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Critical Areas Ordinance Update

Best Available Science Review

CITY OF BREMERTON

OCTOBER 2025

Prepared for:

City of Bremerton
Community Development Department
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CITY OF BREMERTON

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Acronyms and Abbreviations

BAS	Best Available Science
BMC	Bremerton Municipal Code
BMP	Best Management Practices
CAO	Critical Areas Ordinance
CARA	Critical Aquifer Recharge Area
CFHMP	Critical Flood Hazard Management Plan
CMZ	Channel Migration Zone
Commerce	Washington State Department of Commerce
DNR	Washington State Department of Natural Resources
DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FEMAT	Forest Ecosystem Management Assessment Team
FFA	Frequently Flooded Area
FIRM	Flood Insurance Rate Map
FWHCA	Fish and Wildlife Habitat Conservation Area
GIS	Geographic Information System
GMA	Growth Management Act
LID	Low Impact Development
NFIP	National Flood Insurance Program
NHD	National Hydrography Dataset
NMFS	National Marine Fisheries Service
OHWM	Ordinary High Water Mark
PHS	Priority Habitats and Species
RCW	Revised Code of Washington
RMZ	Riparian Management Zone
SMP	Shoreline Master Program
SPTH	Site Potential Tree Height
USACE	U.S. Army Corps of Engineers
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WHPA	Wellhead Protection Areas

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1. INTRODUCTION

This review of the best available science (BAS) was compiled to support the City of Bremerton's Critical Areas Ordinance (CAO) update. As a requirement of the Washington State Growth Management Act (GMA), cities and counties must complete periodic updates to their comprehensive plans and development regulations. The City of Bremerton's CAO is codified in Chapter 20.14 of the Bremerton Municipal Code (BMC). This document sets the framework for planned CAO updates in Bremerton. It serves as the basis for a gap analysis to identify where updates to current critical area regulations should be prioritized for consistency with BAS.

Under the GMA, Bremerton must "*include the 'best available science' (BAS) when developing policies and development regulations to protect the functions and values of critical areas and must give 'special consideration' to conservation or protection measures necessary to preserve or enhance anadromous fisheries*[1]" (WAC 365-195-900). Regulated critical areas include wetlands, areas with a critical recharging effect on aquifers used for potable water, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas (RCW 36.70A.030).

While the BAS review is a resource for critical area management, it is not intended to provide definitive answers for all policy and regulatory decisions. Policy and regulations should incorporate BAS but also necessitate decision-making processes based on societal values. Additionally, ecological systems are highly complex, and the scientific body of knowledge is constantly evolving with the advancement of new research and technology. Despite these advancements, there are limits to the current state of science, and certain topics may not be fully understood. . In accordance with WAC 365-195-920, decision-makers may opt for a precautionary or no-risk approach when scientific information is incomplete.

1.1 Best Available Science

BAS means the current and best available information that follows a valid scientific process as specified in WAC 365-195-900 through WAC 365-195-925. Characteristics of a valid scientific process include peer review, standardized methods, logical conclusions and reasonable inferences, quantitative analysis, proper context, and references. Common sources of scientific information include research, monitoring, inventory, modeling, assessment, and synthesis (WAC 365-195-905). BAS literature reviews are a synthesis of the current scientific body of knowledge, and only resources that meet these requirements are included as reference materials for this BAS.

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[1] Anadromous refers to fish or fish species that spend portions of their life cycle in both fresh and salt waters, entering fresh water from the ocean to spawn.

In accordance with the GMA, the City of Bremerton (City) last completed a comprehensive update of its critical areas policies and regulations in 2016. Much of the science foundational to critical areas has not changed during this period and is still largely valid.

The 2016 BAS Review built upon the information presented in the 2006 BAS Review, which was primarily a list of references organized by topic. The City of Bremerton heavily relied upon the existing BAS literature determined by other local, state, and federal natural resource agencies to meet the BAS Criteria (WAC 365-195-905(2)). Review of BAS for local applicability to the City of Bremerton was assisted by a Technical Review Committee, convened by the City and composed of representatives from local, state, and natural resource agencies, and various community stakeholder groups. Committee members were guided by a duty and purpose of assisting the city in determining what BAS is appropriate to consider in updating the CAO. Similarly, this BAS review does not intend to repeat information that has been comprehensively addressed elsewhere. Rather, established science or previous study findings are summarized or referenced where applicable in this document.

1.2 Climate Change

As of July 2023, with the passage of Washington House Bill 1181: Climate Change in Local Comprehensive Planning, the GMA requires jurisdictions to incorporate and evaluate the effects of climate change in long-range planning. Climate change is anticipated to have a profound influence on natural systems. Addressing anticipated climate change effects on critical areas allows decision-makers to incorporate climate resilience into policy and regulations. Anthropogenic global climate change is projected to impact climatic variation and natural resources in the Pacific Northwest. Climate models project annual temperature increases totaling 3.2 degrees Fahrenheit by the 2040s (Mote & Salathe 2010). At current rates of warming, global warming may exceed 2.7 degrees Fahrenheit (1.5 degrees Celsius) by 2030 (Snover et al. 2019). Modeled changes include reduced regional snowpack, reduced summer water supply, and a greater frequency and duration of extreme weather events, including flooding and high temperatures (Mauger et al. 2015).

As described in the *Kitsap County Climate Change Resiliency Assessment*, since 1900, sea levels in Bremerton have risen at a rate of approximately 1 inch every 12.3 years, and heavy rainfall event intensity increased by 50%.

Climate change studies and modelling continue to provide information about what changes to expect globally and in the Pacific Northwest. However, climate change is a complex issue, and guidance on how best to manage critical areas in a changing environment is continually evolving.

These predicted effects are referenced and expanded upon throughout the document.

<u>Increasing air temperatures and more extreme heat</u>

- Long-term warming, a lengthening of the frost-free season, and more frequent nighttime heat waves have been observed (Mauger, Casola, et al. 2015).
- Models predict more "hot days" each year (Ecology 2024).
- Global warming of about 1°C has already occurred. Warming may exceed 1.5°C (2.7°F) by 2030 (Snover, et al. 2019).

Seasonal changes to precipitation patterns

- Increases in both the frequency and intensity of heavy rainfall events have been documented in western Washington (Mauger, Casola, et al. 2015).
- Summer precipitation is expected to decrease (Mauger, Casola, et al. 2015) and droughts will be more common (Ecology 2024).
- An observed and projected decrease in snowpack is anticipated to result in reduced stream flows later in the year (Ecology 2024).
- Increasingly larger and more frequent floods are predicted with less snow and heavier, more frequent precipitation events (Ecology 2024).
- A likely reduction in groundwater availability is anticipated due to changes in precipitation patterns and intensity and timing of snowmelt, combined with increased summer demand from people and ecosystems (Ecology 2024).

Rising sea levels and changing Puget Sound conditions

- Sea levels have risen across Washington's coastline and are expected to continue to rise at an accelerated pace (Ecology 2024).
- Projected future sea level rise estimates include:
    - An increase of 1.5-2.5 feet for all coastal areas of the state by 2100 (Ecology 2024).
- With higher sea levels, coastal flooding and damage from storm surges are predicted to increase (Mauger, Casola, et al. 2015).
- Washington's coastal water temperatures have increased by 1.2°F since 1900, and warming is expected to continue (Ecology 2024).
- The acidity of the Puget Sound is increasing (i.e., pH values are decreasing) due to the absorption of carbon dioxide from the atmosphere into Puget Sound waters (Ecology 2024) (Mauger, Casola, et al. 2015).

Increasing risk of wildfire and smoke

- Hotter, drier summers and snowpack loss are projected to result in conditions that increase the likelihood of wildfires west of the Cascades (Mauger, Casola, et al. 2015); although the greatest wildfire risk increases occur outside of the Puget Sound region (Ecology 2024).
- While the overall risk from wildfires in Bremerton may not be as extreme as in other parts of the state, smoke from wildfires elsewhere often moves into the Puget Sound basin. Projections for future changes in the frequency or intensity of wildfire smoke are not available (Ecology 2024). The impact of wildfire smoke on natural systems is not fully understood (Voisin, et al. 2023).

Changing environmental conditions for flora, fauna, and pathogens

- Climate change effects are anticipated to alter the timing of biological events, species' geographic distributions, productivity, and resilience of terrestrial ecosystems (Mauger, Casola, et al. 2015).
- The prevalence and location of certain pests and pathogens will likely shift. Responses are likely to be species- and host-specific (Mauger, Casola, et al. 2015).

- Introduced, adaptable species may experience greater opportunity to become established and spread after disturbance, while locally evolved flora and fauna may experience stress from environmental changes that exceed historic ranges/thresholds. Plant and animal adaptability and resilience to climate change vary by species.

2. WETLANDS

2.1 Definitions

Washington State defines wetlands in WAC 365-190-030(24) as follows:

> *"Wetland" or "wetlands" means areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. However, wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate conversion of wetlands, if permitted by the county or city.*

BMC 20.14.200 defines "wetlands as "*areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands include artificial wetlands created from nonwetland areas to mitigate the conversion of wetlands. Identification of wetlands and delineation of their boundaries pursuant to this chapter shall be done in accordance with the approved federal wetland delineation manual and applicable regional supplements. All areas within the City meeting the wetland designation criteria in that procedure are hereby designated critical areas and are subject to the provisions of this program."*

2.2 Functions and Values

The capacity of an individual wetland to perform functions is dependent upon multiple factors, including the wetland's landform or hydrogeomorphic class. For example, wetlands on slopes have less potential to store water relative to depressional wetlands. Wetland functions are also dependent on the geomorphic and hydrologic characteristics of each wetland (Brinson and Vicksburg 1993; Hruby and Yahnke 2023). Other factors that impact wetland functions are landscape setting, vegetation structure, hydroperiods, proximity to potential sources of pollution, and priority habitat corridors and connectivity. Wetlands naturally perform several functions at low cost relative to engineered solutions, such as water storage, flood protection, water reserve, pollutant and nutrient retention, and provisional fisheries habitat; these are valued as human services (Hattermann et al. 2008).

For regulatory purposes, wetland functions and values are commonly ranked in a rating system. The current BAS-based rapid assessment tool for wetland functions is the *Washington State Wetland Rating System for Western Washington* (Hruby and Yahnke 2023) developed by the Washington State Department of Ecology (Ecology). The Ecology wetland rating system broadly groups wetland functional values into three categories: 1) water quality functions, 2) flood storage or hydrologic functions, and 3) habitat functions(Sheldon et al. 2005a; Hruby and Yahnke 2023) The functional score for each category is ranked as high, medium, or low. Each category assesses the site's potential to perform each function, relative to the landscape setting, and value to society.

Wetlands are highly productive ecosystems that deliver important functions through various physical, chemical, and biological processes. Previous literature has established that wetlands provide numerous ecological benefits, along with cultural, social, and economic values. The specific functions of a wetland can vary due to multiple factors, including its landform (or hydrogeomorphic classification), landscape setting, vegetation structure, hydroperiods, and the presence or absence of priority habitats and species. The primary ecological functions of wetlands can be grouped into several categories (Sheldon et al. 2005a):

Improving Water Quality:

- Intercepting and detaining surface water runoff
- Sediment removal
- Filtering, removing, and transforming pollutants
- Uptake of nutrients such as phosphorus and nitrogen
- Shading.

Maintaining the Water Regime in a Watershed (Hydrologic Functions):

- Water storage
- Reducing water velocity
- Stabilizing banks and controlling erosion
- Desynchronizing surface water flows to mitigate flooding
- Groundwater recharge
- Maintaining base stream flows during dry seasons

Providing Habitat:

- Supporting water-dependent and water-associated organisms
- Hosting unique plant communities
- Offering specific habitat requirements for certain species
- Serving as a surface water source
- Demonstrating a diversity of hydrologic regimes
- Exhibiting structural complexity
- Facilitating connectivity to other ecosystems

- Influencing climate and weather patterns
- Affecting topography and geology
- Providing essential nutrients
- Supporting food webs

Wetlands mapped in the City of Bremerton by the National Wetland Inventory (NWI) and Kitsap County are presented in Figure 1 below.

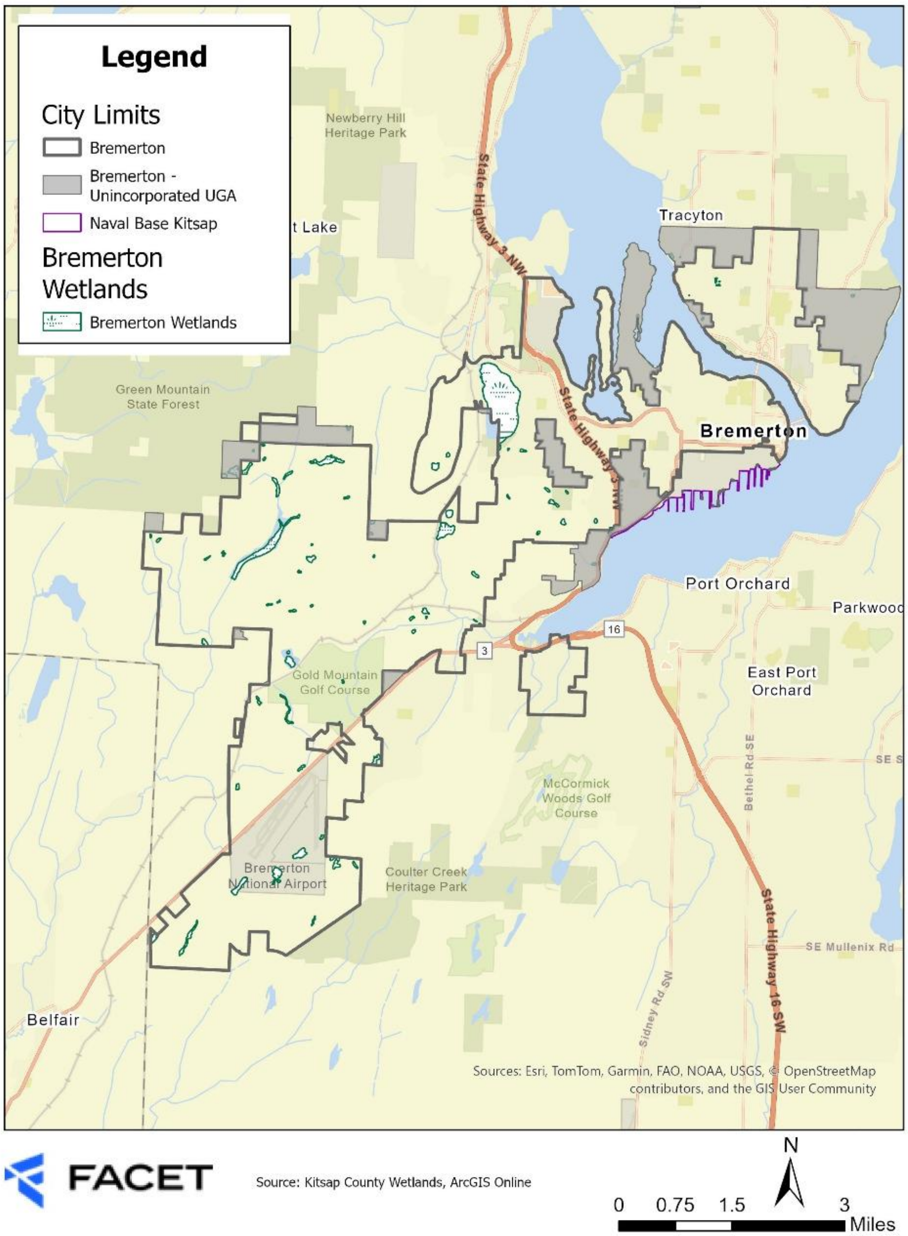

Figure 1. Wetlands in the City of Bremerton.

2.3 Key Protection Strategies

2.3.1 Identification and Classification

County and national-scale online resources, such as the Kitsap County GIS layers and the National Wetland Inventory (NWI) provide modeled estimates of wetland locations. While these online databases are useful planning tools, site-specific planning and development require individual studies conducted by qualified professionals. Wetlands are often more abundant than indicated in inventory databases and may change over time.

The nationwide standard for wetland delineations is outlined in the U.S. Army Corps of Engineers (USACE) Wetlands Delineation Manual (U.S.Army Corps Engineers 1987). In the City of Bremerton, the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region, Version 2.0, also applies (U.S.Army Corps Engineers 2010).

The Washington State Department of Ecology has developed a statewide wetland rating system, which has undergone periodic updates. There are two versions: one for eastern Washington and one for western Washington. The Washington State Wetland Rating System for Western Washington, Version 2 (Hruby and Yahnke 2023), is applicable in the City of Bremerton and serves as the regional standard. This current version is similar to the prior publication from 2014, with updates focused on clarifications, formatting improvements, updated website links, and annotations.

Ecology's rating system is a rapid assessment tool that evaluates wetland functions in three categories: water quality, hydrology, and habitat. This evaluation considers site potential, landscape potential, and societal value (Hruby and Yahnke 2023). Using this system, wetlands are classified into one of four categories. The classification system is designed to assist agencies in making decisions about the protection and management of wetlands. It is also used to establish appropriate buffer distances from wetland categories, based on the preservation of their functions and values.

2.3.2 Management Resources and Standards

Ecology's latest wetland guidance for CAO updates was issued in October 2022 (Ecology 2022). The guidance provides three BAS-based options for wetland buffer tables.

Ecology's preferred option, Option 1, provides the most flexibility and site-specific buffers. This option considers habitat score and includes the potential to reduce the buffer through the provision of a habitat corridor and implementation of minimization measures to reduce the level of impact from the adjacent land use. Use of the lowest buffer widths under this option, shown in Table 1 below, requires the implementation of minimization measures. If an applicant chooses not to apply the applicable minimization measures, then an approximately 33% increase in the width of all buffers is required. Note that to use the reduced widths in Table 1, the protection of a wildlife corridor is also required between higher functioning wetlands that score six or more habitat points and certain other protected areas. If this cannot be provided, then the non-reduced (33% increase) buffer would be required for those higher-functioning wetlands.

Table 1. Ecology Wetland Buffer Option 1.

Wetland Category	Habitat Score 3-5 Points	Habitat Score 6-7 Points	Habitat Score 8-9 Points	Buffer Width Based on Special Characteristics
Category I & II: Based on rating of functions (and not listed below)	75	110	225	NA
Category I & II: Forested	75	110	150	NA
Category I: Bogs, calcareous fens, and Wetlands of High Conservation Value	NA	NA	NA	190
Category I: Alkali	NA	NA	NA	150
Category II: Vernal pool	NA	NA	NA	150
Category III	60	110	150	NA
Category IV	40	40	40	NA

Ecology buffer Option 2, shown in Table 2 below, is based on wetland category and the level of impact from the adjacent proposed or existing land use. This option necessitates the inclusion of a table with levels of impacts from proposed land use types.

Table 2. Ecology Wetland Buffer Option 2.

Wetland Category	Land Use Impact		
	Low	Moderate	High
I	125	190	250
II	100	150	200
III	75	110	150
IV	25	40	50

Ecology buffer Option 3, shown in Table 3 below, is based solely on the category of wetland. It is the simplest to administer; however, it is the least flexible.

Table 3. Ecology Wetland Buffer Option 3.

Wetland Category	Buffer
I	300
II	300
III	150
IV	50

As discussed above, Ecology buffer Option 1 includes the option of reducing the buffer through the provision of a habitat corridor and implementation of minimization measures to reduce the level of impact from the adjacent land use. Ecology's 2022 guidance has updated the language for habitat corridor requirements. While the overall concept remains the same, more detail and clarification is provided on what a "legally protected, relatively undisturbed and vegetated area" is and what buffer would be required if the applicant is unable to provide a corridor.

Current BAS does not support additional buffer reductions beyond the habitat corridor/minimization measures to reduce the level of impact from adjacent land use described above. In the past, it was common to allow a buffer reduction with the enhancement of existing, degraded buffers. However, Ecology's current buffer recommendations are based on a buffer that is already well vegetated. If the existing buffer area is not currently vegetated in a manner to provide the necessary buffer function, then the buffer area should be planted, or the buffer width should be increased. Reducing buffer area in these circumstances is a high-risk approach to protecting wetland functions and values.

2.4 Climate Change Effects

Wetlands play a critical role in supporting both community and ecosystem resilience to climate change. Coastal wetlands, in particular, help protect nearby communities by buffering shorelines from erosion and reducing flood risks. They hold back floodwaters and slow the rate at which water flows into downstream waterbodies. As sea levels rise, coastal wetlands may naturally adapt by migrating inland. However, when coastal development prevents this migration, wetlands can be lost, also known as "coastal squeeze." This phenomenon poses a significant risk to low-lying coastal areas, including parts of Kitsap County, as identified in the *Kitsap County Climate Change Resiliency Assessment*) Wetlands are dynamic, highly productive ecosystems that provide vital services, including water quality improvement, hydrologic regulation, and critical habitat. Like riparian corridors, they also help regulate microclimates, offering localized cooling and providing refuge for species affected by rising temperatures. Wetlands serve as movement corridors for species shifting their ranges due to climate impacts, and they offer refuge for moisture-dependent species during drought conditions (ASWM 2015).

Wetlands also play a significant role in carbon storage, helping to mitigate climate change. They sequester carbon both in organic soils and vegetation. Undisturbed wetlands store about twice as much carbon as those degraded by human activities (Nahlik and Fennessy 2016). Bogs, in particular, are notable carbon sinks but are highly sensitive to disturbances, especially changes in stormwater input and pH levels.

Wetlands offer numerous ecological and economic benefits, including flood control, contaminant filtration, groundwater recharge, fish and wildlife habitat, and recreational opportunities (KCDCD, 2017). However, climate-induced changes in wetland composition and biodiversity can reduce available habitat and negatively affect groundwater recharge, thereby impacting Bremerton's water resources.

Climate change is expected to alter hydrologic patterns and increase temperatures, which may affect wetland hydroperiods—the seasonal patterns of saturation or inundation. Some wetlands may experience increased ponding, while others may dry up or lose their seasonal characteristics altogether (Halabisky 2017, Ecology n.d.).

As outlined in *Appendix B: Bremerton Climate Impacts* of the *Kitsap County Climate Change Resiliency Assessment* (Kitsap County 2020), higher evaporation rates and declining water quality due to climate change could reduce the extent of wetlands and threaten amphibian populations. These cold-blooded species are especially vulnerable to rising water temperatures (Mauger et al. 2015). Declines in amphibian populations could have cascading effects on downstream ecosystems and local food webs.

Although wetlands are inherently adaptable, their capacity to respond to rapid environmental changes is limited. Altered stormwater runoff and disruptions to seasonal hydrology may impair the ability of wetland soils and vegetation to retain, process, and sequester pollutants (EPA 2015). Climate change is also shifting native plant species distributions. Research continues into the adaptive capacity and climate tolerance of these species (Vose et al. 2012).

2.4.1 Strategies to Manage Climate Change Impacts on Wetlands

Current wetland protection standards from Ecology (2022) adopt a moderate-risk approach, meaning there is a possibility of moderate impacts on wetland functions when these standards, primarily focused on buffers, are applied. The Best Available Science (BAS) review indicates that wetlands are highly valuable for supporting anadromous fish and enhancing climate resilience, yet they remain vulnerable to the effects of climate change.

The City may consider implementing the following additional strategies for managing wetland resources:

- Create and maintain a comprehensive database of wetlands within the city.
- Identify wetlands that may be at risk from climate change effects, particularly those where surface water is the primary source of hydrology.
- Incorporate climate resiliency into mitigation planning, which includes:

- Assessing the potential loss of wetland functions in relation to climate change during the mitigation process.
- Planning for climate change impacts when developing mitigation and restoration plans. This may involve considering a wider range of hydrologic conditions and avoiding or limiting the use of plant species that are predicted to be susceptible to climate change stresses and pests.
- Considering assisted migration for the selection of native seed sources from areas more adapted to future climate conditions.
- Require applicants to document compliance with all applicable local, state, and federal permit requirements.

3. CRITICAL AQUIFER RECHARGE AREAS

3.1 Definitions

Critical aquifer recharge areas (CARAs) are defined in WAC 365-190-030(3) as follows:

> *Critical aquifer recharge areas are areas with a critical recharging effect on aquifers used for potable water, including areas where an aquifer that is a source of drinking water is vulnerable to contamination that would affect the potability of the water, or is susceptible to reduced recharge.*

BMC 20.14.200 defines "Critical aquifer recharge area" as areas determined to have a critical recharging effect on aquifers used for potable water, as classified per BMC 20.14.420.

3.2 Functions and Values

The goal of establishing CARAs is to protect the functions and values of a community’s drinking water by preventing pollution and maintaining the supply. RCW 36.70A.172 requires counties and cities to incorporate the BAS in developing policies and regulations to protect critical areas' functions and values. Counties and cities must also consider conservation or protection measures necessary to preserve or enhance anadromous fisheries (Ecology 2021a). Since groundwater is an important component of stream flow, it is essential to maintain the groundwater supply for streams to protect salmon and other anadromous species. Groundwater conditions can also influence geologic hazards, including flooding, landslides, and erosion hazards.

Groundwater quantity is essential for providing potable water and supporting ecological processes dependent on groundwater, both of which can be affected by land use and human activities. While aquifer recharge areas replenish groundwater supplies, they can also serve as a conduit for introducing contaminants to groundwater. Vulnerability to public water supply is primarily influenced by two main factors: the history of contamination loading and the hydrogeologic susceptibility of the aquifer (Washington Department Health 2017).

Aquifer water levels are determined by the balance between recharge, storage, and discharge. Recharge areas are usually at higher elevations than discharge areas, although subsurface conditions can alter this pattern (Driscoll 1986). Recharge can occur from sources such as rainfall, snowmelt, lakes, rivers, streams, and wetlands, while discharge happens when water exits the aquifer to surface bodies like springs and streams.

Land use changes, such as replacing forests with urban development, can reduce aquifer recharge and increase runoff. However, some practices may enhance recharge, such as when homes discharge water from a river into septic systems, potentially increasing aquifer levels while also posing contamination risks (Dunne and Leopold 1978; Winter 1998).

The City of Bremerton is situated in the Kitsap Water Resources Inventory Area (WRIA 15). The Streamflow Restoration Law (RCW 90.94) mandates the Department of Ecology to develop and adopt Watershed Restoration and Enhancement Plans, commonly referred to as watershed plans. The Kitsap (WRIA 15) Watershed Plan assesses the potential consumptive impacts of new permit-exempt domestic groundwater withdrawals on instream flows over a 20-year period (2018-2038) and identifies projects and actions to mitigate those impacts while providing net ecological benefits to the watershed (WRIA 15) (Ecology 2024).

This watershed plan projects an increase of 5,215 new permit-exempt domestic well connections (PE wells) during the planning horizon (2018-2038). The estimated consumptive water use associated with these new PE wells is 717.8 acre-feet per year (AFY), which translates to approximately 123 gallons per day per household in WRIA 15. The projects and actions outlined in this watershed plan aim to address and mitigate the consumptive water use from these 5,215 new PE wells. (Ecology 2024)

Importantly, the plan includes initiatives that are expected to provide an offset of 2,873.1 AFY to benefit streamflows and enhance the watershed. Additionally, other projects in the plan will contribute to improving fish and wildlife habitat through the restoration of floodplains and wetlands, as well as enhancements to riparian zones and nearshore areas.(Ecology 2024)

Per BMC 20.14.420 Classification and Designation:

> *(a) Category I Critical Aquifer Recharge Areas. Category I critical aquifer recharge areas are those areas where potential for certain land use activities to adversely affect groundwater is high. Category I critical aquifer recharge areas include:*
>
> > *(1) Areas inside the five (5) year time-of-travel zone for Group A water system wells, calculated in accordance with the Washington State Source Water Assessment Program.*
> >
> > *(2) Ten (10) year time-of-travel zones in wellhead protection areas are included as critical aquifer recharge when a well draws its water from an aquifer that is at or above sea level and is without an overlying protective impermeable layer.*

(3) Areas identified as regionally significant aquifer recharge areas and identified as such by the City are:

(i) Gorst Basin Aquifer recharge area, and

(ii) Other areas that may be identified in the future.

(b) Category II Critical Aquifer Recharge Areas. Category II critical aquifer recharge areas are areas that provide recharge to aquifers that are current or potentially will become potable water supplies and are vulnerable to contamination based on the type of land use activity. These include the following:

(1) Highly Permeable Soils (Group A Hydrologic Soils). The general location and characteristics of Group A hydrologic soils in the City is given in the Soils Survey of Kitsap County by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). The soil survey information is available at the Department of Community Development.

(2) Areas Above Shallow/Vashon Principal Aquifers. Surface areas above shallow, principal aquifer(s) which are not separated from the underlying aquifers by an impermeable layer that provides adequate protections to preclude the proposed land use from contaminating the shallow aquifer(s) below, are considered aquifer recharge areas of concern. (Ord. 5301 §3 (Exh. B) (part), 2016: Ord. 4965 §7 (part), 2006)

Type I CARAs mapped in the City of Bremerton are shown in Figure 2 below.

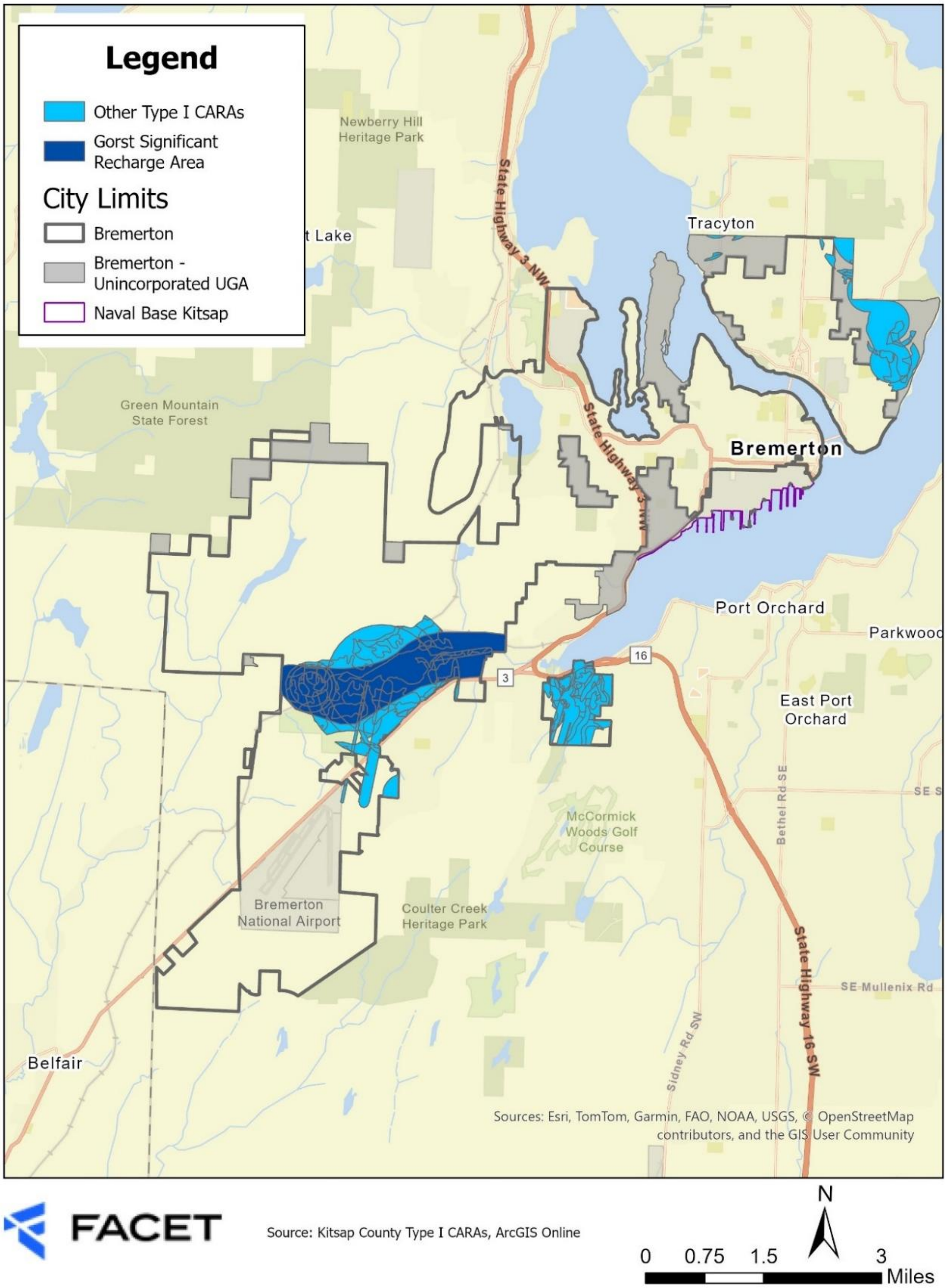

Figure 2. Type I CARAs in the City of Bremerton.

3.3 Key Protection Strategies

The City of Bremerton regulations, including classification, prohibited activities, site assessment requirements, and mitigation for impacts, are specified in BMC 20.14.420-.450.

Key protection strategies for CARAs are based on identifying and protecting CARAs through regulations and educational community outreach. The 2021 Ecology CARA Guidance recommends the following eight steps to characterize and protect CARAs in a local community (Ecology 2021a). Many recommendations have been addressed in the WRIA 15 Watershed Restoration and Enhancement Plan.

1. *Identify where groundwater resources are located.*
2. *Analyze the susceptibility of the natural setting where groundwater occurs.*
3. *Inventory existing potential sources of groundwater contamination.*
4. *Classify the relative vulnerability of groundwater to contamination events.*
5. *Designate areas that are at risk of contamination events.*
6. *Protect by minimizing activities and conditions that pose contamination risks.*
7. *Ensure that contamination prevention plans and best management practices (BMPs) are implemented and followed. Review BMPs for infiltration designs with water quality treatment. Stormwater control usually affects the vadose zone and seasonal water tables with low risk to deeper water supply aquifers. Some exceptions are those glacial outwash plains with extensive deposits of coarse gravels near the surface.*
8. *Manage groundwater withdrawals and recharge impacts to maintain availability for drinking water sources and maintain stream base flow from groundwater to support in-stream flows, especially for salmon-bearing streams.*

Watershed planning is recommended to maintain in-stream flow as required by the 2018 Streamflow Restoration Act and for water supply planning under the 1998 Watershed Planning Act (Ecology 2021). In addition, remediation of contaminated sites and groundwater and treatment of existing sources of pollution should be a primary focus for the City of Bremerton. Implementing the WRIA 15 Watershed Restoration and Enhancement Plan will help ensure these requirements and guidelines are met.

3.4 Climate Change Effects

Climate change impacts on surface and groundwater quality and quantity based on regional trends are summarized below.

- Hotter, drier summers will reduce ground surface saturation during the growing season. This is likely to reduce wetland areas and the groundwater recharge they provide.
- Changes to seasonal precipitation patterns are likely to reduce groundwater recharge. This would reduce stream flows that are supported, in part, by groundwater.

- Wildfires will bring more particulates into the environment and settle into surface and groundwater.
- Increased winter flooding increases the likelihood of overwhelming stormwater treatment facilities and flooding roads, which may transport contaminants into surface water, including local streams and wetlands.

Changes to surface water inputs will alter the timing, frequency, and duration of surface water presence are projected to alter hydrologic patterns. Altered hydrology is projected to include earlier peak stream flows, increased frequency and extent of flooding, and reduced summer flows (Mauger et al. 2015).

However, groundwater is likely to be more resilient under climate change stressors relative to surface water resources (EPA 2015). Ecology notes in their *Draft Critical Aquifer Recharge Areas Guidance* that groundwater impacts may occur with climate change. The primary stressors noted are changes in the timing and amount of groundwater recharge, and increased pressure to use groundwater as surface water conditions change. Ecology recommends focusing on water conservation (2021a).

Population growth also presents challenges for protecting critical aquifer recharge areas as land use intensity increases (Ecology 2021a). For example, multi-year droughts can increase reliance on groundwater sources, lead to reductions in groundwater tables, aquifer depletion, and potentially result in saltwater intrusion (Asinas et al. 2022a).

According to the *Kitsap County Climate Change Resiliency Assessment* (Kitsap County 2020), many public water systems in Kitsap County serve at least 25 people or have 15 or more connections with only a single water source with no back-up supply. Communities that are reliant on single-source systems may have increased vulnerability to future water shortages or water quality degradation (May et al. 2018).

3.4.1 Strategies to Manage Climate Change Impacts on CARAs

The following are general BAS-supported strategies to minimize climate change impacts on CARAs that may be applicable for WHPA management in the City of Bremerton

- Ecology recommends understanding water resources, tracking water levels and recharge sources, and focusing on water conservation as a strategy to plan for climate change impacts (Ecology 2021b).
- Manage stormwater to maintain groundwater recharge in CARAs. Utilize a 20-year planning horizon to manage supply and demand, given climate trends and projections (Asinas et al. 2022b).
- Design stormwater systems to better mimic natural systems and mitigate some of the functions lost elsewhere in the landscape due to changes in surface and groundwater inputs. For example, the use of roadside bioswales may be expanded. Stormwater treatment capacity may be increased as needed to protect water quality and manage water quantity.
- Planning and implementing flood mitigation strategies can reduce the likelihood of contaminated runoff events.

- Promote and incentivize low-impact development, specifically infiltration of clean runoff to support aquifer recharge.

4. FREQUENTLY FLOODED AREAS

4.1 Definitions

Frequently flooded areas (FFAs) are defined in WAC 365-190-030(8) as follows:

> *Frequently flooded areas are lands in the flood plain subject to at least a one percent or greater chance of flooding in any given year, or within areas subject to flooding due to high groundwater. These areas include, but are not limited to, streams, rivers, lakes, coastal areas, wetlands, and areas where high groundwater forms ponds on the ground surface.*

BMC 20.14.200 defines "Frequently flooded areas" as lands in the floodplain subject to a one (1) percent or greater chance of flooding in any given year and those lands that provide important flood storage, conveyance, and attenuation functions, as determined by the Director in accordance with WAC 365-190-080(3). Frequently flooded areas perform important hydrologic functions and may present a risk to persons and property. Classifications of frequently flooded areas include, at a minimum, the one hundred (100) year floodplain designations of the Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP).

4.2 Functions and Values

Floods are natural events that can lead to property destruction and loss of life, but they also play a crucial role in sustaining river systems. Floods typically occur after significant storm events, but they can also result from the release of impounded water due to dam or levee failures, or activities like beaver dam construction. Floodplains and floodplain complexes (FFAs) are dynamic and ecologically productive environments that provide essential habitats for fish and wildlife. They are vital components of watershed processes, including:

- Floodwater storage and conveyance
- Nutrient and sediment deposition
- Mobilization of large woody debris

For centuries, floodplains have been directly impacted by agriculture, residential development, and urbanization, as these geographic areas are often well-suited for development during periods between floods. They have also experienced indirect impacts from similar watershed-scale land use changes. The increase in impervious surfaces and deforestation has heightened the magnitude and frequency of flooding (Booth et al. 2004). In turn, these increased flooding events present greater risks to people and infrastructure within floodplains.

Historically, efforts to mitigate floodplain risks have sometimes worsened downstream flood impacts and harmed fish and wildlife habitats. Examples of such mitigation efforts include channel straightening, armoring, the construction of dikes and levees, and floodplain filling. Landscape-level assessments show that patterns of urban development, particularly the area and distribution of impervious surfaces, influence watershed functions (Alberti et al. 2006). These effects can lead to stream channel downcutting, a process linked to watersheds with frequent and short-duration high peak flows. This downcutting further disconnects floodplains, increases in-stream erosion, and deposits sediment in downstream areas, leading to blocked culverts (Booth 1990). Stream incision can also disrupt surface and groundwater interactions, potentially resulting in lower water table levels (Petralia 2022).

Extreme floods have both positive and negative impacts on stream health. Negative effects include physical trauma and stress to aquatic organisms, displacement or stranding of species, erosion and sedimentation, loss of vegetation, pollution, disruptions to food webs and spawning, and interrupted migration patterns. Consequently, extreme floods have been shown to reduce fish densities (Milner et al. 2013). However, some studies indicate that fish populations can be resilient to flood impacts at a basin scale and often recover quickly (George et al. 2015). Potential positive effects of flooding include the creation of new habitats and the redistribution of nutrients (Peters et al. 2015).

Flooding can lead to substantial economic costs due to damaged homes and infrastructure, business interruptions, and loss of life. The human and societal costs of flooding have risen over time, driven by an increasing population and infrastructure in floodplains, as well as climate change.

In 2008, the National Marine Fisheries Service (NMFS) issued a Biological Opinion under Section 7 of the Endangered Species Act, stating that the implementation of the National Flood Insurance program could have adverse effects on threatened and endangered species.

4.3 Key Protection Strategies

4.3.1 Identification and Classification

The Federal Emergency Management Agency (FEMA) maintains and updates flood maps, called Flood Insurance Rate Maps (FIRM). FEMA flood maps include any place considered to have a high risk of flooding, which is a one percent chance of flooding each year or higher. FEMA maps are based on past flood events and do not include sea level rise or other climate impacts (Commerce 2023).

4.3.2 Management Resources and Standards

The National Flood Insurance Program (NFIP), which is administered by FEMA, establishes basic building standards designed to protect floodplain ecological functions, buildings, infrastructure, and people from flood risk. These standards represent the minimum requirements, and local jurisdictions have the option to implement stricter standards to further mitigate risks (Commerce 2023).

In the Puget Sound region, the implementation of the NFIP poses risks to the continued existence of federally threatened salmonids and resident killer whales. In response, the NMFS has established

Reasonable and Prudent Alternatives to ensure that development within the Special Flood Hazard Area (100-year floodplain), floodway, Channel Migration Zone (CMZ), and riparian buffer zones does not negatively impact water quality, flood volumes, flood velocities, spawning substrate, or floodplain refugia for listed salmonids.

FEMA oversees the NFIP, but the responsibility for implementing floodplain management ordinances falls to local jurisdictions. These jurisdictions are tasked with ensuring that development activities do not harm listed species. Projects located within FEMA-designated floodplains must conduct habitat assessments to evaluate their potential effects on federally listed endangered species. Specifically, it is crucial that floodplain storage volumes remain unchanged and that base flood elevation levels are not increased.

FEMA flood zones are not currently mapped within the City of Bremerton. (Figure 3)

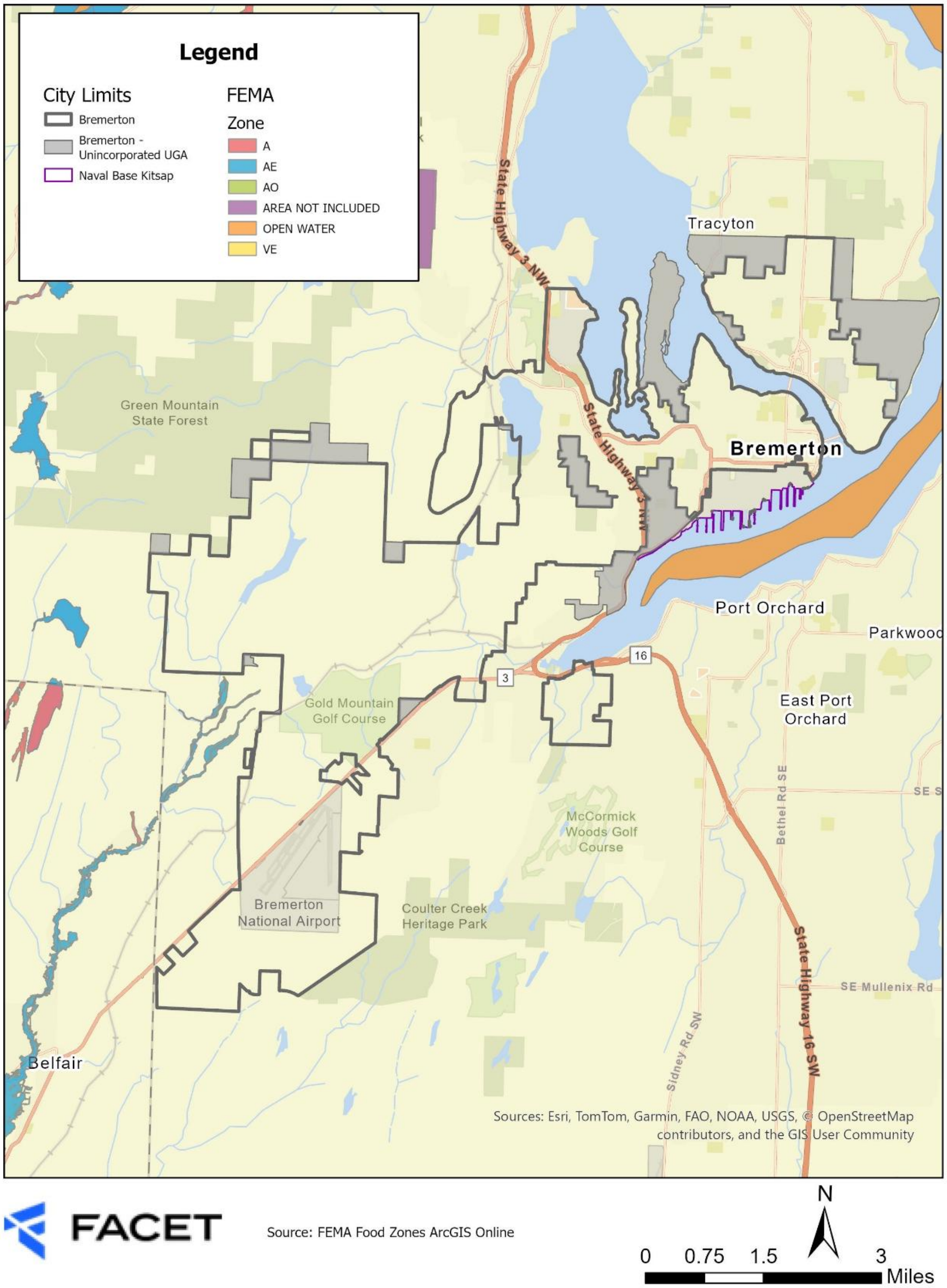

Figure 3. FEMA Flood Zones in City of Bremerton.

4.4 Climate Change Effects

Seasonal changes in the Pacific Northwest are projected to entail wetter autumns and winters and drier summers (Mote and Salanthe, 2010). Increased precipitation in autumn and winter with climate change will increase the frequency of flood events in any given year (W. D. Ecology 2024). The projected increases in extreme precipitation and flooding will increase the risk of interruptions to transit, food systems, ecosystems, and municipal operations while damaging structures and critical infrastructure located in or adjacent to the currently designated floodplains.

Flooding is the most repetitive and damaging natural hazard in Kitsap County (Kitsap County 2025). Bremerton has had 5 flood insurance claims with an estimated flood insurance coverage of $15 million (dollar year not reported) through FEMA's National Flood Insurance Program (Kitsap County 2025). Coastal cities and adjacent areas of the county are anticipated to experience risk to their infrastructure and structures, worth approximately $13.4 million (Kitsap County 2020). Future risk of flooding is anticipated to increase in urban areas because of increasing heavy rains, sea level rise, and storm surges. This flooding activity may overwhelm existing stormwater and wastewater infrastructure capacity (Kitsap County 2020b).

As described in the *Kitsap County Climate Change Resiliency Assessment* (Kitsap County 2020), sea level rise projections indicate a 51% and a 98% risk of at least one flood over four (4) feet occurring in Kitsap County between 2020 and 2050 under low and high emissions scenarios, respectively (Climate Central 2016). Two square miles of land are projected to be at risk of being impacted by a flood exceeding four feet in Kitsap County. Within those two square miles, there are 1,521 individuals, 940 homes, ten miles of public roads, and an estimated property value of over $300 million (Climate Central 2016). These impacts are projected to increase in severity under higher emissions scenarios. Increased flooding may increase sediment transport in winter and spring (Mauger et al. 2015). Extreme flood events may negatively impact instream habitats by mobilizing sediment and pollutants (Talbot et al. 2018).

Federal Emergency Management Agency (FEMA) maps play a central role in the County's approach to protecting frequently flooded areas. However, these maps cover less than half the frequently flooded areas in the county, are currently based only on past flood events, and do not consider future flood risk. These maps do not consider sea level rise, other climate change impacts, or channel migration zones (Commerce 2023).

To integrate climate change into flood risk management in Washington State, an interagency group called the Washington Silver Jackets was formed. This group works to develop improved estimates of future flooding, develop resources for local planners, build capacity and coordinate on resiliency, improve public engagement, and coordinate floodplain management goals (Mauger and Kennard 2017).

Evaluations specific to Kitsap County to anticipate precipitation and flooding increases will inform strategic land use planning to mitigate climate change impacts and risks (Bell et al. 2016). As described in the *Comprehensive Emergency Management Plan* (Kitsap County 2025), the installation of rain gauges throughout Kitsap County has provided improved information on water tables, droughts, and rainfall data to inform future mitigation strategies.

4.4.1 Strategies to Manage Climate Change Impacts on FFAs

The Washington Silver Jackets is an interagency group formed in 2010 to plan and manage flood risks. This group works to develop improved estimates of future flooding, develop resources for local planners, build capacity and coordinate on resiliency, improve public engagement, and coordinate floodplain management goals (Mauger & Kennard, 2017). The University of Washington Climate Impacts Group has collaborated with the Washington Silver Jackets to integrate climate change predictions and impacts into flood management planning efforts. This resulted in the development of the report: *Integrating Climate Resilience in Flood Risk Management: a Work Plan for the Washington Silver Jackets Team,* which provides a framework for strategic management (Mauger & Kennard 2017).

- Develop improved estimates of future flood impacts (Mauger & Kennard 2017).
- Develop resources for local planners (Mauger & Kennard 2017).
- Build capacity and coordination on resilient floodplain management (Mauger & Kennard 2017).
- Improve public engagement (Mauger & Kennard 2017).
- Coordinate floodplain goals and management (Mauger & Kennard 2017).
- Maintain and update Comprehensive Flood Hazard Management Plan (CFHMP) and Shoreline Master Program (SMP) to support stormwater management, salmonid habitat, and streamflow planning (Ecology 2021a).
- Implement and enforce Kitsap County and Washington State laws and policies regarding flood prevention during permitting and development.
- Encourage and incentivize restoration actions to restore floodplain connectivity to streams and wetlands and protect or restore riparian corridors to maintain the microclimate.
- Utilize the FEMA Climate Resiliency approach to support flood hazard management planning and follow grant funding opportunities.
- Refine topographic floodplain analysis to identify potential changes in floodplain extents.
- Address HRDAs by limiting development and installing recommended stormwater drainage.

5. GEOLOGICALLY HAZARDOUS AREAS

5.1 Hazard Characterization

Geologically hazardous areas are defined by Washington State as “areas that, because of their susceptibility to erosion, sliding, earthquake, or other geological events, are not suited to the siting of commercial, residential, or industrial development consistent with public health or safety concerns” (WAC 365-190-030). The four main types of geologically hazardous areas are erosion hazard areas, landslide hazard areas, seismic hazard areas, and areas subject to other geologic events such as coal mine hazards and volcanic hazards (WAC 365-190-120).

BMC 20.14.200 defines "Geologically hazardous areas" as areas that may not be suited to development consistent with public health, safety, or environmental standards, because of their steep slopes, susceptibility to erosion, sliding, earthquakes, or other geological events. For the purposes of this code, "geologically hazardous areas" are those areas receiving high or moderate geologically hazardous classifications per BMC 20.14.600 through 20.14.660.

5.1.1 Erosion Hazard Areas

Washington State defines erosion hazard areas according to WAC 365-190-030(5) as follows:

> *"Erosion hazard areas" are those areas containing soils which, according to the United States Department of Agriculture Natural Resources Conservation Service Soil Survey Program, may experience significant erosion. Erosion hazard areas also include coastal erosion-prone areas and channel migration zones.*

Furthermore, according to WAC 365-190-120(5), "erosion hazard areas include areas likely to become unstable, such as bluffs, steep slopes, and areas with unconsolidated soils."

BMC 20.14.200 does not currently define erosion hazard areas.

Landslide hazard areas are defined as "areas at risk of mass movement due to a combination of geologic, topographic, and hydrologic factors," under WAC 365-190-030(10).

In addition, according to WAC 365-190-120(6):

> *They include any areas susceptible to landslide because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors, and include, at a minimum, the following:*
>
> *(a) Areas of historic failures, such as:*
> - *(i) Those areas delineated by the United States Department of Agriculture Natural Resources Conservation Service as having a significant limitation for building site development;*
> - *(ii) Those coastal areas mapped as class u (unstable), uos (unstable old slides), and urs (unstable recent slides) in the department of ecology Washington coastal atlas; or*
> - *(iii) Areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the United States Geological Survey or Washington department of natural resources.*
>
> *(b) Areas with all three of the following characteristics:*
> - *(i) Slopes steeper than 15 percent;*
> - *(ii) Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and*
> - *(iii) Springs or groundwater seepage.*
>
> *(c) Areas that have shown movement during the holocene epoch (from 10,000 years ago to the present) or which are underlain or covered by mass wastage debris of this epoch;*

(d) *Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials;*
(e) *Slopes having gradients steeper than 80 percent subject to rockfall during seismic shaking;*
(f) *Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action, including stream channel migration zones;*
(g) *Areas that show evidence of, or are at risk from snow avalanches;*
(h) *Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding; and*
(i) *Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of bedrock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least 10 feet of vertical relief.*

BMC 20.14.200 does not currently define landslide hazard area.

5.1.2 Seismic Hazard Areas

Washington State defines landslide hazard areas as "areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, debris flows, lahars, or tsunamis" under WAC 365-190-030(18). In addition, seismic hazard areas also include areas subject to severe risk of damage as a result of subsidence and surface faulting (WAC 365-190-120).

BMC 20.14.200 defines "Seismic hazard areas" means areas that are subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, or soil liquefaction.

The City of Bremerton falls within the Cascadia, Seattle, and Tacoma Seismic Scenarios as Very Strong and Severe Shaking Intensity, and numerous faults and folds are shown on the Department of Natural Resources (DNR) Geologic Information Portal for the area (Figure 4).

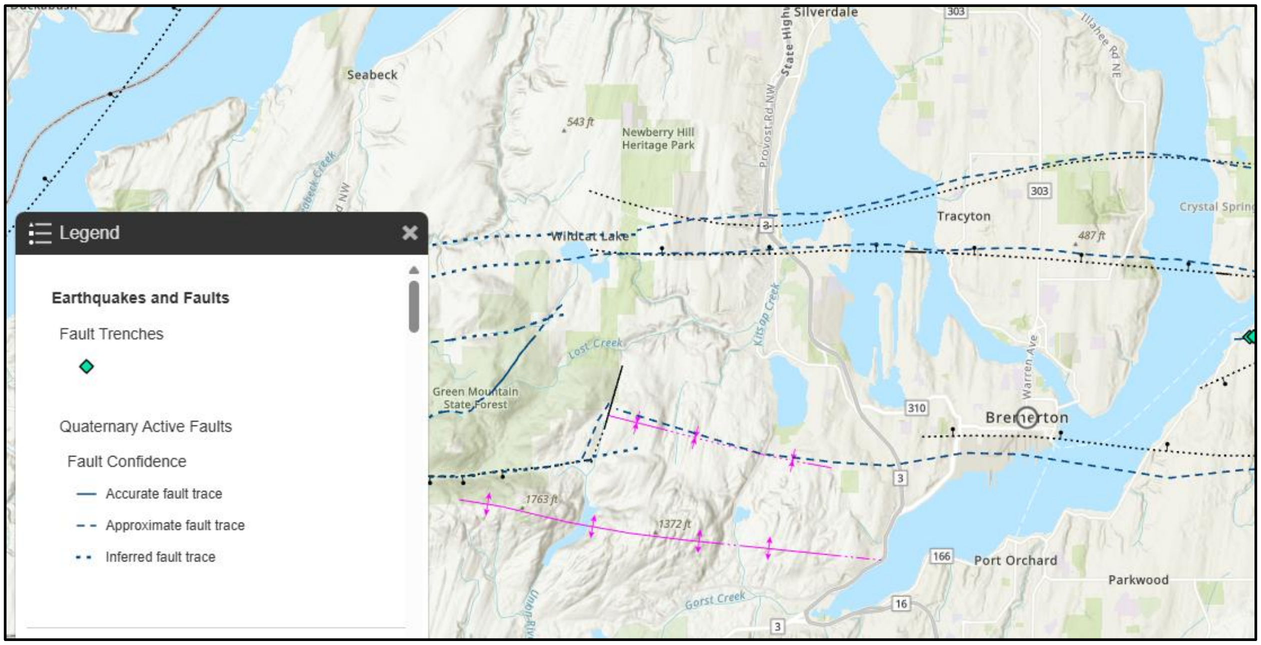

Figure 4. Faults and Folds in City of Bremerton (DNR Geologic Information Portal).

5.1.3 Tsunami hazard zone

Tsunamis are listed as a seismic hazard per WAC 365.190.120(7). DNR provides information regarding tsunamis and seiches[2]. DNR has mapped tsunami hazard zones within the City of Bremerton (Figure 6).

5.2 Key Protection Strategies

5.2.1 Identification and Classification

Landslides can be fast or slow, and deep or shallow, initiating from the bottom of a slope, the top of a slope, or somewhere in between. Areas prone to landslide, particularly along the shoreline in Bremerton, are commonly slopes comprised of relatively permeable materials, such as sand and gravel, over a less permeable material, such as bedrock or clay. The most common type of landslide in the

[2] A seiche is a standing wave that can form in enclosed bodies of water such as lakes, bays, and even swimming pools. When seismic waves shift shorelines during an earthquake, this movement pushes the water toward one side of the basin.

Puget Sound region occurs in response to either heavy precipitation (Tubbs 1974) or elevated groundwater conditions (Thorsen 1989) in colluvium derived from glacial deposits. Glacial deposits often result in surface layers that are more permeable than the deeper layers, causing water to perch at the contact between the two layers. The weight and increase in pore pressure from the water cause the upper layer to fail and slide over the deeper, more resistant layer.

Most coastal bluff retreat (top of the bluff recedes landward) within the Puget Sound occurs through landsliding, most of which are shallow landslides and debris avalanches. Large slumps and landslides are less common and seem to be associated with taller bluffs (Shipman 2004) and are triggered by elevated groundwater and seismic activity (Chleborad 2006). According to Shipman (2004), steeper slopes are more prone to failure due to increased gravitational stresses. However, due to the heterogeneous nature of bluff geology in the Puget Sound lowlands, variability in hydrologic conditions and rock strengths make landslides difficult to predict.

Bremerton has had 6 landslides, representing 3.4% of landslides in the County, affecting 1.1 square miles (Kitsap County 2020). Approximately 1,800 people, or about 4.8% of Bremerton's population, live in landslide hazard areas. Additionally, about 4.5% of Bremerton's building stock, or 625 structures, and 64 critical facilities are located within the landslide hazard area.

Activities associated with urban development, including vegetation removal and increased impervious surfaces, can increase the landslide hazard of susceptible areas. Vegetation plays a significant role in landslide potential by intercepting a substantial amount of rainfall, preventing it from infiltrating into the soil. Roots from vegetation also take up and transpire some of the water that does reach the soil (Watson and Burnett 1995). This reduces the amount of water that rests at the contact between the permeable and impermeable layers. A dense matrix of roots can also lend considerable strength to the soil on a slope (Schmidt et al. 2001), decreasing the likelihood of slope failure and shallow-rapid landslides.

Geologic hazard areas mapped in the City of Bremerton are presented in Figure 5. Tsunami hazard areas mapped by DNR via the Washington Geologic Information Portal[3] are presented in Figure 6.

[3] https://dnr.wa.gov/washington-geological-survey/geologic-hazards-and-environment/geologic-hazard-maps

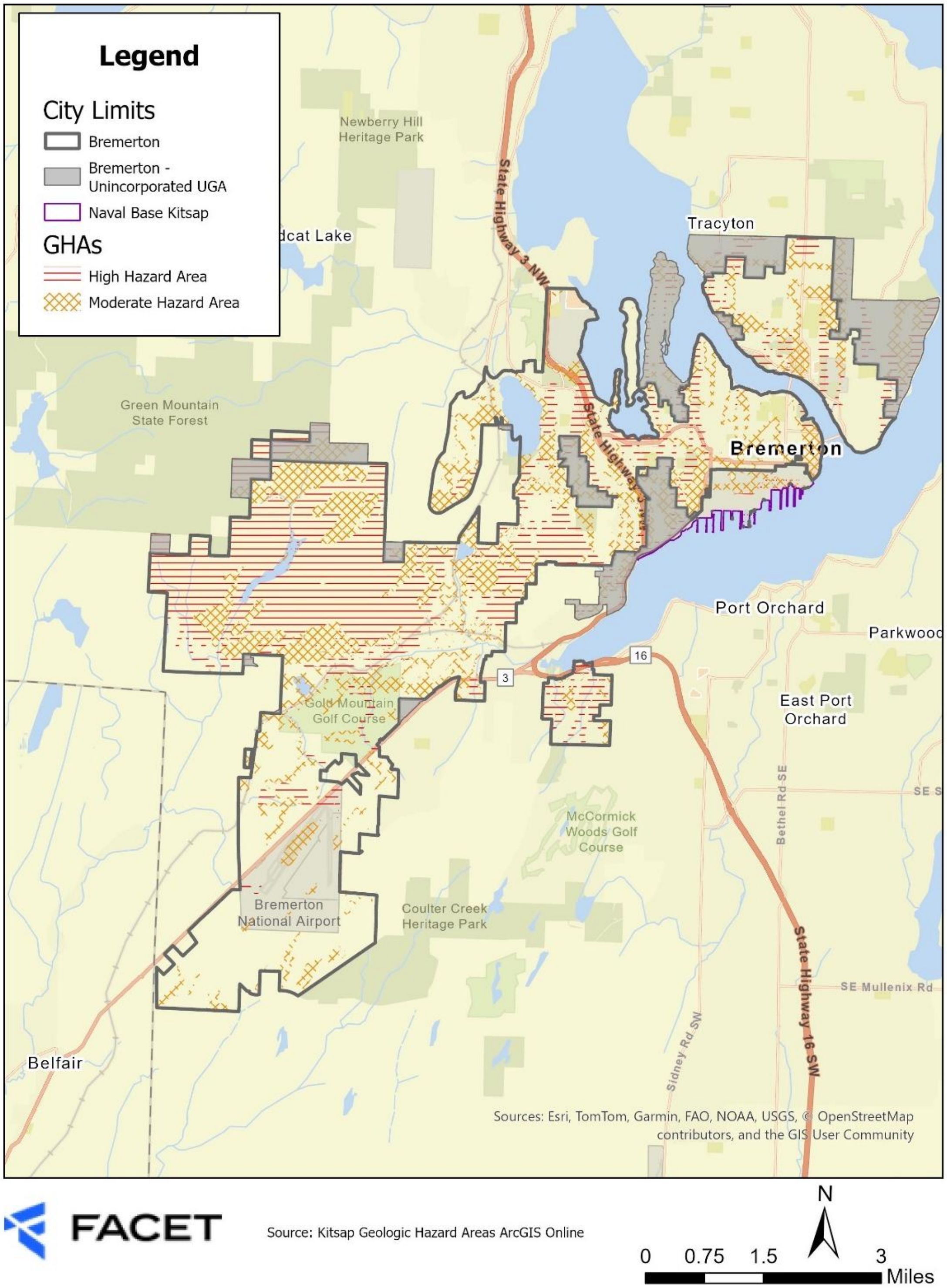

Figure 5. Geologic Hazard Areas in City of Bremerton.

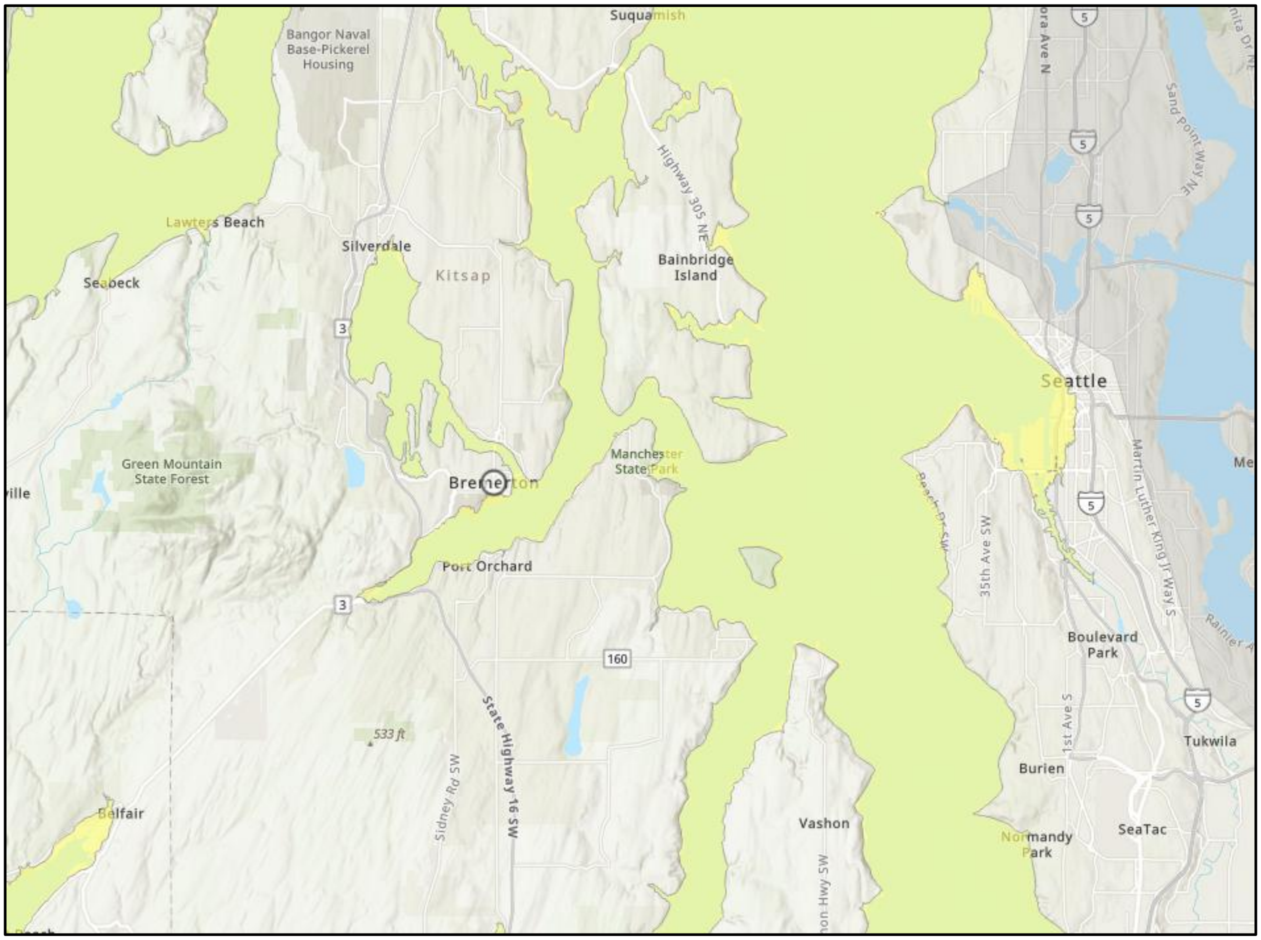

Figure 6. Tsunami hazard areas (DNR Geologic Information Portal) (green overlay indicates mapped Tsunami hazard areas).

5.2.2 Management Resources and Standards

The primary goal of protection measures for geological hazards is to safeguard people and property. Risk management occurs during the planning and development phases to minimize risks by limiting occupancy and development in areas prone to geological hazards. The risks associated with development in these hazardous areas are assessed using classification systems, which inform site-specific development restrictions and requirements.

One effective strategy for managing risk is to establish protective buffers around geological hazard areas to restrict development. In the case of development in areas susceptible to erosion or landslides, it is essential to implement design and construction standards that maintain slope stability and ensure that the development is resilient to potential hazards. Any development occurring within the hazard area or its buffer should be evaluated on a site-specific basis by a licensed geotechnical engineer or engineering geologist. The methods employed in site studies must adhere to best professional standards and should include subsurface exploration and soil testing at an appropriate frequency as needed.

While the general approach is to avoid disturbing geological hazard areas, WAC 365-190-120(2) states, "*Some geological hazards can be mitigated by engineering, design, or modified construction or mining practices so that risks to health and safety are acceptable*."

Following the Oso landslide in March 2014, the SR-530 Landslide Commission identified additional protection strategies. Recommendations from the commission include integrating and funding Washington's emergency management system, supporting a statewide landslide hazard and risk mapping program, establishing a geologic hazards resilience institute, conducting landslide investigations, and enhancing public awareness of geological hazards (Landslide Commission 2014). To improve landslide hazard and risk mapping, collaboration among agencies and landowners is advised, along with risk prioritization and the use of lidar mapping and GIS database tools.

According to the SR-530 Landslide Commission's findings from 2014, updates to critical area regulations are recommended to better identify and regulate land uses in geological hazard areas. As noted in the 2016 BAS Review, the Landslide Commission's final report recommends identifying "critical area buffer widths based on site-specific geotechnical studies" as an innovative development regulation that counties and cities should adopt (Landslide Commission 2014).

Seismic hazards can be managed by applying earthquake-resistant building standards in at-risk areas. The Washington State Building Code (WAC 51-50) provides guidance based on the 2018 International Building Code, with amendments specific to the state, including several directly related to seismic standards.

5.3 Climate Change Effects

Geologically hazardous areas, particularly erosion hazard areas and landslide hazard areas, are prone to impacts from changing patterns in precipitation and associated stress on native trees and shrubs and groundcover plants. Climate change models project warmer, drier summers and increased precipitation in other seasons while maintaining roughly the same amount of annual precipitation (Dalton et al. 2013). This indicates that heavy rain will be more common outside of summer months. When the magnitude and frequency of rain events increase, it can over-saturate soils and contribute to instability. Rainfall intensity and duration are predictors for landslide events (Chleborad et al. 2006, DNR 2020). Extreme precipitation events modeled by the UW Climate Impacts Group (CIG) are expected to increase in intensity and frequency (Morgan and Gills 2021). If significant plant mortality occurs in dry summer periods, in conjunction with heavy rains, there will potentially be less vegetation rooted in hazard areas to stabilize them.

Coastal areas will also become more prone to erosion and landslides, coupled with increased precipitation intensity, sea level rise, and increased flood inundation of estuarine and riverine systems. As described in the *Kitsap County Climate Change Resilience Study* (Kitsap County 2020), sea levels in Bremerton have risen at a rate of approximately one inch every 12.3 years, and heavy rainfall event intensity increased by 50% since 1990 ((Kitsap County 2020). The cities of Bainbridge Island and Port Orchard have experienced similar precipitation and sea level rise impacts. Concurrently, sea level rise and increased riverine inundation could also increase tsunami inundation in the event of seismic activity.

5.3.1 Strategies to Manage Climate Change Impacts on Geologically Hazardous Areas

- Encourage or require climate-informed design for development and infrastructure in or near geologic hazard areas (DNR 2020).
- Require appropriate surface and groundwater management practices for development near coastal bluffs.
- Encourage utilization of soft shore protection strategies.
- Identify and prioritize geologic hazards within the City, then update mapping as needed using current practices such as LiDAR and GIS database tools.
- Keep in communication with the governor's office to ensure the City of Bremerton is included in statewide collaborative efforts to manage geologic hazard areas.
- Manage vegetation for climate resilience and slope stability.

6. FISH AND WILDLIFE HABITAT CONSERVATION AREAS

6.1 Definition

Washington State defines fish and wildlife habitat conservation areas (FWHCAs) in WAC 365-190-030(6) as follows:

(a) "Fish and wildlife habitat conservation areas" are areas that serve a critical role in sustaining needed habitats and species for the functional integrity of the ecosystem, and which, if altered, may reduce the likelihood that the species will persist over the long term. These areas may include, but are not limited to, rare or vulnerable ecological systems, communities, and habitat or habitat elements including seasonal ranges, breeding habitat, winter range, and movement corridors; and areas with high relative population density or species richness. Counties and cities may also designate locally important habitats and species.

(b) "Habitats of local importance" designated as fish and wildlife habitat conservation areas include those areas found to be locally important by counties and cities.

(c) "Fish and wildlife habitat conservation areas" does not include such artificial features or constructs as irrigation delivery systems, irrigation infrastructure, irrigation canals, or drainage ditches that lie within the boundaries of, and are maintained by, a port district or an irrigation district or company.

The following FWHCAs must be considered for classification and designation (WAC 365-190-130):

(a) Areas where endangered, threatened, and sensitive species have a primary association;
(b) Habitats and species of local importance, as determined locally;
(c) Commercial and recreational shellfish areas;
(d) Kelp and eelgrass beds; herring, smelt, and other forage fish spawning areas;
(e) Naturally occurring ponds under 20 acres and their submerged aquatic beds that provide fish or wildlife habitat;
(f) Waters of the state;
(g) Lakes, ponds, streams, and rivers planted with game fish by a governmental or tribal entity; and
(h) State natural area preserves, natural resource conservation areas, and state wildlife areas.

BMC 20.14.200 defines "Fish and wildlife habitat conservation areas" as areas necessary for maintaining species in suitable habitats within their natural geographic distribution so that the habitat available is sufficient to support viable populations over the long term, and isolated subpopulations are not created, as designated by WAC 365-190-130. These areas include:

A. Areas with which state or federally designated endangered, threatened, and sensitive species have a primary association;
B. Priority habitat species and species of local importance, including, but not limited to, areas designated as priority habitat by the Washington Department of Fish and Wildlife;
C. Streams and watercourses used by juvenile salmonids, and habitat of species essential to the juvenile salmonid diet;
D. Commercial and recreational shellfish areas;
E. Kelp, eelgrass beds, herring, smelt, sandlance, and other forage fish spawning habitat;
F. Naturally occurring ponds under twenty (20) acres and their submerged aquatic beds that provide fish or wildlife habitat, including those artificial ponds intentionally created from dry areas in order to mitigate impacts to ponds;
G. Waters of the state, including lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and watercourses within the jurisdiction of the State of Washington;
H. Lakes, ponds, streams, and rivers planted with game fish by a governmental or tribal entity;
I. State natural area preserves and natural resource conservation areas; and
J. Land essential for preserving connections between habitat blocks and open spaces.

6.2 Functions and Values

FWHCA functions include the biological, chemical, and physical habitat conditions and processes that affect wildlife. Since wildlife may include all species, from the largest megafauna to microorganisms, these functions encompass a complex web of interacting ecological processes. At the highest level, FWHCAs function to provide wildlife with suitable habitat. They also provide communities with sources of food and materials for consumptive and productive uses. Additionally, they are valued for a range of non-consumptive cultural, social, and economic benefits (Chardonnet et al. 2002).

6.2.1 Streams, Lakes and Ponds, and Riparian Areas

Streams, lakes, ponds, and their associated riparian areas provide critical habitat for a diverse array of wildlife species. They also provide various landscape and ecosystem functions. Commonly recognized functions and processes that influence the habitat conditions within aquatic FWHCA types are outlined below.

Water Quality

- Fish and other wildlife, like amphibians, require cool, clean water to meet their life history needs.
    - Riparian vegetation influences stream temperatures and microclimate conditions such as air temperature, wind, light, and moisture. Factors affecting water temperature and microclimate include shade, orientation, relative humidity, ambient air temperature, wind, channel dimensions, groundwater, hyporheic exchange, and overhead cover (Quinn et al. 2020).
    - Salmonids have been studied frequently due to their cultural and economic importance, relative sensitivity to high temperatures, and narrow thermal tolerance (Quinn et al. 2020). Amphibians also have narrow thermal tolerances, and they are particularly sensitive to changes in microclimate conditions (Bury 2008).

Hydrologic

- Streams, lakes, and ponds may have complex and extensive connections to other surface waters and groundwater resources in a watershed.
    - Hydrologic forces move material downstream.
- Fish and wildlife are adapted to, and in some instances reliant upon, the natural variability in seasonal and flood flows within a system.
- Riparian vegetation reduces the quantity of surface water runoff through rainwater capture and evapotranspiration (Wynn and Mostaghimi 2007).
- Floodplains, wetlands, and sinuous stream channels attenuate flood flows, which protects downstream areas from flooding.

Physical Habitat Characteristics

- Riparian microclimate affects many ecological processes and functions, including plant growth, decomposition, nutrient cycling, succession, productivity, migration and dispersal of flying insects, soil microbe activity, and fish and amphibian habitat (Brosofske et al. 1997).
- Large woody debris plays a significant role in the geomorphic formation of stream channels and in the creation of diverse channel habitat morphologies (Quinn et al. 2020)
- Streams migrate naturally, which often results in complex natural geomorphology, floodplains, and heterogeneous ecosystems.

- Bank stability is influenced by factors such as bank material, hydraulic forces, and vegetation (Ott 2000).

- Beaver dams incorporate both small and large wood, and serve to slow water, retain sediment, and create pools and off-channel ponds used by rearing coho salmon and cutthroat trout (Pollock et al. 2004; Naiman et al. 1988).

6.2.1.1 Urbanization Impacts

Urbanization affects natural surface waters and riparian areas (and associated fish and wildlife) in significant and numerous ways. This section outlines the mechanisms by which urbanization impacts the key functions and processes previously described.

Changing Landcover and Impervious Surfaces

- Removal of riparian vegetation impacts water quality by increasing stream temperatures (Beschta 1987; Murray et al. 2000; Moore and Palmer 2005; Gomi et al. 2006).
- Widespread removal of forested areas in a watershed is likely to create unstable channels (Booth et al. 2004). Increased erosion and bank instability, coupled with a reduction of forest cover, simplify stream morphology, leading to incised, wider, and straighter stream channels (Konrad and Booth 2005).
- Impervious surfaces impact hydrologic functions.
    - Impervious surface is positively correlated with high flow volumes, daily streamflow variability, and negatively correlated with groundwater recharge rates and summer low flow volumes (Burges et al. 1998; Cuo et al. 2009; Konrad and Booth 2005)
    - Flows become more synchronized and become more variable and volatile (Sheldon et al. 2005b).
    - Less dynamic stream morphology is linked to accelerated water transport and reduced temporary instream flood storage capacity (Kaufmann and Faustini 2012).
    - Hydrological functions are also altered through soil compaction, draining, and ditching across a landscape (Moore and Wondzell 2005; Booth et al. 2004).

Habitat Removal, Degradation, and Fragmentation

- Habitat loss, degradation, and fragmentation have profound impacts on wildlife and their ecosystems (Gaston 2010; Wiegand et al. 2005; Young et al. 2016).
- Anthropogenic inputs and disturbance from high-intensity land uses (e.g., noise, light, physical intrusions by people and pets, pollution, garbage, etc.) degrade retained habitats in urban settings.
- Fragmentation from roads, fences, buildings, and various land uses restricts interpatch movements and migrations in urban landscapes (Wiegand, Revilla, and Moloney 2005).
- Urban areas tend to contribute a disproportionate amount of sediment and contaminants to receiving waters (Soranno et al. 1996). Heavy metals, bacterial pathogens, as well as PCBs, hydrocarbons, and endocrine-disrupting chemicals are aquatic contaminants that are commonly associated with urban and agricultural land uses.

- Some contaminants have significant effects on aquatic organisms. For example, coho salmon pre-spawn mortality is caused by a breakdown product of tire wear, 6PPD-quinone (Tian et al. 2021). Coho pre-spawn mortality is also positively correlated with the relative proportion of roads, impervious surfaces, and commercial land cover within a basin (Feist et al. 2011).
- Fine sediment adversely affects stream habitat (Jensen et al. 2009; Galbraith et al. 2006; Knutson et al. 2004)

- Cumulative impacts of direct and indirect habitat alterations, including hydrologic changes, compromise water quality, and habitat fragmentation tend to reduce the habitat functions and values of wetlands and riparian areas (Azous and Horner 2010; Sheldon et al. 2005b).

6.2.2 FWHCAs in the City of Bremerton

FHWCAs in the City include waterbodies, streams, and associated riparian areas, wildlife corridors, and priority species and habitats. Waterbodies include the Union River Reservoir, Port Washington Narrows and the Puget Sound shoreline. There are also numerous streams, including salmonid streams. Figure 8 presents the streams and fish distribution as mapped by Ecology's National Hydrography Dataset (NHD) and WDFW's Statewide Washington Integrated Fish Distribution online mapping layers. Priority Habitat Species (PHS) listed for the City of Bremerton and surrounding areas are presented in Table 4.

Table 4. PHS Species in the City of Bremerton and adjacent area.

Occurence Name	Federal Status	State Status	Sensitive Location
Mountain quail			No
Summer Chum	N/A	N/A	No
Surf Smelt	N/A	N/A	No
Fall Chum	N/A	N/A	No
Rainbow Trout	N/A	N/A	No
Coho	N/A	N/A	No
Winter Steelhead	N/A	N/A	No
Fall Chinook	N/A	N/A	No
Steelhead	Threatened	N/A	No
Pacific Sand Lance	N/A	N/A	No
Chum	Not Warranted	N/A	No
Coho	Candidate	N/A	No
Cutthroat	Not Warranted	N/A	No
Chum	Threatened	N/A	No
Hardshell Clam	N/A	N/A	No
Subtidal Hardshell Clam	N/A	N/A	No
Wood Duck	N/A	N/A	No
Shorebird Concentrations	N/A	N/A	No
Wetlands	N/A	N/A	No
Waterfowl Concentrations	N/A	N/A	No
Esturine Zone	N/A	N/A	No
Great blue heron	N/A	N/A	No
Caspian tern	N/A	N/A	No
Purple martin	N/A	N/A	No
Estuarine and Marine Wetland	N/A	N/A	No
Freshwater Pond	N/A	N/A	No
Freshwater Emergent Wetland	N/A	N/A	No
Freshwater Forested/Shrub Wetland	N/A	N/A	No
Riverine	N/A	N/A	No
Lake	N/A	N/A	No

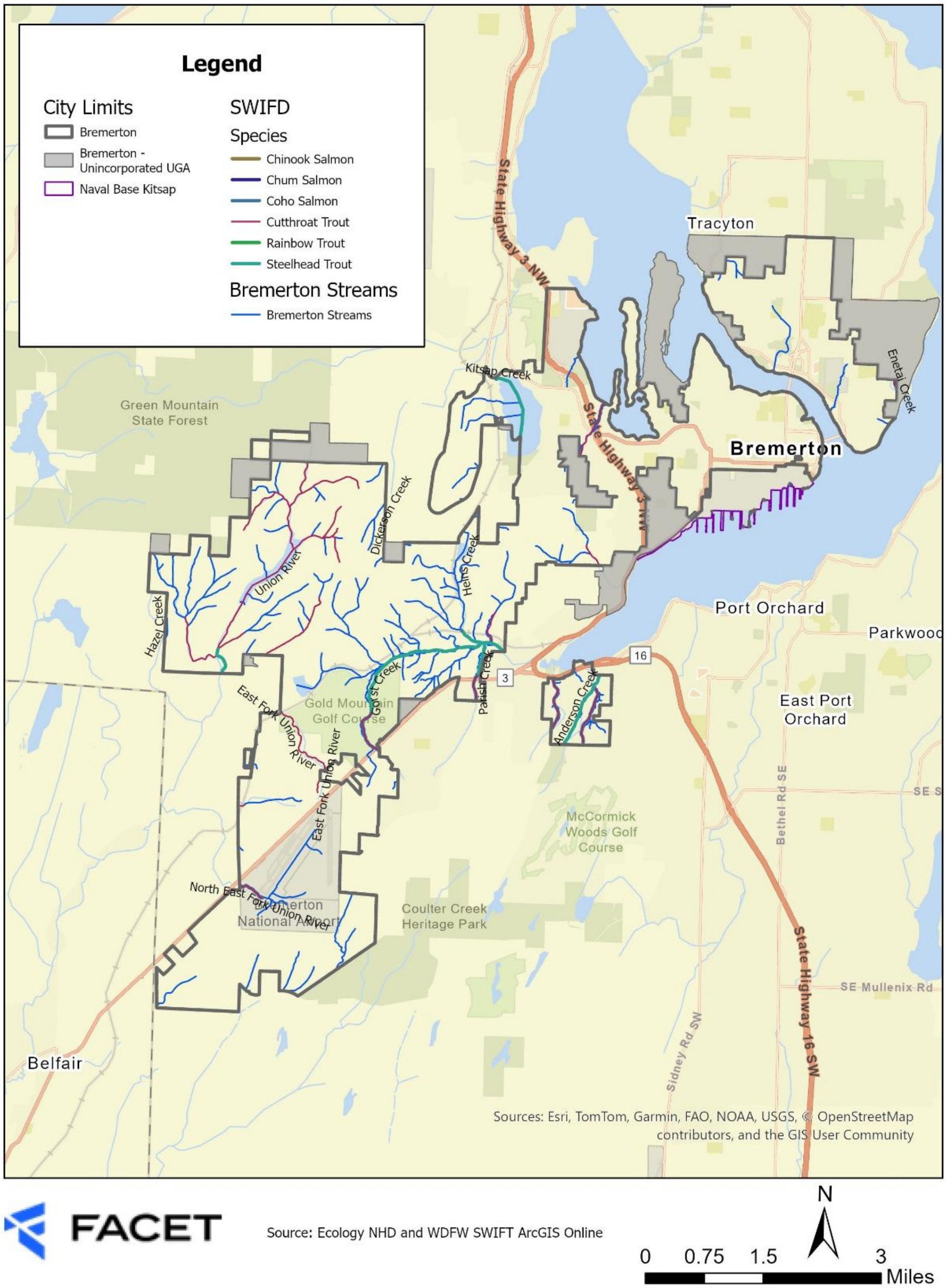

Figure 7. Streams and Fish Distribution in the City of Bremerton.

6.3 Key Protection Strategies

6.3.1 Identification and Classification

Numerous online resources are available that can be used to aid in determining the likely presence or absence of the various types of FWHCAs. Several important online mapping tools are listed below; however, this list is not exhaustive. Not all FWHCAs are mapped, and anything identified online should be verified in the field by a qualified biologist.

- National Oceanic and Atmospheric Administration (NOAA) Fisheries Maps
- U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation online tool
- WDFW Priority Habitats and Species Database (PHS on the Web)
- Washington State DNR Natural Heritage Program Data Explorer
- Streams are mapped by the City of Bremerton and other Kitsap County and Washington State agency resources.

6.3.1.1 Waters of the State

The Waters of the State encompass lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, wetlands, and all other surface waters and watercourses (RWC 90.48.020, WAC 173-201A-020). The ordinary high water mark (OHWM) is typically used to determine the edge of surface waters for jurisdictional purposes. For tidal waters, the USACE utilizes the high tide line to establish jurisdiction, while the Ecology uses the OHWM if it is present; if the OHWM cannot be found, Ecology refers to the mean higher high tide line. Although the definitions and guidance for determining the OHWM differ slightly between the USACE and Ecology, they are largely similar.

The OHWM should be determined in the field by a qualified biologist using one of the following manuals:

- National Ordinary High Water Mark Field Delineation Manual for Rivers and Streams (David et al. 2025)
- Determining the Ordinary High Water Mark for Shoreline Management Act Compliance in Washington State (Anderson et al. 2016).

DNR classifies streams and other bodies of water using a water typing system, as defined by WAC 222-16-030. This system is based on various characteristics, fish use, and the functions of natural water features, as summarized in Table 5. Common characteristics of water typing systems include flow volume, fish use and accessibility, seasonality, and the presence of salmonids.

Table 5. Water type classification.

Type	Description
Type S= Shoreline	Streams and waterbodies that are designated "shorelines of the state" as defined in chapter 90.58.030 RCW.
Type F= Fish	Streams and waterbodies that are known to be used by fish, or meet the physical criteria to be potentially used by fish. Fish streams may or may not have flowing water all year; they may be perennial or seasonal.
Type Np= Non-Fish	Streams that have flow year-round and may have spatially intermittent dry reaches downstream of perennial flow. Type Np streams do not meet the physical criteria of a Type F stream. This also includes streams that have been proven not to contain fish using methods described in Forest Practices Board Manual Section 13.
Type Ns= Non-Fish Seasonal	Streams that do not have surface flow during at least some portion of the year, and do not meet the physical criteria of a Type F stream.

6.3.2 Management Resources and Standards

6.3.2.1 Buffers based on Water Typing

Many jurisdictions in Washington State have managed stream and riparian habitats using buffers, which are determined by a specific water type classification. This protection mechanism arose in the forestry industry after stream habitats were impacted during the industrial forestry expansion in the mid-20th century (Richardson et al. 2012). The benefit of the set-width prescriptive buffer is that it is relatively simple to establish, implement, and administer. If fixed-width buffers are implemented, buffers should be sufficiently wide to ensure that riparian buffers are effective under a range of variable conditions. The latest BAS and state guidance recommend a conceptual shift from the fixed-width buffer approach regarding the way that streams and riparian areas are protected, as described in the next section. The City currently utilizes a framework that defines specific buffer widths based on the specific water type classification (Table 6).

Table 6. Buffer widths assessed by stream type, as per BMC 20.14.730 Table 1.

Stream Type	Current Buffers (ft)
Type F	150
Type Np	50
Team Ns	35

FACET

6.3.2.2 Riparian Management Zone and Site Potential Tree Height

In 2020, the Washington Department of Fish and Wildlife (WDFW) issued guidance based on BAS for protecting riparian areas (Rentz et al. 2020). This guidance shifts the focus from "stream buffers" to "riparian management zones" (RMZs), defined as scientifically determined areas adjacent to rivers and streams that can provide full ecological function based on the site potential tree height (SPTH) framework. RMZs should be regulated as fish and wildlife habitat conservation areas, emphasizing their ecological value rather than just serving as river and stream buffers.

WDFW recommends RMZ widths based on site potential tree height, which is the average maximum height of the tallest dominant trees (200 years or older). If the site potential tree height is less than 100 feet, a minimum RMZ width of 100 feet is recommended to ensure effective biofiltration and runoff management. This width is estimated to achieve 95% pollution removal and about 85% surface nitrogen removal (Rentz et al. 2020). RMZ widths should be measured from the outer edge of the channel migration zone or the ordinary high-water mark where there is no migration zone present.

WDFW has developed a web-based tool for determining site potential tree height using the 200-year site index ($SPTH_{200}$). In the City of Bremerton, site potential tree heights range from 75 to 231 feet, (Rentz et al. 2020). In developed areas, WDFW recommends effective watershed management and conservation to restore riparian functions. Their RMZ establishment and management recommendations are detailed in the "Riparian Ecosystems, Volume 2: Management Recommendations" document.

A graphical representation of the Forest Ecosystem Management Assessment Team (FEMAT) Curves, which are a model developed to guide the protection of riparian functions based on site potential tree heights, is shown in Figure 8 . The $SPTH_{200}$ framework provides a practical dimension for RMZs, as it is sufficient to protect almost all riparian functions while maximizing ecological benefits. Facet (2025) has prepared a memorandum outlining $SPTH_{200}$ in the City of Bremerton and the difference between $SPTH_{200}$ riparian management zones and current regulatory buffers.

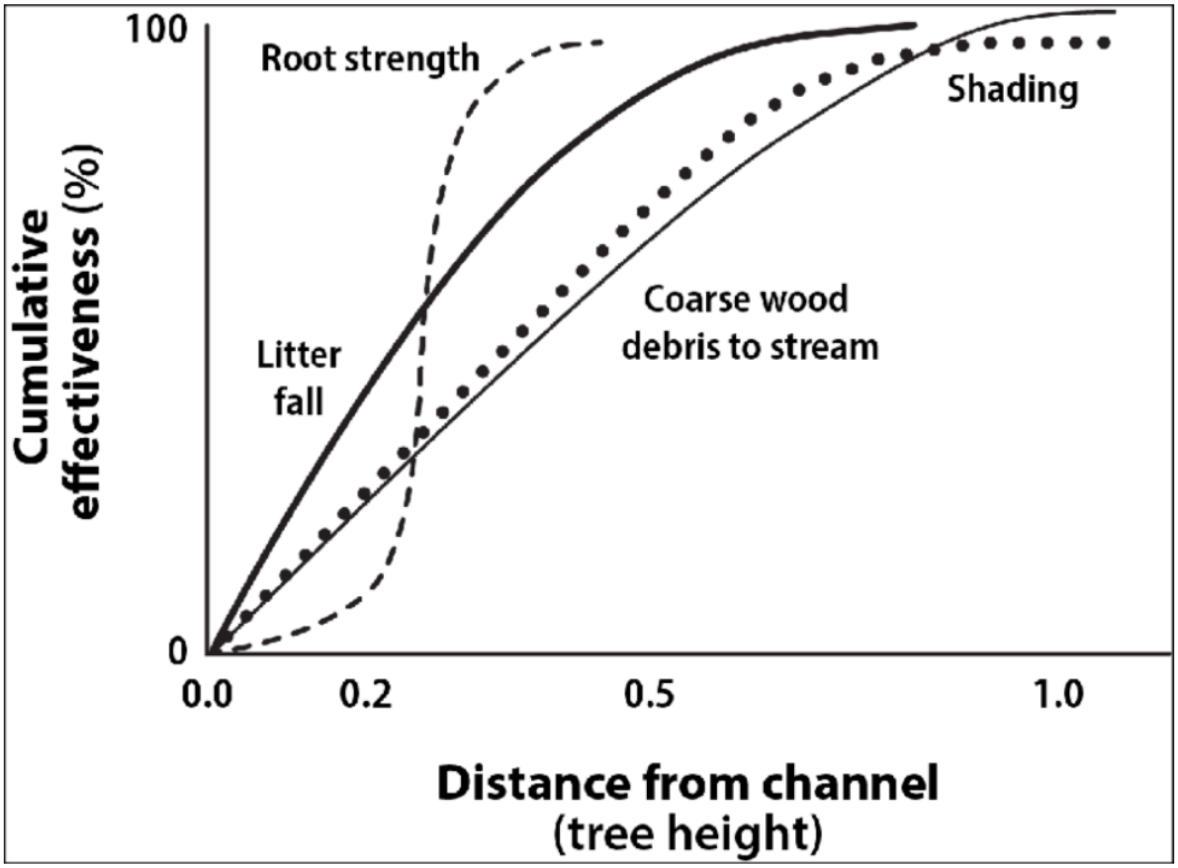

Figure 8. The "FEMAT Curves": a conceptual model of the contributions of key riparian ecosystem functions that influence aquatic ecosystems by distance and cumulative effectiveness. Tree height refers to the average relative height of the site's potential tree height (reproduced from FEMAT 1993).

Establishing functional RMZs using the recommended methods may not be practical in many developed areas. Therefore, WDFW advocates for effective watershed management, preservation, and protection to facilitate nearly full restoration of riparian ecosystem habitat functions, as feasible, within existing constraints. WDFW's additional management recommendations for urban riparian ecosystems include the following:

- Delineate stream ordinary high-water marks and associated riparian management zones. - Document current conditions and identify degraded riparian areas for restoration.
- Maintain or enhance functions through regulations and voluntary measures.
- Prioritize opportunities to maintain and restore in-stream and riparian connectivity.
- Manage stormwater according to the latest guidelines from the Washington State Department of Ecology.

- Require stormwater retrofitting for redevelopment projects (Rentz et al. 2020).

Research, based on BAS, suggests various management measures and buffer considerations to help preserve habitat functions for fish and wildlife. Effective strategies to mitigate the impacts of urbanization and manage associated runoff may include:

- Limiting or consolidating development densities and impervious surface coverage.
- Reducing vegetation clearing and retaining forest cover
- Concentrating activities that impact the environment, particularly roads and sources of pollution, away from watercourses.
- Minimizing the total area of roads and encouraging joint use of new access roads.
- Protecting vegetation and restricting development near hydrologic source areas.
- Maintaining densely vegetated riparian buffers with native trees, shrubs, and ground cover species.
- Implementing low-impact development (LID) techniques.
- Practicing municipal stormwater treatment.
- Promoting public education.

To achieve improved water quality in the city's streams, lakes, and ponds, riparian buffer areas should be effectively utilized for both biofiltration of stormwater runoff and protection from adjacent land uses. These goals can be accomplished by establishing dense, well-rooted vegetated buffer areas.

Biofiltration swales, created wetlands, and infiltration opportunities can intercept specific stormwater runoff discharges before they reach stream channels. When stormwater runoff is directed through stream buffers using pipes or ditch-like channels, it bypasses buffer areas, which diminishes their effectiveness.

GIS ANALYSIS

To understand the potential implications for parcels adjacent to stream corridors in the City of Bremerton, a GIS desktop analysis was conducted to determine the number of tax parcels that would potentially be encumbered by utilizing the $SPTH_{200}$ methodology. The stream layer analyzed was based on DNR's Hydrocourses, with additional streams from Ecology's NHD layer included as needed. Because the Washington DNR GIS layer does not distinguish between Np and Ns streams, all Type N streams were buffered at 50 feet under current conditions. All areas of the city limits were included in the analysis except U.S. Navy property per the City's direction. Type S waters were also not included in the analysis due to the jurisdiction of the SMP.

RESULTS

Results indicate the current buffer widths are generally less than $SPTH_{200}$ recommendations. For Type F streams, 4.1 out of 35.1 stream miles meet or exceed $SPTH_{200}$ values. None of the Type N streams meet or exceed $SPTH_{200}$ values, which was expected given the City's current buffer requirements for Type N streams are narrower than the $SPTH_{200}$ minimum of 100 feet. $SPTH_{200}$ values within the City's jurisdiction range from 100 to 235 feet. The most common (by stream length) $SPTH_{200}$ width was 193 ft.

Table 7 below describes that approximately 86% of the existing buffer widths for Type F streams and 100% of the existing buffer widths for Type N streams are below the $SPTH_{200}$ values based on the data from the WDFW $SPTH_{200}$ online mapping tool[4]. Table 8 describes the distribution of $SPTH_{200}$ RMZ width across the city for each stream classification.

Table 7. Stream miles where current regulations either meet/exceed or are less than $SPTH_{200}$ values.

Stream Type	Current buffer is less than $SPTH_{200}$ (miles)	Current buffer meets or exceeds $SPTH_{200}$ (miles)	Grand Total (miles)
F (150 ft)	30.2	4.1	35.1
N (50 ft)	41.4	0.0	41.4

Table 8. The occurrence of different $SPTH_{200}$ RMZ widths by stream type.

$STPH_{200}$ RMZ Occurrence - miles						
$SPTH_{200}$ RMZ Width (ft)	**Type F**	**Type N**	**Type S**	**Untyped (U)**	**Unknown (X)**	**Grand Total (miles)**
100	0.8	0.2	0.0	0.1	0.0	1.1
105	3.1	1.8	0.0	0.0	0.0	4.9
185	0.6	2.6	0.0	0.1	0.0	3.3
187	1.6	1.1	0.0	0.1	0.0	2.8
193	5.0	14.4	0.1	1.4	0.2	21.1
194	4.3	0.6	0.0	0.0	0.0	5.0
196	3.4	4.4	0.0	0.4	0.0	8.2
198	0.0	0.0	0.0	0.0	0.0	0.0
200	0.4	4.2	0.0	0.1	0.0	4.7
204	3.2	1.6	0.0	0.2	0.0	5.1
221	0.5	0.4	0.0	0.0	0.0	0.9
225	0.0	0.0	0.0	0.0	0.0	0.0
227	1.8	4.4	0.0	0.2	0.0	6.4
231	1.1	2.3	0.0	0.1	0.0	3.5
235	0.0	0.1	0.0	0.0	0.0	0.1
Grand Total	**26.1**	**38.0**	**0.1**	**2.7**	**0.2**	**67.0**

[4] https://wdfw.maps.arcgis.com/apps/MapJournal/index.html?appid=35b39e40a2af447b9556ef1314a5622d

Affected Area by Parcel

Table 9 describes the total area affected in acres and the acres of parcels affected by the existing buffer widths compared to the $SPTH_{200}$ RMZ width. It should be noted that the number of parcels affected does not necessarily equal the number of property owners affected, as some owners may hold more than one parcel. This data also includes publicly owned parcels and right-of-way (ROW) properties. Figure 9 displays the portion of parcels by stream type buffers. Table 10 and Figure 10 demonstrate the breakdown of acres of land affected by riparian buffers per zoning classification. The majority of land affected by buffers are located within areas zoned as the City's Utility Land and Watershed. Areas zoned as Low Density Residential R10 are the third largest affected by buffers, as shown in Figure 11.

Table 9. Comparison of parcels potentially affected increased buffers widths.

	Total Area (Acres)	# of Affected Parcels
Type F (150 ft)	945.4	462
Type N (50 ft)	554.1	210
SPTH	***3161.1***	***872***

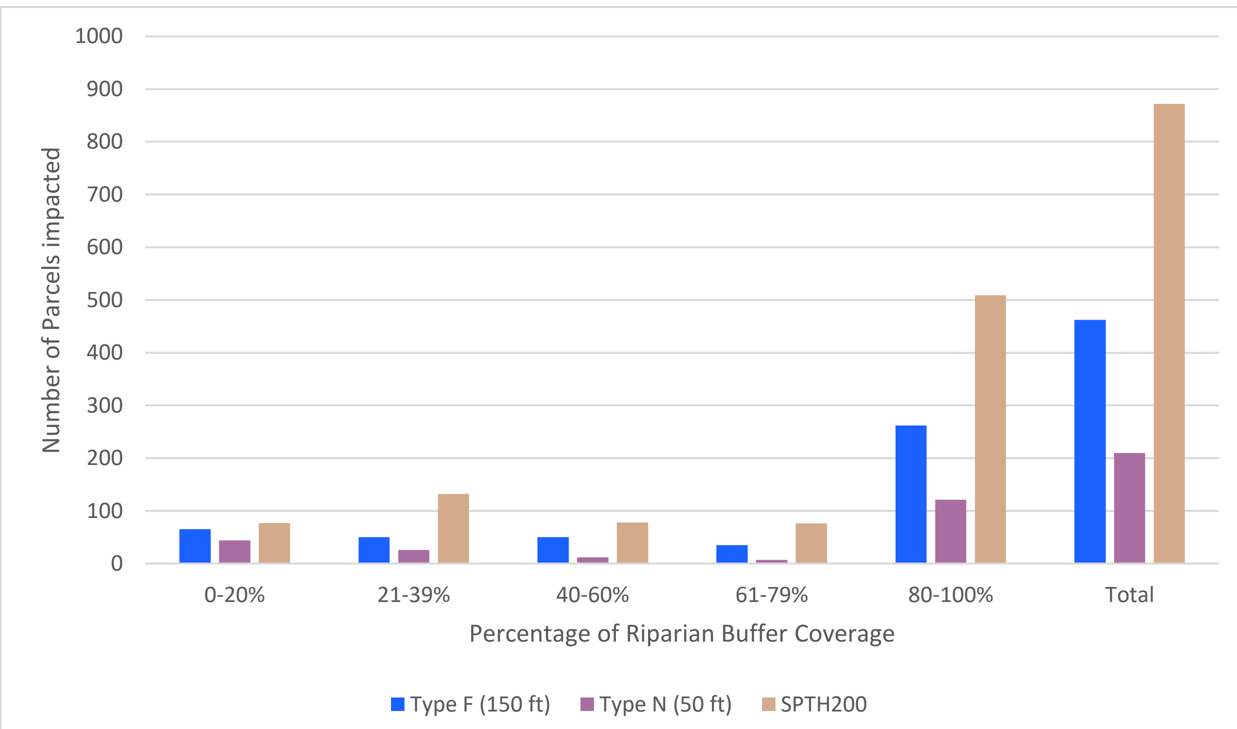

Figure 9. Number of parcels impacted by percentage of riparian buffer coverage.

Table 10. Acres of land in riparian buffers by Zoning Classification.

Zoning Classification	Sum of Area $SPTH_{200}$ (Acres)	Sum of Area_F150 (Acres)	Sum of Area N50 (Acres)
City_Utility_Land	1339.6	205.3	254.4
Downtown_Mixed_Use	1.6	0.3	0.0
East_Park_High_Density	0.2	0.0	0.0
East_Park_Low_Density_Residential	0.4	0.3	0.0
East_Park_Medium_Density_Residential	0.3	0.1	0.0
East_Park_Open_Space	0.7	0.7	0.0
Freeway_Corridor	10.4	11.3	0.4
General_Commercial	3.0	74.6	6.6
High_Density_Residential	11.7	12.1	0.0
Industrial	36.9	1.6	6.1
Low_Density_Residential_R10	603.3	265.9	75.6
Medium_Density_Residential	26.8	21.0	0.0
PSIC_Aviation_Business	0.2	23.0	23.1
PSIC_General_Industrial	168.9	95.0	14.0
PSIC_Mixed_Employment	28.9	0.0	8.1
PSIC_Port_Industrial_Mix	77.5	1.7	16.3
Watershed	850.9	232.5	149.4

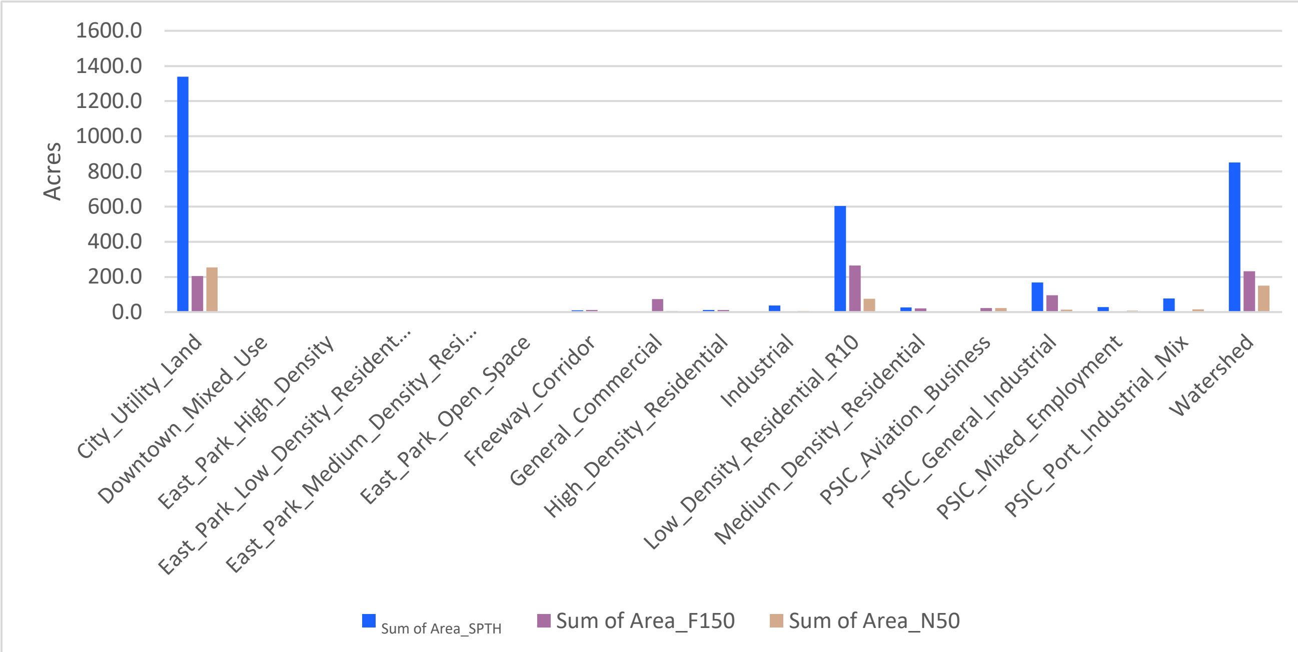

Figure 10. Acres of Riparian Buffers by Zoning Classification.

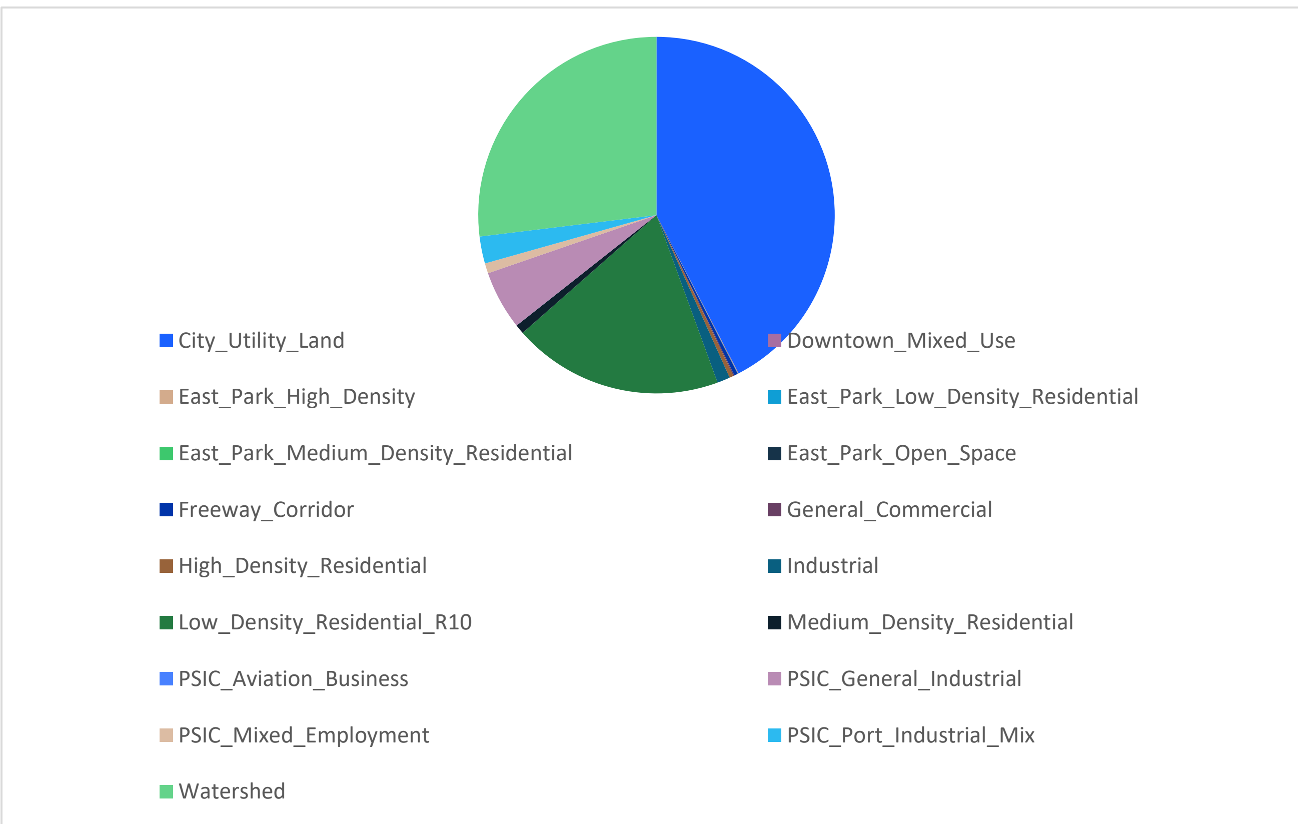

Figure 11. Proportion of area, by zoning, potentially affected by SPTH200 RMZ.

6.3.2.3 Endangered, Threatened, or Sensitive Species; Species of Local Importance; and their Habitats

Effective strategies based on BAS can be implemented to protect both state and federally listed endangered or threatened species, as well as Priority Species and Habitats (PHS) identified by the WDFW. The WDFW, U.S. Fish and Wildlife Service (USFWS), and the NMFS provide valuable information on management recommendations tailored to specific species. These guidelines can guide management practices at both the city and site levels. While there is accessible information for well-known species, many regulated species are under-researched and do not have specific management recommendations from state agencies. When species or habitat-specific management guidance is available from WDFW documents, it is important to follow or adapt these recommendations to fit local regulations. Below is a list of general management strategies aimed at protecting terrestrial habitats.

General Terrestrial Habitat Management Recommendations

- Existing high-quality habitats should be retained because habitat loss is one of the most important factors influencing biodiversity and loss of species (Beninde et al. 2015).
- Generally, manage land use development to minimize fragmentation of native habitat, particularly large, intact habitat areas. Where large forest stands exist, manage for forest-interior species and avoid fragmentation (Donnelly and Marzluff 2004; Diffendorfer et al. 1995; Mason et al. 2007; Pardini et al. 2005; WDFW 2009)
- Manage agricultural development to limit fragmentation and edge habitats; preserve vegetative structural diversity whenever possible in agricultural areas by retaining hedge rows and areas of native vegetation (Southerland 1993).
- Protect priority habitats that have a primary association with an ESA-list species or species of local importance by continuing to regulate for adherence to WDFW management recommendations and other applicable regulatory requirements.
- Control invasive species where needed on a site- and species-specific basis. Address invasive species specifically in areas where environmental conditions tend to promote infestation, including created edges, roadways, and riparian zones where they are contiguous with developed areas that may act as a seed source (McKinney 2002; Olden et al. 2004; Pimentel et al. 2005).
- Maintain or provide habitat connectivity with vegetated corridors between habitat patches (Gilbert-Norton et al. 2010).
- Protect, maintain, and promote habitat features such as snags and downed wood (Blewett and Marzluff 2005).
- Manage for increase native vegetative cover in landscaping and discourage lawns (Nelson and Nelson 2001).
- Plan habitat areas away from roads (Fahrig et al. 1995; Lehtinen et al. 1999).
- Promote buffers of adequate width to support wildlife guilds in adjacent habitat (Ficetola et al. 2009; Semlitsch and Bodie 2003; Crawford and Semlitsch 2007).
- Identify existing habitat patches and corridors and maintain connectivity with vegetated corridors to limit fragmentation and edge habitat (Gillies and St. Clair 2008; Gilbert-Norton et

al. 2010). Preserve habitat patches of at least moderate size 35 ha (86 ac) within developed areas (Kissling and Garton 2008).

- Promote restoration of FWHCAs, buffers, and other management zones through critical area regulations and public outreach. Encourage stewardship on a parcel-by-parcel and county-wide scale.

6.4 Climate Change Effects

Changes in temperatures and seasonal precipitation patterns are projected to place additional stressors on fish and wildlife habitat conservation areas. Some loss of riparian vegetation is anticipated due to the stresses of climate change, primarily warmer and drier summers. A reduction in riparian vegetation potentially triggers a cascading effect. A decrease in riparian vegetation would decrease shading, increase stream temperature, decrease detrital inputs, reduce available habitat structure, and reduce stream bank stability. Changes in seasonal hydrologic cycles may increase the frequency and magnitude of flashy runoff events, which would increase peak winter flows, mobilize greater volumes of sediments and pollutants into streams, reduce groundwater recharge that supports base stream flows in summer, and result in decreased streamflow overall. Instream habitats are particularly negatively impacted by excess sediment discharge and deposition.

Stressors associated with climate change are projected to significantly impact fish and wildlife species, including Chinook, coho, and sockeye salmon, steelhead and bull trout, and amphibians. The surface and subsurface water temperatures in Hood Canal and Puget Sound have already warmed from 0.8-1.6 degrees Fahrenheit since 1950 (Mauger et al. 2015). The projected impacts from climate change will result in increased mortality of these species and will directly impact downstream ecosystems and the marine food system (Mauger et al. 2015).

6.4.1 Strategies to Manage Climate Change Impacts on FWHCAs

The following actions or policies have been developed for other local jurisdictions in coordination with the University of Washington Climate Impacts Group (CIG). They are potential strategies the City of Bremerton could use to reduce negative climate change impacts on FWHCAs[5].

- Promote the retention of trees and forests and maintain tree replacement and reforestation requirements.

- Encourage and incentivize the enhancement and restoration of native forest patches throughout the City, particularly where connectivity to one or more FWHCAs is identified. Both voluntary and required restoration planting should be paired with monitoring and maintenance that allows for dry-season irrigation and adaptive management.

- Consider assisted migration for the seed selection of native plants from locations better adapted to future climate conditions.

[5] https://www.redmond.gov/1708/Climate-Preparedness

- Manage stormwater infrastructure to avoid and minimize discharges of increased and/or untreated runoff to streams, offsetting the anticipated increase in intensive rainfall events. Promote using LIDs to manage stormwater effectively for minimal downstream impacts.
- Update and maintain regulations for habitats and species of local importance. This may include adding mapping resources to help identify the locations of potential habitats and species requiring protection and management.
- Prioritize protection of streams and riparian corridors to reduce the stresses of climate change on native fish species and anadromous fish, such as Chinook salmon.
- Identify and protect cold water refugia in water bodies.
- Conduct vulnerability assessments and climate action plans.

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Appendix A. $SPTH_{200}$ Analysis