	YEAR 2050	YEAR 2080	YEAR 2100
Snohomish River	0.8 feet	1.5 feet	2.2 feet
Stillaguamish River	0.7 feet	1.5 feet	2.2 feet

4

To better understand the impacts of sea level rise on groundwater, the Conservation District hired Cardno to assess the impact of rising sea levels on groundwater levels in the spring and fall on floodplain agricultural land.[3] The study examined the lower Snohomish and Stillaguamish basin floodplains from the mouth upstream to the extent of tidal influence on groundwater levels for each river system. For the Snohomish River, the study area extended from the mouth of Possession Sound to Thomas' Eddy at river mile 16.1. The Stillaguamish River study area extended from the mouth of the river at Hatt Slough upstream to the Pioneer Highway Bridge at river mile 7.4.

In order to confirm assumptions about geology and to document groundwater levels across seasons, Cardno installed wells throughout the study areas. They also used data from existing wells operated by Snohomish County, the Stillaguamish Tribe, and the Washington Department of Fish and Wildlife. Cardno used the recently released *Projected Sea Level Rise for Washington State – A 2018 Assessment*[4] to incorporate projections of relative sea level rise into the analysis. Sea level rise was assumed to affect river channels up to the current extent of tidal influence.

Examination of existing groundwater conditions showed that groundwater at farms in both the Snohomish and Stillaguamish watersheds tend to decline about one foot per month through the spring. In the fall, higher river flows cause groundwater levels to increase to early-spring elevations. Based on this information about current conditions, the groundwater study was able to project delays in spring cultivation by calculating how long it would take future groundwater levels, raised by sea level rise, to fall to current spring conditions.

Results indicate that rising sea levels are anticipated to delay the time when farmers access their fields in the spring. While natural variation will continue, sea level rise will generally increase the delay of start times for working fields and this increase will become more and more pronounced with time. For low-lying farmland, delays could reach three weeks by the 2050's and four to five weeks by the 2080s. Areas closer to the Puget Sound coast (within a few miles) will feel the greatest effects of this change because of their proximity to rising marine waters. Figures V-1 through V-4 at the end of this chapter show 2050 and 2100 groundwater projections for both the Snohomish and Stillaguamish watersheds.

The Take-Away: Groundwater

Rising sea levels are anticipated to delay the time when farmers can access their fields in the spring by up to four weeks by the 2050s and up to five weeks by the 2080s.

The study found that the effects of sea level rise on the timing of groundwater conditions in the fall are not likely to be significant because anticipated changes in levels would be within the range already experienced under natural tidal cycles. Therefore, the delay in start times for working fields in the spring would not be made up in the fall.

A separate analysis was conducted for Ebey Island in the Lower Snohomish River floodplain. Because no groundwater data is available for Ebey Island, well data from nearby Smith Island was used as an analog. It was found that groundwater levels on Smith Island track the levels of Puget Sound tides and are within a foot of the height of the adjacent slough during summer months. If we apply this relationship to Ebey Island, it indicates that sea level rise could have a direct impact on groundwater levels. The analysis shows that a number of areas on the island would lie below the groundwater table and be inundated without active drainage and pumping (see Figure V-5 at the end of this chapter). However, farmers on Ebey Island have stated that pumping and drainage effectively dry out all cultivated areas. This emphasizes the critical role pumping plays in maintaining agricultural viability, a role that will become even more important with sea level rise.

Saltwater Intrusion

Agricultural areas located near marine waters can suffer from saltwater intrusion, which occurs when saline waters move into groundwater aquifers. In the Lower Stillaguamish and Snohomish River floodplains, groundwater with increased salinity due to saltwater intrusion could affect the growing conditions for crops if that salinity reaches root zones. Though salts are crucial plant nutrients, high concentrations of any one salt or many different salts can be toxic to plants. Sea level rise could increase saltwater intrusion into groundwater in these areas as the saltwater interface rises in relation to freshwater aquifers.

In addition to analyzing groundwater levels and ponding, the aforementioned groundwater study completed by Cardno also assessed the effect of sea level rise on saltwater intrusion into shallow groundwater. Cardno measured salinity levels in the wells drilled for the groundwater level study, as well as analyzed data from partner's wells. Salinity impacts are measured in millisiemens per centimeter (mS/cm), a metric that measures conductivity values as a surrogate to salinity. Based on the salt tolerance of crops most commonly grown in the Lower Stillaguamish and Snohomish River floodplains (corn, grass, beets, spinach, and cabbage) and the depth of the wells used in the study, it was assumed that 3 mS/cm would best indicate potential impacts of saltwater intrusion on agricultural production. The response of plants to 0-2 mS/cm is mostly negligible, while sensitive plants can experience yield impacts with 2-4 mS/cm. Most plants would be restricted by 4-8 mS/cm, and only tolerant plants can grow under conditions with 8 mS/cm or more.

In the Lower Stillaguamish, existing conductivity measurements at wells within 1,000 feet of Hatt Slough showed a range of 0.1 to 6.7 mS/cm in late August 2016. These readings suggest that crops in the lower estuary may already be stressed by existing salinity conditions. Farmers in this area confirm that this is true in patches, but that most land is still highly productive. Data suggests that rising sea levels of one foot will increase conductivity measurements by approximately 1 mS/cm in the groundwater of farms near the coast. Figure V-6 at the end of this chapter shows the late spring/early summer salinity threshold in the Stillaguamish estuary currently, as well as predictions for where the salinity impact will expand to in the future.

The Take-Away: Saltwater Intrusion

On Florence Island in the Lower Stillaguamish, patches of farmland already experience saltwater intrusion above crop tolerance thresholds, and those impacts are likely to increase in severity over the next 50 years.

Areas closest to the shoreline are at the highest risk of saltwater intrusion. Areas within 5,000 feet of the shoreline are especially vulnerable, and areas within 10,000 feet could also experience increases over time.

Increasing pumping on Florence Island is not recommended unless additional groundwater analysis negates the finding of this study, as pumping could result in increasing the amount of agricultural land impacted by salinity.

Geographic location is a key factor in saltwater intrusion impacts. Areas closest to the shoreline have the highest risk of increased groundwater salinity intrusion due to rising sea levels. Areas within 5,000 feet of the shoreline are especially vulnerable to groundwater salinity intrusion to the shallow rooting zone of crops but areas within 10,000 feet may also experience measurable increases over time. To a high level of certainty, Florence Island (near the mouth of the Stillaguamish River) already experiences salinity above crop tolerance thresholds, and those impacts are likely to increase in severity over the next 50 years. In contrast, agricultural land on Ebey Island in the Snohomish River floodplain may not experience significant increases in salinity intrusion to shallow groundwater due to its location further from marine waters. Because the Marshland and French Slough Flood Control Districts are greater than 20,000 feet from the marine boundary, sea level rise is not expected to cause significant increases in salinity intrusion to shallow groundwater.

Traditional pumping and infrastructure solutions to rising seas may not provide adequate protection for the future. For example, installation of pumps to reduce groundwater impacts to drainage could draw deep, salty groundwater upward, closer to the rooting zone of crops. Future improvements to pumps and drainage systems must consider groundwater salinity intrusion effects from rising sea levels. In the Snohomish River, pumping in the Marshland and French Slough Diking Districts is not likely to impact groundwater salinity, but additional analysis is recommended before implementing a more aggressive pumping approach further downstream on Ebey Island. In the Stillaguamish River, increasing the amount of pumping on Florence Island is not recommended unless additional groundwater analysis negates the finding of this study, as pumping could result in increasing impact of salinity on agricultural land.

The interplay of sea level rise, groundwater, and surface water management for the lower Stillaguamish and Snohomish River floodplains is complex and many uncertainties remain that have not yet been resolved. The study recommends a focused data collection effort to evaluate the degree to which salinity already affects crop yields in the region.

Land Subsidence and Channel Aggradation

Subsidence refers to the downward sinking of the ground surface. Subsidence of agricultural lands can occur from the lack of sediment inputs to the floodplain, soil compaction, groundwater withdrawals, and decomposition of soil organics. Aggradation refers to the rising of the ground surface and, in this study, refers to the accumulation of sediment within the river channel. Aggradation can increase the risk of flooding because it decreases the capacity of the river to carry flood volumes. Subsidence contributes to drainage issues in agricultural fields and can increase the risk of levee failure through settling and shifting. Therefore, aggradation within the river channel and subsidence of adjacent farmland can increase the flood and drainage impacts to some agricultural areas.

The Take-Away: Subsidence and Aggradation

The analysis of subsidence for both the Stillaguamish and the Snohomish floodplains showed little direct evidence for regional subsidence, and limits the calculation of localized subsidence to no more than 2.4 inches per decade if it is occurring at all.

The Stillaguamish River channel is aggrading near the mouth, and this trend is likely to continue into the future. The Lower Snohomish River is not aggrading, but upper reaches (from the SR-9 Bridge to the Skykomish) show some aggradation.

In order to study whether land subsidence and aggradation is affecting agriculture in the Snohomish and Stillaguamish River floodplains, the Conservation District contracted Cardno to conduct subsidence and aggradation studies for each watershed. To evaluate subsidence, Cardno re-surveyed elevations in areas that have been surveyed in the past, including monuments and benchmarks, roads, agricultural lands, and levees. The study also involved analysis of the vertical difference between elevations from multiple LiDAR datasets. To evaluate aggradation, Cardno compared recent channel cross-sections to historical surveys, evaluating 48 cross-sections of the Stillaguamish River and its tributaries and 19 cross-sections of the Snohomish River.

The analysis of subsidence[5] in the Stillaguamish floodplain was inconclusive. The accuracy of LiDAR data comparisons was suspected to be influenced by varying heights of vegetation, making accurate conclusions difficult. The resurvey of benchmarks suggests localized subsidence in known locations, but does not provide an indication of larger-scale agricultural land subsidence. In general, the data shows little direct evidence for regional subsidence and limits the magnitude of localized subsidence to no more than 2.4 inches per decade in some areas. The study concludes that the impact of sea level rise on groundwater levels and salinity as well as the impact of larger winter flood events should be a greater concern than subsidence.

Potential subsidence in the Snohomish River floodplain was also assessed using LiDAR data as well as re-survey of benchmarks. This analysis showed a range of subsidence from 1 to 6 inches approximately every 10 years in some areas.[6] In general, however, the uncertainty in the LiDAR comparisons exceed the magnitude of elevation change that may have occurred, so the datasets are not conclusive. Similar to the Stillaguamish River, the data limits the likely magnitude of subsidence to no more than 2.4 inches per decade, and primarily in areas with high organic soils on Ebey Island and in the Marshland and French Slough Flood Control Districts. Local farmers indicate that organic soils subside more quickly in the years after initial clearing, draining and cultivation than in subsequent years.

In the Stillaguamish River, cross-sections of the river channel showed that both the main channel and the Old Main Channel experienced aggradation from 1997 to 2011.[5] The general trend of aggradation is expected to continue into the future. Dredging in the Lower Stillaguamish River is not considered to be an option for mitigating this risk because it would not reduce future sediment inputs that would continue to aggrade the river and because it would only cause a negligible decrease in the peak flood stage.

Analysis of the Lower Snohomish River showed that the river channel has remained stable from year to year and has not aggraded.[6] However, the upper reach of the river (from the SR-9 Bridge to the confluence of the Skykomish and Snohomish Rivers) showed aggradation. This reach may experience modest aggradation into the future.

Crops

The *State of the Knowledge: Climate Change in Puget Sound* reports that the impacts of climate change on local agriculture include increased temperatures, changes in seasonal precipitation and a lengthening of the growing season, all of which may positively or negatively impact specific agricultural products or farmland.[1] Washington State University's Center for Sustaining Agriculture and Natural Resources developed an online Climate Visualization Tool that allows farmers to visualize

Climate Change

"Seeds are planted and sprout undercover and we, as farmers, wait for the rain to stop and fields to dry out enough to do soil work and prepare beds for getting all of these plants in the ground. This past spring was similar to ones in the past, only the rains didn't let up in April as they normally do. While a little extra rain might be a small inconvenience to some, this kind of climatic event makes a very real impact on farmers and food production. Most farmers are 4-6 weeks behind schedule because of delays brought on by abnormal rainfalls, but nature itself is also behind. Asparagus, a perennial crop, was also weeks late in coming up this year. What will next Spring bring? How much added resilience is necessary to withstand these changes?"

Libby Reed, Orange Star Farm, Photovoice 2017 projected climate changes as they relate specifically to agricultural crops in the Pacific Northwest. The tool shows crops grown in 6 km x 6 km grids across the landscape and provides projections to the years 2040, 2060 and 2080 for impacts associated with:

- Temperature
- Growing degree day accumulation
- Growing season length
- Precipitation
- Climate analogues

The tool can be found at http://agclimatetools.cahnrs.wsu.edu/cbcct/.

Below is a summary of the projected impacts of climate change on temperature, growing season, and precipitation as they relate to future crop viability in Snohomish County.

The Take-Away: Crop impacts

Increasing air temperatures in summer months are projected to negatively impact some existing crops while at the same time providing opportunities for new types of agricultural production. This warming will result in a longer growing season but also an accelerated growing degree day accumulation, which can have a negative impact on yields. Models project a decrease in summer precipitation and an increase in winter precipitation.

By the 2040s, Snohomish County is predicted to have similar growing conditions to Santa Cruz County, CA, just south of San Jose. And by the 2080s, conditions are expected to be most similar to Santa Barbara County, CA, just north of Los Angeles.

TEMPERATURE

Increasing air temperatures in summer months are projected to negatively impact some existing crops while at the same time provide opportunities for new types of agricultural production. The agricultural areas in the lowlands of the Puget Sound region have warmed 1.3°F in the last 120 years with nighttime temperature rising faster than daytime temperature.[1] In Snohomish County, climate models consistently project continued warming in the lowlands, although the magnitude of change can vary by model. Depending on the emissions scenario used (low or high greenhouse gas emissions), average projected increases in annual average temperatures are 4.0°F - 5.5°F by midcentury and 5.5°F - 8.5°F by the end of the century. Projections also indicate that we will see an increase in extreme heat events, while the frequency of extreme cold events will decrease.[1] In addition to the potentially positive or negative impacts to growing degree day accumulation described below, warming related risks include exposure to heat stress events and insufficient chill accumulation before bloom for perennial trees.[7]

GROWING DEGREE DAYS

Warming can result in accelerated growing degree day accumulation, which can lead to earlier maturity and decreases in yields for some crops or more time under optimal conditions resulting in yield increases for other crops.[8] Growing degree days are the plant's calendar, determining its phenology or timing of growth stages. It is a measurement of heat accumulation based on minimum and maximum daily temperatures and crop-specific optimal high and low temperature thresholds. Overall yield impacts are very crop- and location-specific and depend of the relative balance between temperature effects which can be positive or negative and a carbon dioxide fertilization effect which is generally positive.[8]

The maturity of annual crops such as corn, barley, and potatoes in Snohomish County is projected to advance by about a month by midcentury, and by a couple of months by end of the century. This will open up new opportunities, including the potential to double crop if there is sufficient water availability as well as the potential to access new markets via crops that become suitable under these new conditions.[9,10]

GROWING SEASON LENGTH

The growing season length, defined as the number of frost free days (number of days between the last frost in spring and the first frost in fall), is also predicted to increase.[11] While the current growing season length in Snohomish County is approximately 260 days, projections show approximate lengthening of the growing season of 75 days by midcentury and 100 days by the end of the century. This measurement of the growing season length does not take into account other factors influencing the ability to grow crops such as groundwater levels and the availability of light during winter months.

PRECIPITATION

Natural variability in annual precipitation is high, making future projections highly variable. Models consistently indicate, however, a projected decrease in summer precipitation under all greenhouse gas emissions scenarios. Most models predict a decline in summer precipitation of 22%, on average, by the 2050s.[1]

While winter, spring, and fall precipitation projections show only modest increases (2 – 11% on average) by mid-century, precipitation extremes are projected to increase and occur more frequently. As temperatures increase, models predict that rain will be the dominant form of precipitation in most watersheds in the Puget Sound by the end of the century – watersheds such as the Snohomish River that have historically been highly influenced by snowfall.[1] These shifts in the hydrologic cycle will mean more flooding in winter months and lower stream flows in summer months.

CLIMATE ANALOGUES

Researchers at WSU conducted an analysis of crop growing condition analogues that can help farmers plan for future conditions.[12] Using soil and climate data for the Western U.S., this analysis answers the question “is there another county whose current growing conditions are similar to what is predicted for Snohomish County?” This information is shown by county for Washington, Oregon, and Idaho using the Climate Visualization Tool linked above.

By the 2040s, Snohomish County is predicted to have similar growing conditions to Santa Cruz County, CA, just south of San Jose. And by the 2080s, conditions are expected to be most similar to Santa Barbara County, CA, just north of Los Angeles. Information such as the types of crops, management practices, and pest control in analogue counties can provide valuable information to Snohomish County farmers wanting to plan for and manage risk into the future.

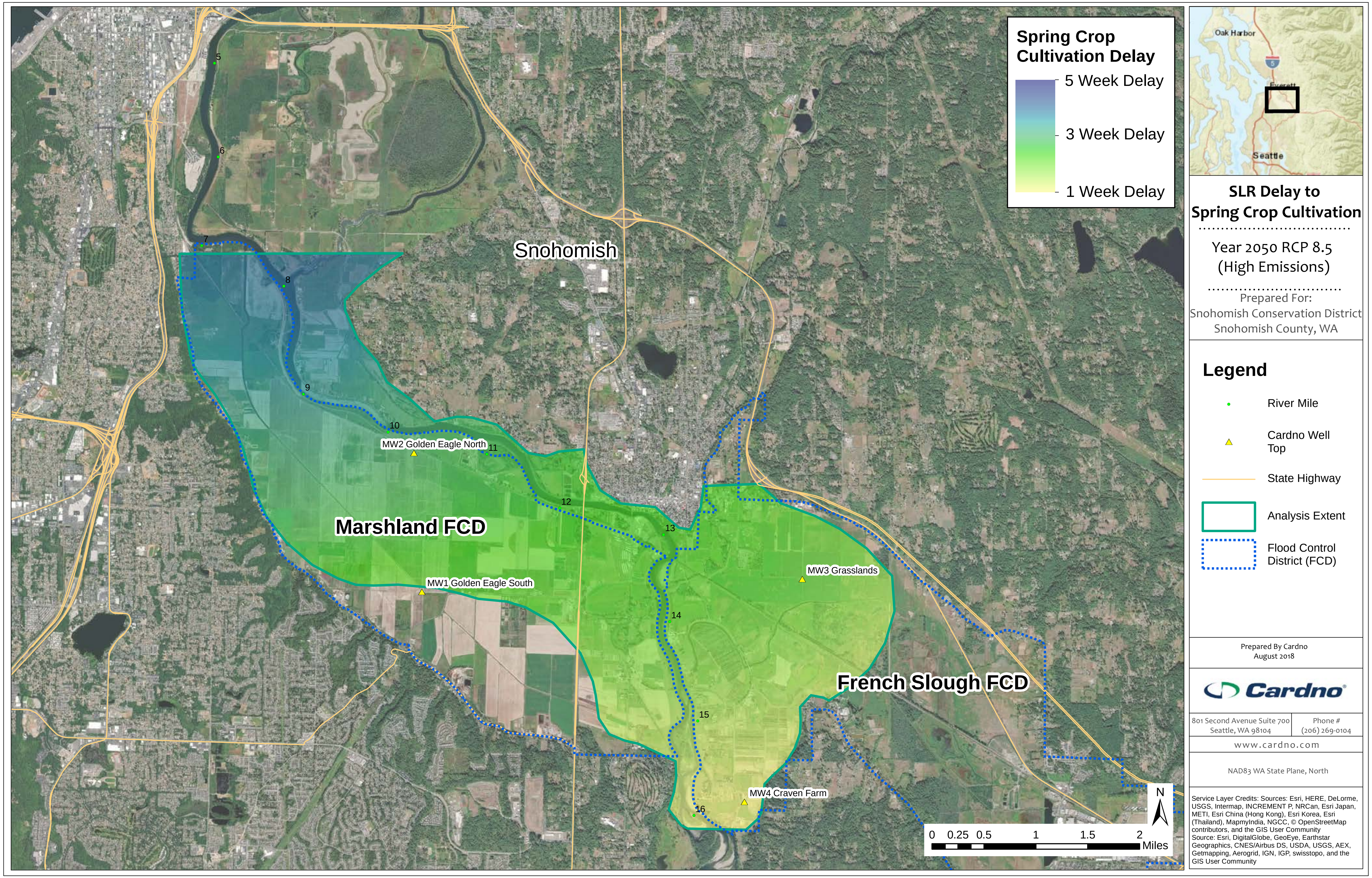

Figure V-1. SLR Delay to Spring Crop Cultivation, Snohomish Floodplain, Year 2050. This figure shows the projected delay to spring crop cultivation due to changes in groundwater levels. The projection is shown for the year 2050 using RCP 8.5 scenario (high emissions).

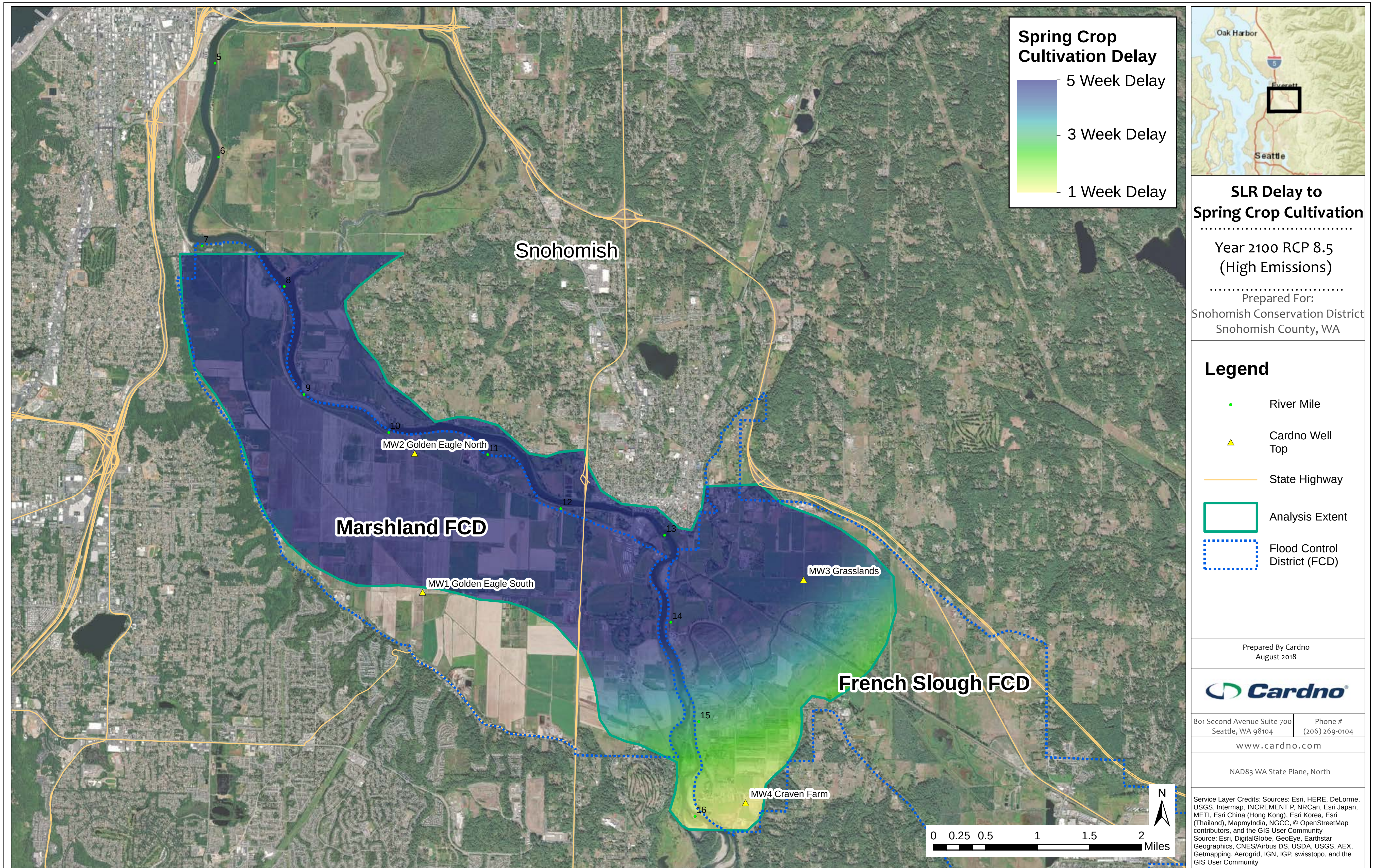

Figure V-2. SLR Delay to Spring Crop Cultivation, Snohomish Floodplain, Year 2100. This figure shows the projected delay to spring crop cultivation due to changes in groundwater levels. The projection is shown for the year 2100 using an RCP 8.5 scenario (high emissions).

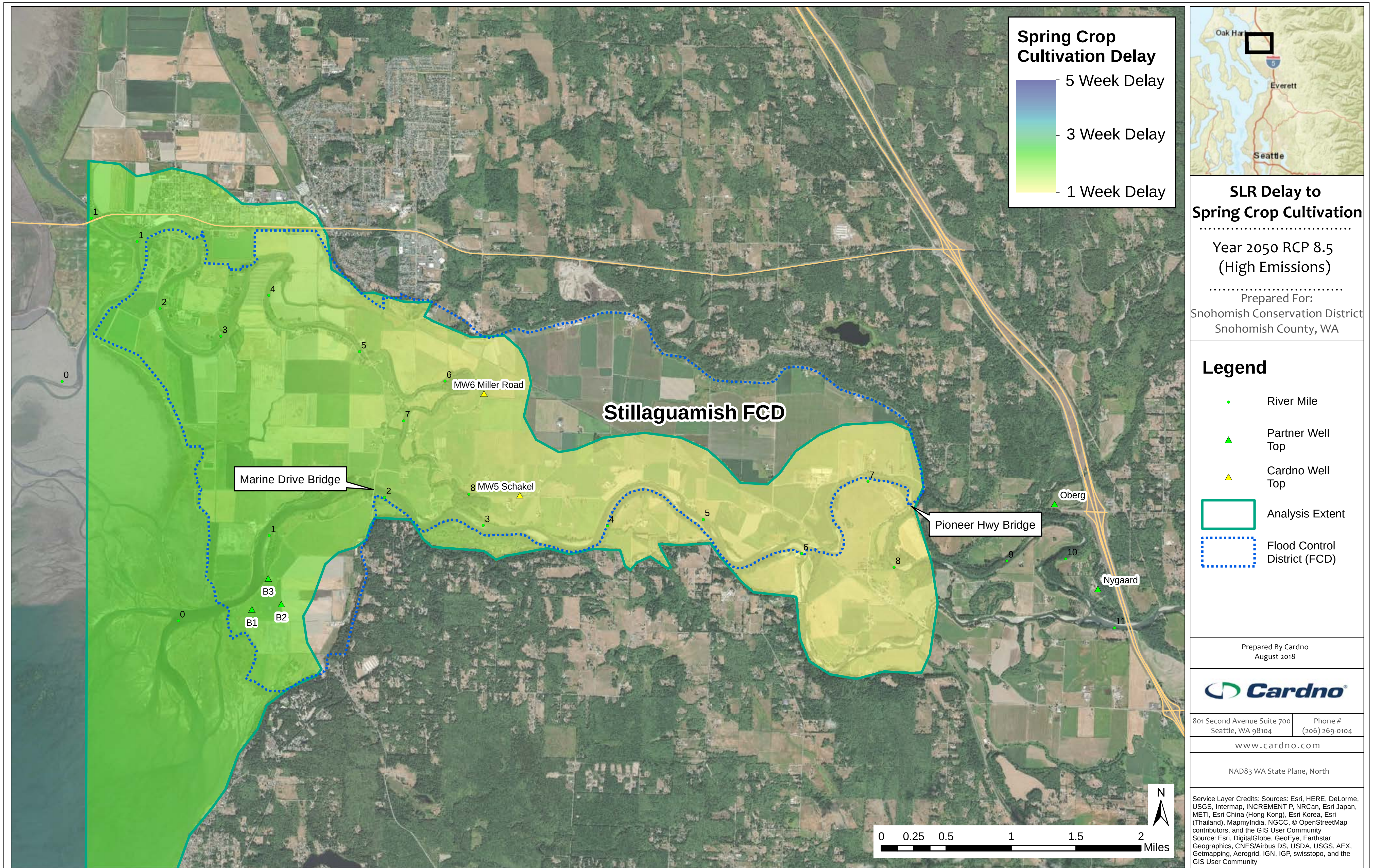

Figure V-3. SLR Delay to Spring Crop Cultivation, Stillaguamish Floodplain, Year 2050. This figure shows the projected delay to spring crop cultivation due to changes in groundwater levels. The projection is shown for the year 2050 using an RCP 8.5 scenario (high emissions).

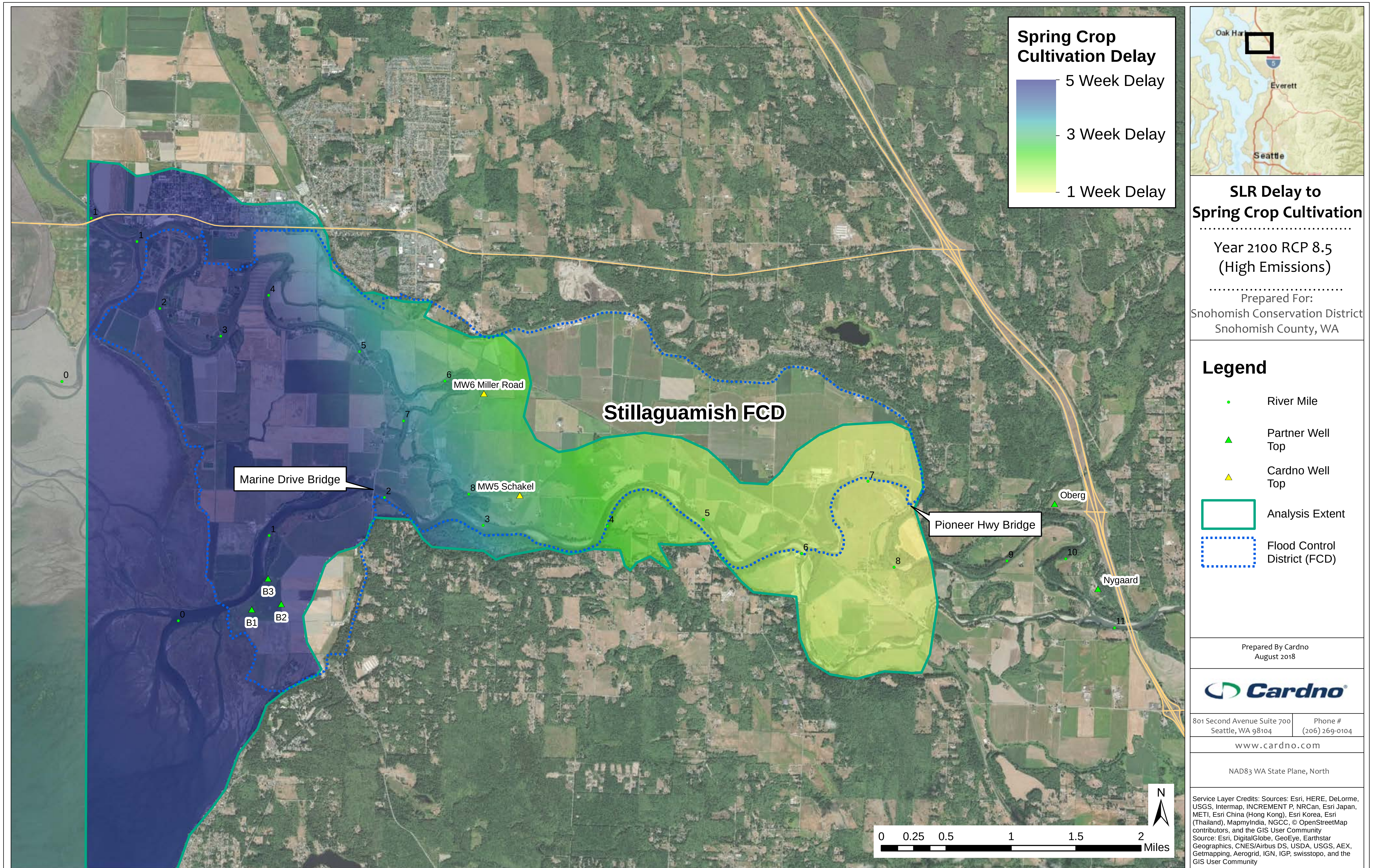

Figure V-4. SLR Delay to Spring Crop Cultivation, Stillaguamish Floodplain, Year 2100. This figure shows the projected delay to spring crop cultivation due to changes in groundwater levels. The projection is shown for the year 2100 using an RCP 8.5 scenario (high emissions).

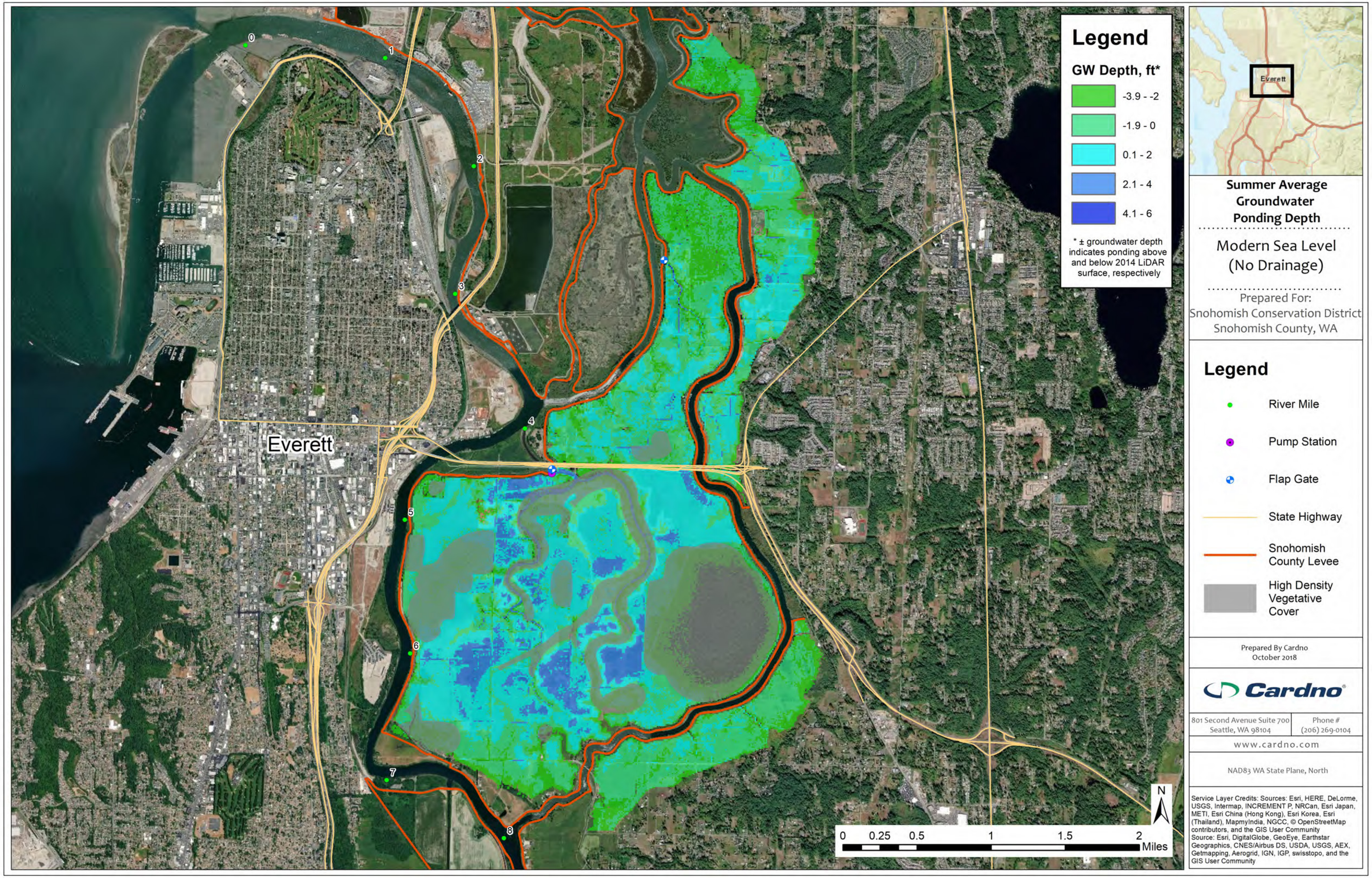

Figure V-5. Projected Depth-to-Groundwater Map for Ebey Island and Vicinity. This figure shows the projected depth-to-groundwater map for Ebey Island under modern sea level and assuming no pumping. The blue areas lie at elevations below the assumed groundwater table, and so are currently dependent on active drainage measures to remain dry. In general, the darker blue areas closely correspond to wet areas or boils that are readily observed on aerial photographs.

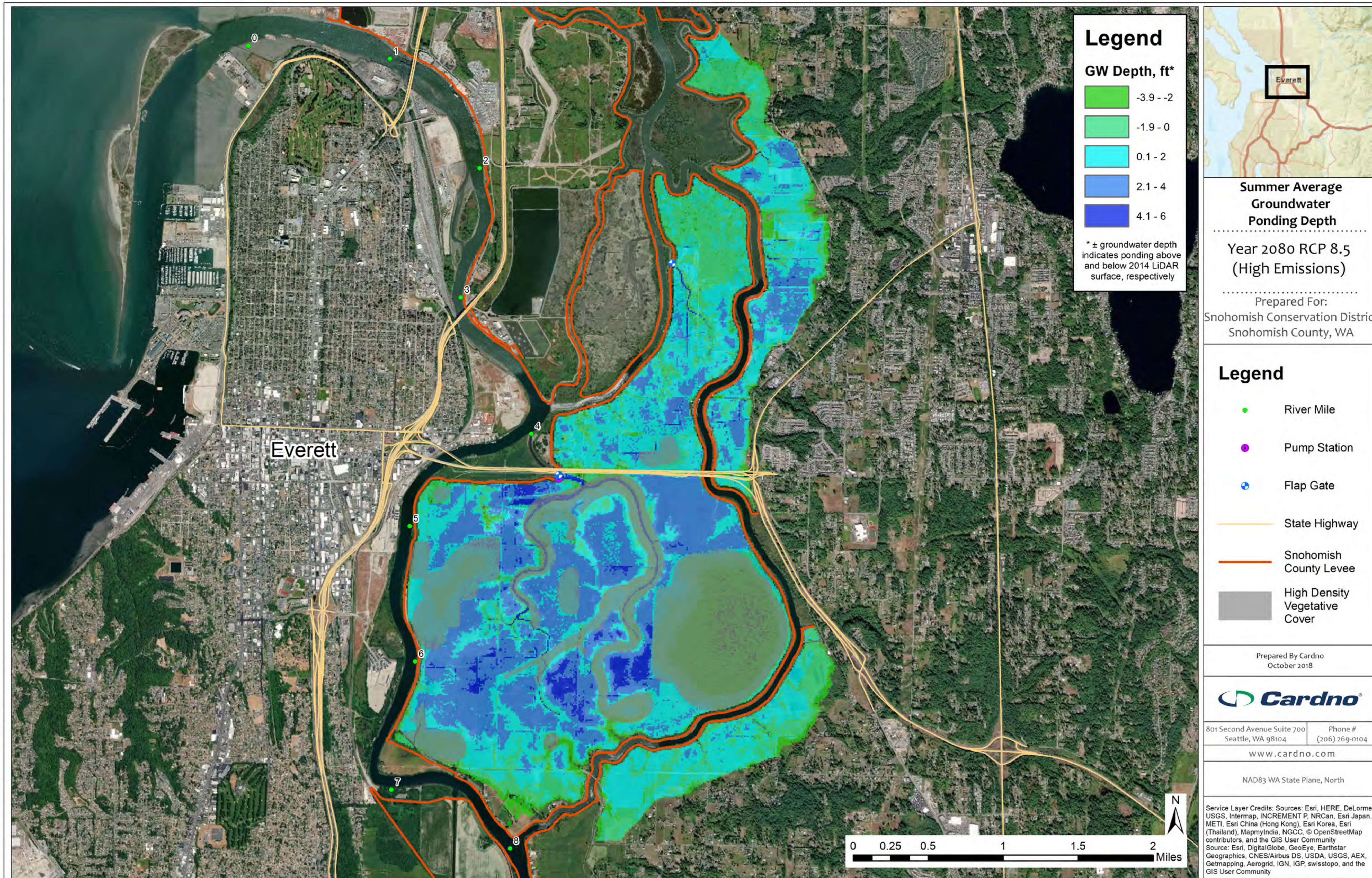

Figure V-6. Future Conditions Depth-to-Groundwater Map for Ebey Island and Vicinity. This figure shows the projected depth-to-groundwater map for Ebey Island in 2080 under an RCP 8.5 (high emissions) scenario.

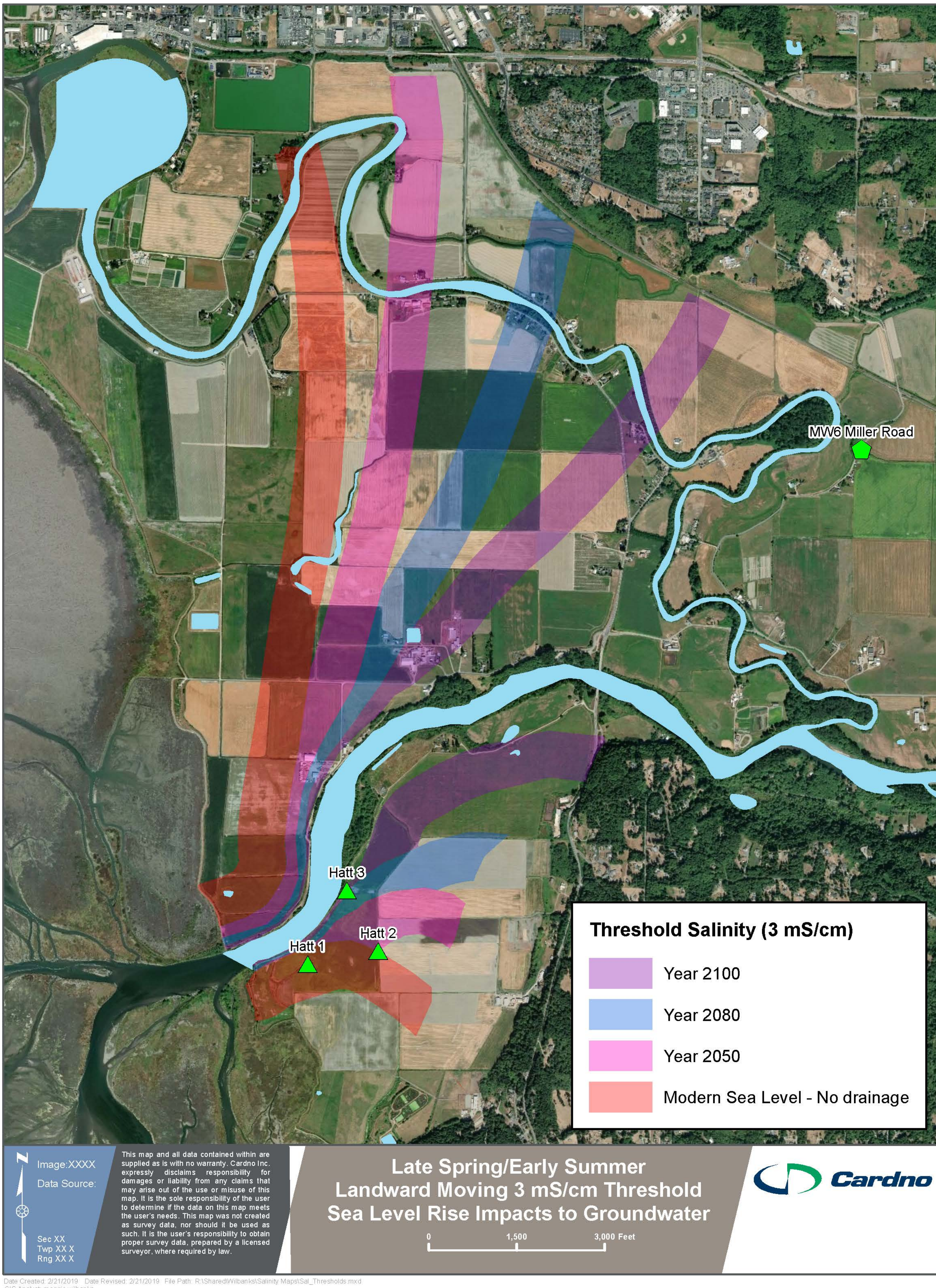

Figure V-7. Early Summer Salinity Intrusion to Groundwater. This figure shows the projected level of salinity intrusion in the Stillaguamish Estuary out to 2100. The shaded lines represent where the threshold for crop impacts is expected to reach for that year.

1 Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

2 Fathom, 2019. Puget Sound Hazard Mapping Report.

3 Cardno, 2019. Climate impacts to groundwater in the Lower Snohomish and Stillaguamish River basins. Report produced for the Snohomish Conservation District. Lake Stevens, WA.

4 Miller, I.M., H. Morgan, G. Mauger, T. Newton, R. Weldon, D. Schmidt, M. Welch, and E. Grossman, 2018. *Project Sea Level Rise for Washington State – A 2018 Assessment*. A collaboration of the Washington Sea Grant, University of Washington Climate Impacts Group, Oregon State University, University of Washington, and US Geological Survey, Prepared for the Washington Coastal Resilience Project.

5 Cardno, 2019. Technical Memo: Stillaguamish Flood Control District subsidence and sedimentation study. Report produced for the Stillaguamish Flood Control District. Lake Stevens, WA.

6 Cardno, 2019. Technical Memo: Lower Snohomish River district subsidence and sedimentation study. Report produced for the Snohomish Conservation District. Lake Stevens, WA.

7 Noorazar, H., L. Kalcsits, V.P. Jones and K. Rajagopalan. Tree-fruit production risks in the Pacific Northwest due to insufficient chill accumulation. Climatic Change (In preparation).

8 Rajagopalan K., K. Chinnayakanahalli, C. Stockle, R. Nelson, C. Kruger, M. Brady, K. Malek, S. Dinesh, M.E. Barber, G. Yorgey and J. Adam, 2018. Impacts of near-term regional climate change on agriculture in the Columbia River basin. Water Resources Research.

9 Barik, M., J.C. Adam, J. Yoder, M.P. Brady, D. Haller, M.E. Barber, Hall, S.A., C.E. Kruger, G.G. Yorgey, M. Downes, C.O. Stockle, B. Aryal, T. Carlson, G. Damiano, S. Dhungel, C. Einberger, K. Hamel-Reiken, M. Liu, K. Malek, S. McClure, R. Nelson, M. O'Brien, J. Padowski, K. Rajagopalan, Z. Rakib, B. Rushi, W. Valdez (2017), 2016, Technical Supplement for the Columbia River Basin Long-Term Water Supply and Demand Forecast. Publication No. 16-12-008. Washington Department of Ecology, Olympia, WA. 216 pp. Available online at: https://fortress.wa.gov/ecy/publications/SummaryPages/1612008.html

10 Bisbis, M.B., Gruda, N. and Blanke, M., 2018. Potential impacts of climate change on vegetable production and product quality–A review. Journal of Cleaner Production, 170, pp.1602-1620.

11 Climate Visualization Tool (CVT) http://agclimatetools.cahnrs.wsu.edu/cbcct/. (Last accessed September 2019).

12 Potter N., K. Rajagopalan, and M. Brady. (2018) *Using Climate Analogues to Obtain a Causal Estimate of the Impact of Climate on Agricultural Productivity.* Proceedings of Agriculture and Applied Economics Association Annual Meeting, Washington D.C.

Chapter VI
Priority Needs

The agricultural community in Snohomish County is facing many current and projected challenges associated with increased development and a changing climate. Through a robust community engagement process, farmers provided priority resilience needs for their specific reach. This chapter documents the major themes raised during this community engagement process. The chapter is followed by eleven individual Reach Summaries (Chapter VII) that characterize existing farming and infrastructure, projected impacts to agricultural viability, and prioritized resilience needs.

Addressing the following resilience needs will require partnership building, innovative approaches to problem solving, creative thinking, and funding acquisition. Farmers highlighted the need for grant and/or loan funding to help them address many of these issues described below.

Priority needs include farmland conservation, drainage infrastructure and maintenance, compensation for upland runoff, flood protection, access to irrigation water, drought resilience practices, and additional groundwater analysis.

Farmland Conservation

Through a stakeholder led prioritization process, PCC Farmland Trust and partners on the Snohomish Farmland Conservation Working Group identified a 10-year protection target of 15,000 acres of high priority farmland. Much of Snohomish County's commercial farmland is in the floodplain, where state and local regulations provide partial barriers to conversion of the land. Still, many farms in both the floodplains and upland areas continue to be lost to development, habitat restoration, businesses, and other uses. While this 10-year acreage target does include upland agricultural land protection goals, a focus on farms utilizing the highly productive soils of the floodplains is critical to ensure a viable agricultural system in the county.

Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to reach the 10-year protection target or satisfy farmer interest. In addition, the per acre easement payments to farmers through these two programs are often too low to incentivize participation. Potential options for increasing funding available include growing the TDR program, securing grants, and/or leveraging additional taxes.

Drainage Infrastructure and Maintenance

Diking, drainage, and flood control districts across the County consistently report insufficient funding to manage current drainage needs, citing runoff from upland areas and increased flooding as major impacts. Climate change projections indicate increased stormwater runoff and flood frequency and scale, highlighting the need for improvements to and increased capacity of drainage systems.

Many agricultural areas require a drainage needs assessment to inform projects that would increase capacity of existing culverts, tide gates, and pump stations as well as replace aging infrastructure. Assistance acquiring and complying with permits for infrastructure improvement projects as well as regular maintenance of drainage conveyances is critical. In addition, individual farms would benefit from increased technical and funding assistance for drainage improvements.

Compensation for Upland Runoff

Development of upland areas has resulted in increased runoff reaching floodplain areas, in many cases exacerbating drainage challenges for farmers. A few diking, drainage, and flood control districts have agreements with local jurisdictions to collect stormwater fees to help offset the costs associated with increased runoff and sediment, while most do not. There is a need to work with individual districts and local jurisdictions to help develop these compensation agreements and potentially increase revenue under existing agreements.

Projects or initiatives to reduce upland runoff would also greatly benefit farmers. These potentially include use of green stormwater infrastructure, regulatory changes to county and city development codes, and education or incentives for urban and suburban landowners and developers to reduce runoff from their properties.

Farming a few feet above sea level

"In drier years, farming a few feet above sea level is always a bit of a gamble. Yet as the clouds build and the winter rain falls, I wonder if it is a matter of climate change or all the development (and its consequential gutters, pavement, and sewer lines) that encircle the valley. Are we building an agricultural legacy, or an urban drain field?"

Nick Pate, Raising Cane Ranch, Photovoice 2017

Flood Protection

While farms in the floodplain are often inundated in winter months, damages are minimized and spring drainage made possible through a system of sea dikes, river levees, and riverbank protection projects. In many places, this flood protection infrastructure is in need of improvement or replacement, and in others, there is a need for additional protection. With flood frequency and severity predicted to increase, impacts to this infrastructure will increase.

In the upper reaches of the watersheds, flood protection (in the form of bank stabilization) is needed to protect against loss of farmland to a migrating river channel. In the lower floodplain, flood protection needs include levee maintenance, flood fencing and waterbreak planting to lessen sediment and debris deposition on farms. Larger landscape-scale projects or approaches to water management that increase the capacity of the floodplain or channel to store flood waters are also recommended if they lessen the impacts of flood events on farm infrastructure, protect banks, and improve agricultural productivity. Finding creative solutions to increasing water storage on farmland, while reducing the negative impacts of long-term inundation and meeting increased spring drainage needs, could provide a win-win for farm, flood, and wildlife interests.

Access to Irrigation Water

Many farms do not have legal water rights, yet have a need for irrigation water to maintain their viability. Any withdrawal of surface water requires a water right and most commercial withdrawals of groundwater do as well. Climate change projections indicate the need for irrigation water will increase with less precipitation falling in summer months and with increasing temperatures. The Department of Ecology manages water resources in Washington State, including the issuance of water rights. At this time, applying for new water rights is not a feasible option for farmers as basins are closed to additional water withdrawals.

There is a need for creative approaches to providing access to water for farmers. Potential options include allowance of water withdrawals or capture during winter months, on-farm water storage, and/or the coordinated management and leasing of water rights at a landscape scale.

Assistance Implementing Drought Resilience Practices

There are numerous techniques that can be used to increase a farm's resilience to drought or to reduce the need for irrigation. Existing incentive and grant programs through the state and federal government provide cost-share funding for practices that build soil water holding capacity, hold and/or store water, and increase irrigation efficiency. These programs, however, are often highly competitive or pay low rates. With climate predictions indicating hotter and drier summers, additional funding is needed to incentivize practices such as cover cropping, no-till, compost or biochar application and agroforestry. In addition, research and/or on-farm trials of newly developing drainage infrastructure, such as controlled release of water from drain tiles or drainage ditches, is needed.

"We may have enough water now but we may not have enough in five years. We need to be looking to the future."

Jesse Allen, farmer, Photovoice 2017

Additional Groundwater Analysis

Further study of groundwater levels and saltwater intrusion are recommended in the estuaries of the Stillaguamish and Snohomish Rivers to validate predicted impacts of sea level rise on farmland.

In the Lower Stillaguamish River floodplain, projections for saltwater intrusion on Florence Island and in Drainage District 7 have been extrapolated from groundwater well data south of Hatt Slough. Cardno, the consultant who completed the groundwater assessment for this project, recommends collection and analysis of additional well data in these specific locations.

In the Lower Snohomish River floodplain, projections of groundwater levels on Ebey Island and in Diking Districts 2 and 4 have been extrapolated from groundwater well data on Smith Island. If increased pumping is considered as a tool to combat a rising groundwater table, further study is recommended to determine if this will result in upward migration of salty groundwater thus impacting crop yields.

Other Needs

While the intent of this Agriculture Resilience Plan is to focus on needs and actions to make the agricultural land itself more viable and resilient to future change, farmers also provided valuable feedback into other market, research, and education-related needs. These include:

- **Assistance complying with regulations –** The costs of and time associated with complying with county and state regulations puts incredible pressure on farmers, particularly smaller operations.
- **Research into new crop varieties –** The impacts of changing land use, climate, and markets continues to necessitate research into crop varieties that are resilient, drought tolerant, salt tolerant, and/or slower to mature.
- **Improvement of market infrastructure –** Processing facilities and equipment as well as venues for selling local products would assist in market expansion.
- **Flood risk training for new landowners –** New farmers moving into the floodplain could benefit greatly from training on how to minimize flood risk by accessing flood data available through Snohomish County as well as future flood projections.

Chapter VII
Reach Summaries

The following Reach Summaries characterize existing farming and infrastructure, projected impacts to agricultural viability, and prioritized resilience needs for eleven reaches within the Stillaguamish and Snohomish River floodplains (Figures VII-1 and VII-2 below). Through a robust community engagement process, farmers first learned about projected changes to flooding, groundwater, land subsidence and weather. Over 75 local farmers engaged in this process whereby they identified priority actions needed to ensure agricultural resilience into the future. Within each reach summary, the Resilience Needs section represents the primary needs identified by the farmers and categorizes them into tier one and tier two to guide implementation efforts.

The Steering Committee recommends an adaptive, county-wide approach to implementing these needs using criteria that includes likelihood of success, cost-benefit, availability of funding, and benefit to county-wide agriculture.

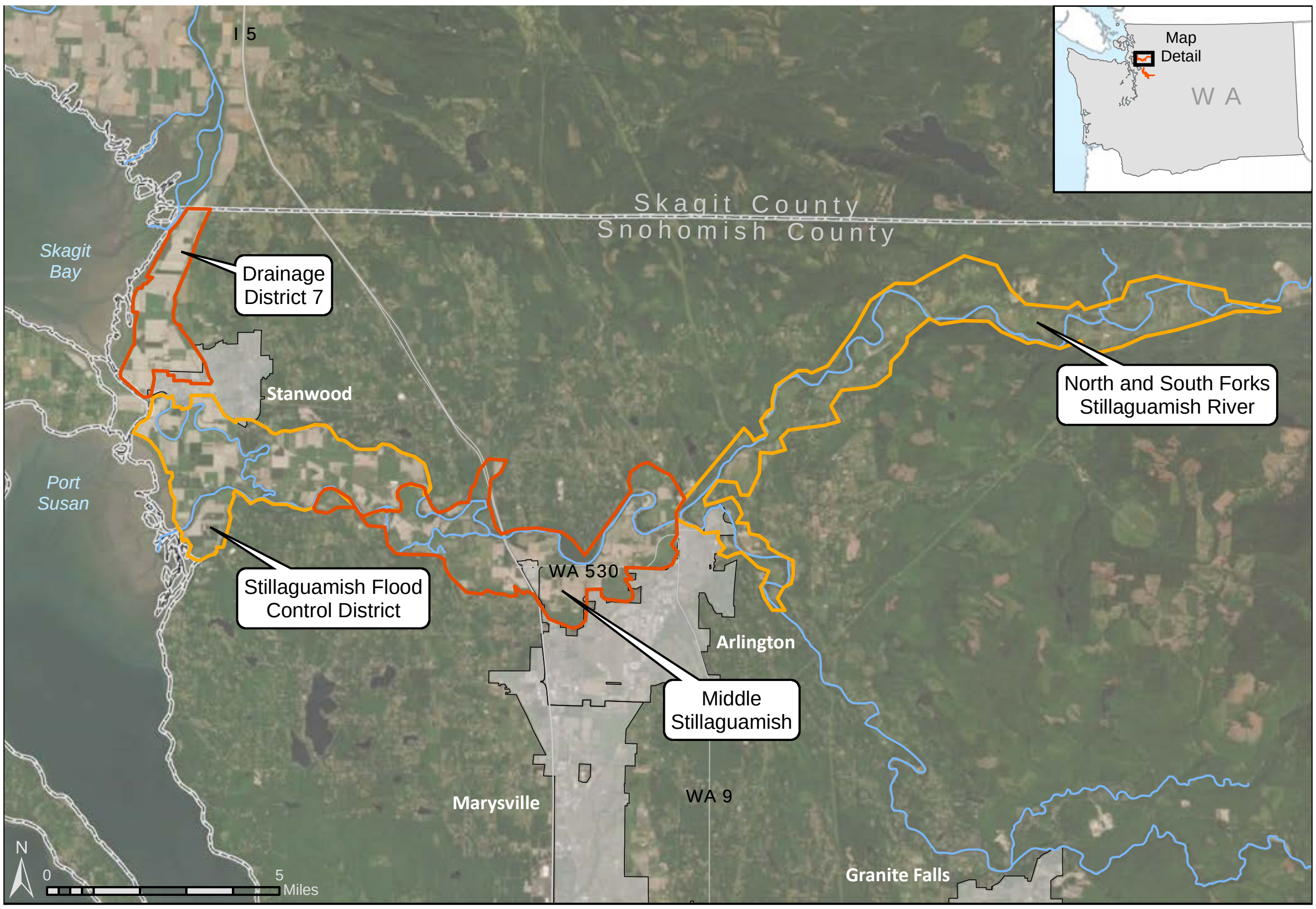

Figure VII-1. Stillaguamish River floodplain reaches. Four sections of the floodplain were delineated based on drainage and flood control district boundaries, floodplain dynamics, and agricultural resilience needs.

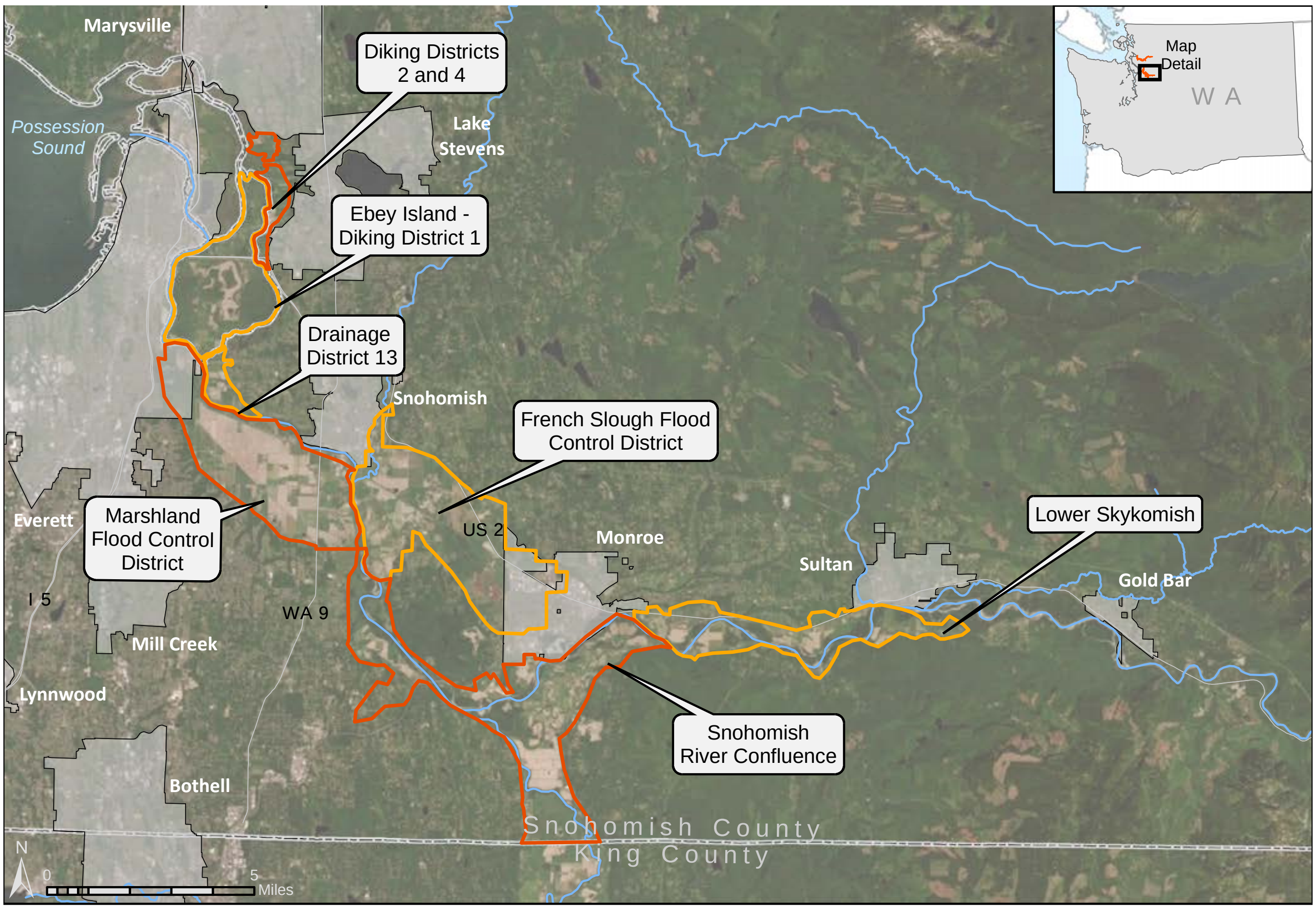

Figure VII-2. Snohomish River floodplain reaches. Seven sections of the floodplain were delineated based on diking, drainage and flood control district boundaries, floodplain dynamics, and agricultural resilience needs.

South Skagit Flats – Drainage and Diking Improvement District 7

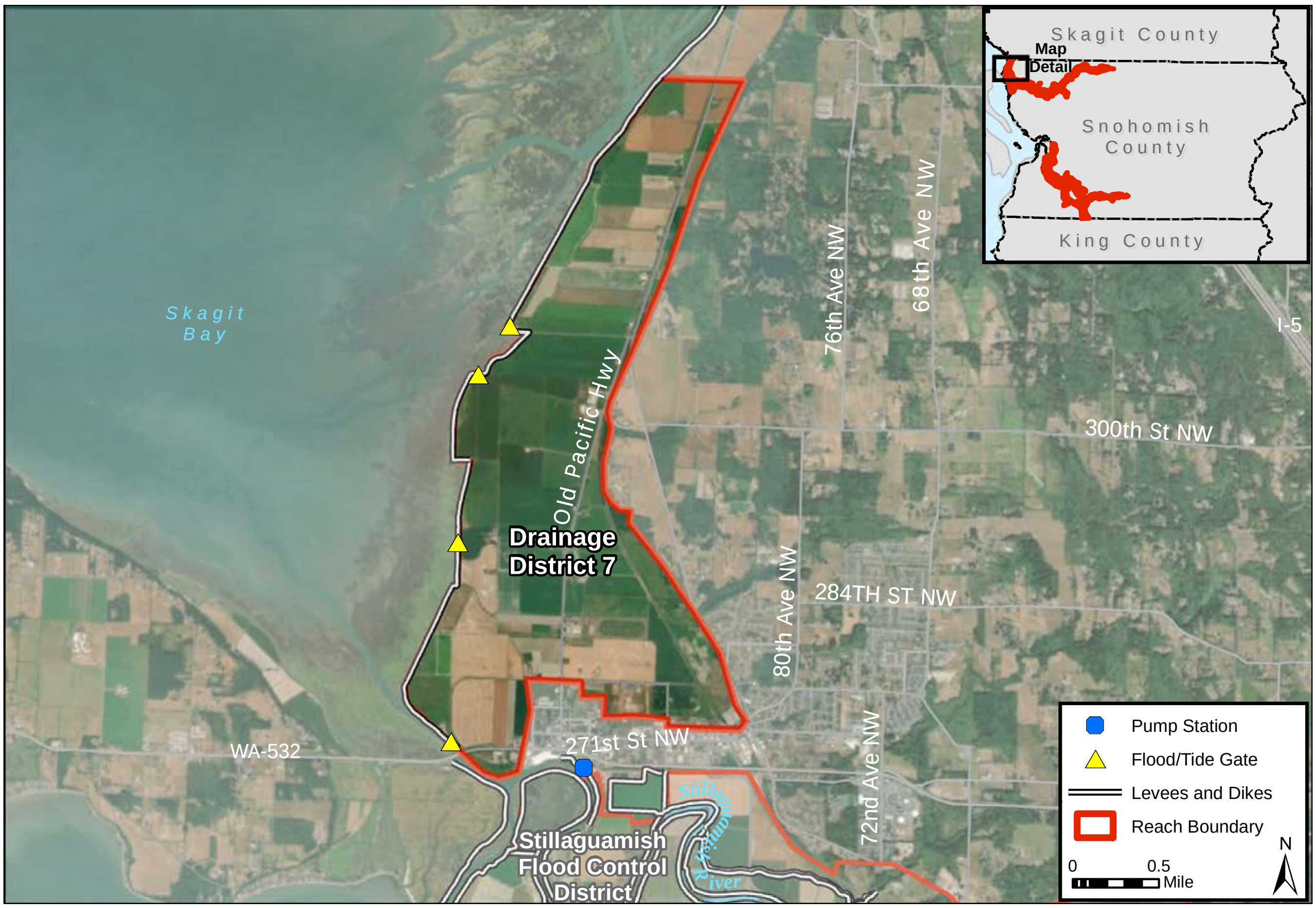

Figure VII-3. Map of Drainage District 7. This figure shows the boundary of Drainage and Diking Improvement District 7, along with the locations of existing levees and tide gates.

Description

Drainage and Diking Improvement District 7 is the agricultural zone north of the City of Stanwood to the County line along Skagit Bay. Of the total 1,850 acres in active agriculture, several hundred acres of high value seed crops are rotated with approximately 800 acres of cereal grains. There is one commercial dairy managing approximately 500 acres of the feed crops along with several hundred acres of vegetables.

DRAINAGE AND FLOOD PROTECTION

Drainage District 7 manages the water conveyances that flow from the uplands through the District into Skagit Bay. The District also manages a sea dike protecting farmland and the City of Stanwood from tidal inundation and storm surges. Most of the waterways in this area gravity-drain through tide gates at the bay, with the exception of Irvine

Slough at the southern end which drains through a pump station operated by the City of Stanwood. The District is actively working to secure funds to bring the sea dike up to Army Corps of Engineers standards so the agency will assist with dike maintenance and repair flood damages. Several areas of the dike are currently too low and/or too narrow to meet standards.

ZONING

The agricultural land in this area is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make development in this area difficult. Subdivision of larger farms into smaller farms, however, does threaten the viability of the interconnected system of forage, feed, and seed crops.

Current and future impacts

FLOODING

Currently, the main source of flooding in the District is surface water runoff from the uplands, but sea level rise projections point toward the likelihood of increasing impacts from coastal flooding. This area is also at risk if the levee along the Skagit River breaks near Conway.

New modeling work completed for this planning effort shows a projected increased frequency of sea dike overtopping as a result of sea level rise and the associated coastal flooding.[1] The modeling work completed is at a coarse scale (10m) and is thus most appropriate for general risk assessment and planning purposes, not for site-level analysis. It shows, however, that current overtopping occurs during the 25-year coastal flood event (4% annual chance) and is expected to occur at the 2-year coastal flood event (50% annual chance) by mid-century.[1] There are plans currently underway to raise and fortify the sea dike in several places, which would reduce this frequency. More detailed site-specific hydraulic modeling would better inform the understanding of the future risk of saltwater inundation.

GROUNDWATER LEVELS AND DRAINAGE

Groundwater levels in this area correlate with the height of Puget Sound. While the projected rise in local sea levels ranges greatly, median values indicate an increase of 8 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] This translates into an increase in the height of the groundwater table on agricultural lands, which can impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on sea level rise projections and found projected median delays of several weeks throughout the lower portion of the Stillaguamish Valley. While the study does not include most of Drainage District 7, assumptions that the same mechanisms are at play indicate similar projections as those shown for Florence Island. This would mean median delays of five weeks predicted by the year 2080 (RCP 8.5).[3]

These projected sea level rise impacts on groundwater will exacerbate already occurring drainage challenges caused primarily by flooding from upland runoff. Snohomish County completed a study of drainage needs for the lower portion of the District (Unnamed Slough, Douglas Creek, and Irvine Slough) in 2014 and 2015 to develop a plan to decrease lowland flooding.[4,5] Modeling indicated that projects aimed at increasing water detention in the uplands would only marginally reduce the impact upland runoff has on lowland flooding.[4] Several scenarios for improving flood water conveyance through culvert replacements and channel excavation within the District were recommended to improve drainage for farmers.

SALTWATER INTRUSION TO GROUNDWATER

As sea level continues to rise, the intrusion of salt into the groundwater could have yield impacts on crops grown in the District. A groundwater study completed as part of this plan indicates that a portion of Florence Island may already be experiencing yield impacts.[3] While the study does not include Drainage District 7, similar mechanisms are likely at play and would indicate similar projections as those shown for Florence Island. Producer testimony confirms this is true in patches. The amount of freshwater coming off the hill, however, may mean reduced saltwater impacts in the groundwater as compared to the projections for Florence Island. Installation of pumps and drainage infrastructure to reduce the impacts of rising groundwater levels in Drainage District 7 may result in pulling salty groundwater upward and further negatively impacting crop yields.

OTHER

Other current and projected impacts:

- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights threatens crop yields and the willingness of seed companies to sign contracts with local farmers.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have water rights, and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. With rising sea levels, existing ditches may or may not be able to provide freshwater for irrigation into the future. There is a need for creative approaches to sourcing freshwater for irrigation in this District.

- **Sea dike improvements.** The goal of the District is to bring the sea dike up to Army Corps of Engineers standards and enroll it in the PL84-99 program to better protect farmland and the City of Stanwood and to provide the assurance that breaches will be repaired by the agency. This would require raising and widening the dike in places. This may also result in re-routing lower Douglas Creek and/or adding a pump station.

- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several projects are recommended. Snohomish County identified numerous culverts that need to be upsized and channels that need to be excavated to increase capacity in the southern section of the District.[5] An assessment of the northern section would likely yield similar results. In addition, upgrades to tide-gates would improve farmland drainage and potentially provide benefits to fish habitat.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and increased flooding as a result of climate change will stress an already financially limited drainage district. Assisting the District in securing agreements with local jurisdictions to compensate for upland stormwater runoff would support ditch and waterway maintenance. Farmers would also benefit from assistance with replacing or installing drainage infrastructure on individual farms.

- **Additional groundwater well data collected and analyzed.** Projections developed in this study used data from wells just south of Hatt Slough and on Camano Island. Additional well data and analysis in Drainage District 7 and the surrounding area could validate the projections.

- **Reduce upland runoff.** A modeling effort completed for Snohomish County concluded marginal improvements to lowland drainage would result from implementation of upland detention efforts.[4] However, this work could help mitigate for future climate change and development.

- **Research on new crop varieties.** Research into new crop varieties and markets that are more resilient to changes in the landscape may help farmers offset losses in production of existing crops. Funding for infrastructure and processing may also be needed.

Lower Stillaguamish River – Stillaguamish Flood Control District

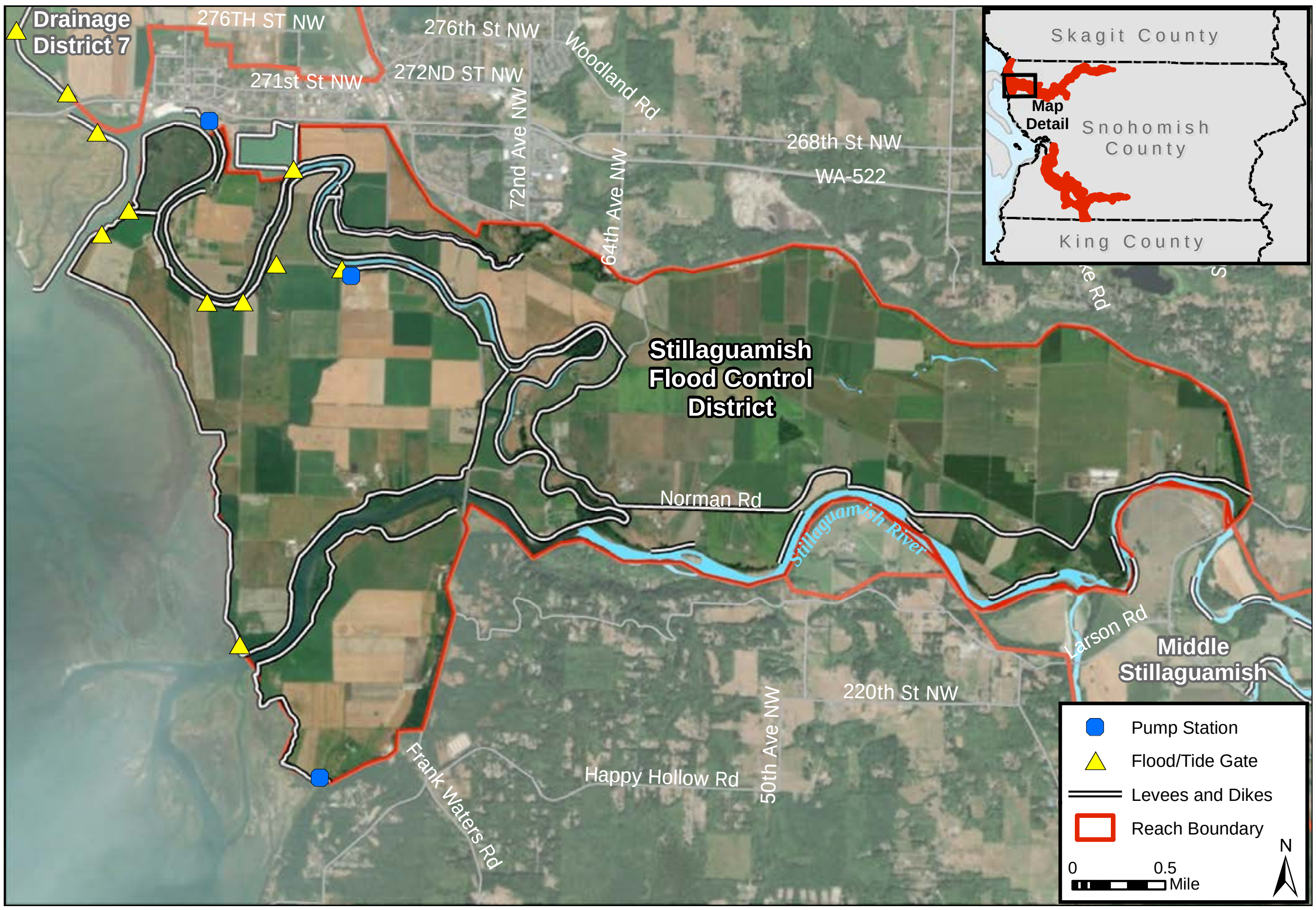

Figure VII-4. Map of the Stillaguamish Flood Control District. This figure shows the boundary of the Flood Control District and the locations of existing levees, flood control gates, and pump stations.

Description

The Lower Stillaguamish River Valley contains one of the largest areas of contiguous commercial agriculture in Snohomish County. The valley supports an integrated system of cropping that relies on field rotations and coordination between multiple farmers to support the seed production industry. Feed crops (hay and corn), cereal grains, potatoes, and seed crops rotate through approximately 4,500 acres of the total 5,100 acres of active agricultural land. There are six commercial dairies managing the bulk of the forage and feed crops along with numerous beef and smaller livestock-based farming operations. In addition, there are smaller areas of agricultural land dedicated to growing berries, vegetables, and other crops.

DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage is managed by the Stillaguamish Flood Control District, an entity that uses fees collected from landowners within this area to maintain a system of river levees, sea dikes, tide gates, and a pump station. Most of the area gravity-drains through maintained tide and flood gates, and the District maintains a pump station that assists with drainage on Florence Island in the winter and spring. The portion of land south of Hatt Slough (the Port Susan Pooling Agreement area) also has a pump station that is used infrequently in the spring to augment gravity drainage through a tide-gated culvert. Nearly the entirety of Drainage District 12 is located within the boundaries of the Flood Control District. The District collects landowner fees specifically for drainage system maintenance within its boundaries.

The levees, along with multiple shoreline armoring projects, were built between 1870 and 1950, largely by local farmers. The river levees were raised in 2016, and both these and the sea dikes are in good condition. In 2013, most of the levee was certified to Army Corps of Engineers standards and enrolled in the PL84-99 program, which means that the federal agency will repair levees that have been damaged as a result of a flood. The agency will also assist with the costs, permitting, and design of regular levee maintenance, although this is ultimately the responsibility of the District.

ZONING

Aside from the small portion of the Lower Stillaguamish Valley within the city limits of Stanwood, the agricultural land in this reach is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make development in this area difficult. Subdivision of larger farms into smaller farms, however, does threaten the viability of the interconnected system of feed, cereal grains, and seed crops as farmers rotate ground amongst each other regularly.

Current and future impacts

FLOODING

Flow records for the Stillaguamish River are available from 1928 to the present and show that the five largest recorded floods have occurred in the last 15 years.[6] New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Stillaguamish River watershed, the current flooding extent for the 2-year flood (50% annual chance event) is projected to more than quadruple by the middle of the century, increasing from 9,095 acres inundated to 38,575 acres.[1] The frequency of flood events is also projected to increase. Farmers in this area identified the 17-ft and 19-ft flood stages (at the Stillaguamish River at Arlington #34 gauge) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen three times as often by the 2080s.

LAND SUBSIDENCE

A study of land subsidence completed for the Flood Control District indicates that some areas of the landscape may be sinking minimally due to the cultivation and subsequent decomposition of organic soils as well as the depletion of groundwater.[8] The area of greatest impact appears to be northeast of the railroad in the Miller Creek drainage, although the rate of 4 inches of subsidence between 2003 and 2015 had such a high margin of error that the result was inconclusive.

GROUNDWATER LEVELS

Groundwater levels in the lower valley correlate with the height of Puget Sound and river flood levels. While projections of the rise in local sea levels range greatly, median values indicate an increase of 8 inches by 2050 and over 2 feet by 2100 (using RCP 8.5 50th percentile values).[2] This translates into an increase in the height of the groundwater table on agricultural lands which can impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on sea level rise projections and found a projected median delays of several weeks throughout the lower portion of the valley. On Florence Island, median delays of five weeks are predicted by the year 2080 (RCP 8.5).[3]

SALTWATER INTRUSION TO GROUNDWATER

As sea levels continue to rise, the intrusion of salt into groundwater could have yield impacts on crops grown in the Lower Stillaguamish. A groundwater study completed as part of this Plan indicates that a portion of Florence Island may already be experiencing yield impacts, and producer testimony confirms this is true in patches.[3] The projections show yield impacts expanding to include nearly all of Florence Island by 2100. Installation of pumps and drainage infrastructure to reduce the impacts of rising groundwater levels in the lower portion of the District could result in pulling salty groundwater upward and further impacting crop yields.

OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased drainage issues.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights will threaten viable crop yields.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers who are dependent on land rotation.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have sufficient water rights, and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several projects are recommended. Tide and flood gates in several locations need to be upsized to pass higher projected flood and stormwater flows as well as improve drainage in the spring.
- **Additional groundwater well data collected and analyzed.** Projections developed for groundwater levels and saltwater intrusion used data from wells just south of Hatt Slough and on Camano Island. Additional well data and analysis on Florence Island and the surrounding area could validate the projections provided.
- **Reduction in flood damages.** Infrastructure damage caused by flooding puts added financial burden on an already economically distressed industry. Increasing the capacity of the river and floodplain to hold floodwater, if done strategically, could reduce flood impacts on surrounding farms.
- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and increased flooding as a result of climate change will stress an already financially limited flood control district. Assisting the District in securing agreements with local jurisdictions to compensate for upland stormwater runoff would support ditch and waterway maintenance. Farmers would also benefit from assistance with replacing or installing drainage infrastructure on individual farms.
- **Increased funding for larger levee and drainage infrastructure projects.** Although levees and pumps are in good condition, there is no contingency plan

for future repair and/or replacement needs. Options and partnerships for developing a grant and/or loan program for larger resilience projects should be explored.

- **Research on new crop varieties.** Research into new crop varieties and markets that are more resilient to changes in the landscape may help farmers offset losses in production of existing crops. Funding for infrastructure and processing may also be needed.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Conserve existing farmland.** The system of crop rotations in the valley necessitates maintenance of the existing agricultural land base. Loss of farmland to subdivision or habitat restoration threatens the viability of seed farms and will continue to result in loss of agricultural services that support farmers. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. Innovative approaches should be pursued to increase the funding available to remove development rights and also allow for other potential uses such as restoration if farming is no longer viable in the future.

- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated predictions, and improved notification to farmers are needed.

Middle Stillaguamish River – Silvana to Arlington

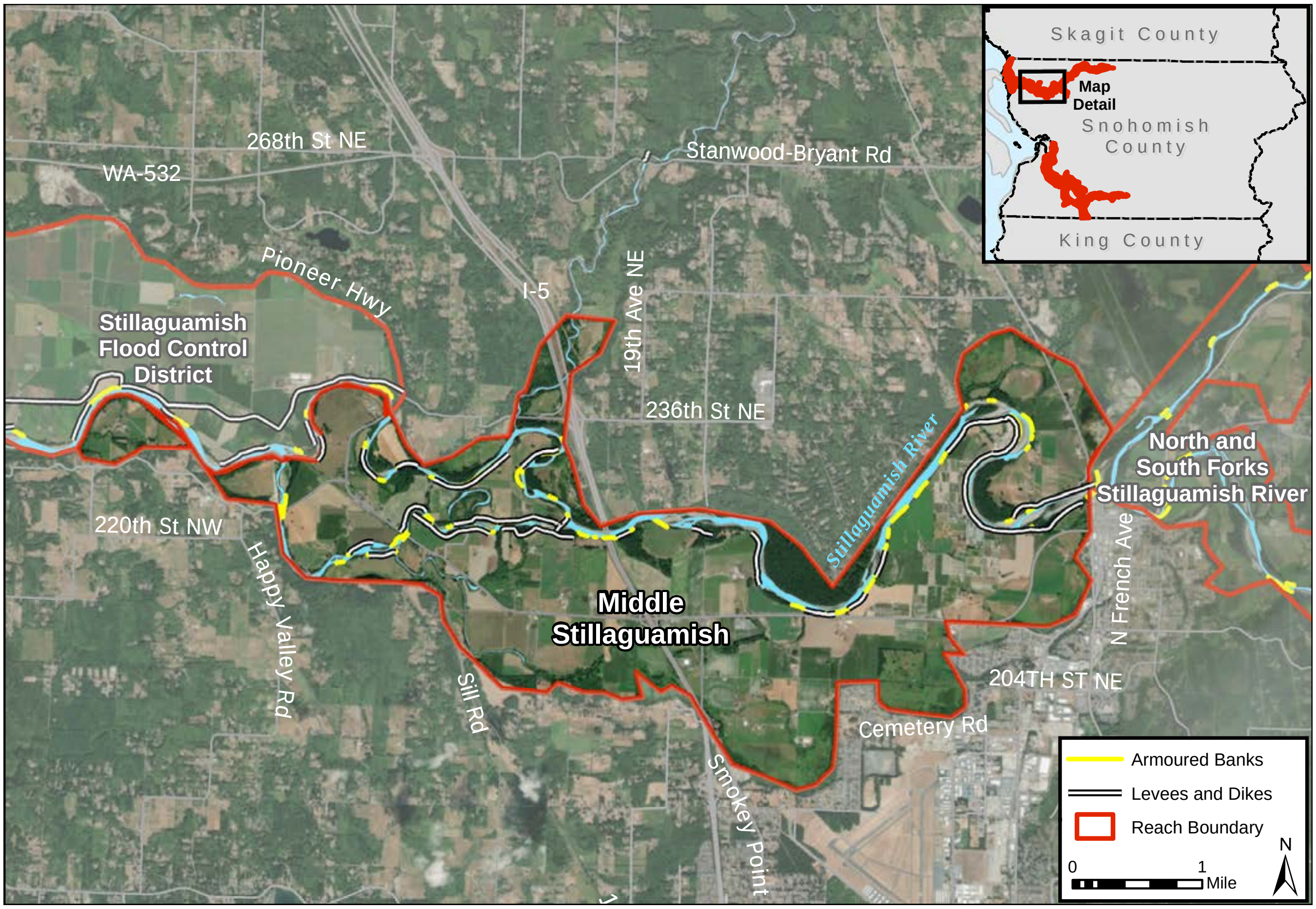

Figure VII-5. Map of Middle Stillaguamish River floodplain. This figure shows the boundary of the Middle Stillaguamish River reach along with existing levees and revetments.

Description

The Middle Stillaguamish River Valley supports a robust commercial agricultural industry yet faces development pressures due to its proximity to Interstate 5 and the City of Arlington. Feed crops (hay, pasture, and silage corn), cereal grains, and seed crops dominate the landscape, utilizing approximately 2,800 acres of the total 3,800 acres in active agriculture. There are four commercial dairies managing the bulk of the feed crops, along with smaller areas dedicated to growing vegetables or nursery stock, and raising beef and small livestock.

DRAINAGE AND FLOOD PROTECTION

This area is not managed by an organized diking or flood control district. The levees are not contiguous as in the Lower Stillaguamish, but rather provide protection against flood flows and debris at strategic locations along the river. The levees were largely built by the U.S. Army Corps of Engineers between 1920 and 1950 and continue to be managed by the agency today. The Corps also constructed many shoreline armoring projects that are now managed by individual farmers. There are a few sections of levee that are managed by Snohomish County.

ZONING

The agricultural land in this reach is primarily zoned Agriculture-10 Acre, aside from the small portion of the floodplain that was annexed into the City of Arlington. Extra protections against development or subdivision of large farms are provided by the density fringe regulatory framework, although these protections do not extend east of Interstate 5. Loss of commercial farmland to development or subdivision is a real threat in this reach due to the proximity to a growing urban center and the lack of density fringe protections east of Interstate 5.

Current and future impacts

FLOODING

Flow records for the Stillaguamish River are available from 1928 to the present and show that the five largest recorded floods have occurred in the last 15 years.[6] New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events), with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Stillaguamish River watershed, the current flooding extent for the 2-year flood (50% annual chance event) is projected to more than quadruple by the middle of the century, increasing from 9,095 acres inundated to 38,575 acres.[1] The frequency of flood events is also projected to increase. Farmers in this area identified the 17-ft and 19-ft flood stages (at the Stillaguamish River at Arlington #34 gauge) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen three times as often by the 2080s. Flood damage was a primary concern of producers in this reach, who have already noticed more intense and longer duration flooding than in the past. Farmers are concerned about the potential impacts recent development near the intersection of Highway 530 and Interstate 5 will have on local flooding.

The major impacts of flooding in this reach include:

- Sand and silt deposition on fields, which can result in decreased yields
- Soil erosion, which occurs along concentrated flow paths in fields
- Flood debris on fields, which requires costly clean-up and repair
- Damage to structures, which results in costly repair
- Threats to livestock, including harm to animals, decreased milk production, or impacted milk transport
- Bank erosion, which causes loss of farmland and threats to levees

GROUNDWATER LEVELS AND SALTWATER INTRUSION

Groundwater levels and saltwater intrusion in the Middle Stillaguamish are not expected to be impacted by rising sea levels due to the steep gradient of the valley and distance from the Puget Sound.[3] Groundwater levels may be impacted by increased riverine flooding or upland stormwater runoff, although these effects are predicted to be shorter in duration than the sustained impacts of sea level rise downriver.

OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased field inundation.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights will threaten viable crop yields.

- Economic pressures for producers are resulting in subdivision of large farms and reducing the available acreage needed for current commercial farmers to be viable.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have sufficient water rights and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Reduction in flood damages.** Crop yield impacts caused by flood-deposited sediment, soil erosion, and flood debris removal costs put added financial burden on an already economically distressed industry. Flood protection projects such as flood fencing and waterbreak planting in strategic locations could lessen the impact of inundation on individual farms. Bank erosion also damages levees or results in loss of farmland. Increasing the capacity of the river and floodplain to hold flood waters, if done strategically, could reduce flood impacts on surrounding farms.
- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated predictions, and improved notification to farmers are needed.
- **Conserve existing farmland.** The proximity of this floodplain reach to the City of Arlington and Interstate 5, in addition to the lack of density fringe protections east of the freeway, make farmland protection a high priority. Subdivision of farms threatens the viability of farming and will continue to result in loss of agricultural services that support farmers. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. Innovative approaches should be pursued to increase the funding available to remove development rights.
- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Financial assistance to repair shoreline armoring.** In the event of a large flood, which is projected to occur more frequently, existing shoreline armoring may be damaged on individual properties.
- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and increased flooding as a result of climate change will increase the drainage burden of farmers in the floodplain. There is a need to explore ways to increase the funding available to include compensation for upland stormwater runoff impacts.
- **Reduce upland runoff.** There is a need to explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or education and incentives for urban/suburban landowners to reduce impervious surfaces or implement drainage projects on their properties.
- **Farm pads.** Assistance with funding and permitting to install farm pads for livestock sanctuary and equipment storage during floods would help mitigate the impacts of projected higher intensity and more frequent flooding.
- **Research alternative on-farm drainage infrastructure techniques.** There is a need to fund research and pilot projects looking at ways to better construct and manage drain tile or ditch systems to hold water back during summer months.

North and South Fork Stillaguamish River

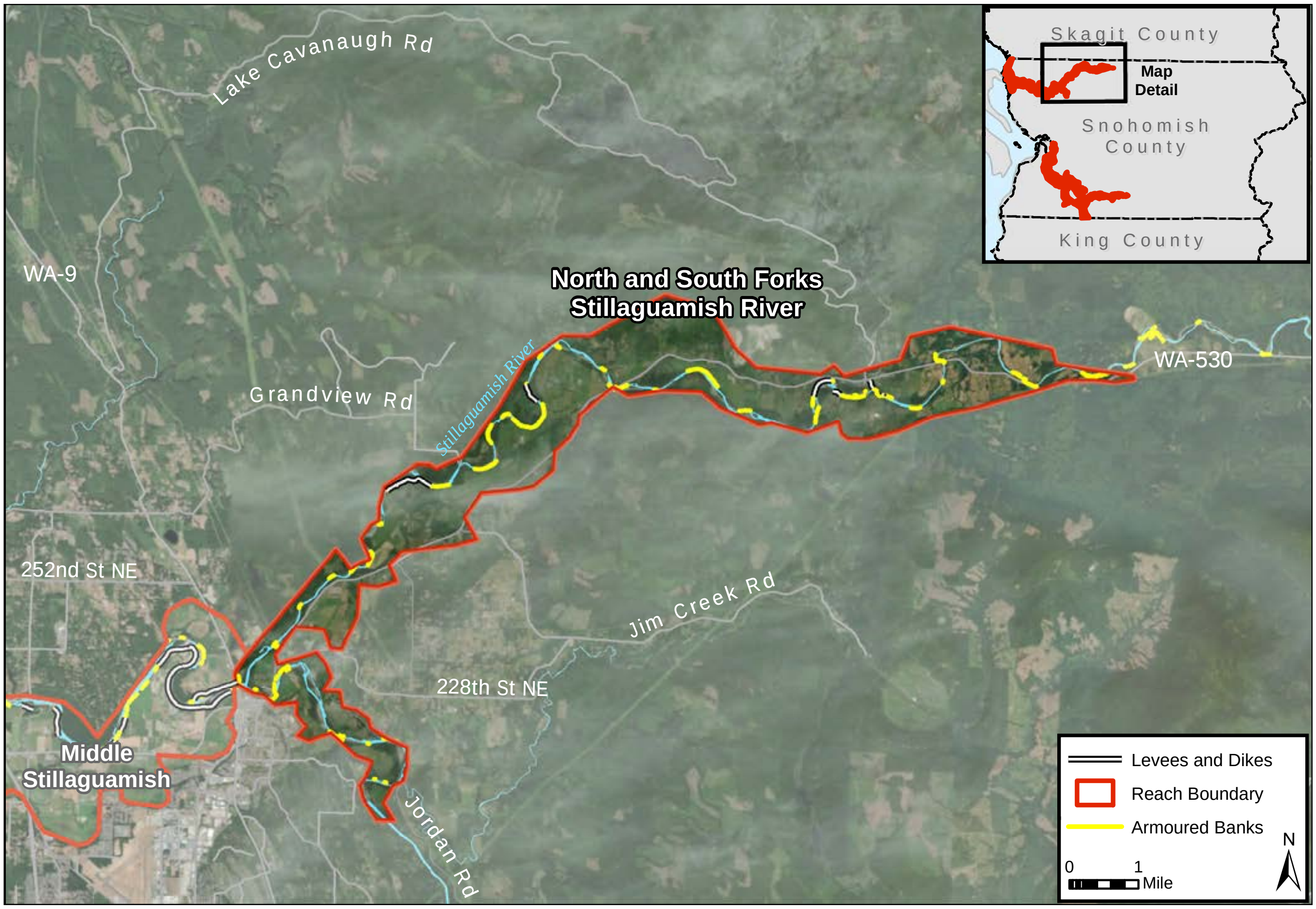

Figure VII-6. Map of North and South Forks of the Stillaguamish River floodplain. This figure shows the boundary of the North and South Fork Stillaguamish River reach along with existing levees and revetments.

Description

While the floodplain narrows above the confluence of the North and South Fork Stillaguamish River, commercial agriculture remains viable and is critical in supporting the larger agricultural industry in Snohomish County. The primary agricultural production zone extends partway up the South Fork where the floodplain width allows, and up the North Fork past Oso.

The North and South Fork Stillaguamish area represents approximately 3,000 acres of commercial agricultural land predominately in feed and forage production to support the livestock industry and two commercial dairies. In addition, smaller acreages support production of cereal grains, seed crops, and forestry.

DRAINAGE AND FLOOD PROTECTION

This area is not managed by an organized diking or flood control district. Existing levees are not contiguous as in the Lower Stillaguamish, but rather provide protection against flood flows and debris at strategic locations along the river. The levees along with multiple shoreline armoring projects were built primarily between 1920 and 1950, largely by the Army Corps of Engineers. Individual farmers maintain drainage infrastructure as well as shoreline armoring projects on their properties.

ZONING

The agricultural land in this reach is primarily zoned Agriculture-10 Acre, although there are some areas where active commercial agricultural land is zoned Rural-5 Acre. The density fringe regulatory framework protections that exist in downstream floodplain reaches do not extend into this area, although much of the area is designated as floodway. The floodway designation carries significant restrictions on development (SCC 30.65.220), yet loss of commercial farmland to development or subdivision is a threat near the City of Arlington.

Current and future impacts

FLOODING

Flow records for the Stillaguamish River are available from 1928 to the present and show that the five largest recorded floods have occurred in the last 15 years.[6] New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Stillaguamish River watershed, the current flooding extent for the 2-year flood (50% annual chance event) is projected to more than quadruple by the middle of the century, increasing from 9,095 acres inundated to 38,575 acres.[1] The frequency of flood events is also projected to increase. Flood debris and the associated damage and clean-up costs are a concern for producers in this reach. In a few areas, bank erosion also threatens agricultural land.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Reduction in flood damages.** Crop yield impacts caused by flood-deposited sediment, soil erosion, and flood debris removal costs put added financial burden on an already economically distressed industry. Flood protection projects such as flood fencing and waterbreak planting in strategic locations could lessen the impact of inundation on individual farms. Bank erosion also damages levees or results in loss of farmland. Increasing the capacity of the river and floodplain to hold flood waters, if done strategically, could reduce flood impacts on surrounding farms.

- **Protect farmland from riverbank erosion.** Numerous bank stabilization projects were put in place in the early to mid-1900s. Several of these have started to erode but new permit requirements have made it difficult and costly for farmers to repair them or construct new projects.

- **Conserve existing farmland.** The proximity of this floodplain reach to the City of Arlington makes farmland protection a high priority. Subdivision of farms threatens the viability of farming and will continue to result in loss of agricultural services that support farmers. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. Innovative approaches should be pursued to increase the funding available to remove development rights.

- **Access to water for irrigation.** Most farms do not have sufficient water rights and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.

Snohomish River Estuary – Diking Districts 2 and 4

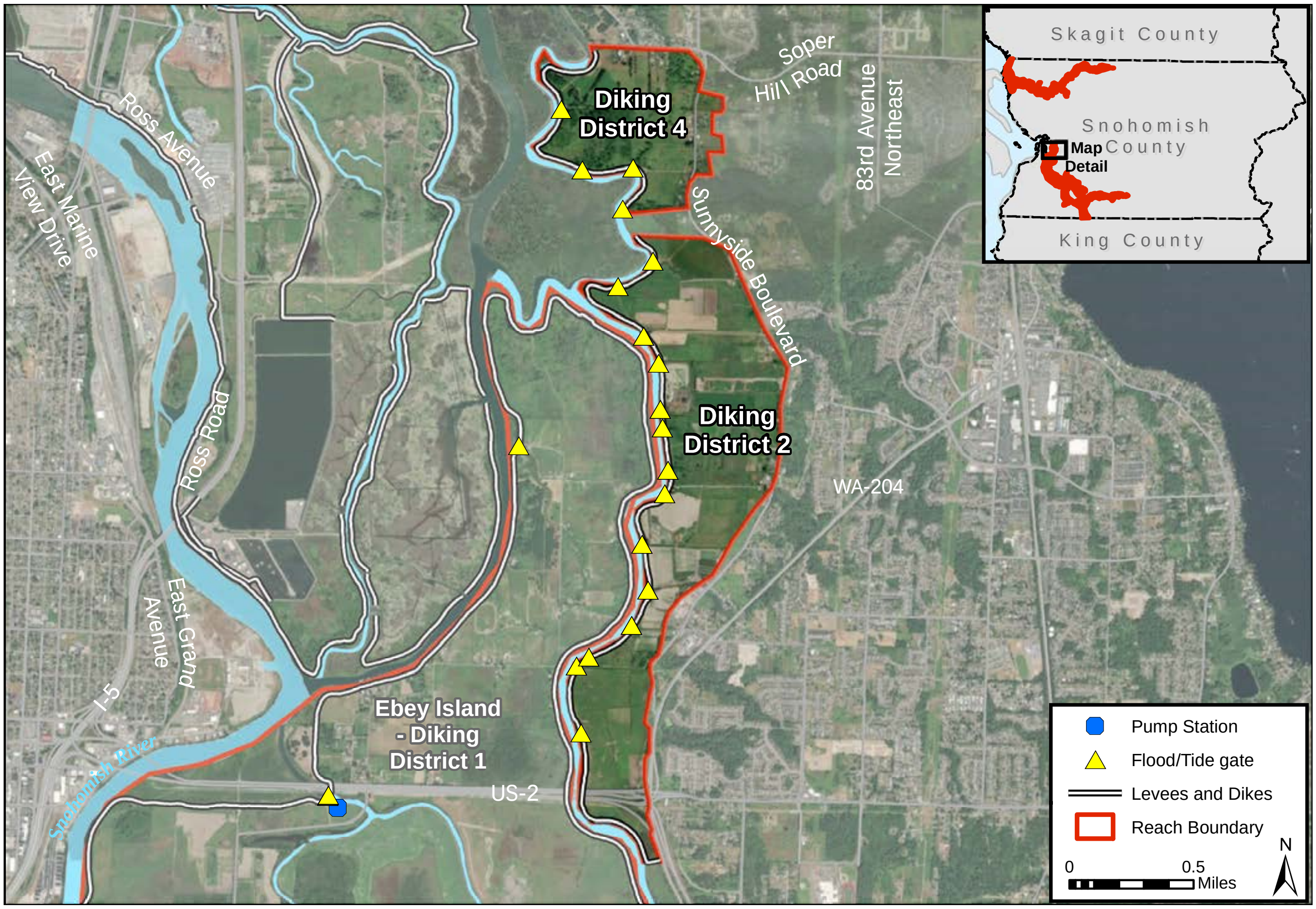

Figure VII-7. Map of Diking Districts 2 and 4. This figure shows the boundary of the diking districts, along with existing levees and tide gates.

Description

Diking Districts 2 and 4 are small districts along the eastern border of the estuary floodplain. Approximately 525 acres of the total 790 acres within the two districts is in agricultural use. Farming consists of pasture (300 acres), hay and silage (150 acres), and agritourism and vegetable production (75 acres).

DRAINAGE AND FLOOD PROTECTION

Flood protection and limited agricultural drainage is managed by Diking Districts 2 and 4, entities that use fees collected from landowners within the area to maintain river levees and tide gates. Historically, the County and City of Lake Stevens provided funding to Diking District 2 for drainage maintenance to compensate for upland runoff impacts, but that agreement has expired. Water gravity drains through the districts and out a series of tide gates along the levee. Flooding in these districts is primarily a result of upland drainage flowing off the hill, as the levees rarely overtop.

The levees were built in the early 1900s. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to protect against water from larger events. In 1991, members of the Snohomish River Coordinated Diking Council (Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers) participated in development of the Snohomish River Comprehensive Flood Control Management Plan and agreed to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that Diking Districts 2 and 4 rarely experience overtopping levees as flood pressure is released in upriver floodplain areas first.

The levees are not currently enrolled in the PL84-99 Army Corps of Engineers program; therefore, levee repair and maintenance are the responsibility of the districts. Diking District 2 is actively working to bring their levee up to Army Corps of Engineers standards so the agency will provide assistance.

ZONING

Diking District 2 is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Despite these protections, subdivision of larger farms into smaller farms, as well as conversion to non-agricultural uses, threatens the viability of commercial agriculture in this area so close to the urban centers of Everett and Lake Stevens.

Diking District 4, however, has approximately half its acreage in Agriculture-10 Acre zoning and half in Rural-5 Acre zoning. The portion zoned Agriculture-10 Acre also has protections provided by the density fringe regulatory framework, making non-agricultural related development in this area more difficult. Losing farmland to non-agricultural uses is a threat in the portion of the District zoned Rural-5 Acre.

Current and future impacts

FLOODING

Flooding of farmland in the Snohomish River Estuary is highly influenced by sea levels (tides and local storm surge) as well as river levels. In addition, Diking Districts 2 and 4 receive considerable upland runoff during floods, making drainage maintenance in these districts highly complex.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s.

While this modeling effort did not include flood projections for the smaller drainages coming from the uplands, we can expect both land use changes (development) and climate change to exacerbate the impacts of upland runoff in Diking Districts 2 and 4.

GROUNDWATER LEVELS

Groundwater levels in Diking Districts 2 and 4 are projected to be impacted by sea level rise. While the predicted rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] Diking District 4 is over 3.5 miles from the mouth of the Snohomish River, yet the low gradient of the river translates into groundwater level impacts from sea level rise throughout both districts. These increases may impact the timing of crop planting and hay cultivation in the spring as well as the length of water inundation on fields. A groundwater study completed as part of this plan shows that Diking Districts 2 and 4 are predicted to experience increases in the groundwater table similar to projected increases in sea level, resulting in considerably higher water tables by 2100.[3]

SALTWATER INTRUSION TO GROUNDWATER

A groundwater study completed as part of this Plan indicates that saltwater intrusion in groundwater is not likely to be a threat to soils in these districts or other agricultural lands in the vicinity due to the distance from the Puget Sound.[3] Data from wells further upriver showed no sign of saltwater intrusion, so data from Snohomish County wells on Smith Island were used to determine the potential impact in this area. Further study of groundwater levels and salinity is recommended in Diking Districts 1 (Ebey), 2, and 4 and Drainage District 13 to improve the predictions calculated from the Smith Island well dataset. In particular, if active pumping is considered as a replacement to the existing gravity drainage system, further study would be necessary to determine if this may result in pulling salty groundwater upward and impacting crop yields.

There are several locations where salinity is currently impacting water in drainage ditches that had been used for irrigation in the past. If applied to farm fields unknowingly, this saline water could impact soil health and crop yields. This lack of surface water for irrigation is impacting several local farms.

OTHER

Other current and projected impacts:

- Loss or subdivision of farmland in these districts is reducing the available acreage needed for current commercial farmers to be viable as well as the feasibility of maintaining drainage infrastructure.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and higher groundwater tables (as a result of climate change) will stress already financially limited diking districts. There is a need to renew (District 2) and develop (District 4) agreements with cities and the county to compensate for upland stormwater and sediment impacts to drainage.

- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several projects are recommended. These include improvements to through-flow for streams and replacement of failed culverts. Capacity of existing tide gates is sufficient, but these may require upsizing if upland runoff increases.

- **Conserve existing farmland.** The proximity of these districts to the cities of Lake Stevens and Marysville put development pressure on commercial farmland. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape-scale. Innovative approaches should be pursued to increase the funding available to remove development rights.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem services markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Access to water for irrigation.** Most farms do not have sufficient water rights or are no longer able to withdraw from ditches now inundated with saltwater. While many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.

- **Reduce upland runoff.** There is a need to explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or education and incentives for urban/suburban landowners to reduce impervious surfaces or implement drainage projects on their properties.

- **Assistance with beaver management.** Beaver presence along some waterways is impacting farmland drainage.

Snohomish River Estuary – Diking District 1 – Ebey Island

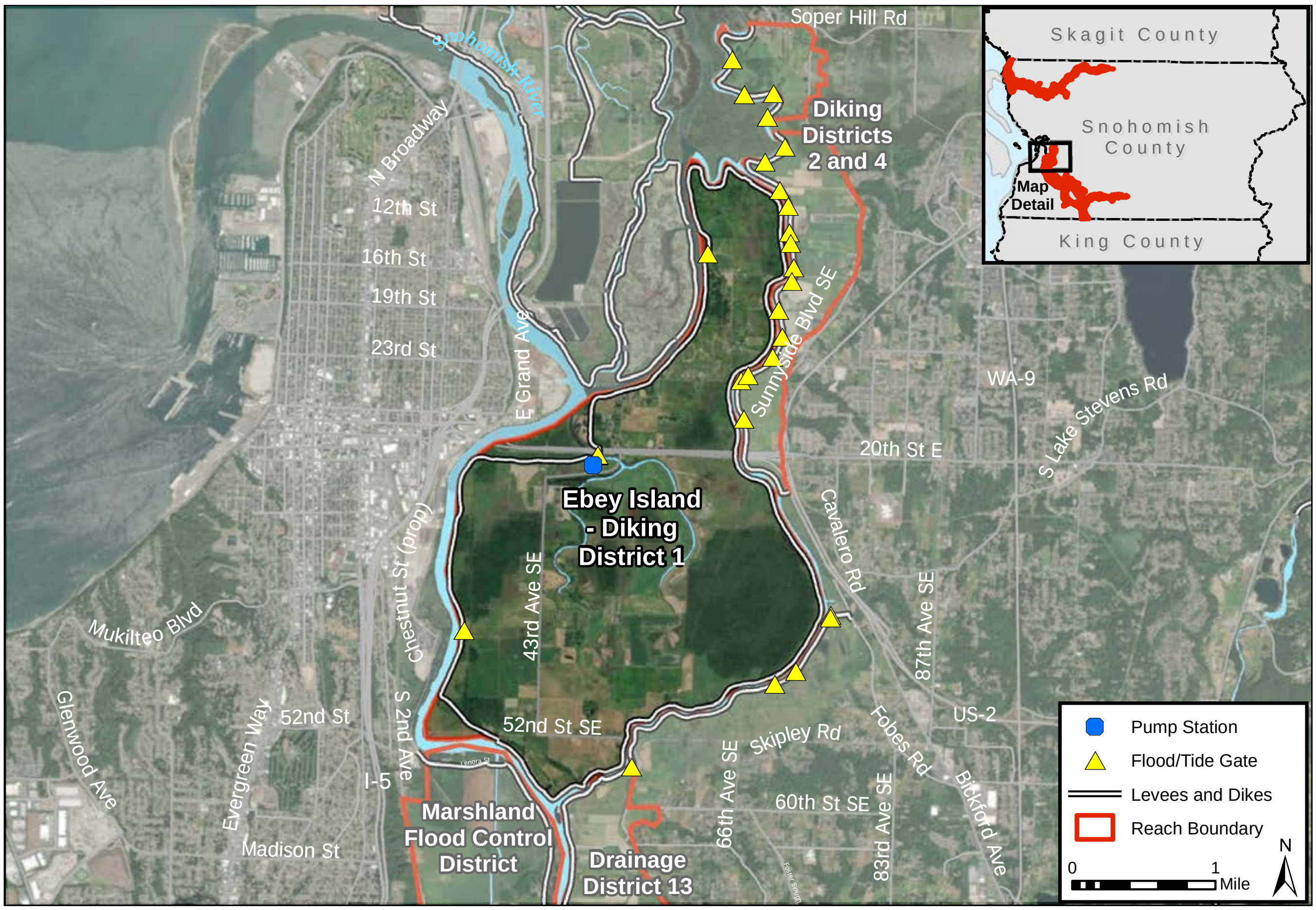

Figure VII-8. Map of Diking District 1 – Ebey Island. This figure shows the boundary of Diking District 1, along with existing levees, tide or flood control gates and pump station.

Description

Ebey Island, in the estuary of the Snohomish River, supports commercial agriculture, but in a limited capacity due to the many challenges associated with this tidally influenced, low lying, and low gradient section of the floodplain. Approximately 41% of the island is in active agricultural use, with successful farms producing cereal grains, hay, and forage (pasture grass). The cooler temperatures associated with the proximity to the Puget Sound create a challenge for some slower ripening crops like corn.[10] The Washington Department of Fish and Wildlife owns a significant portion of the island, managing 1,285 acres of the total 3,940, which they lease a portion of for farming.

DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage are managed by Diking District 1, an entity that uses fees collected from landowners within the area to maintain a drainage system including ditches, tide/flood gates, a pump station, and river levees.

The levees were built by the District and local farmers in the early 1900's along with multiple shoreline armoring projects. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to exclude water from larger events. In 1991, the Coordinated Diking Council was formed through an Interlocal Agreement between Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers agreeing to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that Ebey Island levees rarely overtop since the upstream districts overtop and fill up first, thus alleviating flood flows downstream.

South of Highway 2, the island drains through several managed ditches and waterways to Deadwater Slough, near the highway, through a series of tide gates and a pump station. The District relies on gravity drainage most of the time, but typically pumps water between February and May to prepare for spring cultivation and pasture growth. North of Highway 2, a section of the levee overtops every winter, but this back-watering effect from the tides just fills the ditches with freshwater that sits on top of the saltwater and does not negatively impact farmland production.

ZONING

Ebey Island is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Subdivision of larger farms into smaller farms, however, does threaten the viability of traditional commercial agriculture in this area.

Current and future impacts

FLOODING

The Snohomish River floodplain is low gradient with tidal influence extending 16 miles upriver. Flooding in the estuary around Ebey Island is influenced by river levels, tides and sea level rise, creating a "coastal squeeze" that can exacerbate flooding issues and negatively impact drainage of farmland.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s. In addition, sea level rise may further exacerbate flooding in the Lower Snohomish as higher water levels translate to higher storm surge heights.

Although the current 100-year flood (1% annual chance) does not overtop the levee on Ebey Island, the flood modeling projections indicate that the 100-year flood could start to overtop levees in the 2080s. While overtopping is infrequent, the increased pressure of higher floodwaters may threaten the integrity of levees and lead to failure.

To protect from current and future flood pressures, the levees protecting Drainage District 1 need to be reinforced in several places as a result of erosion on the river side. It can be difficult to get permits to place rip-rap, so the District resorts to reinforcing the levee on the inland side, resulting in a loss of farmland. Levee breaches, as opposed to overtopping, are the real threat to farmland in the District. A recent levee breach was quickly plugged but posed a serious risk, while a levee breach in 1990 caused destruction to agricultural infrastructure and viability.

An additional threat to levee integrity is the Highway 2 trestle, where bridge pilings rack large amounts of debris during large floods. If not removed quickly, the debris acts as a dam, backing up water and threatening to blow out the levee behind the trestle.

GROUNDWATER LEVELS

Groundwater levels in the lower valley correlate with the height of the Puget Sound and river flood levels. While the predicted rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] This translates into a similar but muted increase in the height of the groundwater table on agricultural lands which can impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan showed that Ebey Island groundwater levels were based both on river levels and sea levels making it hard to determine the projected impacts of sea level rise.[3] Maps of existing and predicted ponded levels, however, show higher impacts into the future with a need for greater pumping in the spring to allow for planting and crop growth (Figures V-5 and V-6). From the southernmost tip of Ebey Island and extending upriver through French Slough Flood Control District, delays in spring cultivation based on sea level rise predictions were calculated. The study found projected median delays of 4 weeks by 2050 and 5 weeks by 2080 on the southern tip of Ebey Island (RCP 8.5).[3] This study only looked at the impacts of sea level rise on groundwater levels and did not take into account the ability of this district to actively pump water out of the system. Increased pumping, therefore, could mitigate the impacts of these rising groundwater levels.

SALTWATER INTRUSION TO GROUNDWATER

A groundwater study completed as part of this Plan indicates that saltwater intrusion is not likely to be a threat to agricultural viability on Ebey Island or other agricultural lands in the vicinity due to the distance from the Puget Sound.[3] Data from wells further upriver showed no sign of saltwater intrusion, so data from Snohomish County wells on Smith Island were used to determine the potential impact on Ebey Island. Further study of groundwater levels and salinity is recommended in Diking Districts 1 (Ebey), 2, and 4, and Drainage District 13 to improve the predictions calculated from the Smith Island well dataset. In particular, if increased pumping is implemented to combat drainage issues into the future, further study is necessary to determine if this may result in pulling salty groundwater upward and impacting crop yields.

LAND SUBSIDENCE

Much of the land in the District was wetland associated with the floodplain of the Snohomish River that has since been drained for agricultural use. Approximately 1,200 acres are soils high in organic matter content that built up over years of saturation. While only a portion of these soils are cultivated, cultivation has likely resulted in higher decomposition rates, causing the land to subside over time. A study of subsidence rates completed for this planning effort in the Lower Snohomish River floodplain was inconclusive in this area.[11] If subsidence is occurring, the impacts of sea level rise are likely to cause more significant impacts to drainage than subsidence.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Drainage infrastructure repair and improvements.** The existing pumps are old and frequently being repaired or rebuilt. There is a need to replace the pumps to support continued and potentially increased pumping. In addition, many tide gates are failing and in need of replacement, repair, or upsizing to protect against floodwaters and projected increases in flood heights and frequency.

- **Levee improvements.** Sections of the levee are in need of repair and reinforcement. Most of these are north of Highway 2. The District is currently working to upgrade levees to Army Corps of Engineers standards so they can be enrolled in the PL84-99 program. This will reduce the possibility of a levee breach and provide assurance that levee breaches or damage will be repaired by the agency.

- **Additional groundwater well data collected and analyzed.** Projections developed for groundwater levels and saltwater intrusion used data from wells downriver on Smith Island. Additional well data and analysis on Ebey Island and the surrounding area is needed to validate predictions and inform the impact of additional pumping on groundwater salinity.

- **Protect levee from impacts of Highway 2 trestle.** Several actions can be taken to lessen the impact and protect levees from debris racking on the Highway 2 pilings during flood events. One action could be to work with the State to develop a more proactive approach to removing debris before it poses a threat to farming infrastructure. Improvements to the levee adjacent to the trestle may also lessen the threat of a levee breach.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water-holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Financial assistance for drainage system maintenance.** The drainage and pumping needs associated with higher groundwater tables as a result of sea level rise will stress an already financially limited diking district. There is a need explore ways to increase the funding available for drainage assistance.

Lower Snohomish River – Drainage District 13 – Swans Trail Slough

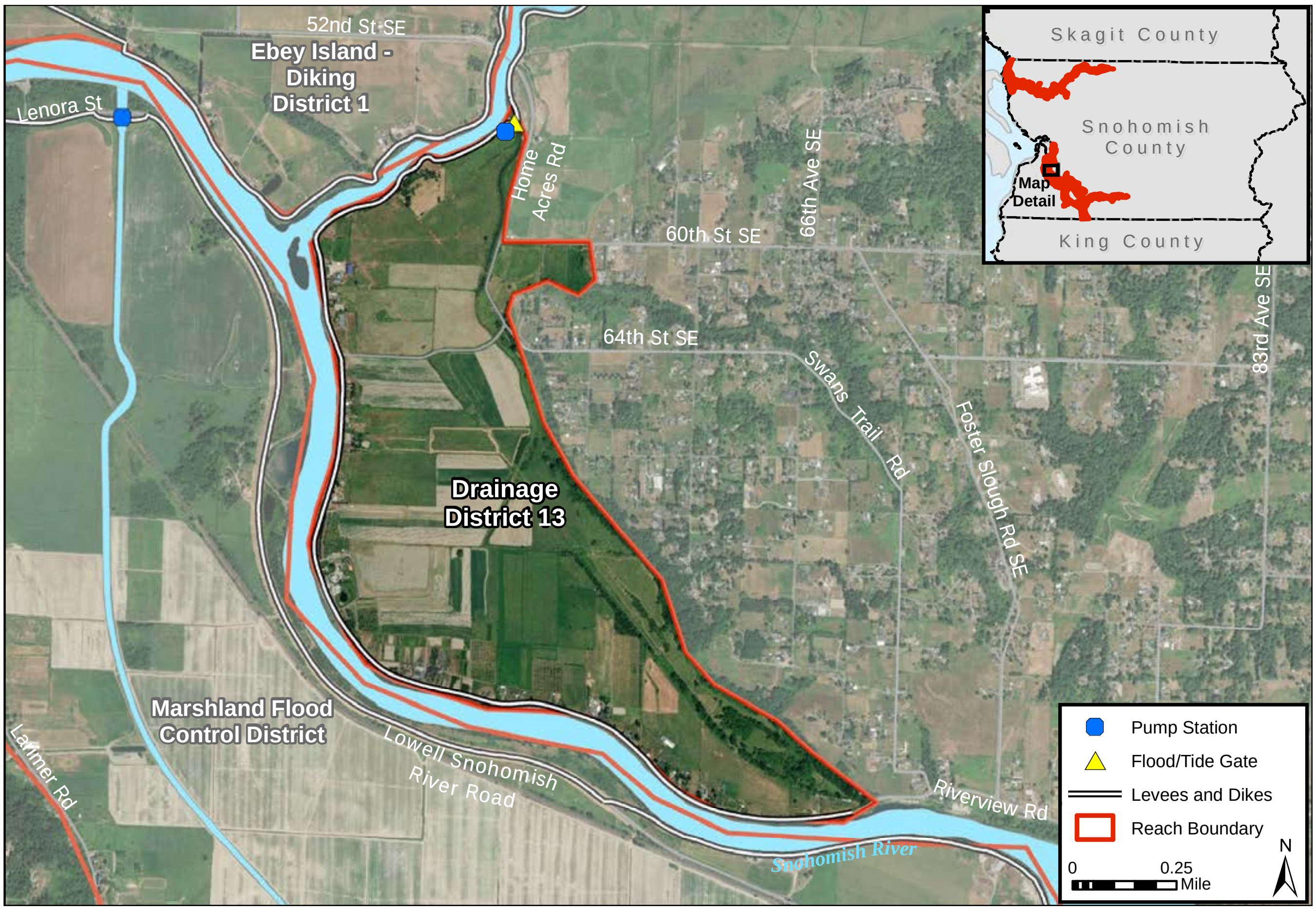

Figure VII-9. Map of Drainage Improvement District 13. This figure shows the boundary of the Drainage District 13 reach, including existing levees, tide and flood control gates and a pump station.

Description

Drainage Improvement District 13 is a narrow district nested between the Snohomish River and the largely developed Fobes Hill uplands. Just over 400 of the 580 total acres in the District support commercial agriculture, primarily growing hay and silage as well as supporting cattle, small livestock, vegetables, fruit, agritourism, and other smaller enterprises.

DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage is managed by Drainage Improvement District 13, an entity that uses fees collected from landowners within the area to maintain a system of ditches, river levees, and a pump station. Swans Trail Slough is a natural drainage that collects water off the uplands and flows south to north along a sliver of farmland north of the old railroad grade. The railroad grade separates this drainage from a system of managed ditches draining most of the farmland in the District. These two systems meet up approximately halfway up the District. The water from both systems gravity-drains into Ebey Slough through a 6 ft diameter tide gate when the water level in Ebey Slough is lower than Swans Trail Slough. When the water level in Ebey Slough is high due to snow melt or storms, the District runs its 12-inch diameter fish-friendly pump to move water out of the District, primarily in the spring. In 2007, the District installed a new tide gate and pump.

The levees were built in the early 1900s by local farmers. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to protect against water from larger events. In 1991, members of the Snohomish River Coordinated Diking Council (Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers) participated in development of the Snohomish River Comprehensive Flood Control Management Plan and agreed to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that Drainage District 13 levees overtop at the same time as both the Marshland and French Slough Flood Control District levees, relieving flood pressures and the risk of levee failure. The levee is not enrolled in the PL84-99 Army Corps of Engineers program and as such, levee repair and maintenance is the responsibility of the District.

ZONING

Drainage Improvement District 13 is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Despite these protections, subdivision of larger farms into smaller farms as well as conversion to non-agricultural uses threaten the viability of traditional commercial agriculture in this area so close to the urban centers of Everett and Snohomish.

Current and future impacts

FLOODING

The Snohomish River estuary is low gradient with tidal influence extending 16 miles upriver to the confluence of the Skykomish and Snoqualmie Rivers near Monroe. Flooding in Drainage District 13 is influenced primarily by river levels, but also by tides and sea level rise which can exacerbate flooding issues and impact drainage of farmland.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s.

Higher intensity floods will mean more frequent overtopping of levees, although flood damage is not a major concern for farmers in this area. Higher and more frequent floods could, however, increase the potential for a levee failure, which would cause extensive damage to farm and community infrastructure.

GROUNDWATER LEVELS

Groundwater levels in Drainage District 13 are projected to be impacted by sea level rise. While the projected rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] Drainage District 13 is over eight miles from the mouth of the Snohomish

River, yet the low gradient of the river translates into groundwater level impacts from sea level rise throughout the District. These increases may impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on sea level rise predictions. The study found projected median delays of 3-4 weeks by 2050 and 5 weeks by 2100 throughout Drainage District 13 (RCP 8.5).[3] This study only looked at the impacts of sea level rise on groundwater levels and did not take into account the ability of this district to actively pump water out of the system. Increased pumping, therefore, could mitigate the impacts of these rising groundwater levels.

The existing tide gates are sufficient for the amount of acreage that is drained, although increased flooding and groundwater levels in the future may necessitate the addition of another tide gate to improve gravity drainage and reduce the need for additional pumping. The tide gate pipes are over 30 years old and will need replacement soon along with needed improvements to the adjacent levee.

SALTWATER INTRUSION TO GROUNDWATER

A groundwater study completed as part of this plan indicates that saltwater intrusion is not likely to be a threat to agricultural viability in Drainage District 13 or other agricultural lands in vicinity due to the distance from the Puget Sound.[3] Data from wells further upriver showed no sign of saltwater intrusion, so data from Snohomish County wells on Smith Island were used to determine the potential impact in this area. Further study of groundwater levels and salinity is recommended in Drainage District 13 and Diking Districts 1 (Ebey), 2, and 4 to improve the predictions calculated from the Smith Island well dataset. In particular, if increased pumping is implemented to combat drainage issues into the future, further study is necessary to determine if this may result in pulling salty groundwater upward and impacting crop yields.

OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased field inundation.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers to be viable.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several projects are recommended. These include improvements to the levee in specific locations, pump station capacity upgrades, and drainage system culvert replacements.
- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and more intense flooding as a result of climate change will increase the drainage burden of farmers in this district. It would help to explore ways to increase the funding available to include compensation from upland stormwater runoff impacts to pay for ditch and waterway maintenance as well as to assist with electricity costs for the pump station.
- **Reduce upland runoff.** Explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or educating and incentivizing urban/suburban landowners to reduce impervious or drainage projects on their properties. Restoration of Swans Trail Slough north of the railroad grade could also help to store or infiltrate upland runoff.
- **Assistance with permitting for drainage system maintenance.** Assist the District with the state and federal permitting process to allow for improved drainage system maintenance.

- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Conserve existing farmland.** The proximity of this floodplain reach to the cities of Everett and Snohomish put development pressure on commercial farmland. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. Innovative approaches should be pursued to increase the funding available to remove development rights.

- **Manage impact of nutria on levee integrity.** Nutria are non-native invasive rodents whose burrowing can damage levee infrastructure and result in levee failure. It would help to assist with nutria control and/or eradication.

Lower Snohomish River – Marshland Flood Control District

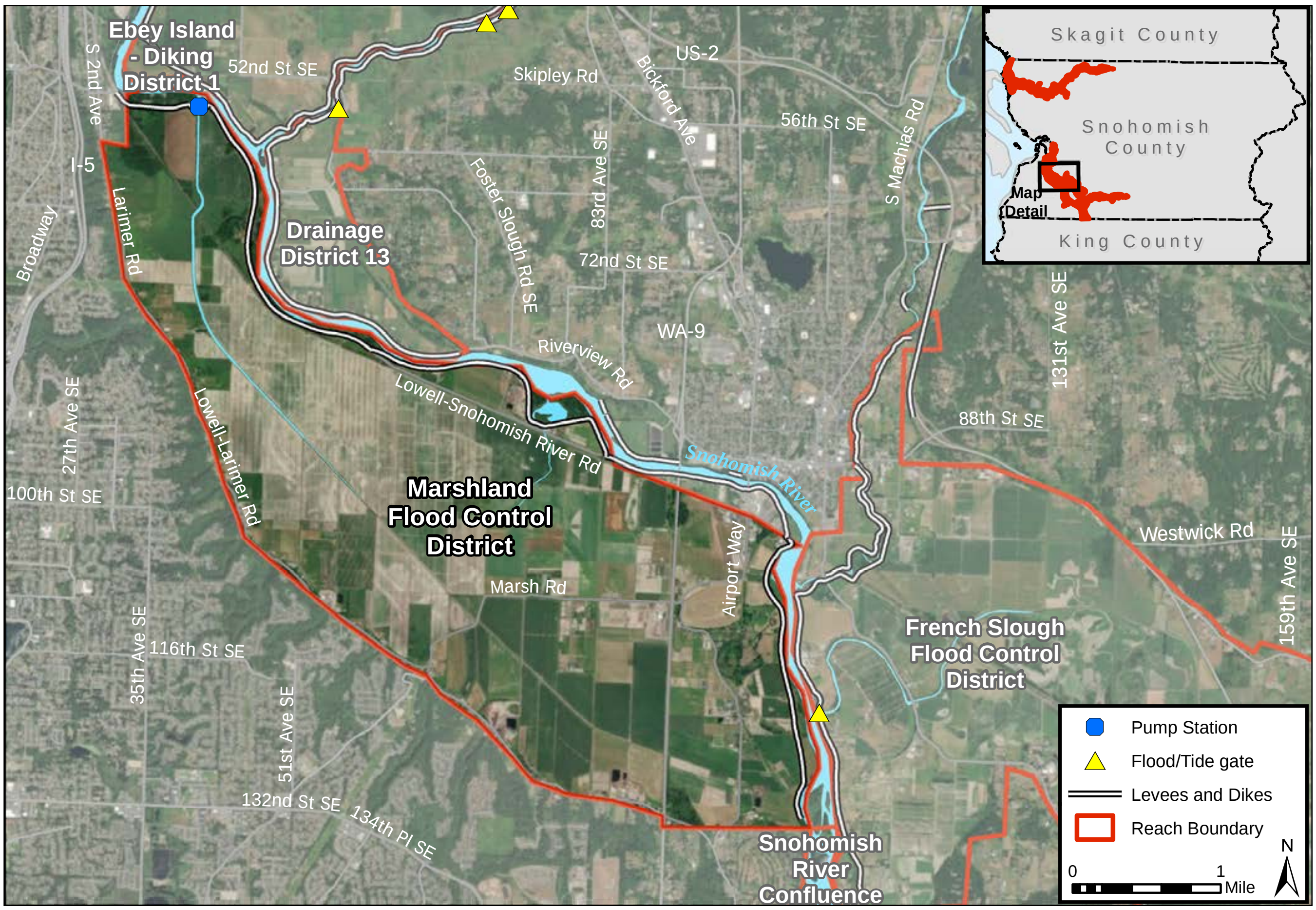

Figure VII-10. Map of Marshland Flood Control District. This figure shows the boundary of the Flood Control District, along with existing levees, tide or flood gates, and pump stations.

Description

The Marshland Flood Control District spans the floodplain south of the Snohomish River between the cities of Everett and Snohomish. Despite the proximity to these two growing urban centers, over 70% of the District's 6,400 acres is maintained as commercial agriculture. The largest landholder operates a 1,500-acre blueberry farm. The other primary commercial farming enterprises include cereal grains (1,000 acres), hay or silage (800 acres), a commercial dairy, and other local livestock producers. The District also supports grazing, vegetable production, turf grass, and other agricultural related businesses such as composting and agritourism.

DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage is managed by the Marshland Flood Control District, an entity that uses fees collected from landowners within the area and from local jurisdictions to maintain a system of ditches, river levees, a flood canal, and a pump station.

The levees were built in the early 1900s and upgraded with help from the Soil Conservation Service (now Natural Resources Conservation Service) in the early 1960s. The flood canal was dug and the pump station built with federal help at that same time. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to protect against water from larger events. In 1991, members of the Snohomish River Coordinated Diking Council (Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers) participated in development of the Snohomish River Comprehensive Flood Control Management Plan and agreed to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that the Marshland levee overtops at the same time as other district levees, relieving flood pressures and the risk of levee failure. In 2015, most of the levee was certified to Army Corps of Engineers standards and enrolled in the PL84-99 program so the federal agency will repair levees if damaged as a result of a flood. The agency will also design, obtain permits, and assist with 80% of the cost of repairs, although levee maintenance is ultimately the responsibility of the District.

The Marshland Flood Control District receives a considerable volume of water draining off the upland areas within both unincorporated Snohomish County and the City of Everett. This runoff results in deposition of large volumes of sediment in the District's ditches and flood canals. Sediment ponds have been built at six locations adjacent to Lowell Larimer Road to capture these deposits. The waterways within the District require ongoing maintenance to clean out sediment and grass to maintain flow. The District receives funding from Snohomish County and the City of Everett to compensate for the increased impact of stormwater and sediment inputs.

The pump station consists of two 100 hp pumps and four 250 hp pumps that move water from the District into the Snohomish River. The pumps run throughout the year, but primarily between October and June. The pump station does not provide fish access between the Snohomish River and the District, allowing for a more streamlined permitting process for drainage infrastructure maintenance.

ZONING

The Marshland Flood Control District is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Despite these protections, subdivision of larger farms into smaller farms as well as conversion to non-agricultural uses threaten the viability of traditional commercial agriculture in this area so close to the urban centers of Everett and Snohomish.

Current and future impacts

FLOODING

The Snohomish River estuary is low gradient with tidal influence extending 16 miles upriver to the confluence of the Skykomish and Snoqualmie Rivers near Monroe. Flooding in the Marshland Flood Control District is influenced primarily by upland runoff and river levels, although sea level rise is also projected to exacerbate flooding issues and impact drainage of farmland.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s.

Most flood-prone structures in the District have been raised in recent years, so while higher intensity and more frequent floods will mean more levee overtopping, the greater risk is a levee failure. A levee breach would cause extensive damage to farm and community infrastructure. One section of levee, in particular, is at risk of damage as it receives considerable pressure from Pilchuck River flood flows and deposited sediment.

GROUNDWATER LEVELS

Groundwater levels in the Marshland Flood Control District are projected to be impacted by sea level rise. While the predicted rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] The Marshland Flood Control District is over seven miles from the mouth of the Snohomish River, yet the low gradient of the river translates into groundwater level impacts from sea level rise through most of the District. These increases may impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on sea level rise predictions. The study found median predicted delays of 2-4 weeks by 2050 and 5 weeks through most of the District by 2100 (RCP 8.5).[3] This study only looked at the impacts of sea level rise on groundwater levels and did not take into account the ability of this district to actively pump water out of the system. Increased pumping, therefore, could mitigate the impacts of these rising groundwater levels.

LAND SUBSIDENCE

Much of the land in this district was wetland associated with the floodplain of the Snohomish River that has since been drained for agricultural use. As such, approximately 1,600 acres are soils high in organic matter. Cultivation and drainage of these soils has resulted in higher decomposition rates, causing the land to subside quickly.

A study of subsidence rates completed for this planning effort in the Lower Snohomish River floodplain indicates rates of approximately 1 to 6 inches of subsidence every 10 years in some areas, although there is a large amount of error associated with this estimation.[11]

OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased field inundation.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights will threaten viable crop yields.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers to be viable.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have sufficient water rights, and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Reduce upland runoff.** There is a need to explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or education and incentives for urban/suburban landowners to reduce impervious surfaces or implement drainage projects on their properties.
- **Reduce subsidence.** Explore creative approaches to reducing subsidence in areas where organic soils are decomposing, potentially through soil augmentation.
- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay

sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Additional financial assistance for drainage system maintenance.** Increased upland stormwater runoff and more intense flooding as a result of climate change will increase the drainage burden on farmers in the floodplain. It would help to explore ways to increase the amount of stormwater runoff funding received from local jurisdictions to support ditch and waterway maintenance as well as assist with electricity costs to run the pump station. Farmers would also benefit from assistance with replacing or installing drainage infrastructure on individual farms.

- **Flood risk training for new landowners.** New farmers moving into the District could benefit greatly from training on how to minimize flood risk by accessing flood data and predictions available through Snohomish County and preparing for floods.

- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated projections, and improved notification to farmers are needed.

- **Conserve existing farmland.** The proximity of this floodplain reach to the cities of Everett and Snohomish puts development pressure on commercial farmland. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape scale. There is a need to pursue innovative approaches to increasing funding available to remove development rights.

- **Research alternative on-farm drainage infrastructure techniques.** The District could benefit from funding for research and pilot projects looking at ways to better construct and manage drain tile or ditch systems to hold water back during summer months.

Lower Snohomish River – French Slough Flood Control District

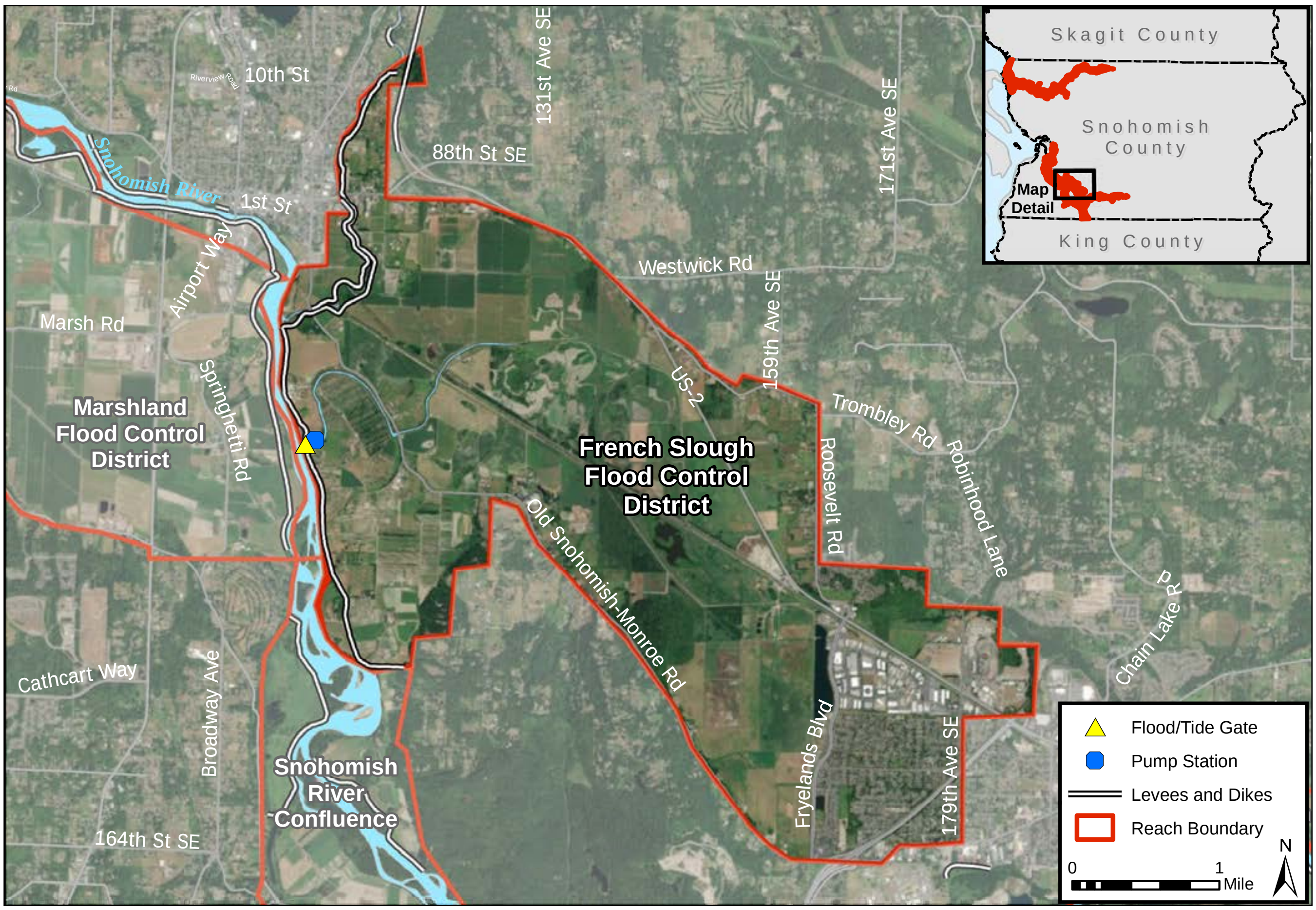

Figure VII-11. Map of French Slough Flood Control District. This figure shows the boundary of the Flood Control District, along with existing levees, tide or flood gates, and pump stations.

Description

The French Slough Flood Control District spans the floodplain between the cities of Snohomish and Monroe. Despite the proximity to these growing urban centers, over half of the 7,600 acres are maintained as commercial agriculture. A large portion of the agricultural land produces commercial grains or hay and silage (800 acres) to support local dairies (one of which is within the District). Another large portion (1,000 acres) is managed as private duck hunting clubs, which utilize a portion of their ground for cereal grains and silage. Nursery operations cover just under 300 acres, and vegetable and flower operations cover approximately 200 acres. There are also many small livestock operations and commercial horse stables.

DRAINAGE AND FLOOD PROTECTION

Flood protection and agricultural drainage is managed by the French Slough Flood Control District, an entity that uses fees collected from landowners within the area to maintain a system of ditches, river levees and a pump station. A significant portion of the District is lower than mean river levels for much of the year and extremely flat. For this reason, the levees and pump station are necessary to keep the land drained so present farming practices can occur.[12]

The levees were built in the early 1900s and upgraded with help from the Soil Conservation Service (now Natural Resources Conservation Service) in the early 1960s, at the same time the pump station was built and French Slough was widened and straightened. The diking and levee system in the Lower Snohomish River was constructed to provide flood protection for lower level floods but not so high as to protect against water from larger events. In 1991, members of the Snohomish River Coordinated Diking Council (Diking Districts 1-5, Drainage Districts 6 and 13, French Slough and Marshland Flood Control Districts and a few private dike managers) participated in development of the Snohomish River Comprehensive Flood Control Management Plan and agreed to maintain their levees at one foot above modeled 5-year flood levels.[9] The result of this agreement has been that the French Slough levee overtops at the same time as other district levees, relieving flood pressures and the risk of breaches. In 2013, most of the dike was certified to Army Corps of Engineers standards and enrolled in the PL84-99 program, so the federal agency will repair levees if damaged as a result of a flood. The agency will also assist with the costs, permitting, and design of regular levee maintenance, although this is ultimately the responsibility of the District.

The land within the French Slough Flood Control District receives considerable water from the uplands. The waterways require frequent maintenance to clean out sediment and grass to maintain flow. The District receives minimal funding from Snohomish County to compensate for upland stormwater and sediment inputs. The pump station consists of two 150 hp pumps and four 450 hp pumps that move water from French Slough to the Snohomish River, although one pump can handle most of the pumping needs for about seven months of the year. All water leaving the District is pumped, except the water leaving through the flood gates after a flood. A fish ladder provides access to adult salmon migrating up French Creek in the fall and a pair of fish-friendly pumps provides downstream access to juveniles in the spring and early summer.

ZONING

The French Slough Flood Control District is zoned Agriculture-10 Acre. This zoning designation, along with additional protections provided by the density fringe regulatory framework, make non-agricultural related development in this area difficult. Despite these protections, subdivision of larger farms into smaller farms as well as conversion to non-agricultural uses threaten the viability of traditional commercial agriculture in this area so close to the urban centers of Snohomish and Monroe.

Current and future impacts

FLOODING

The Snohomish River estuary is low gradient with tidal influence extending 16 miles upriver to the confluence of the Skykomish and Snoqualmie Rivers near Monroe. Flooding in the French Slough Flood Control District is influenced primarily by river levels and upland runoff, although sea level rise is also projected to exacerbate flooding issues and impact the drainage of farmland.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] The frequency of flood events is also projected to increase. Farmers in the Lower Snohomish identified the 17-ft and 23-ft flood stages (at Monroe gauge #12150800) as critical thresholds used for risk management (e.g. when levees overtop, livestock must be evacuated, structures flood, etc.). The models show that the 17-ft stage height is currently exceeded about one day per year and is projected to be exceeded for 3 days per year, on average, by the 2050s.[7] The 23-ft flood is projected to happen two to three times as often by the 2050s and three to four times as often by the 2080s.

Most flood-prone structures in the District have been raised in recent years, so while higher intensity and more frequent floods will mean more levee overtopping, the greater risk is a levee failure. A levee breach would cause extensive damage to farm and community infrastructure. A section of levee at the mouth of the Pilchuck River, for example, has received pressure from both flood waters and sediment deposition in recent years and has needed repair and fortification.

GROUNDWATER LEVELS

Groundwater levels in the French Slough Flood Control District are projected to be impacted by sea level rise. While the predicted rise in local sea level ranges greatly, median values indicate an increase of 10 inches by 2050 and over 2 feet by 2100 (RCP 8.5 50th percentile values).[2] French Slough Flood Control District is 13 miles from the mouth of the Snohomish River, yet the low gradient of the river translates into groundwater level impacts from sea level rise into a portion of the District. These increases may impact the timing of crop cultivation and hay harvest in the spring. A groundwater study completed as part of this plan calculated delays in spring cultivation based on these sea level rise predictions. The study found median projected delays of 4 weeks by 2080 and 5 weeks by 2100 in the downstream (western) portion of the District (RCP 8.5).[3] This study only looked at the impacts of sea level rise on groundwater levels and did not take into account the ability of this District to actively pump water out of the system. Increased pumping, therefore, could mitigate the impact of these rising groundwater levels.

LAND SUBSIDENCE

Much of the land in this district was once a 4,000-acre scrub-shrub wetland in the lower French Creek watershed that has since been drained for agricultural use.[13]
As such, approximately 2,000 acres are soils high in organic matter. Cultivation and drainage of these soils has resulted in higher decomposition rates, causing the land to subside quickly. A study of subsidence rates completed for this planning effort in the Lower Snohomish River floodplain indicates rates of approximately 1-6 inches of subsidence every 10 years in some areas, although there is a large amount of error associated with this estimation.[11]

OTHER

Other current and projected impacts:

- Continued increases in surface water runoff coming from upland areas cause sedimentation of drainage ditches and increased field inundation.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. The lack of available water rights threatens viable crop yields.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers to be viable.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and more intense flooding as a result of climate change will increase the drainage burden of farmers in the floodplain. New permitting requirements for increased protections for fish during ditch cleaning have also resulted in higher costs to complete maintenance. There is a need to explore ways to increase the amount of stormwater runoff funding received from local jurisdictions to support ditch and waterway maintenance as well as assist with electricity costs to run the pump station. Farmers would also benefit from assistance replacing or installing drainage infrastructure on individual farms.
- **Increased funding available for larger levee and drainage infrastructure projects.** Although levees and pumps are in good condition, a levee breach would mean costly repairs that would exhaust the existing

contingency funds available. It would help to explore options and partnerships for developing a grant and/or loan program for larger resilience projects.

- **Access to water for irrigation.** Most farms do not have sufficient water rights, and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Flood risk training for new landowners.** New farmers moving into the District could benefit greatly from training on how to minimize flood risk by accessing flood data and predictions available through Snohomish County and by preparing for floods.
- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated predictions, and improved notification to farmers are needed.
- **Reduce subsidence.** There is a need to explore creative approaches to reducing subsidence in areas where organic soils are decomposing, potentially through soil augmentation.
- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Conserve existing farmland.** The proximity of this floodplain reach to the cities of Snohomish and Monroe put development pressure on commercial farmland. Existing funding sources for Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR) programs are insufficient to protect farmland at the landscape-scale. There is a need to pursue innovative approaches to increasing funding available to remove development rights.
- **Research alternative on-farm drainage infrastructure techniques.** The District could benefit from funding for research and pilot projects looking at ways to better construct and manage drain tile or ditch systems to hold water back during summer months.
- **Assistance with permitting for drainage system maintenance.** Every 5 years, the District is required to renew their Hydraulic Project Approval permit with the Department of Fish and Wildlife, allowing them to maintain their drainage infrastructure. The District could use assistance with this process through staff capacity and funding.
- **Reduce upland runoff.** It would help to explore the use of green stormwater infrastructure, regulatory changes to county and city code, and/or education and incentives for urban/suburban landowners to reduce impervious or drainage projects on their properties.

Snohomish River Confluence – Tualco Valley and Vicinity

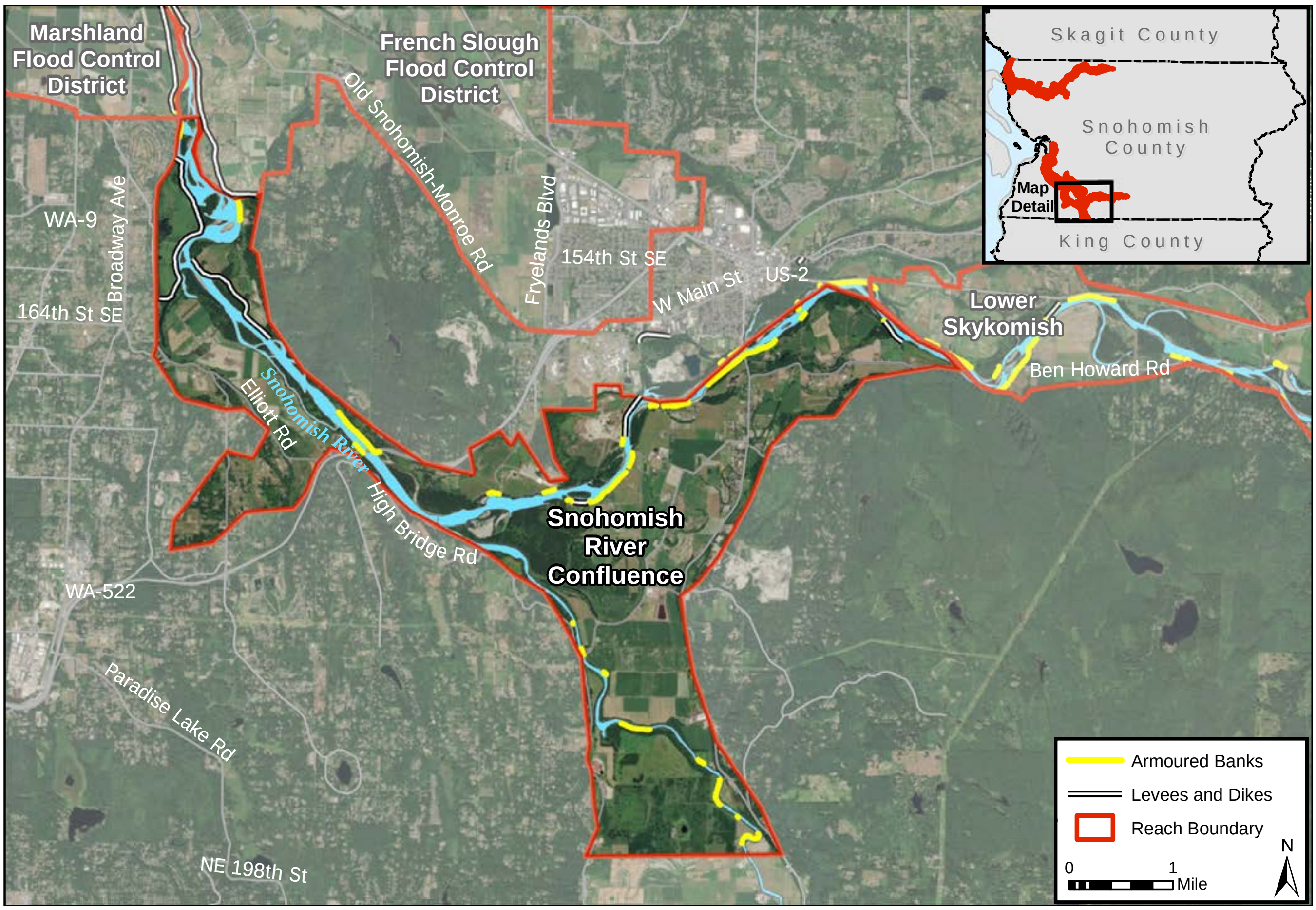

Figure VII-12. Map of the Snohomish River Confluence. This figures shows the boundary of the Tualco Valley and vicinity along with existing levees and revetments.

Description

The agricultural area in the vicinity of the Tualco Valley supports a thriving agricultural industry which is able to take advantage of a wide floodplain with rich soils, yet is far enough from larger urban centers to remove some of the pressures associated with development and to keep land prices low. Of the 8,800 acres in this area, approximately half is actively used for commercial agriculture. The livestock industry dominates this area, with approximately 1,000 acres in hay and silage (to support the five small and large-scale dairies) and 1,300 acres in pasture. Smaller acreages are dedicated to producing cereal grains, vegetables, and flowers. Between 2004 and 2011, this area was the focus of a farmland protection effort by Snohomish County that resulted in more than 450 acres of farms being protected from future development through a Purchase of Development Rights program.

DRAINAGE AND FLOOD PROTECTION

This area is not managed by an organized diking or flood control district. The levees are not contiguous as in the Lower Snohomish, but rather provide protection against flood flows and debris at strategic locations along the river. The levees along with multiple shoreline armoring projects were built primarily between 1920 and 1950, largely by the Army Corps of Engineers. Individual farmers maintain drainage infrastructure as well as shoreline armoring projects on their properties.

ZONING

The agricultural land in this reach is primarily zoned Agriculture-10 Acre. The density fringe regulatory framework protections that exist in downstream floodplain reaches do not extend into this area, although much of the area is designated as floodway. The floodway designation carries significant restrictions on development (SCC 30.65.220). For this reason, loss of commercial farmland to development or subdivision is not a major threat.

Current and future impacts

FLOODING

The Snohomish River estuary is low gradient, with tidal influence extending 16 miles upriver to the confluence of the Skykomish and Snoqualmie Rivers near Monroe. While there is a muted tidal signal in and around the Tualco Valley, flooding is largely dependent on river flows and not tides or sea level.

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events.[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1]

Local farmers have already noticed more intense and longer duration flooding than in the past. The major impacts of flooding in this reach include:

- Sand and silt deposition on fields, which can result in decreased yields
- Flood debris on fields, which requires costly clean-up and repair
- Damage to structures, which results in costly repair
- Threats to livestock, including harm to animals, decreased milk production, or impacted milk transport
- Pasture inundation, which can harm pasture grass
- Bank erosion, which causes loss of farmland in limited locations

GROUNDWATER LEVELS

Groundwater levels and saltwater intrusion in the Snohomish Confluence area are not expected to be impacted by rising sea levels due to the large distance from the Puget Sound.[3] Groundwater levels may be impacted by increased riverine flooding or upland stormwater runoff, although these effects are predicted to be shorter in duration than the sustained impacts of sea level rise downriver.

RIVER CHANNEL AGGRADATION

Local farmers report that they have noticed channel aggradation in this reach of the Snohomish and Skykomish Rivers. In a study of aggradation completed as part of this plan, channel aggradation was identified between river miles 12 and 17 (from the City of Snohomish just past the confluence of the Skykomish and Snoqualmie Rivers) between 2001 and 2017.[11] The overall capacity of the channel to carry flood waters, however, was not reduced, likely due to channel widening.[11] This study, therefore, concluded that changes in flooding on agricultural land are not a result of river channel aggradation.

OTHER

Other current and projected impacts:

- Continued increases in surface water drainage coming from upland areas cause sedimentation of drainage ditches and increased field inundation. Permitting constraints also make it difficult to clean these waterways in a timely manner.
- Farmers have seen an increased need for irrigation in recent years. Many farmers have not traditionally irrigated and do not have water rights. Lack of available water rights will threaten viable crop yields.
- Economic pressures for producers are resulting in subdivision of large farms and reduction of the available acreage needed for current commercial farmers to be viable.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Access to water for irrigation.** Most farms do not have sufficient water rights and while many have not traditionally needed to irrigate, higher temperatures and less summer precipitation has resulted in higher irrigation needs in recent years. There is a need to develop creative approaches to providing irrigation water to farmers.
- **Financial assistance for drainage system maintenance.** Increased upland stormwater runoff and more intense flooding as a result of climate change will increase the drainage burden of farmers in the floodplain. There is a need to explore ways to increase funding available to include compensation from upland stormwater runoff impacts to pay for ditch and waterway maintenance.
- **Drainage infrastructure improvements.** To improve existing drainage and increase resilience to future groundwater and flooding impacts, several types of actions are recommended. Both on-farm drainage improvements (e.g. tile systems) and landscape-scale drainage projects along waterways (e.g. culvert replacements and channel excavation) will increase resilience to changes in hydrology.
- **Funding for drought resilience Best Management Practices.** Existing incentive programs do not pay sufficient rates for practices that build soil health and increase the water holding capacity of soils. Funding and equipment is needed for practices such as cover cropping, no-till, compost or biochar application, and agroforestry. Developing ecosystem service markets for carbon sequestration or water quality could provide funding for these practices and increase the economic resilience of farms.

TIER TWO (LOWER PRIORITY)

- **Flood risk training for new landowners.** New farmers moving into the District could benefit greatly from training on how to minimize flood risk by accessing flood data and predictions available through Snohomish County and by preparing for floods.
- **Improve flood warning system.** Farmers have very little time to prepare for floods and limited flood warning information. Real-time gauges, more sophisticated predictions, and improved notification to farmers are needed.
- **Research alternative on-farm drainage infrastructure techniques.** The District could benefit from funding for research and pilot projects looking at ways to better construct and manage drain tile or ditch systems to hold water back during summer months.
- **Reduce upland runoff.** Explore the use of green stormwater infrastructure, regulatory changes to county code, and/or education and incentives for urban/suburban landowners to reduce impervious or drainage projects on their properties.

Lower Skykomish River

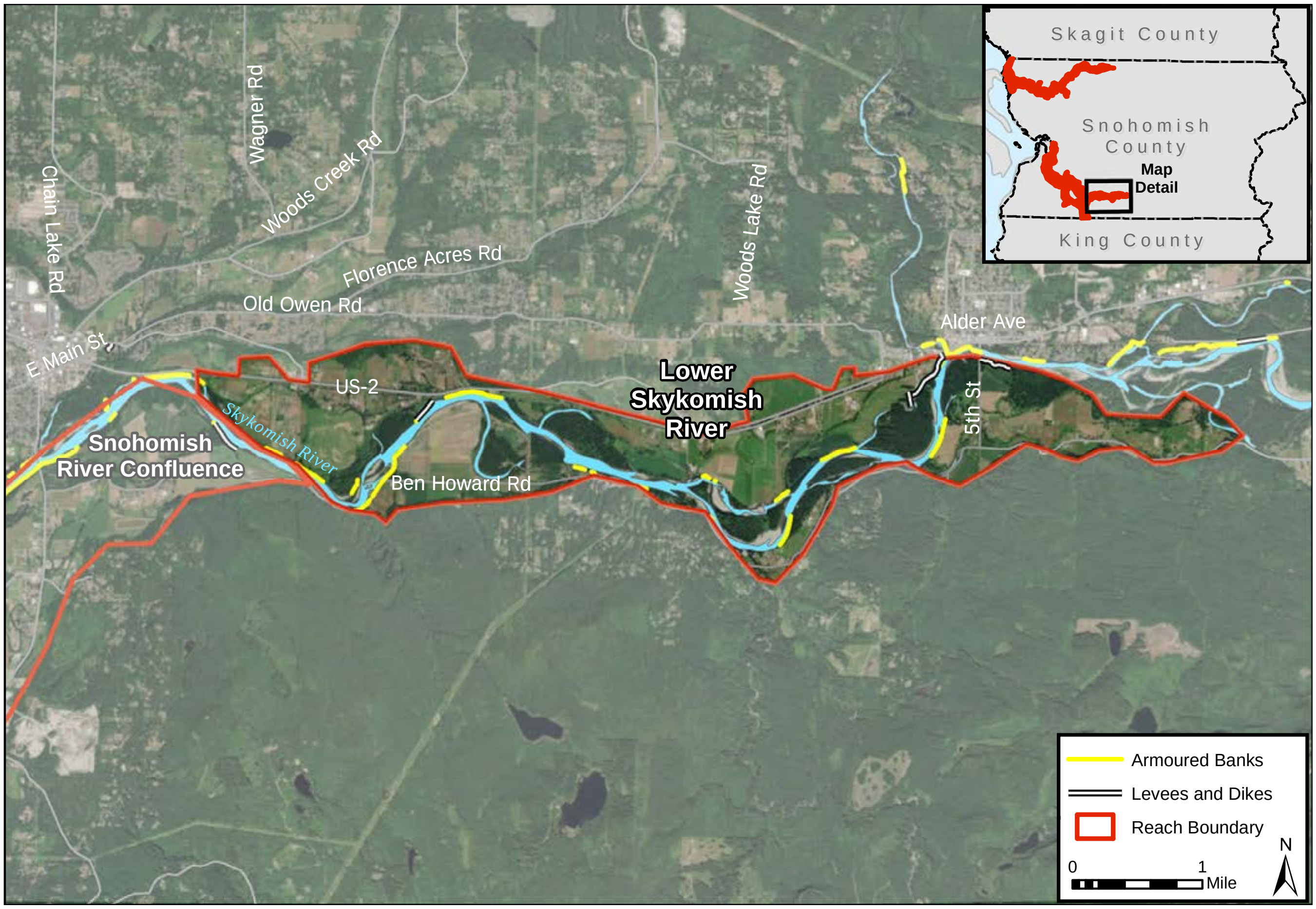

Figure VII-13. Map of Lower Skykomish River floodplain. This figure shows the boundary of the Lower Skykomish River, along with existing levees and revetments.

Description

The floodplain narrows above the confluence of the Skykomish and Snoqualmie Rivers, but commercial agriculture remains viable up the Skykomish River for approximately fifteen additional miles. The Lower Skykomish area represents approximately 1,700 acres of commercial agricultural land predominately in feed and forage production to support the livestock industry and local dairies. In addition, smaller acreages support production of vegetables, cereal grains and nursery plants.

DRAINAGE AND FLOOD PROTECTION

This area is not managed by an organized diking or flood control district. Existing levees are not contiguous as in the Lower Snohomish, but rather provide protection against flood flows and debris at strategic locations along the river. The levees along with multiple shoreline armoring projects were built primarily between 1920 and 1960, largely by the Army Corps of Engineers. Individual farmers maintain drainage infrastructure as well as shoreline armoring projects on their properties.

ZONING

The agricultural land in this reach is primarily zoned Agriculture-10 Acre. The density fringe regulatory framework protections that exist in downstream floodplain reaches do not extend into this area, although much of the area is designated as floodway. The floodway designation carries significant restrictions on development (SCC 30.65.220). For this reason, as well as the large distance from urban areas, loss of commercial farmland to development or subdivision is not a major threat.

Current and future impacts

FLOODING

New modeling work completed for this planning effort shows strong evidence for increased frequency and extent of flooding (2-, 10-, 25- and 100-year events) with particularly impactful changes for the more frequent 2- and 10-year flood events).[7] In the Snohomish River watershed, projections indicate that the acreage inundated in a 2-year flood will more than double, increasing from 16,946 acres to 40,134 acres by mid-century.[1] In the Lower Skykomish River floodplain, the current modeled 2-year event does not leave the river channel, yet by the 2050's it is expected to inundate much of the floodplain. The frequency of flood events is also projected to increase.

The largest projected impact of these higher intensity floods will be loss of farmland to eroding riverbanks. Much of this reach has been armored with rip rap along banks, locking the channel into place to reduce channel migration. This has had the added effect of causing channel incision in some areas, further exacerbating bank erosion by disconnecting the river from the floodplain during larger floods.

Resilience Needs

TIER ONE (HIGH PRIORITY AND IMMEDIATE)

- **Protect farmland from riverbank erosion.** Numerous bank stabilization projects were put in place in the mid-1900s. Several of these have started to erode, but new permit requirements have made it difficult and costly for farmers to repair them or construct new projects.

1 Fathom. 2019, Puget Sound Hazard Mapping Report.

2 Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E. 2018. Projected Sea Level Rise for Washington State – A 2018 Assessment. A collaboration of Washington Sea Grant, University of Washington Climate Impacts Group, University of Oregon, University of Washington, and US Geological Survey. Prepared for the Washington Coastal Resilience Project.

3 Cardno, 2019. Climate impacts to groundwater in the Lower Snohomish and Stillaguamish River basins. Report produced for the Snohomish Conservation District. Lake Stevens, WA.

4 Northwest Hydraulic Consultants (NHC), 2014. Douglas Creek and vicinity hydrologic and hydraulic modeling. Report prepared for Snohomish County. Everett, WA.

5 Snohomish County Public Works Surface Water Management (SWM), 2015. Douglas Creek and vicinity basin characterization report. Everett, WA.

6 Snohomish County Surface Water Management (SWM) and the SLS Executive Committee, 2018. Mainstem Stillaguamish River Reach-scale Plan. Snohomish County Department of Public Works and the Executive Committee of the Sustainable Lands Strategy. Everett, Washington.

7 Mauger, G.S., S.-Y. Lee, and J.S. Won. 2019, Mapping the future of flood risk for the Stillaguamish and Snohomish Rivers. Report prepared for the Snohomish Conservation District. Climate Impacts Group, University of Washington, Seattle.

8 Cardno, 2019. Technical Memo: Stillaguamish Flood Control District subsidence and sedimentation study. Report produced for the Snohomish Conservation District. Lake Stevens, WA.

9 Snohomish County Public Works Surface Water Management (SWM), 1991. Snohomish River Comprehensive Flood Control Management Plan. Everett, WA.

10 Bartelheimer, D., 2019. Personal communication with Cindy Dittbrenner (Snohomish Conservation District). October 20, 2019.

11 Cardno, 2019. Technical Memo: Lower Snohomish River District subsidence and sedimentation study. Report produced for the Snohomish Conservation District. Lake Stevens, WA.

12 Wheeler, Neil, 2019. Personal communication with Cindy Dittbrenner (Snohomish Conservation District). August 27, 2019.

13 Snohomish County, 2004. French Creek Watershed Management Plan. Everett, WA.

Chapter VIII
Next Steps

"We grow produce for people now but we take care of the land for our children. We want them to grow up in a healthy world."

Anna Caruso, Caruso Farms, Photovoice 2017

This Agriculture Resilience Plan for Snohomish County will help ensure the viability of our farmlands into the future. The next step is to continue to work together as an agricultural community to implement the actions included in this Plan. The Steering Committee recognizes that these actions cannot be achieved without **collaboration and partnership**. The needs represented in this plan, therefore, are a starting point for collaborative thinking with partners, communities and government bodies about how we manage our land and our natural resources in a time of changes and uncertainty.

While there are many economic, regulatory and policy factors influencing the success of our local farms, the actions prescribed in this Plan are aimed at ensuring the viability, protection, and resilience of the land itself. These include both county-wide actions and those specific to different reaches of the floodplain. The actions are diverse and include policy changes, re-allocation of tax dollars, landscape-scale project implementation, on-farm resource needs, and continuing research and education.

Through partnerships developed as part of the **Sustainable Lands Strategy** (SLS), the farming community in Snohomish County hopes to find mutually beneficial solutions to managing our natural resources for agricultural resilience, salmon habitat recovery, and flood protection. The newly launched Integration Team is an SLS initiative that brings partners together to develop packages of projects and actions that support these multiple interests as well as procure funding to support project implementation. We hope that both the technical information provided through this planning effort as well as the identification of prioritized agricultural needs will help further this collaborative approach to land management.

A working appendix to this Plan will be the **Project List** that is continually refined and adapted to reflect the changing needs of the agricultural landscape and the collaborative process facilitated by the Integration Team to develop innovative, landscape-scale solutions to community resilience.

"This is farmer led. This is not a plan that's going to sit on a shelf somewhere. It's a plan that's going to lead to action to help real farmers with real concerns."

Karen Wolden-Fuentes, Hazel Blue Acres Farm