Watershed Restoration and Enhancement Plan WRIA 9 – Duwamish-Green Watershed

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Acronyms

Acronym	Definition
AE	Application Efficiency
AFY	Acre-Feet per Year
CFS	Cubic Feet per Second
CU	Consumptive Use
CUF	Consumptive Use Factor
GPD	Gallons per Day
GIS	Geographic Information System
IR	Irrigation Requirements
LIO	Local Integrating Organization
MAR	Managed Aquifer Recharge
NEB	Net Ecological Benefit
PE	Permit-Exempt
RCW	Revised Code of Washington
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WRE	Watershed Restoration and Enhancement
WRIA	Water Resource Inventory Area
WWT	Washington Water Trust

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Executive Summary

In January 2018, the Washington State Legislature passed the Streamflow Restoration law (Revised Code of Washington (RCW) 90.94). The law clarifies how local governments issue building permits for homes intending to use a permit-exempt well for their domestic water supply and requires local watershed planning in 15 water resource inventory areas (WRIAs), including the Duwamish-Green watershed (WRIA 9). The law directs the Department of Ecology to lead Watershed Restoration and Enhancement Committees to develop Watershed Restoration and Enhancement Plans (watershed plans). Watershed plans must estimate the potential consumptive impacts of new permit-exempt domestic groundwater withdrawals on instream flows over 20 years (2018-2038), identify projects and actions to offset those impacts, and provide a net ecological benefit to the WRIA. This Watershed Restoration and Enhancement Plan meets the requirements of the law.

The Department of Ecology (Ecology) established the Duwamish-Green (WRIA 9) Watershed Restoration and Enhancement Committee (Committee) in October 2018 and invited representatives from the following entities in the watershed to participate: tribal governments, county governments, city governments, Department of Fish and Wildlife, the largest non-municipal water purveyor, and interest groups. The WRIA 9 Committee met for over 2 years to develop a watershed plan.

Ecology issued the Final Guidance on Determining Net Ecological Benefit (Final NEB Guidance) (Ecology 2019) to ensure consistency, conformity with state law, and transparency in implementing RCW 90.94. The Final NEB Guidance describes the minimum planning requirements: include clear and systematic logic, delineate subbasins, estimate new consumptive water use, evaluate impacts of new consumptive water use, and describe and evaluate projects and actions for their offset potential.

The WRIA 9 Committee divided WRIA 9 into 12 subbasins for purposes of assessing consumptive use and project offsets, as shown in Figure ES.1.

The WRIA 9 Committee projects that a total of 632 new permit-exempt domestic wells (PE wells) will be installed within WRIA 9 during the 20-year planning horizon. The WRIA 9 Committee used this 20-year PE well projection to estimate 247.7 acre-feet per year (AFY), or 0.34 cubic feet per second (cfs), of new consumptive water use in WRIA 9 that this watershed plan must address and offset.

The WRIA 9 Committee sought projects to offset at least 495.4 AFY to account for uncertainties in the PE well projection and consumptive use estimate, including higher rates of water use that could result from climate change and changing development patterns. The WRIA 9 Committee developed the water offset target by doubling the 247.7 AFY consumptive use estimate. The offset target of 495.4 AFY also accounts for uncertainties related to project implementation.

The watershed plan includes three water rights acquisitions projects, two managed aquifer recharge projects, and one streamflow augmentation project to offset consumptive use. If implemented, these six water offset projects will provide an estimated offset of 1,075 AFY and exceed the offset target. A total of ten habitat projects are included in the watershed plan.

Ecological benefits associated with these projects are myriad and include floodplain restoration, wetland reconnection, availability of off-channel habitat for juvenile salmonids, increase in groundwater levels and baseflow, and increase in channel complexity. The ecological and streamflow benefits from habitat projects are supplemental to the quantified water offsets and contribute to achieving a net ecological benefit.

The WRIA 9 Committee has recommended adaptive management measures in the plan for the purpose of addressing uncertainty in plan implementation. Adaptive management measures include PE well tracking, project implementation tracking, and periodic watershed plan implementation reporting, with recommended adjustments to the plan. These measures, in addition to the surplus water offset and supplemental habitat improvement projects, provide reasonable assurance that the plan will adequately offset new consumptive use from PE wells anticipated during the planning horizon.

Based on the information and analyses summarized in this plan, the WRIA 9 Committee finds that this plan, if implemented, achieves a net ecological benefit, as required by RCW 90.94.030 and defined by the Final NEB Guidance (Ecology 2019).

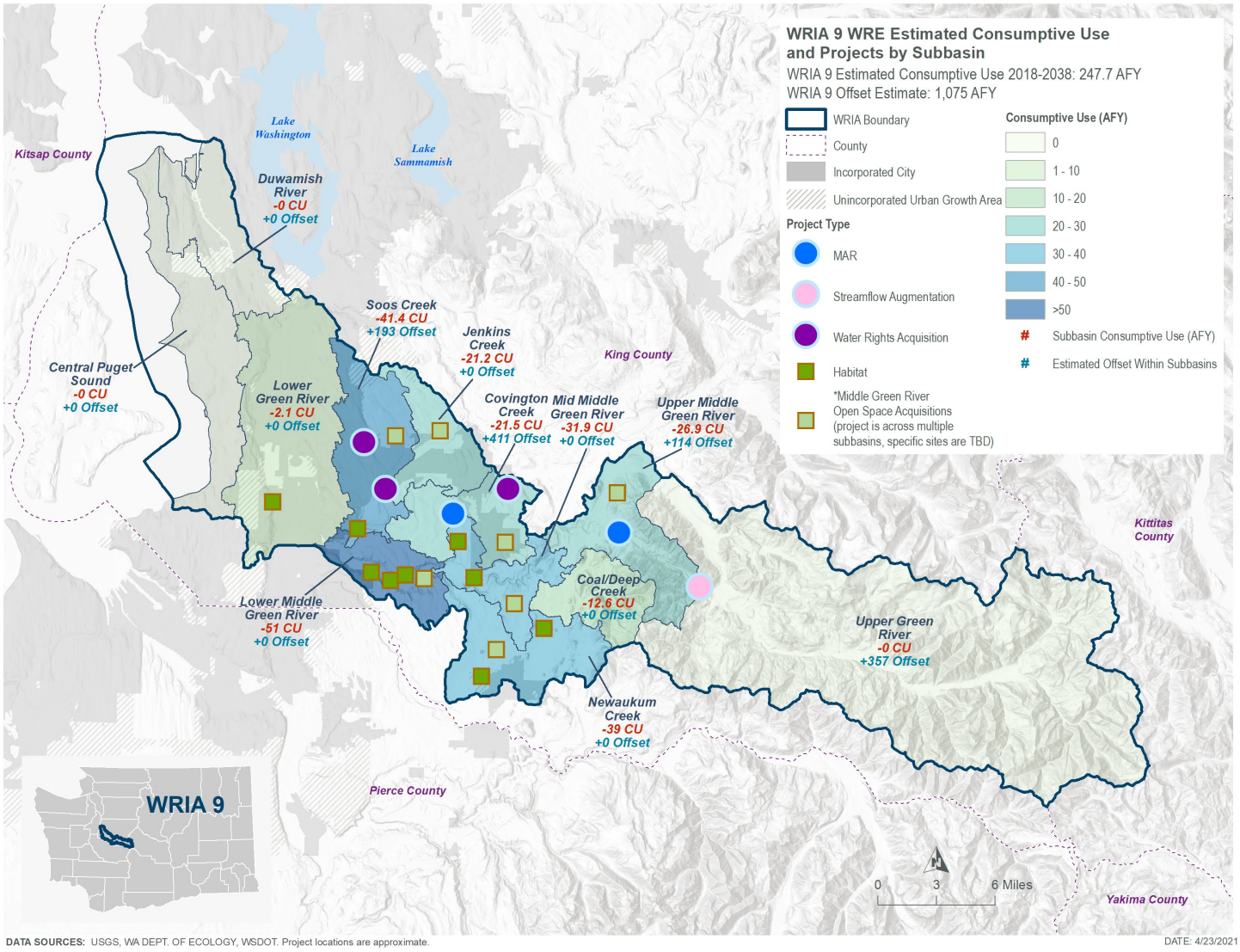


Figure ES.1: WRIA 9 Estimated Consumptive Use and Projects by Subbasin

Chapter One: Plan Overview

1.1 Plan Purpose and Structure

The purpose of the Water Resource Inventory Area (WRIA) 9 Watershed Restoration and Enhancement Plan is to offset the impacts of new permit-exempt domestic wells (PE wells) to streamflows. The plan is one requirement of RCW 90.94.030. The law clarifies how local jurisdictions issue building permits for homes that use a permit-exempt well for a water source. Watershed Restoration and Enhancement Plans (watershed plans) must estimate the potential consumptive impacts of new permit-exempt domestic groundwater withdrawals on instream flows over 20 years (2018-2038), identify projects and actions to offset those impacts, and provide a net ecological benefit to the WRIA. The law requires that local watershed planning take place in 15 WRIAs across the state, including in the Duwamish–Green watershed (WRIA 9). The WRIA 9 Watershed Restoration and Enhancement Plan is coordinated with priorities for salmon recovery and watershed recovery, while ensuring it meets the intent of the law.

Pumping from wells can reduce groundwater discharge to springs and streams by capturing water that would otherwise have discharged naturally, reducing flows. Consumptive water use (that portion not returned to the aquifer) reduces streamflow, both seasonally and as average annual recharge. A well pumping from an aquifer connected to a surface water body can either reduce the quantity of water discharging to the river or increase the quantity of water leaking out of the river (Culhane et al. 1995). Projects and actions to offset new consumptive water use associated with permit-exempt domestic wells have become a focus to minimize future impacts to instream flows and restore streamflow.

While this watershed plan is narrow in scope and is not intended to address all water uses or related issues within the watershed, successful completion of the plan by the WRIA 9 Watershed Restoration and Enhancement Committee (Committee) represents a noteworthy achievement regarding a technically and politically complex issue.

This watershed plan is divided into 7 Chapters:

1. Overview of the plan purpose and scope and plan development process;
2. Overview of the watershed, including land use and salmon presence, other planning efforts, hydrology and hydrogeology;
3. Summary of the subbasins;
4. Permit-exempt well projections and consumptive water use estimates;
5. Description of the recommended projects and actions identified to offset future permit-exempt domestic water use in WRIA 9;
6. Explanation of recommended adaptive management and implementation measures; and
7. Evaluation and consideration of the net ecological benefits.

1.1.1 Legal and Regulatory Background for the WRIA 9 Watershed Restoration and Enhancement Plan

In January 2018, the Washington State Legislature passed Engrossed Substitute Senate Bill (ESSB) 6091 (session law 2018 c 1). This law was enacted in response to the State Supreme Court's 2016 decision in Whatcom County vs. Hirst, Futurewise, et al. (commonly referred to as the "Hirst decision"). As it relates to this Committee's work, the law, now primarily codified as RCW 90.94, clarifies how local governments can issue building permits for homes intending to use a permit-exempt well for their domestic water supply. The law also requires local watershed planning in 15 WRIAs, including WRIA 9.

1.1.2 Permit-Exempt Domestic Wells

This Watershed Restoration and Enhancement Plan, the law that calls for it, and the Hirst decision are all concerned with the effects of new permit-exempt domestic water use on streamflows. Several laws pertain to the management of groundwater permit-exempt wells in WRIA 9 and are summarized in brief here for the purpose of providing context for the WRIA 9 watershed plan.

First and foremost, RCW 90.44.050, commonly referred to as "the Groundwater Permit Exemption," establishes that certain small withdrawals of groundwater are exempt from the state's water right permitting requirements, including small indoor and outdoor water use associated with homes. It is important to note that although these withdrawals do not require a state water right permit, the water right is still legally established by the beneficial use. Even though a water right permit is not required for small domestic uses under RCW 90.44.050, these withdrawals of water are subject to the prior appropriations scheme as are any other water uses. There is still regulatory oversight, including from local jurisdictions. Specifically, in order for an applicant to receive a building permit from their local government for a new home, the applicant must satisfy the provisions of RCW 19.27.097 for what constitutes evidence of an adequate water supply.

RCW 90.94.030 adds to the management regime for new homes using permit-exempt domestic well withdrawals in WRIA 9 and elsewhere. For example, local governments must, among other responsibilities relating to new permit-exempt domestic wells, collect a $500 fee for each building permit and record withdrawal restrictions on the title of the affected properties. Additionally, this law restricts new permit-exempt domestic withdrawals in WRIA 9 to a maximum annual average of 950 gallons per day per connection (which may be curtailed to 350 gallons per day per connection for indoor use only during drought), subject to the five thousand gallons per day and ½-acre outdoor irrigation of non-commercial lawn/garden limits established in RCW 90.44.050. Ecology has published its interpretation and implementation of RCW 19.27.097 and RCW 90.94 in Water Resources POL-2094 (Ecology 2019a). The WRIA 9 Committee directs readers to those laws and policy for comprehensive details and agency interpretations.

1.1.3 Planning Requirements under RCW 90.94.030

While supplementing the local building permit requirements, RCW 90.94.030(3) goes on to establish the planning criteria for WRIA 9. In doing so, it sets the minimum standard for Ecology's collaboration with the WRIA 9 Committee in the preparation of this watershed plan. In practice, the process of plan development was one of integration, collectively shared work, and a striving for consensus described in the WRIA 9 Committee's adopted operating principles, which are further discussed below and in Appendix D.

In addition to these procedural requirements, the law and consequently this watershed plan, is concerned with the identification of projects and actions intended to offset the anticipated impacts from new permit-exempt domestic groundwater withdrawals over the 20 year planning horizon and provide a net ecological benefit. In establishing the primary purpose of this watershed plan, RCW 90.94.030(3) also details both the required and recommended plan elements. Regarding the WRIA 9 Committee's approach to selecting projects and actions, the law also speaks to "high and lower priority projects." The WRIA 9 Committee understands that, as provided in the Final Guidance on Determining Net Ecological Benefit, "use of these terms is not the sole critical factor in determining whether a plan achieves a [net ecological benefit] NEB…and that plan development should be focused on developing projects that provide the most benefits…regardless of how they align with [these] labels" (Ecology 2019, p. 12). It is the perspective of the WRIA 9 Committee that this locally approved plan satisfies the requirements of RCW 90.94.030.

1.2 Requirements of the Watershed Restoration and Enhancement Plan

RCW 90.94.030 of the Streamflow Restoration law directs Ecology to establish a Watershed Restoration and Enhancement Committee in the Duwamish-Green watershed for the sole purpose of developing a Watershed Restoration and Enhancement Plan in collaboration with the WRIA 9 Committee. Ecology determined that the intent was best served through collective development of the watershed plan, using an open and transparent setting and process that builds on local needs.

At a minimum, the watershed plan must include projects and actions necessary to offset projected consumptive impacts of new permit-exempt domestic groundwater withdrawals on streamflows and provide a net ecological benefit (NEB) to the WRIA.

Ecology issued the Streamflow Restoration Policy and Interpretive Statement (POL-2094) and Final Guidance on Determining Net Ecological Benefit (GUID-2094) in July 2019 to ensure consistency, conformity with state law, and transparency in implementing RCW 90.94. The Final Guidance on Determining Net Ecological Benefit (hereafter referred to as Final NEB Guidance) establishes Ecology's interpretation of the term "net ecological benefit." It also informs planning groups on the standards Ecology will apply when reviewing a watershed plan completed under RCW 90.94.020 or RCW 90.94.030. The minimum planning requirements identified in the Final NEB Guidance include the following (Ecology 2019, pp 7-8):

1. Clear and Systematic Logic: Watershed plans must be prepared with implementation in mind.
2. Delineate Subbasins: The committee must divide the WRIA into suitably sized subbasins to allow meaningful analysis of the relationship between new consumptive use and offsets.
3. Estimate New Consumptive Water Use: Watershed plans must include a new consumptive water use estimate for each subbasin, and the technical basis for such estimate.
4. Evaluate Impacts from New Consumptive Water use: Watershed plans must consider both the estimated quantity of new consumptive water use from new permit-exempt domestic wells initiated within the planning horizon and how those impacts will be distributed.
5. Describe and Evaluate Projects and Actions for their Offset Potential: Watershed plans must, at a minimum, identify projects and actions intended to offset impacts associated with new consumptive water use.

The law requires that all members of the WRIA 9 Committee approve the plan prior to submission to Ecology for review. Ecology must then determine that the plan's recommended streamflow restoration projects and actions will result in a net ecological benefit to instream resources within the WRIA after accounting for projected use of new permit-exempt domestic wells over the 20-year period of 2018-2038.

1.3 Overview of the WRIA 9 Committee

1.3.1 Formation

The Streamflow Restoration law instructed Ecology to chair the WRIA 9 Committee, and invite representatives from the following entities in the watershed to participate:

- Each federally recognized tribal government with reservation land or usual and accustomed harvest area within the WRIA.
- Each county government within the WRIA.
- Each city government within the WRIA.
- Washington State Department of Fish and Wildlife.
- The largest publicly-owned water purveyor providing water within the WRIA that is not a municipality.
- The largest irrigation district within the WRIA.[2]

Ecology sent invitation letters to each of the entities named in the law in September of 2018.

[2] There are no irrigation districts located in WRIA 9.

The law also required Ecology to invite local organizations representing agricultural interests, environmental interests, and the residential construction industry. Businesses, environmental groups, agricultural organizations, conservation districts, and local governments nominated interest group representatives. Local governments on the WRIA 9 Committee voted on the nominees in order to select local organizations to represent agricultural interests, the residential construction industry, and environmental interests. Ecology invited the selected entities to participate on the WRIA 9 Committee.

The WRIA 9 Committee members are included in Table 1.1. This list includes all of the members identified by the Legislature that agreed to participate on the WRIA 9 Committee.[3]

Table 1.1: WRIA 9 Entities and Membership

Entity Name	**Representing**
King County	County government
City of Auburn	City government
City of Black Diamond	City government
City of Enumclaw	City government
City of Kent	City government
City of Normandy Park	City government
City of Seattle	City government
City of Tukwila	City government
Muckleshoot Indian Tribe	Tribal government
Washington Department of Ecology	State agency
Washington Department of Fish and Wildlife	State agency
Covington Water District	Water utility
King County Agriculture Program	Agricultural interest
Master Builders Association of King and Snohomish Counties	Residential construction
Center for Environmental Law and Policy	Environmental interest
WRIA 9 Watershed Ecosystem Forum – ex officio	Salmon Recovery Lead Entity
Tacoma Water – ex officio	Municipal water purveyor

The WRIA 9 Committee roster with names of representatives and alternates is available in Appendix C.

The WRIA 9 Committee invited the WRIA 9 Watershed Ecosystem Forum and Tacoma Water to participate as “ex officio” members. Although not identified in the law, the ex officio members provide valuable information and perspective as subject matter experts. The ex officio members are active but non-voting participants of the WRIA 9 Committee.

1.3.2 Committee Structure and Decision Making

The WRIA 9 Committee held its first meeting in October 2018. Between October 2018 and February 2021, the WRIA 9 Committee held 22 committee meetings open to the public. The WRIA 9 Committee met monthly or every other month, and as needed to meet deadlines.

[3] The law did not require invited entities to participate, and some chose not to participate on the Committee.

The two and a half years of planning consisted of planning group formation, data gathering, and developing plan components. WRIA 9 Committee members had varying degrees of understanding concerning hydrogeology, water law, salmon recovery, and rural development. Ecology technical staff, WRIA 9 Committee members, and partners presented on topics to provide context for components of the plan.

In addition to playing the role of WRIA 9 Committee chair, Ecology staff provided administrative support and technical assistance, and contracted with consultants to provide facilitation and technical support for the WRIA 9 Committee. The facilitation team from Cascadia Consulting supported the WRIA 9 Committee's discussions and decision-making. The technical consultants from GeoEngineers and Northwest Hydraulic Consultants developed products that informed WRIA 9 Committee decisions and development of the plan. The technical consultants developed all of the technical memorandums referenced throughout this plan.

Cities had the option of participating in the Committee through a caucus, with one person attending the Committee meetings as the caucus representative. The cities of Black Diamond, Normandy Park, and Tukwila decided to form a cities caucus with the WRIA 9 Watershed Ecosystem Forum representative serving as the caucus representative. The caucus representative's attendance and vote represented the participation and vote of all members of the caucus. The caucus had one collective vote on decisions that did not require approval by all Committee members. For decisions that required approval by all Committee members (adopting or amending the operating principles and final plan approval), each caucus member voted individually.

The WRIA 9 Committee established a technical workgroup to support planning efforts and to achieve specific tasks. The workgroup was open to all WRIA 9 Committee members as well as non-Committee members that brought capacity or expertise to the Committee. The workgroup made no binding decisions, but presented information to the Committee as either recommendations or findings. The WRIA 9 Committee acted on workgroup recommendations, as it deemed appropriate.

During the initial WRIA 9 Committee meetings, members developed and agreed to operating principles.[4] The operating principles set forward a process for meeting, participation expectations, procedures for voting, structure of the WRIA 9 Committee, communication, and other needs in order to support the WRIA 9 Committee in reaching agreement on a final plan.

This planning process, by statutory design, brought diverse perspectives to the table. The authorizing legislation requires all members of the Committee to approve the final plan prior to Ecology's review.[5] It was important for the Committee to identify a clear process for how it made decisions. The Committee strived for consensus for interim decisions because consensus on decisions during plan development served as the best indicator of the Committee's progress toward an approved plan. Consensus was reached on all interim decisions. The chair and

[4] Approved and signed operating principles can be found in Appendix D and on the WRIA 9 Committee webpage.
[5] "…all members of a Watershed Restoration and Enhancement Committee must approve the plan prior to adoption" RCW 90.94.030(3).

facilitator documented agreement and dissenting opinions in meeting summaries, as outlined in the Committee's operating principles. The Committee did not make any decisions by two-thirds majority.

The WRIA 9 Committee reviewed components of the watershed plan and the draft plan on an iterative basis. Once the WRIA 9 Committee reached initial agreement on the final draft of the watershed plan, broader review and approval by the entities represented on the WRIA 9 Committee was sought, as needed. The WRIA 9 Committee reached final agreement on the Watershed Restoration and Enhancement Plan on February 23, 2021.

Chapter Two: Watershed Overview

2.1 Brief Introduction to WRIA 9

The Duwamish-Green watershed is one of the 62 designated major watersheds in Washington State, formed as a result of the Water Resources Act of 1971. The Duwamish-Green watershed is located in King County, Washington and is approximately 482 square miles in area. It includes all the lands drained by the Duwamish-Green River, including marine nearshore areas that drain directly to Puget Sound. WRIA 9 is bounded on the north by WRIA 8 (Cedar-Sammamish), on the west by Puget Sound, on the south by WRIA 10 (Puyallup-White), and on the east by WRIA 38 (Naches) and WRIA 39 (Upper Yakima).

The upper portion of the watershed contains Howard Hanson Dam, an earthen dam on the Green River constructed for flood control. The City of Tacoma operates a diversion facility approximately three miles downstream from Howard Hanson Dam for municipal water supply. Lower portions of the watershed contain Lake Sawyer and Lake Youngs. Numerous smaller lakes, ponds, and wetlands are present throughout the watershed. Over the last 200 years, construction of dams, levees, and other flood control projects, and development of the Duwamish Estuary altered the watershed from its pre-development state (WRIA 9 Steering Committee 2005). The Duwamish River, and the lower portion of the Green River, have been extensively channelized.

The watershed includes one major river, the Duwamish-Green River. The Green River originates in the Cascade Range south of Snoqualmie Pass and flows in a generally northwest direction before becoming the Duwamish River at the historical confluence with the Black River near the City of Tukwila. The Duwamish River is highly channelized and flows northwest before discharging to Elliott Bay in the City of Seattle. The overall length of the Duwamish-Green River system is 93 miles. The mean annual flow in the Green River is 1,350 cubic feet per second measured near Auburn (U.S. Geological Survey 2020). Tributaries within the system include Coal Creek, Deep Creek, Newaukum Creek, and Soos Creek (Covington Creek and Jenkins Creek flow into Soos Creek).

2.1.1 Land Use in WRIA 9

The eastern or upland portion of the watershed extending from the Tacoma Headworks Diversion Dam on the west, to the eastern boundary of WRIA 9, is the Green River Municipal Watershed. Tacoma Public Utilities manages the Green River Municipal Watershed for municipal water supply under a Habitat Conservation Plan (Tacoma Public Utilities 2001) and a 1995 agreement with the Muckleshoot Indian Tribe. This portion of the watershed consists of forestland and has limited public access. Land uses shift to agriculture, suburban developments, and small urban centers such as Black Diamond and Enumclaw in the foothills of the Cascade Mountains. Extending from the cities of Auburn and Kent to the cities of Burien, Tukwila, Renton, and Seattle, the northwest portion of WRIA 9 is highly urbanized, characterized by a combination of residential, industrial, commercial, transportation, communication, and utility land covers. Approximately 30 percent of the watershed is within a city or designated urban growth area.

The Duwamish-Green watershed is one of the most heavily populated watersheds in Washington. Industry, agriculture, commercial facilities, individual residences, and municipalities compete for a limited water supply, causing a strain on water availability. These out of stream uses compete with instream water needs, including providing water for salmon and other aquatic resources.

2.1.2 Tribal Reservations and Tribal Treaty Rights

Federally Recognized Indian Tribes are sovereign nations with rights over natural resources, including enough water to fulfill the purposes of their reservations. Some of the ancestral lands and use areas of the people of the Muckleshoot Indian Tribe, and the lands of the Muckleshoot Indian Reservation, are located in WRIA 9. The Muckleshoot Indian Tribe holds reserved treaty rights to fish, hunt, and gather throughout WRIA 9 and claims the earliest (most senior) priority rights to water within the Duwamish-Green watershed. While unquantified, federally reserved water rights intended to serve current and future uses may be reserved by and protected in treaties, executive orders, and federal court decisions. The Tribe's water rights can extend to instream flows and minimum lake levels necessary to protect resources in all areas where the Tribe may have reserved rights. Treaty rights to fish can support claims for fish habitat, including instream flow. Nothing in this plan can alter tribal rights.

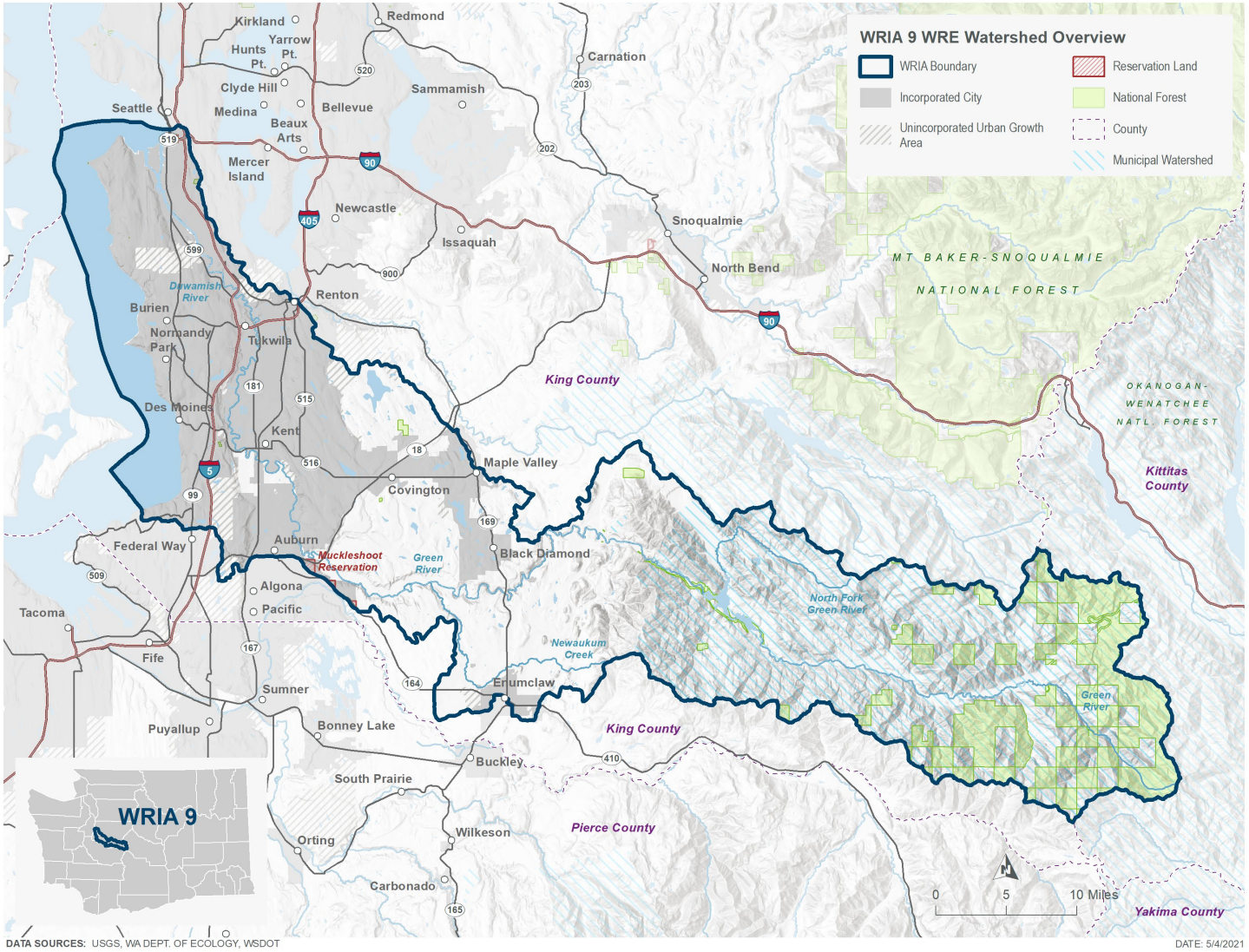


Figure 2.1: WRIA 9 Watershed Overview

2.1.3 Salmonids in WRIA 9

The Duwamish-Green watershed is an important and potentially productive system for salmonids. Several tributaries provide spawning and rearing habitat for salmon, steelhead, and bull trout. These streams often experience low streamflows during critical migration and spawning time. In addition, levees, dams, migration barriers, and other flood control and navigation measures have further limited habitat along the river and tributaries. The quality and quantity of spawning and rearing habitat, water quality, including water temperature, and low streamflows all affect local salmon populations (WRIA 9 Steering Committee 2005).

The Soos Creek system, Newaukum Creek, and Crisp Creek are also important systems for both natural and hatchery salmon resources. The state's Soos Creek Hatchery is located near the mouth of the creek and has just undergone a major rehabilitation. The Keta Creek Hatchery is located on Crisp Creek and owned and operated by the Muckleshoot Indian Tribe, who work with Washington Department of Fish and Wildlife (WDFW) and other tribes on fish propagation programs.

Salmon Presence (Fish Population and Life Histories)

The Duwamish-Green watershed has anadromous salmon runs that include four of the five North American Pacific salmon species (WDFW Salmonscape 2020, SWIFD 2020). Chinook (*Oncorhynchus tshawytscha*), Coho (*Oncorhynchus kisutch*), Chum (*Oncorhynchus keta*), and Pink salmon (*Oncorhynchus gorbuscha*) migrate in and out of the Duwamish-Green watershed from Puget Sound. There is no established run of Sockeye salmon (*Oncorhynchus nerka*) within the watershed; however, stray individuals have been observed in the basin. Steelhead trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarkii clarkii*), rainbow trout (*Oncorhynchus mykiss*), and bull trout (*Salvelinus confluentus*) also inhabit the watershed.

The Puget Sound evolutionarily significant unit of Chinook salmon was designated as threatened under the Endangered Species Act (ESA) in 1999 (64 FR 14308). Designated critical habitat for Chinook salmon includes marine nearshore and freshwater habitats within WRIA 9 (70 FR 52629). The Puget Sound distinct population segment of steelhead trout was designated as threatened under ESA in 2007 (72 FR 26722). Final designated critical habitat for Puget Sound steelhead includes freshwater and estuarine habitat in Puget Sound, Washington (81 FR 9251) including areas within WRIA 9. The Coastal-Puget Sound Distinct Population Segment of bull trout was designated as threatened under ESA in 1999. Critical habitat has been designated for bull trout and includes both freshwater and saltwater aquatic habitat within WRIA 9 (75 FR 63897). Table 2.1 below lists the species present in the Duwamish-Green watershed and their regulatory status.

Table 2.1: Salmonids Present within the Duwamish-Green Watershed

Common Name	**Scientific Name**	**Evolutionary Significant Unit**	**Critical Habitat**	**Regulatory Agency Status**
Chinook salmon	*Oncorhynchus tshawytscha*	Puget Sound Chinook	Yes/2005	NMFS/ Threatened/ 1999
Chum salmon	*Oncorhynchus keta*	Puget Sound Chum	No	No listing
Coho salmon	*Oncorhynchus kisutch*	Puget Sound/Strait of Georgia Coho	No	NMFS/Species of Concern/1997
Pink salmon	*Oncorhynchus gorbuscha*	No listing	No listing	No listing
Sockeye salmon	*Oncorhynchus nerka*	No listing	No listing	No listing
Steelhead trout	*Oncorhynchus mykiss*	Puget Sound Steelhead	Yes/2016	NMFS/ Threatened/ 2007
Bull trout	*Salvelinus confluentus*	Puget Sound Dolly Varden/Bull trout	Yes/2010	USFWS/ Threatened/ 1999
Coastal Cutthroat Trout	*Oncorhynchus clarkii clarkii*	No listing	No listing	No listing
Rainbow trout	*Oncorhynchus mykiss*	No listing	No listing	No listing

Table 2.2 below lists the run timing and life stages of anadromous salmon and trout present throughout the watershed. Watershed specific data concerning salmonid life history and timing was largely summarized from the 2000 King County Habitat Limiting Factors and Reconnaissance Assessment for Salmon Habitat (Kerwin 2000).

Table 2.2: Salmonid Life History Patterns within the Duwamish-Green Watershed

Species	Freshwater Life Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Subbasin Presence
Sockeye[1]	Upstream migration						■	■	■	■	■			Duwamish River Lower Green River Lower Middle Green River Mid Middle Green River Upper Middle Green River Newaukum Creek Soos Creek
	Spawning									■	■	■	■	
	Fry emergence	■	■	■	■	■	■							
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	
	Smolt outmigration				■	■	■	■						
Chinook (fall)	Upstream migration							■	■	■	■			All
	Spawning									■	■	■	■	
	Incubation	■	■	■	■						■	■	■	
	Juvenile rearing	■	■	■	■	■	■	■	■					
	Juvenile outmigration	■	■	■	■	■	■	■	■	■				
Coho	Upstream migration										■	■	■	Central Puget Sound Duwamish River Lower Green River Lower Middle Green River Mid Middle Green River Upper Middle Green River Upper Green River Newaukum Creek Soos Creek Jenkins Creek Covington Creek
	Spawning	■	■									■	■	
	Incubation	■	■	■	■								■	
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	
	Smolt outmigration				■	■	■	■						
Chum	Upstream migration										■	■	■	Central Puget Sound Duwamish River Lower Green River Lower Middle Green River Mid Middle Green River Upper Middle Green River Upper Green River Newaukum Creek Soos Creek Covington Creek
	Spawning											■	■	
	Incubation	■	■	■	■							■	■	
	Juvenile rearing			■	■	■	■							
	Juvenile outmigration			■	■	■	■							
Pink	Upstream migration								■	■				Duwamish River

Species	Freshwater Life Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Subbasin Presence
	Spawning									■	■			Lower Green River Lower Middle Green River Mid Middle Green River Newaukum Creek Soos Creek
	Incubation	■	■	■	■	■					■	■	■	
	Juvenile rearing			■	■	■	■							
	Juvenile outmigration				■	■	■							
Bull trout[2]	Upstream migration							■	■	■	■			Duwamish River Lower Green River Lower Middle Green River Mid Middle Green River Upper Middle Green River
	Spawning									■	■	■	■	
	Incubation	■	■	■	■	■	■	■	■	■	■	■	■	
Coastal Cutthroat trout[3]	Upstream migration	■	■	■	■	■	■	■	■	■	■	■	■	All
	Spawning	■	■	■	■	■	■	■	■	■	■	■	■	
	Incubation		■	■	■	■	■	■	■	■	■	■	■	
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	
	Smolt outmigration				■	■	■	■	■	■	■	■	■	
Steelhead trout (winter)	Upstream migration	■	■	■	■								■	Central Puget Sound Duwamish River Lower Green River Lower Middle Green River Mid Middle Green River Upper Middle Green River Upper Green River Newaukum Creek Soos Creek Jenkins Creek Covington Creek
	Spawning			■	■	■	■	■	■	■	■	■	■	
	Incubation				■	■	■	■	■	■	■	■	■	
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	
	Smolt outmigration				■	■	■	■	■	■	■	■	■	
Steelhead trout (summer)	Upstream migration					■	■	■	■	■	■	■	■	Duwamish River Lower Green River Lower Middle Green River Mid Middle Green River Upper Middle Green River Soos Creek
	Spawning		■	■	■	■	■	■	■	■	■	■	■	
	Incubation			■	■	■	■	■	■	■	■	■	■	
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	
	Smolt outmigration					■	■	■	■	■	■	■	■	

Species	Freshwater Life Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Subbasin Presence
Rainbow trout[4]	Spawning			■	■	■	■							Lower Green River Lower Middle Green River Upper Middle Green River Upper Green River
	Incubation				■	■	■	■						

Notes:

1. There is no established run of Sockeye within the watershed. This data reflects stray individuals observed within the watershed. Information on sockeye life history specifically within the Green and Duwamish watershed is either unavailable or extremely limited. Sockeye life history patterns for the Puget Sound Region were used within this report (Gustafson et al. 1997).
2. Information on bull trout life history specifically within the Green and Duwamish watershed is either unavailable or extremely limited. Bull trout life history patterns for the Puget Sound Region were used within this report (King County 2000).
3. Information on coastal cutthroat trout life history specifically within the Green and Duwamish watershed is either unavailable or extremely limited. Coastal cutthroat trout life history patterns for the Puget Sound Region were used within this report (Johnson et al. 1999).
4. Information on rainbow trout life history specifically with the Green and Duwamish watershed is unavailable. Rainbow trout life history patterns for the Puget Sound Region were used within this report (Blanton et al. 2011).

Current Habitat Conditions

Habitat conditions within the Duwamish-Green watershed were abstracted from the 2000 King County Habitat Limiting Factors and Reconnaissance Assessment for Salmon Habitat (Kerwin 2000). The Duwamish-Green watershed has been severely impacted by a variety of land uses ranging from commercial forestry in the Upper Green River, a mix of residential and agricultural land uses within the Middle Green River, to a mix of dense residential, industrial, and commercial development in the Lower Green River (King County 2000). Fundamental historical changes to WRIA 9 include the diversion of the White River from the Green River to the Puyallup River (1911), the diversion of the Black and Cedar Rivers from the Duwamish River to Lake Washington (1916), the filling, draining, or dredging of the Duwamish estuary tidelands (1900-1940), the channelization and diking of the Duwamish-Green River (1945-2000), and the construction of the Howard Hanson Dam (1962).

The Habitat Limiting Factors and Reconnaissance Assessment (Kerwin 2000) lists the following primary limiting factors and impacts within the Duwamish-Green watershed:

- Dams and other fish passage barriers
- Loss of riparian habitat
- Excessive sedimentation
- Decreased water quality (pollution and elevated water temperatures)
- Altered mainstem and tributary hydrology
- Gravel starvation and scouring
- Disconnected floodplain habitat and loss of associated rearing habitats
- Introduction of non-native plant and animal species
- Loss of estuarine habitat
- Reduction of large woody debris and channel complexity
- Alteration/loss of marine nearshore habitat

Although there are some common issues across WRIA 9, habitat conditions vary within the watershed's subbasins and are described below.

Upper Green River

Areas around the Upper Green River have been extensively logged and the region is a mix of old-growth, second-growth, and recently logged areas. Logging practices around tributaries to the Upper Green River have resulted in reduced riparian habitat functions, creation of fish passage barriers, increased sedimentation, decreased water quality, and altered stream hydrology. However, the Upper Green River represents relatively intact habitat compared to river reaches below the Howards Hanson Dam. The dam, located at RM 64.5, is a barrier to upstream fish migration, although some salmonids are manually transported above the dam, providing them access to quality habitat upstream.

Upper Middle Green River, Mid Middle Green River, Lower Middle Green River

The Middle Green River was separated into three distinct subbasins separated by the river confluences with Newaukum and Franklin Creeks. The Middle Green River and its tributaries are mainly affected by residential and agricultural land uses. Levees and revetments have altered natural flow regimes, reduced side-channel and off-channel habitats, and constrained channel migration. Development has also created fish passage barriers, reduced in-channel large woody debris, increased impervious surfaces, and reduced and degraded riparian habitat. The Middle Green River is also affected by low streamflows (Lombard and Somers 2004).

Lower Green River

The Lower Green River subbasin combines the Lower Green River downstream from the Soos Creek confluence, the Black River, and Mill Creek. The Lower Green River is bordered by dense residential, commercial, and industrial development. Revetments and levees within the system have disconnected most side channels and tributaries from the active floodplain and degraded or eliminated riparian habitat. The Lower Green River is also affected by low streamflows (Lombard and Somers 2004; King County 2009).

Coal/Deep

The Coal/Deep subbasin combines the Coal Creek and Deep Creek watersheds and is characterized by a mixture of land uses including commercial forestry, rural residential development, and agriculture. Wildfires and commercial logging have degraded riparian habitat throughout the subbasin. Both creeks drain into small lakes without outlets; there is no surface water connection between this subbasin and the Green River. However, water likely seeps underground, and these lakes are considered important cold water sources to the Green River.

Newaukum Creek

The Newaukum Creek subbasin drains to the Green River and is dominated by agricultural development. The subbasin is an important source of spawning gravel to the mainstem Green River and supports healthy populations of Steelhead trout, and Coho and Chinook salmon. Intense agricultural development has severely degraded riparian habitat and eliminated off-channel and wetland habitat within the subbasin. Other stressors include a lack of large woody debris (LWD), numerous fish passage barriers, high levels of fecal coliform bacteria, high turbidity, and numerous bank modifications. Newaukum Creek is also affected by low streamflows (Lombard and Somers 2004; King County 2009).

Covington Creek, Jenkins Creek, Soos Creek

The Covington Creek and Jenkins Creek subbasins both drain to the Soos Creek subbasin which drains to the Green River. These subbasins are characterized by a mix of agriculture, urban, suburban, and rural residential or commercial development. Fish passage barriers, low instream flows, and high water temperatures limit upstream migration of adult salmonids in these subbasins. Erosion and sedimentation problems have been identified across the subbasins. Although these subbasins have some of the largest wetland areas in the Green River basin, past and current trends of drainage and filling wetlands limits this potential off-channel habitat.

Urbanization and development pressures are expected to increase demands on habitat within these subbasins. The Big Soos Creek system, including Jenkins and Covington Creeks, is also affected by low streamflows (Lombard and Somers 2004; King County 2009).

Duwamish River

The Duwamish River subbasin includes the Duwamish River and Longfellow Creek. This subbasin has been highly impacted by residential, commercial, and industrial development resulting in poor habitat quality. Over 97 percent of the original wetlands and sub-tidal habitats associated with the estuary have been filled over the last 100 years. Decreased water quality and increased sedimentation are both issues within the Duwamish River and Elliot Bay.

Central Puget Sound

The Central Puget Sound subbasin includes marine nearshore areas and independent tributaries to Puget Sound within WRIA 9. This subbasin has been substantially impacted by residential, commercial, and industrial development. Few natural areas or parks remain on the marine shoreline. Tidal flats and marshes have been filled or dredged. Salmonid habitat in these areas has been destroyed, altered, and degraded.

Priority Actions

The WRIA 9 Salmon Habitat Plan (WRIA 9 Steering Committee 2005) recommends a combination of projects and programs to protect, restore, rehabilitate, and substitute salmonid habitat and stream processes. Projects include excavating shallow water habitat in estuarine and marine nearshore habitats, installation of large woody debris in freshwater habitats, planting native vegetation and control of invasive weeds throughout the watershed, levee setbacks on the Green River mainstem, introduction of spawning gravel in the Green River mainstem, side channel reconnection, and the removal of bulkheads in marine nearshore habitats.

2.2 Watershed Planning in WRIA 9

Residents and local, state, federal, and tribal governments have collaborated on watershed and water resource management issues in WRIA 9 for decades. A brief summary of broad watershed planning efforts as they relate to the past, present, and future water availability in the Duwamish-Green watershed is provided below.

2.2.1 Other Planning Efforts in WRIA 9

This watershed plan builds on many of the past efforts to develop comprehensive plans for the entire watershed. For example, the South Central Action Area Caucus Group (South Central Local Integrating Organization) developed an ecosystem recovery plan, as part of the Action Agenda for Puget Sound Recovery. The planning process to develop an ecosystem recovery plan is community based with engagement by local, state, and federal agencies. The approach is holistic, addressing everything from salmon to orca recovery, stormwater runoff, and farmland and forest conservation.

The WRIA 9 Watershed Ecosystem Forum is the Salmon Recovery Lead Entity, a collaboration of local government, state and federal agencies, non-profits, and businesses interests focused on improving watershed health and salmon habitat recovery. The Watershed Ecosystem Forum developed the *Green/Duwamish and Central Puget Sound Salmon Habitat Plan* in 2005. Since 2005, the WRIA 9 Watershed Ecosystem Forum has worked to implement the *Salmon Habitat Plan* (WRIA 9 Steering Committee 2005).

The South Central LIO and WRIA 9 Watershed Ecosystem Forum include many of the same organizations and individuals that participate in the WRIA 9 Watershed Restoration and Enhancement Committee. This history of collaborative planning and shared priorities has supported the success of the Watershed Restoration and Enhancement Plan development in WRIA 9.

Coordinated Water System Plans (CWSPs) are mandated by the Public Water System Coordination Act of 1977. King County passed ordinances ratifying four CWSPs (East King County, Skyway, South King County, and Vashon). These plans ensure that water system service areas are consistent with local growth management plans and development policies. The location of new homes in relation to and within designated retail water system service areas and related policies determine if connection to a water system is available, or the new homes will need to rely on an alternative water source, most likely new permit-exempt domestic wells. Within their designated retail service area(s), water purveyors are given first right of refusal for new connections. The purveyor may decline to provide service if water cannot be made available in a 'reasonable and timely' manner. However, it can be the case that a new permit-exempt well is drilled without making any inquiries with the county or with the local water system.

2.2.2 Coordination with Existing Plans

Throughout the development of this watershed plan, Ecology streamflow restoration staff engaged with staff from the WRIA 9 Watershed Ecosystem Forum, South Central LIO, and the Puget Sound Partnership, providing briefings on the streamflow restoration law, scope of the watershed plan, and plan development status updates. Throughout the planning process, the WRIA 9 Committee has coordinated closely with the WRIA 9 Watershed Ecosystem Forum, including inviting lead entity staff to join the WRIA 9 Committee as an ex officio member, and selecting habitat projects based on information from the Salmon Habitat Plan.

King County planning staff contributed to the plan development to ensure consistency with the county's Comprehensive Plan. The comprehensive plan sets policy for development, housing, public services and facilities, and environmentally sensitive areas, among other topics. The comprehensive plan identifies King County's urban growth areas, sets forth standards for urban and rural development, and provides the basis for zoning districts.

2.3 WRIA 9 Geology, Hydrogeology, Hydrology, and Streamflow

2.3.1 Geologic Setting

Understanding the geologic setting of WRIA 9 helps to characterize surface and groundwater flow through the watershed. The relationships between surface water flow and deeper groundwater are important to understanding how to manage surface water resources and can be helpful in identifying strategies to offset the impacts of pumping from permit-exempt wells.

Within WRIA 9, bedrock forms mountain ranges and uplands and generally consists of igneous and sedimentary rocks. Within drainages and lowland areas, bedrock is overlain by glacial and alluvial sediments (Washington State Department of Natural Resources 2020). A minimum of four major glaciations covered the lower portion of the watershed during the Pleistocene Epoch (about 11,700 years to 2.6 million years ago), the most recent occurrence being the Vashon Stade of the Frasier Glaciation (Jones 1998; Vaccaro et al. 1998; Booth et al. 2003). The present topography and drainage network in WRIA 9 was shaped during the advance and retreat of the Vashon ice sheet (Evans 1996). These processes resulted in glacially-derived ridges and lakes linked by drainage channels (Booth and Goldstein 1994; Evans 1996). Pleistocene-age glacial and interglacial processes resulted in the deposition of a complex assemblage of sedimentary deposits in lowland areas. These glacial deposits consist of glacial till, recessional and advance outwash, and glaciolacustrine deposits. Glacial till deposits generally consist of dense, silty sand with gravel and silt lenses. Outwash deposits generally consist of sand and gravel with locally abundant wood debris and peat. Glaciolacustrine deposits generally consist of silt and clay. This sequence of glacial deposits is hundreds to thousands of feet thick within the lower portions of the watershed (Jones 1996).

Recent alluvial deposits are generally associated with channel and overbank deposits from the modern Duwamish and Green Rivers and their tributaries. These sediments generally consist of stratified silt, sand, gravel, and minor amounts of clay.

Deposits associated with the Osceola Mudflow outcrop are found in the south-central portion of the watershed, near the Cities of Enumclaw and Auburn (Washington State Department of Natural Resources 2020). The Osceola Mudflow is a sequence of lahar deposits that originated in eruptions and avalanche events that occurred at Mount Rainer approximately 5,600 years ago (Vallance and Scott 1997) .

2.3.2 Hydrogeologic Setting

The U.S. Geological Survey identified six hydrogeologic units within the sequence of Puget Sound glacial and alluvial sediments within WRIA 9 (Vaccaro et al. 1998). The hydrogeologic units typically alternate between aquifer units and semi-confining to confining layers (aquitards which lack sufficient permeability to form aquifers).

Within the upper portion of the watershed, glacial and alluvial sediments occur within the Green River valley and drainages associated with area tributaries. Glacial and alluvial sediments are widespread within the lower portion of the watershed and reach thicknesses exceeding 2,000 feet (Jones 1996; Vaccaro et al 1998). Shallow glacial and alluvial aquifers are generally unconfined (under water-table conditions) except where overlain by low permeability confining layers (generally till or glaciolacustrine deposits). Transmissivity (a hydraulic property related to the rate of groundwater flow through an aquifer) and storativity (a hydraulic property related to the capacity of an aquifer to store/release water) of these aquifers vary significantly with

depositional environment and are generally the highest in sands and gravels of glacial outwash and alluvial origin and lowest in fine-grained alluvial and glaciolacustrine deposits. Glacial and alluvial aquifers are characterized by a shallow depth to the groundwater table and, where applicable, a direct hydraulic connection with adjacent surface water.

Bedrock aquifers underlay the entire watershed. However, within the lower portions of the watershed, glacial and alluvial sediments are frequently hundreds of feet thick and bedrock aquifers are seldom targeted by water supply wells. Thickness of the glacial and alluvial hydrogeologic units generally thin to the east within WRIA 9. Much of the watershed southeast of Renton is underlain by relatively shallow and frequently outcropping bedrock.

Bedrock aquifers are generally of relatively low transmissivity and storativity. Wells completed within bedrock aquifers typically do not have high enough capacity for municipal use. However, they can be valuable aquifers for residential water uses, and in specific areas are an important target aquifer for permit-exempt wells.

Recharge to glacial, alluvial, and bedrock aquifers within WRIA 9 is primarily associated with precipitation, applied irrigation, septic systems, leakage from surface water within losing reaches (where streamflow infiltrates to groundwater), through leakage from adjacent aquifers, and mountain front recharge. Watershed aquifers discharge to water supply wells, adjacent aquifers, gaining reaches of streams, springs, wetlands, lakes, and Puget Sound. Summer base flows in WRIA 9 rivers and tributaries are sustained by groundwater (baseflow) on most of the lower-elevation tributaries.

Regionally, groundwater flow direction within watershed aquifers generally is perpendicular to the westerly slope of the Cascade Range, although groundwater flow in shallow aquifers is more influenced by surface topography and streamflow within the watershed and is directed to the northwest. This groundwater flow paradigm is complicated throughout the watershed by aquifer boundaries, aquifer heterogeneities, topography, the influence of gaining and losing stream reaches, well pumping, and other factors.

2.3.3 Hydrology and Streamflow

The Green River and its headwaters are located in a snowmelt transition region where the rivers are fed by both snowmelt and rainfall. Within low elevation portions of the watershed, mean annual precipitation ranges from about 30 to 40 inches per year. Mean annual precipitation increases with topographic elevation and can exceed 120 inches within the Cascade Range (MGS Engineering Service and Oregon Climate Service 2006). Most precipitation occurs during the late fall and winter. Precipitation is lowest during the summer when water demands are highest. During these low precipitation periods, streamflow is highly dependent upon groundwater inflow (baseflow).

Washington Administrative Code (WAC) 173-509 set minimum instream flows for the Green River and closed tributaries to the Green River and other streams to further consumptive appropriations.

The U.S. Army Corps of Engineers (Army Corps) operates Howard Hanson Dam and regulates flow in the Green River in coordination with the Green River Flow Management Committee

(Tacoma Public Utilities 2001). The Green River Flow Management Committee consists of representatives from the Army Corps, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Muckleshoot Indian Tribe, Washington Department of Fish and Wildlife, Washington Department of Ecology, King County Department of Natural Resources, and Tacoma Water. A 1995 agreement between Tacoma and the Muckleshoot Indian Tribe includes provisions for instream flows (Tacoma Water 2018). The City of Tacoma operates a diversion facility for municipal supply approximately three miles downstream from Howard Hanson Dam.

Duwamish River and Green River streamflow conditions are summarized by the following:

- USGS stream gage 12105900 (Green River below Howard Hanson Dam): At this upper watershed location, mean daily discharge ranges from 270 cubic feet per second (cfs) in August to 1,620 cfs in January (U.S. Geological Survey 2020).
- USGS stream gage 12113000 (Green River near Auburn): At this lower watershed location, mean daily discharge ranges from 311 cfs in August to 2,350 cfs in January, for the period from January 1962 through December 2019. This gage is one of the compliance points for instream flows in WAC 173-509, as well as the agreement between Tacoma Public Utilities and the Muckleshoot Indian Tribe. This is the furthest downstream gage not affected by tides.
- The USGS stream gage 12112600 (Soos Creek): This gage is on Big Soos Creek above the hatchery. Mean daily discharge ranges from 33 cfs in August to 253 cfs in January, for the period from October 1966 to July 2019.
- The USGS stream gage 12108500 (Newaukum Creek): This gage is on Newaukum Creek. For the period of record from July 1944 to September 2019 the mean daily flows were 19 cfs in August and 112 cfs in January.
- King County gages Jenkins Creek and Covington creeks (26A and 09A, respectively).

Anticipated future climate impacts will result in continued loss of snow in the Cascade Range, combined with rising temperatures and changes in precipitation. Earlier spring snowmelt, lower snowpack, increased evaporative losses, and warmer and drier summer conditions will intensify summer drought conditions and low flow issues in WRIA 9. These climate impacts are expected to drive changes in seasonal streamflows, increasing winter flooding while intensifying summer low flow conditions. For the Green River, climate modeling predicts average minimum flows to be 16 percent lower (range: -21 to -7 percent) by the 2080s for a moderate warming scenario, relative to 1970 to 1999 (Mauger et al. 2015).

Pumping from wells can reduce groundwater discharge to springs and streams by capturing water that would otherwise have discharged naturally. Groundwater pumping may diminish surface water flows. Consumptive water use (that portion not returned to the immediate water environment) potentially reduces streamflow, both seasonally and as average annual recharge. A well drawing from an aquifer connected to a surface water body either directly or through an overlying aquifer can either reduce baseflow or increase the quantity of water leaking out of the river (Culhane et al. 1995).

Chapter Three: Subbasin Delineation

3.1 Introduction to Subbasins

Water Resource Inventory Areas are large watershed areas formalized under Washington Administrative Code for the purpose of administrative water management and planning. WRIAs encompass multiple landscapes, hydrogeologic regimes, levels of development, and variable natural resources. To allow for meaningful analysis of the relationship between new consumptive use and offsets per Ecology's Final NEB Guidance,[6] the WRIA 9 Committee divided WRIA 9 into subbasins. This was helpful in describing the location and timing of projected new consumptive water use, the location and timing of impacts to instream resources, and the necessary scope, scale, and anticipated benefits of projects. In some instances, subbasins did not correspond with hydrologic or geologic basin delineations (e.g. watershed divides).[7]

3.2 Approach to Develop Subbasins

The WRIA 9 Committee divided WRIA 9 into 12 subbasins for purposes of assessing consumptive use and project offsets. The WRIA 9 Committee based their subbasin delineation on existing subwatershed units. The Committee used King County drainage basin boundaries (King County 2018) and applied the following guiding principles to delineate subbasins:

- Use hydrologic boundaries;
- Combine King County drainage basins within the Urban Growth Area with lower expected growth of new homes using PE wells; and
- Delineate subbasins at a finer scale in the area of the watershed expected to have the most new homes using PE wells (the Middle Green River).

The WRIA 9 subbasin delineations are shown in Figure 3.1 and summarized below in Table 3.1. A more detailed description of the subbasin delineation is in the technical memo available in Appendix E. The technical memo also describes other adjustments made to align the subbasin boundaries with the WRIA 9 planning boundary.

[6] "Planning groups must divide the WRIA into suitably sized subbasins to allow meaningful analysis of the relationship between new consumptive use and offsets. Subbasins will help the planning groups understand and describe location and timing of projected new consumptive water use, location and timing of impacts to instream resources, and the necessary scope, scale, and anticipated benefits of projects. Planning at the subbasin scale will also allow planning groups to consider specific reaches in terms of documented presence (e.g., spawning and rearing) of salmonid species listed under the federal Endangered Species Act." Final NEB Guidance p. 7 (Ecology 2019).

[7] This is consistent with Final NEB Guidance that defines subbasins as a geographic subarea within a WRIA. A subbasin is equivalent to the words "same basin or tributary" as used in RCW 90.94.030(3)(b).

Table 3.1: WRIA 9 Subbasins

Subbasin Name	**Primary Rivers and Tributaries**	**County**
Central Puget Sound	Streams draining directly to Puget Sound between the City of Federal Way and the City of Seattle, including Seola Creek, Salmon Creek, Miller Creek, and Des Moines Creek	King County
Duwamish River	Longfellow Creek and Duwamish River	King County
Lower Green River	Green River below river mile 32, including Black River and Mill Creek	King County
Soos Creek	Soos Creek	King County
Jenkins Creek	Jenkins Creek	King County
Covington Creek	Covington Creek	King County
Lower Middle Green River	Green River starting at river mile 32 to the confluence with Newaukum Creek	King County
Mid Middle Green River	Green River between the confluence with Newaukum Creek and confluence with Franklin Creek	King County
Upper Middle Green River	Green River between the confluence with Franklin Creek and Howard Hanson Dam	King County
Newaukum Creek	Newaukum Creek	King County
Coal/Deep Creek	Coal Creek and Deep Creek	King County
Upper Green River	Green River above Howard Hanson Dam	King County

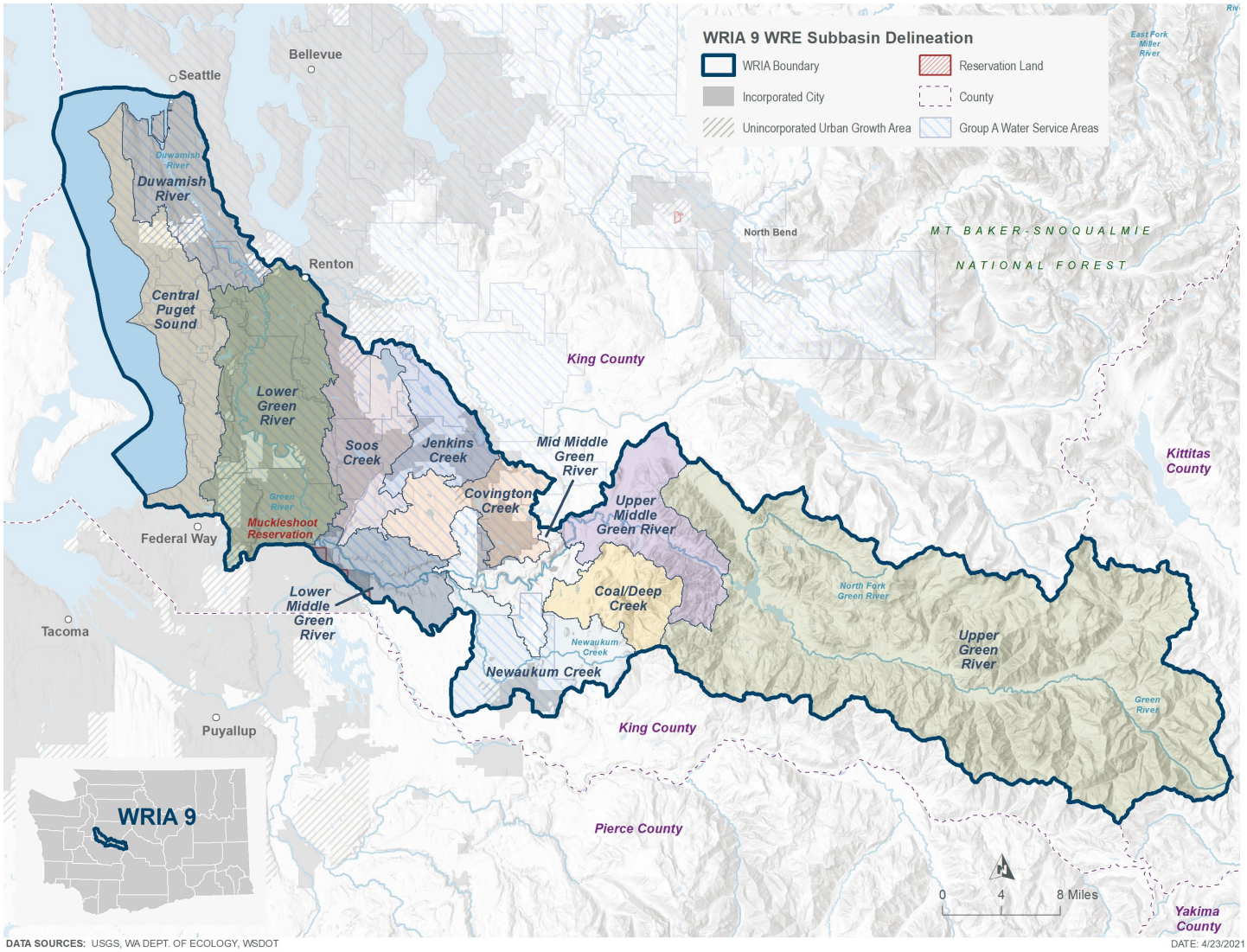


Figure 3.1: WRIA 9 Subbasin Delineation

Chapter Four: New Consumptive Water Use Impacts

4.1 Introduction to Consumptive Use

The Streamflow Restoration law requires watershed plans to include "estimates of the cumulative consumptive water use impacts over the subsequent twenty years, including withdrawals exempt from permitting under RCW 90.44.050" (RCW 90.94.030(3)(e)). The Final NEB Guidance states that, "Watershed plans must include a new consumptive water use estimate for each subbasin, and the technical basis for such estimate" (pg. 7). This chapter provides the WRIA 9 Committee's projections of new permit-exempt domestic well connections (PE wells) and their associated consumptive use for the 20-year planning horizon.[8] This chapter summarizes information from the technical memos (Appendices F and G) prepared for, and reviewed by, the WRIA 9 Committee.

4.2 Projection of New Permit-Exempt Domestic Well Connections (2018 - 2038)

The WRIA 9 Committee projects 632 new PE wells over the planning horizon. Most of these wells are likely to be installed outside of the Urban Growth Area in the following subbasins: Soos Creek, Lower Middle Green River, Mid Middle Green River, Upper Middle Green River, and Newaukum Creek.

The WRIA 9 Committee developed a method that they agreed was appropriate to project the number of new PE wells over the planning horizon in WRIA 9, in order to estimate new consumptive water use. This method, referred to as the PE well projection method, is based on recommendations from Appendix A of Ecology's Final NEB Guidance (Ecology 2019). The following sections provide the 20-year projections of new PE wells for each subbasin within WRIA 9, the methods used to develop the projections (PE well projection method), and uncertainties associated with the projections.

4.2.1 PE Well Connections Projection by Subbasin

This WRIA 9 watershed plan compiles the King County PE well projection data at both the WRIA scale and by subbasin. The projection for new PE wells in WRIA 9 by subbasin is shown in Table 4.1 and Figure 4.1.

[8] New consumptive water use in this document is from projected new homes connected to permit-exempt domestic wells associated with building permits issued during the planning horizon. Generally, new homes will be associated with wells drilled during the planning horizon. However, new uses could occur where new homes are added to existing wells serving group systems under RCW 90.44.050. In this document the well use discussed refers to both these types of new well use. PE wells may be used to supply houses, and in some cases other Equivalent Residential Units (ERUs) such as small apartments. For the purposes of this document, the terms "house" or "home" refer to any permit-exempt domestic groundwater use, including other ERUs.

Table 4.1: Number of PE Wells Projected between 2018 and 2038 for the WRIA 9 Subbasins

Subbasins	King County	Urban Growth Areas	Total PE Wells per Subbasin
Central Puget Sound	0	0	0
Duwamish River	0	0	0
Lower Green River	0	4	4
Soos Creek	72	11	83
Jenkins Creek	44	1	45
Covington Creek	41	0	41
Lower Middle Green River	81	3	84
Mid Middle Green River	100	0	100
Upper Middle Green River	110	0	110
Newaukum Creek	102	1	103
Coal Deep Creek	62	0	62
Upper Green River	0	0	0
Totals	**612**	**20**	**632**

The total projection for WRIA 9 is 632 new PE wells. King County projects approximately 612 new PE wells over the planning horizon within WRIA 9 portions of unincorporated King County. The King County method did not account for potential PE wells in cities or UGAs so the WRIA 9 Committee completed an analysis of potential new PE wells within the UGAs and projected 20 new PE wells (UGA Well Log Spot Check).

4.2.2 Methodology

The WRIA 9 Committee conferred with King County to identify an appropriate method of projecting PE wells within its jurisdiction. King County used historical building data to project new potential PE wells, assuming the rate and general location of past growth will continue over the 20-year planning horizon. Using past building permits to predict future growth is one of the recommended methods in the Final NEB Guidance (Ecology 2019). Due to data availability, King County considered historical rates of connection to water service within water service area boundaries to estimate the number of homes that would be served by community

water systems and municipalities, and remove those from the PE well projection.[9] King County completed the analyses in-house and the methods are described in detail in Appendix F.

The WRIA 9 Committee also looked at potential PE wells within the UGAs using data from Ecology's Well Report Viewer database.

King County completed a PE Well Potential Assessment which identified potential parcels where development could occur within rural King County. The PE Well Potential Assessment results were used to assess whether a subbasin (as identified by the Committee) has the capacity to accommodate the number of PE wells projected over the 20-year planning horizon.

All methods are summarized in the sections below. The WRIA 9 Growth Projections Technical Memorandum provides a more detailed description of the analysis and methods (Appendix F).

King County PE Well Projection Methodology

King County used historical residential building permit and parcel data from 2000 through 2017 to project the number of new PE wells for the planning horizon in unincorporated King County (referred to as the past trends analysis). This data set considers economic and building trends over an 18-year period and the method assumes that past trends will continue.

King County projected the number of new PE wells over the planning horizon using the following steps:

1. Gather historical building permit and parcel data (2000–2017) for new residential structures.[10]
2. Assess the total number of permits and average number of permits per year for WRIA 9.
3. Link building permit and parcel data to determine water source for each building permit/parcel and separate into public, private, and other water source categories. Consider a building permit with water source listed as "private" as a PE well.
4. Calculate the number and percentage of building permits for each type of water source (public, private, or other) inside and outside water services areas by subbasin, and for the WRIA overall.

The WRIA 9 Committee used the King County past trends analysis to develop PE well projections by subbasin using the following steps:

5. Calculate the projected number of PE wells per year for each subbasin by multiplying the average number of building permits per year by the percentage of building permits

[9] Water service area boundaries include areas currently served by existing water lines and may also include areas not yet served by water lines. King County used historic rates of connection to water service to predict future rates of connection because King County does not have County-wide information on the location of water lines.

[10] King County used the time period 2000 through 2017 because that data was available. The building permit data for 2000 through 2017 includes both periods of high growth and periods of low growth. King County compared these data with information from the Vision 2040 regional plan and population data and is confident in using the average of this time period to project into the future.

per subbasin, and percentage of building permits using a private water source (well) per subbasin.

6. Multiply the projected number of PE wells per year per subbasin by 20 to calculate the total of PE wells projected over the 20-year planning horizon for each subbasin.
7. Add 6% to the 20-year PE well projection per subbasin to account for gaps in the building permit and parcel data (6% error is based on the percentage of building permits with "other" as the water source).
8. Tabulate the total PE wells projected over the 20-year planning horizon, including the 6% error, for each subbasin and sum to get the total of PE wells projected over the 20-year planning horizon in rural unincorporated King County.

Urban Growth Area PE Well Projection Methodology

The King County PE well projection methods do not account for potential PE wells within cities or UGAs. However, the WRIA 9 Committee recommended looking at the potential for PE well growth within UGAs. The WRIA 9 Committee completed an analysis of potential PE well growth within the incorporated and unincorporated UGAs using data from Ecology's Well Report Viewer database (referred to as the UGA well log spot check).

The general method included using Ecology's Well Report Viewer database (1998–2018) to query water wells with characteristics of a domestic well[11] within UGAs. The Committee randomly reviewed a subset of the water well reports and calculated the number and percentage of each type of well (domestic, irrigation, other and incorrect) located within the UGAs. They then multiplied the percentage of wells identified as domestic (assumed to be PE wells) by the total number of wells located within UGAs to estimate the number of PE wells installed in UGAs over the past 20-year period. The Committee also cross-checked the physical address of the wells with the UGA boundaries to determine which subbasin the domestic wells were located in. The Committee used the total number of domestic wells per subbasin over the past 20 years to project the number of PE wells located within the UGAs over the planning horizon for each WRIA 9 subbasin. A more detailed methodology is included in Appendix F.

King County PE Well Potential Assessment

King County completed an assessment of parcels available for future residential development in unincorporated King County (referred to as the PE well potential assessment). The Committee used the PE Well Potential Assessment to assess whether a subbasin has the capacity to accommodate the number of PE wells projected over the 20-year planning horizon.

King County used screening criteria to identify parcels with potential for future residential development by subbasin. The total number of parcels and dwelling units[12] (DUs) per subbasin

[11] Ecology's complete Well Report Viewer database was filtered for water wells 6 to 8 inches in diameter and greater than 30 feet deep, which are typical dimensions and depths for domestic wells. The Ecology Well Report Viewer database does not have the ability to filter for permit-exempt domestic wells.

[12] A dwelling unit is a rough estimate of subdivision potential based on parcel size and zoning (e.g. a 22-acre parcel zoned RA-5 is assumed to have 4 dwelling units).

were determined and labeled as inside or outside the water district service boundaries. King County then projected the water source for each parcel (public water or PE well) based on historic rates of connection to water service inside water district service boundaries. King County used historic rates of connection to water service because the County does not have County-wide information on the location of water lines. The WRIA 9 Committee compared the 20-year PE well projection to the PE well potential assessment. In areas where the number of projected PE wells exceeded the potential parcels available, the Committee reallocated those PE wells to the nearest subbasin with parcel capacity and similar growth patterns. The WRIA 9 Committee redistributed 20 wells from the Newaukum Creek subbasin to the Mid Middle Green River subbasin. A more detailed methodology and list of assumptions is included in Appendix F.

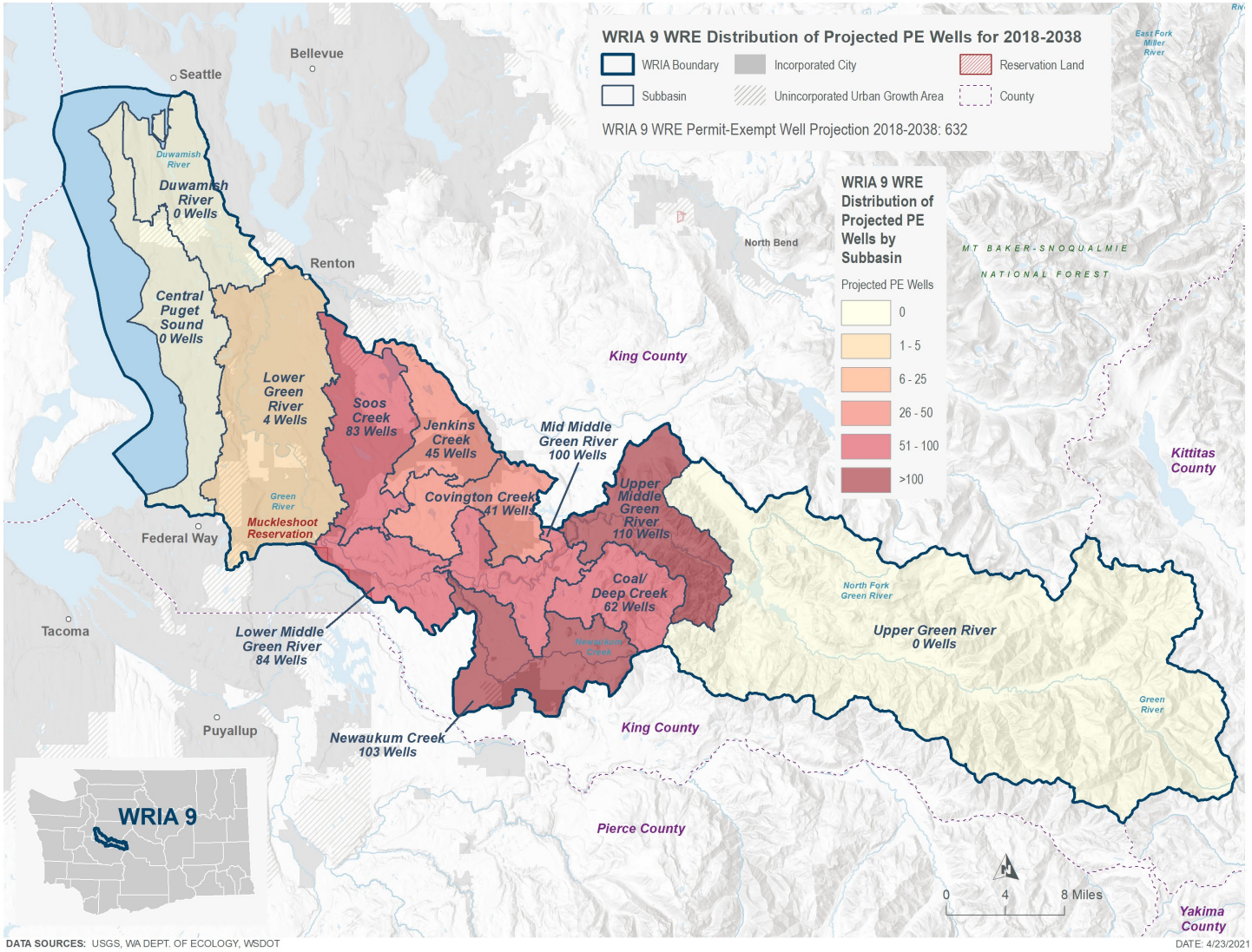


Figure 4.1: WRIA 9 Distribution of Projected PE Wells for 2018-2038

4.3 Impacts of New Consumptive Water Use

The WRIA 9 Committee used the 20-year projection of new PE wells for WRIA 9 (632) to estimate the new consumptive water use (consumptive use) that this watershed plan must address and offset. The WRIA 9 Committee estimates 247.7 acre-feet per year (AFY) (0.34 cfs) of new consumptive water use in WRIA 9. The WRIA 9 Committee added a safety factor to the consumptive use estimate to account for uncertainties in the PE well projections and consumptive use estimate, including higher rates of water use that could result from climate change and changing development patterns. The WRIA 9 Committee sought projects to offset at least 495.4 AFY (hereafter referred to as the offset target), a safety factor of two times the consumptive use estimate of 247.7 AFY.

This section includes an overview of the methods used by the WRIA 9 Committee to estimate new consumptive water use and an overview of the anticipated impacts of new consumptive use in WRIA 9 over the planning horizon. The WRIA 9 Consumptive Use Estimates Technical Memorandum provides a more detailed description of the analysis and alternative scenarios considered (Appendix G).

4.3.1 Methods to Estimate Indoor and Outdoor Consumptive Water Use

Indoor water use patterns differ from outdoor water use. Indoor use is generally constant throughout the year, while outdoor use occurs primarily in the summer months. Also, the portion of water that is consumptive varies for indoor and outdoor water use. Appendix A of the Final NEB Guidance (Ecology 2019) describes a method (referred to as the Irrigated Area Method) which assumes average indoor use per person per day, and reviews aerial imagery to provide a basis to estimate irrigated area of outdoor lawn and garden areas. The Irrigated Area Method accounts for indoor and outdoor consumptive use variances by using separate approaches to estimate indoor and outdoor consumptive use.

To develop the consumptive use estimate, the WRIA 9 Committee used the Irrigated Area Method and relied on assumptions for indoor use and outdoor use from Appendix A of the Final NEB Guidance. This chapter provides a summary of the technical memo which is available in Appendix G.

Consistent with the Final NEB guidance (Appendix B, pg. 25), the Committee assumed impacts from consumptive use on surface water are steady-state, meaning impacts to the stream from pumping do not change over time. This assumption is based on the wide distribution of future well locations and depths across varying hydrogeological conditions.

The WRIA 9 Committee looked at other scenarios for estimating consumptive use, including (1) assuming each home has 0.5-acre irrigated lawn area (legal maximum per PE well[13]) and (2) assuming each home uses 950 gallons of water per day (legal withdrawal limit per PE well

[13] Per RCW 90.44.050

connection[14]). The Committee chose a consumptive use estimate based on the Irrigated Area Method. The technical memo in Appendix G includes the additional consumptive use scenarios and results.

New Indoor Consumptive Water Use

Indoor water use refers to the water that households use in kitchens, bathrooms, and laundry (Ely and Kahle 2012). The WRIA 9 Committee used the Irrigated Area Method and Ecology's recommended assumptions for indoor daily water use per person, local data to estimate the average number of people per household, and applied Ecology's recommended consumptive use factor to estimate new indoor consumptive water use (Ecology 2019). The assumptions the WRIA 9 Committee used to estimate household consumptive indoor water use are:

- 60 gallons per day (gpd) per person.
- 2.73 persons per household assumed for rural portions of King County.
- 10% of indoor use is consumptively used (or a consumptive use factor (CUF) of 0.10), based on the assumption that homes on PE wells are served by onsite sewage systems (septic). Onsite sewage systems return most wastewater back to the immediate water environment; a fraction of that water is lost to the atmosphere through evaporation in the drainfield.

The equation used to estimate household consumptive indoor water use is:

60 gpd x 2.73 people per house x 365 days x .10 CUF

This results in an annual aggregated average of 0.0183 AF[15] (16.4 gpd or 0.000025 cfs[16]) indoor consumptive water use per day per well.

New Outdoor Consumptive Water Uses

Most outdoor water use is for irrigating lawns, gardens, and landscaping. To a lesser extent, households use outdoor water for car and pet washing, exterior home maintenance, pools, and other water-based activities. Water from outdoor use does not enter onsite sewage systems, but instead typically infiltrates into the ground or is lost to the atmosphere through evapotranspiration (Ecology 2019).

The WRIA 9 Committee used aerial imagery to measure the irrigated areas of 211 parcels in eight[17] WRIA 9 subbasins with projected PE wells to develop an average outdoor irrigated area

[14] Legal withdrawal limits from PE wells in WRIA 9 are defined in RCW: "an applicant may obtain approval for a withdrawal exempt from permitting under RCW 90.44.050 for domestic use only, with a maximum annual average withdrawal of nine hundred fifty gallons per day per connection" RCW 90.94.030(4)(a)(vi)(B).

[15] Acre-foot is a unit of volume for water equal to a sheet of water one acre in area and one foot in depth. It is equal to 325,851 gallons of water. 1 acre-foot per year is equal to 893 gallons per day.

[16] Cubic feet per second (CFS) is a rate of the flow in streams and rivers. It is equal to a volume of water one foot high and one foot wide flowing a distance of one foot in one second. 1 cubic foot per second is equal to 646,317 gallons per day.

[17] The analysis covered 8 of the 9 subbasins in WRIA 9 with projected PE well connections. The Lower Green River subbasin (with 4 projected PE wells) did not have any recent building permits for sites without purveyor-provided

per subbasin. Parcels used for the irrigated footprint analysis were selected based on recent (2006-2017) building permits for new single-family residential homes not served by public water. All new home building permit sites in WRIA 9 were included in the analysis. The average irrigated area for 211 parcels, when aggregated across subbasins, was 0.30 acres per parcel.

The WRIA 9 Committee used the following assumptions, recommended in Appendix A of the Final NEB Guidance, to estimate household outdoor consumptive water use:

- The amount of water needed to maintain a lawn varies by subbasin due to varying temperature and precipitation across the watershed. The Committee used the Washington Irrigation Guide (WAIG) (NRCS-USDA 1997) station in Seattle-Tacoma, Kent, and surrounding stations to develop a weighted average crop irrigation requirement (IR) for turf grass in each subbasin (the WRIA average IR is 14.62 inches). This value represents the amount of water needed to maintain a green lawn.
- The irrigation application efficiency (AE) used for WRIA 9 was the Ecology-recommended value of 75%. This increases the amount of water used to meet the crop's irrigation requirement.
- Consumptive use factor (CUF) of 0.8, reflecting 80% consumption for outdoor use. This means 20% of outdoor water is returned to the immediate water environment.
- Outdoor irrigated area per subbasin based on the irrigated footprint analysis (the WRIA average irrigated area size is 0.30 acres per PE well).

The equation used to estimate outdoor consumptive indoor water use is:

IR by subbasin (inches) ÷ 0.75 AE x average irrigated area by subbasin (acres) x 0.80 CUF

First, water loss is accounted for by dividing the crop irrigation requirement by the application efficiency. Next, the total water depth used to maintain turf is multiplied by the area which is irrigated. Finally, the volume of water is multiplied by 80 percent to produce the outdoor consumptive water use. To convert the equation from inches to acre-feet, divide the result by 12.

The result is total outdoor consumptive water use per PE well per subbasin ranging from 0.19 AFY in the Coal/Deep subbasin to 0.59 AFY in the Lower Middle Green River subbasin. The outdoor consumptive use varies by subbasin due to differences in average outdoor irrigated area size and irrigation requirements across the watershed. This is the total annual estimated consumptive use, however the Committee expects that more water use will occur in the summer than in the other months.

4.4 Consumptive Use Estimate for WRIA 9 and by Subbasin

The total consumptive use estimate for WRIA 9 is 247.7 AFY (0.34 cfs). The total consumptive use estimate for WRIA 9 is the number of PE wells projected by subbasin (see section 4.3)

water service, so the average irrigated area for the adjacent Soos Creek subbasin was applied to the Lower Green River subbasin for purposes of consumptive use estimates.

multiplied by the total indoor and outdoor consumptive use per PE well. Table 4.2 summarizes the estimated indoor and outdoor consumptive use by subbasin using the Irrigated Area Method. The highest consumptive use is expected to occur in the subbasin with the largest irrigated area per PE well and the most anticipated new PE wells, as presented in Figure 4.2.

Table 4.2: Consumptive Use (CU) Estimate Based on Irrigated Area Method (1 Home + Subbasin Average Lawn)

Subbasin	Projected PE Wells	Average Lawn Size (Acres)	Indoor CU Per Well (AFY)	Outdoor CU Per Well (AFY)	Total CU/Year Per Well (AFY)	Total CU 2018-2038 (AFY)
Central Puget Sound	0	-	-	-	-	0
Duwamish River	0	-	-	-	-	0
Lower Green	4	0.3	0.0183	0.51	0.53	2.1
Soos Creek	83	0.3	0.0183	0.48	0.50	41.4
Jenkins Creek	45	0.3	0.0183	0.45	0.47	21.2
Covington Creek	41	0.4	0.0183	0.51	0.52	21.5
Lower Middle Green River	84	0.4	0.0183	0.59	0.61	51.0
Mid Middle Green River	100	0.3	0.0183	0.30	0.32	31.9
Upper Middle Green River	110	0.2	0.0183	0.23	0.24	26.9
Newaukum Creek	103	0.3	0.0183	0.36	0.38	39.0
Coal/Deep Creek	62	0.2	0.0183	0.19	0.20	12.6
Upper Green River	0	-	-	-	-	0
WRIA 9	**632**	**0.3**	**0.0183**	**0.42**	**0.43**	**247.7**

Note: Values in table have been rounded.

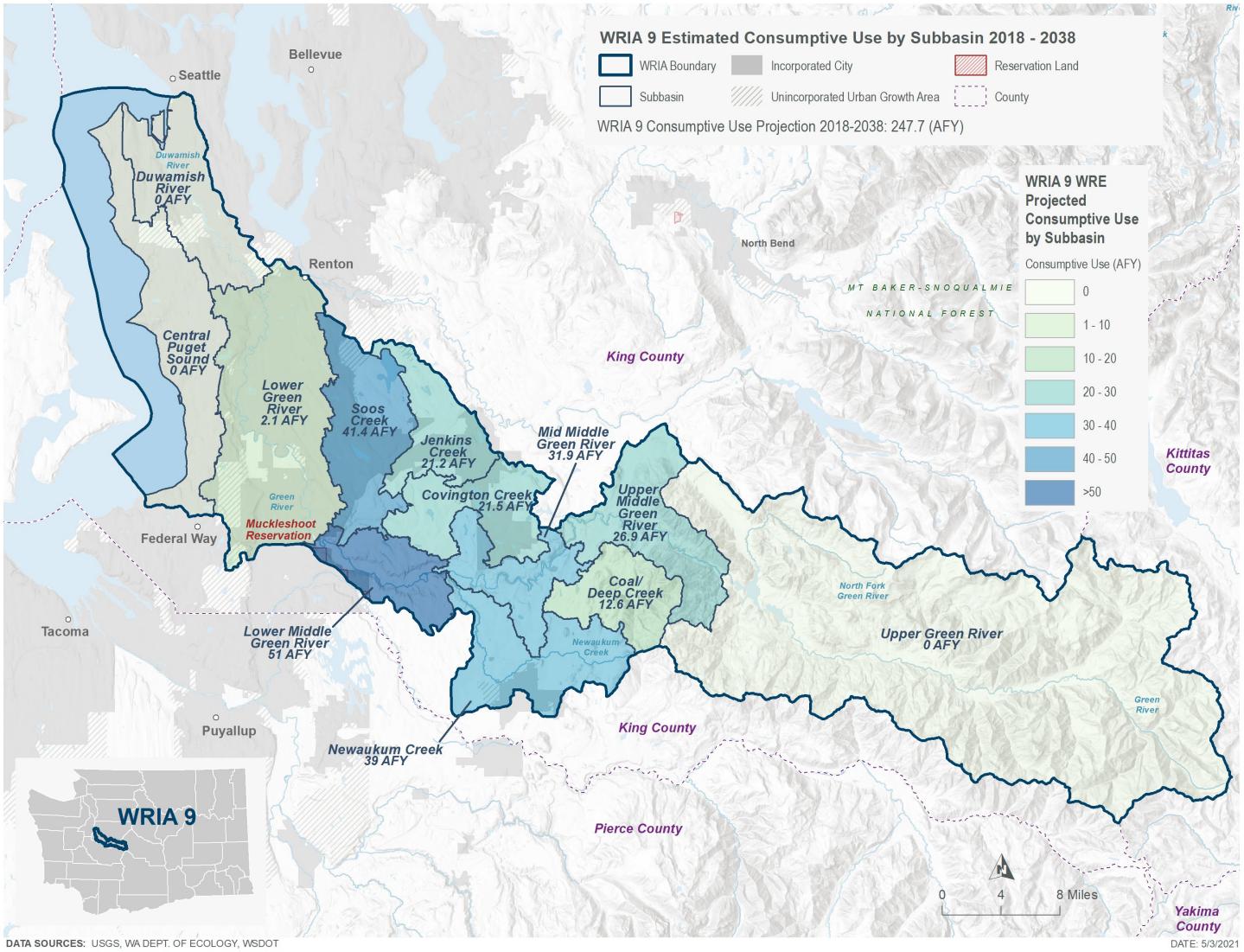


Figure 4.2: WRIA 9 Estimated Consumptive Use by Subbasin 2018-2038

4.5 Summary of Uncertainties and Scenarios

The methods described in Section 4.3 for projecting new PE wells include a number of uncertainties, which were discussed by the WRIA 9 Committee. The Committee recognized uncertainties as inherent to the planning process and addressed uncertainties where feasible. The uncertainties are shared here to provide transparency in the planning process and deliberations of the Committee.

Historical data on the number and location of PE wells within WRIA 9 was not available to inform PE well projections. Therefore, the WRIA 9 Committee relied on building permit data, and agreed on assumptions about the water source, in order to estimate the numbers of past and future PE wells.

Another example of uncertainty is that the County projected new PE wells within unincorporated areas and omitted PE wells installed within city limits, including PE wells installed for lawn watering purposes. Although most cities require new homes to connect to water systems, some allow exceptions if a connection is not available (for instance, if a home is more than 200 feet from a water line), or allow a home to install a PE well for outdoor water use. The WRIA 9 Committee addressed this uncertainty by including a projection for new PE wells within the UGAs.

King County relied on historical data and assumed that these historical building trends will continue into the future. However, water service areas and water lines continue to grow and expand. Water line data was not readily available in King County, so the WRIA 9 Committee was not able to compare actual water lines with the historical data to see if and how the water service has expanded. Additionally, future building trends may not mirror historical building trends as the county and cities continue to direct growth to urban areas (with access to public water service) to preserve rural and resource lands and protect critical areas.

RCW 90.94 requires counties to collect fees for new homes that rely on PE wells and provide a report and portion of those fees to Ecology. King County shared information on the fees collected since those requirements went into effect in January of 2018. King County reported 24 building permits with PE wells identified as the water source within the WRIA 9 portion of unincorporated King County between January 2018 and June 2020. Twenty-four new wells over the 30-month period averages to around 10 new PE wells per year. The WRIA 9 Committee projected approximately 32 new PE wells per year.

The Irrigated Area Method used to estimate consumptive use (described in Section 4.3.1) contains a number of uncertainties and limitations. Measurement of consumptive water use in any setting is difficult, and it is virtually impossible for residential groundwater use, which must account for both indoor and outdoor use. PE wells are generally unmetered, so supply to each home is usually unknown, let alone the amount that is lost to the groundwater system. Therefore, the WRIA 9 Committee was limited to estimating consumptive use based on projections of future growth, local patterns and trends in water use, and generally accepted and reasonable assumptions.

The outdoor consumptive use calculation contains the most uncertainty. In aerial photos used to calculate average irrigated area, many parcels did not demonstrate a clear-cut distinction

between irrigated and non-irrigated lawns and other landscaped areas. It appears that many homeowners irrigate enough to keep lawns alive but not lush (or comparable to quality of commercial turf grass). The WRIA 9 Committee addressed uncertainty and ensured consistency by applying conservative methods that err on the side of a higher irrigated area and having one Geographic Information System (GIS) analyst evaluate all of the selected parcels in the WRIA. Assumptions for the aerial imagery analysis are described in detail in Appendix G.

Other factors of uncertainty in the outdoor consumptive use calculation are the assumptions about irrigation amounts and irrigation efficiencies. The calculation assumes that homeowners water their lawns and gardens at the rate needed for commercial turf grass (e.g., watering at rates that meet crop irrigation requirements per the WAIG). The irrigated area analysis demonstrated that many people irrigate their lawns enough to keep the grass alive through the dry summers, but not at the levels that commercial turf grass requires. The method also assumes that residential pop-up sprinkler systems irrigate the lawns with an efficiency of 75%. In reality, households apply water to their lawns and gardens in many different ways, some more efficient than a 25% water loss. The WRIA 9 Committee discussed these uncertainties and scenarios and recognized that there is a range of water use across the watershed and individual PE well owners.

The consumptive use estimate assumes that current rural residential landscaping practices and outdoor water use will continue over the 20-year planning horizon. Because of uncertainty inherent in estimating growth patterns, domestic PE well pumping rates, and potential changes in outdoor watering practices, the WRIA 9 Committee determined that the conservative assumptions used to estimate consumptive use based on the Irrigated Area Method, and assumptions for outdoor water use in particular, are justified.

To further address uncertainty and have a point of comparison, the Committee developed two additional consumptive use scenarios. One additional scenario assumed each home has the legal maximum 0.5-acre irrigated lawn area per PE well and resulted in a consumptive use estimate of 398.4 AFY for WRIA 9. The second additional scenario assumed each home withdraws the legal limit of 950 gallons per day for indoor and outdoor use and resulted in a consumptive use estimate of 456.9 acre-feet per year for WRIA 9. The technical memo in Appendix G includes the additional consumptive use scenarios and results.

The Committee also compared the Irrigated Area Method to local water purveyor data, taking into consideration several factors: customers connected to public water supply may have incentive to conserve water, in order to reduce their water bill; purveyor data represents total water use (not consumptive use) and does not separate indoor and outdoor water use to account for different consumptive use factors; and water purveyors also serve areas that are more dense and urban. Especially in portions of the watershed with older homes, homes and lawns are smaller and less water is used for irrigation, so a lower water use on average over the service area is expected. The technical memo in Appendix G includes the water purveyor data.

The WRIA 9 Committee developed a water offset target of 495.4 acre-feet per year to account for uncertainties in the PE well projection and consumptive use estimate, including higher rates of water use that could result from climate change and changing development patterns. The WRIA 9 Committee developed the water offset target by doubling the 247.7 acre-feet

consumptive use estimate. This number was compared with the consumptive use scenario that assumes all of the projected PE wells withdraw the legal limit of 950 gallons per day for indoor and outdoor use (456.9 AFY). The offset target of 495.4 AFY also accounts for uncertainties related to project implementation, further discussed in Chapters 5, 6, and 7.

The streamflow restoration law requires PE well users to manage stormwater runoff on-site to the extent practicable by maximizing infiltration, including using low-impact development techniques (RCW 90.94.030(4)(a)(vi)(C)). The benefits from these stormwater infiltration and low-impact development techniques are complex and hard to quantity. However, these unquantified benefits provide an additional factor of safety for the consumptive use estimate.

The WRIA 9 Committee also included plan implementation and adaptive management recommendations to address uncertainties related to the consumptive use estimate and project implementation (see Chapter 6).

Chapter Five: Projects and Actions

5.1 Approach to Identify and Select Projects

Watershed plans must identify projects that offset the potential impacts future PE wells will have on streamflows and provide a net ecological benefit to the WRIA. RCW 90.94.030(3)(b) requires the plan to offset consumptive use at the watershed scale, and states that "the highest priority recommendations must include replacing the quantity of consumptive water use during the same time as the impact and in the same basin or tributary. Lower priority projects include projects not in the same basin or tributary and projects that replace consumptive water supply impacts only during critical flow period."

This chapter provides recommendations from the WRIA 9 Committee for projects and actions to offset consumptive use and meet NEB. The projects are described in this chapter as water offset projects and habitat projects. Water offset projects have a quantified streamflow benefit and contribute to offsetting consumptive use. Habitat projects contribute toward achieving NEB by focusing on actions that improve the ecosystem function and resilience of aquatic systems, support the recovery of threatened or endangered salmonids, and protect instream resources, including important native aquatic species. Habitat projects may also result in an increase in streamflow, but the water offset benefits for these projects is difficult to quantify with a high degree of certainty. Therefore, the Committee did not rely on habitat projects to contribute toward offsetting consumptive use, however the Committee recognized they still provide value and therefore should be included in the plan.

The WRIA 9 Committee identified priorities for project types and locations to guide decisions on which projects to include in the plan. The Committee identified water rights acquisitions projects as a priority for inclusion in the plan. The Committee prioritized water offset projects in the following subbasins in the Middle Green area with higher projected PE wells and consumptive use: Soos, Jenkins, Covington, Lower Middle Green, Mid Middle Green, Upper Middle Green, and Newaukum. The Committee identified priority habitat projects in the following subbasins with both a higher potential impact from PE wells and critical salmon habitat needs: Lower Green, Soos, Lower Middle Green, Mid Middle Green, Upper Middle Green, and Newaukum.

To identify the projects summarized in this chapter, the WRIA 9 Committee assembled a project inventory to capture and track all project ideas throughout the planning process. The project inventory consisted of previously proposed projects as well as new project concepts and ideas.

Technical consultants supported the Committee's development of projects described in this chapter through researching project concepts, analyzing estimated water offset for projects, contacting project sponsors, and developing project descriptions. Initially, Ecology and the technical consultants identified projects with potential streamflow benefit from the WRIA 9 salmon recovery lead entity four-year workplans, the Puget Sound Action Agenda, streamflow restoration grant applications, and other ongoing planning efforts. These projects were assigned a project type consistent with the three project type examples listed in the Final NEB Guidance (Ecology 2019). These project types included: (a) water right acquisition offset

projects; (b) non-acquisition water offset projects; and (c) habitat and other related projects. The WRIA 9 Committee also distributed a Call for Projects to request information on water offset and habitat projects at all stages of development from Committee members and partners in WRIA 9.

Non-acquisition water offset projects were underrepresented within the WRIA 9 project inventory, which consisted largely of habitat and other related projects. Development of new non-acquisition water offset projects with quantifiable streamflow benefits became necessary in order for the plan to achieve the consumptive use offset. These projects are largely centered around changes in how and when water is diverted, withdrawn, conveyed, or used to benefit streamflow and instream resources. Examples include streamflow augmentation and managed aquifer recharge projects.

Non-acquisition water offset project development occurred through three main phases: (1) initial identification through brainstorming sessions during technical workgroup and Committee meetings; (2) prioritization and further analysis; (3) and development of project descriptions for projects included in the plan. Project progression from one phase to the next occurred after the Committee agreed to move the project to the next phase. The three non-acquisition water offset projects that the Committee selected for the plan are described below in section 5.2.1.

In a separate effort, Ecology contracted with Washington Water Trust (WWT) to identify opportunities for water right acquisition water offset projects within WRIA 9, including source switches to municipal water and reclaimed water. In coordination with the WRIA 9 Committee, WWT developed a water right selection criterion based on the unique local nature of water rights and water use in WRIA 9. The water rights assessment consisted of four categories of potential projects: irrigation water rights in priority subbasins, irrigation water rights near existing reclaimed water infrastructure, water rights in the Trust Water Rights Program as a temporary donation, and specific water right acquisition opportunities identified by the Committee. WWT developed eleven water right acquisition project opportunity profiles for consideration by the Committee. The three water rights acquisitions projects that the Committee selected for the plan are described below in section 5.2.1.

The technical workgroup initially developed a list of habitat projects by selecting projects that were in subbasins with higher projected PE wells, projects that are likely to have streamflow benefits, and projects located in areas with habitat critical for salmon. The technical workgroup recommended habitat projects to the Committee for review and the Committee decided to include those habitat projects in the plan. The ten habitat projects that the Committee selected for the plan are described below in section 5.2.2.

After selecting projects to include in the plan, the Committee used the following criteria to organize the list into tiers to reflect the location of the project with respect to subbasin priorities and the likelihood that the project will be implemented. Tier 1 projects provide benefits to priority subbasins and are more likely to be implemented and provide benefits in the near-term. Tier 2 projects are in lower priority subbasins, or are expected take longer to implement because they may need additional outreach to key stakeholders. Water offset projects and habitat projects were tiered separately. For water offset projects, this evaluation considered the following: magnitude of water offset benefit; timing of water offset benefit;

location of water offset benefit with respect to water offset priority subbasins; certainty of implementation; certainty of benefit and effectiveness; resiliency; and durability. For habitat projects, this evaluation considered the following: location of benefit with respect to water offset priority subbasins and habitat priority subbasins; projects which provide multiple benefits; certainty of implementation; certainty of benefit and effectiveness; resiliency; and durability. Since the projects were in different stages of development, with some still conceptual and some ready for implementation, the process to apply the tiering criteria and to create a tiered project list was subjective. The Committee relied on the technical workgroup to develop a recommendation on tiering based on their knowledge of the proposed projects as well as assumptions based on the design and performance of similar projects in the region. The tiering results are included in Table 5.1 and Table 5.2. The WRIA 9 Committee did not use tiering to indicate priorities for funding, and recommends funding for all projects included in the plan, with the water offset projects the highest priority for funding.

Water offset and habitat projects that the Committee selected to offset consumptive use and achieve NEB are summarized below in section 5.2.1 and 5.2.2. Detailed project descriptions and project profiles are included in Appendix H.

In addition to the water offset and habitat projects listed below, section 5.2.3 describes the types of projects and actions that the Committee supports for further development and implementation in the future.

5.2 Projects and Actions

The projects presented below have water offset and/or ecological benefits and the WRIA 9 Committee identified these projects as contributing toward offsetting consumptive use and achieving NEB. The WRIA 9 Committee recommends implementation of all projects included in this chapter.

5.2.1 Water offset projects

Table 5.1 provides a summary of the six water offset projects identified by the Committee to offset consumptive use and contribute toward NEB. The total offset potential for WRIA 9 is 1,075 acre-feet per year. Offset benefits are anticipated in the subbasins listed in Table 5.1 as well as downstream of the respective project locations. Figure 5.1 is a map of the watershed that shows the location of the projects listed in Table 5.1.

The WRIA 9 Committee supports the acquisition of the valid quantity of water for the water right acquisition projects included in the plan. However, to estimate the offset potential for each water right acquisition project, the WRIA 9 Committee used the estimate generated by WWT for the consumptively used portion of the water right. The estimated return flow portion of the water right is not counted as an offset as that portion of water returns to groundwater. Before water rights are acquired and put into the Trust Water Rights Program, Ecology will conduct a full extent and validity analysis to determine the actual quantity available for acquisition and the consumptive use offset component. Since this analysis generally happens after the water right holder has agreed to sell, the Committee relied on the WWT evaluations to estimate the offset volumes listed in Table 5.1. The WRIA 9 Committee recommends that

water right acquisitions projects include removal of water conveyance infrastructure that is no longer needed (e.g. wells, surface water diversions).

The tier 1 water offset projects included in the plan all have project sponsors and are in priority subbasins. Initial conversations with water right holders have occurred for tier 1 water offset projects that include water right acquisitions. Tier 2 projects have more uncertainty related to project implementation.

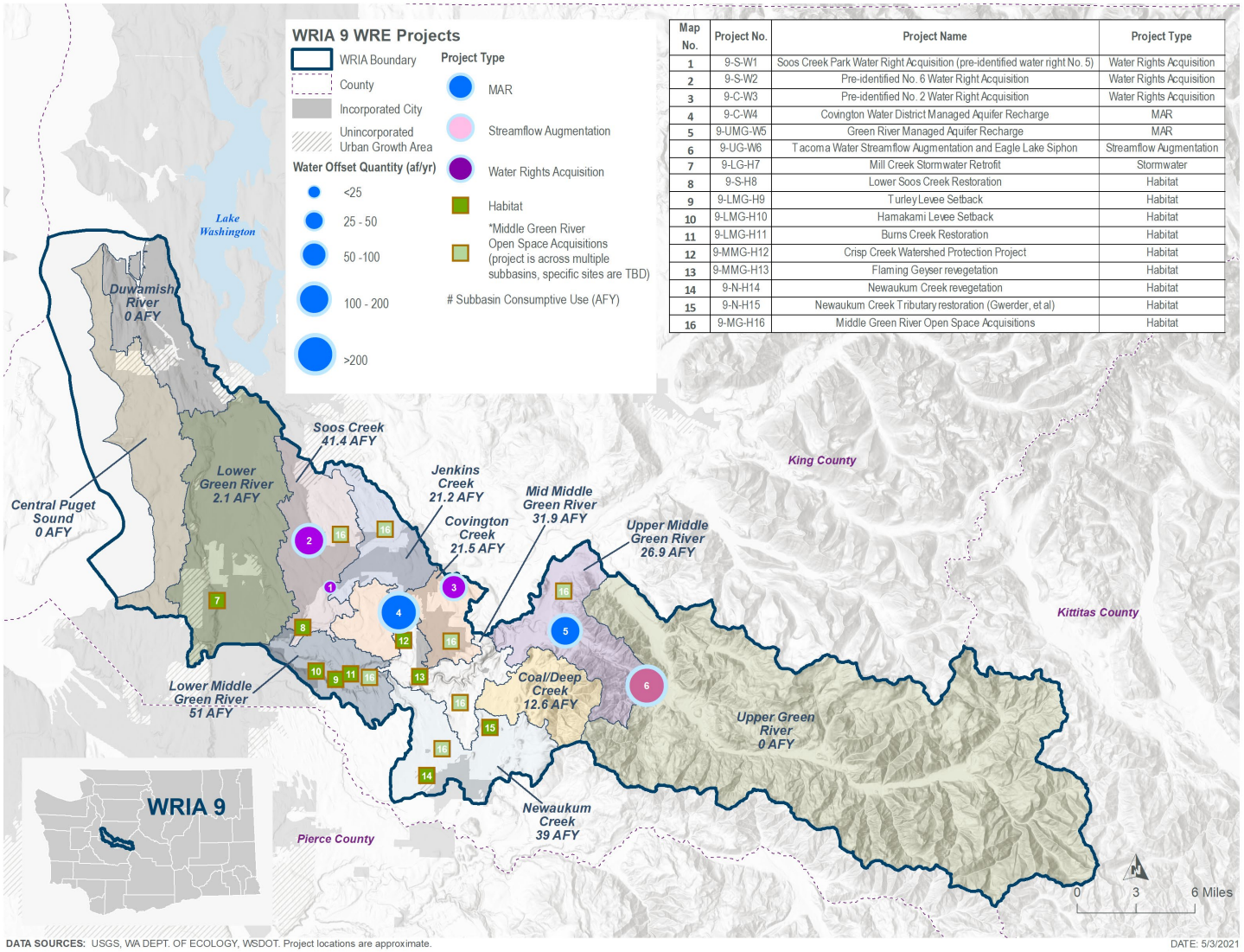
A summary description for each project is provided below. More detailed water offset project descriptions are provided in Appendix H.

Table 5.1: WRIA 9 Water Offset Projects

Project Number	Project Name	Project Type	Subbasin(s)	Water Offset (AFY)	Project Sponsor	Estimated Project Cost	Project Tier
9-S-W1	Soos Creek Park Water Right Acquisition (Pre-Identified Water Right No. 5)	Water right acquisition	Soos	11	King County	$28,300	1
9-S-W2	Pre-Identified No. 6 Water Right Acquisition	Water right acquisition	Soos	182	Washington Water Trust	$467,900	2
Soos Creek Subbasin Subtotal				**193**			
9-C-W3	Pre-Identified No. 2 Water Right Acquisition	Water right acquisition	Covington	54	Washington Water Trust	$138,800	1
9-C-W4	Covington Water District Managed Aquifer Recharge	Water storage and retiming - MAR	Covington	357	Covington Water District	$1,228,800	1
Covington Creek Subbasin Subtotal				**411**			
9-UMG-W5	Green River Managed Aquifer Recharge	Water storage and retiming - MAR	Upper Middle Green	114	Washington Water Trust	$1,125,500	1
Upper Middle Green River Subbasin Subtotal				**114**			
9-UG-W6	Tacoma Water Streamflow Augmentation and Eagle Lake Siphon	Streamflow augmentation	Upper Green	357	Tacoma Water	$400,000	1
Upper Green River Subbasin Subtotal				**357**			

Project Number	Project Name	Project Type	Subbasin(s)	Water Offset (AFY)	Project Sponsor	Estimated Project Cost	Project Tier
WRIA 9 Total Water Offset (Cumulative from above)				**1,075**		**$3,389,300**	
WRIA 9 Consumptive Use Estimate				**247.7**			
WRIA 9 Offset Target				**495.4**			

Notes:
[1] Tier 2 water right acquisition projects do not have detailed project descriptions in Appendix H.



Map No.	Project No.	Project Name	Project Type
1	9-S-W1	Soos Creek Park Water Right Acquisition (pre-identified water right No. 5)	Water Rights Acquisition
2	9-S-W2	Pre-identified No. 6 Water Right Acquisition	Water Rights Acquisition
3	9-C-W3	Pre-identified No. 2 Water Right Acquisition	Water Rights Acquisition
4	9-C-W4	Covington Water District Managed Aquifer Recharge	MAR
5	9-UMG-W5	Green River Managed Aquifer Recharge	MAR
6	9-UG-W6	Tacoma Water Streamflow Augmentation and Eagle Lake Siphon	Streamflow Augmentation
7	9-LG-H7	Mill Creek Stormwater Retrofit	Stormwater
8	9-S-H8	Lower Soos Creek Restoration	Habitat
9	9-LMG-H9	Turley Levee Setback	Habitat
10	9-LMG-H10	Hamakami Levee Setback	Habitat
11	9-LMG-H11	Burns Creek Restoration	Habitat
12	9-MMG-H12	Crisp Creek Watershed Protection Project	Habitat
13	9-MMG-H13	Flaming Geyser revegetation	Habitat
14	9-N-H14	Newaukum Creek revegetation	Habitat
15	9-N-H15	Newaukum Creek Tributary restoration (Gwerder, et al)	Habitat
16	9-MG-H16	Middle Green River Open Space Acquisitions	Habitat

Figure 5.1: WRIA 9 Projects

Soos Creek Subbasin

Project Name: Soos Creek Park Water Right Acquisition (Pre-Identified Water Right No. 5) (9-S-W1)

Project Description: The Soos Creek Park Water Right Acquisition Project proposes to acquire one surface water certificate in the Soos Creek subbasin for an estimated 11 acre-feet annually of consumptively used water. The source is an unnamed spring and the purpose of use is fish propagation and irrigation. This certificate refers to a surface water right that was temporarily donated (from 2020 to 2025) to the Trust Water Rights Program managed by Ecology. The place of use associated with the water right was previously used as a park with ponds and irrigation. Current use appears to be park/open space without ponds or irrigation.

WWT utilized irrigation delineation analysis to estimate consumptive use of 11 AFY. This is an estimate of consumptive use quantity. An extent and validity determination by Ecology would be required to determine the actual quantity available for acquisition.

Initial conversations have occurred between Ecology and King County regarding a transfer of this water right into the Trust Water Rights Program for permanent streamflow benefit. Additional information is included in the project profile in Appendix H.

Project Name: Pre-Identified No. 6 Water Right Acquisition (9-S-W2)

Project Description: The Pre-Identified Water Right Project No. 6 proposes to acquire three groundwater certificates in the Soos Creek subbasin for an estimated 182 acre-feet annually of consumptively used water. These certificates refer to groundwater rights associated with irrigation of a total of 120 acres. The place of use associated with the water right is a golf course. Water right documentation indicates that there are a total of four groundwater supply wells associated with these water right certificates.

WWT utilized irrigation delineation analysis to estimate consumptive use of 182 AFY. This is an estimate of consumptive use quantity. An extent and validity determination by Ecology would be required to determine the actual quantity available for acquisition.

WWT initiated outreach to this water right holder and, as of the time of this plan, did not receive a response.

Covington Creek Subbasin

Project Name: Pre-Identified No. 2 Water Right Acquisition (9-C-W3)

Project Description: The Pre-Identified Water Right Project No. 2 proposes to acquire one surface water certificate in the Covington Creek subbasin for an estimated 54 acre-feet annually of consumptively used water. The source is Ravensdale Lake and the purpose of use is industrial/processing of mineral products. The place of use associated with the water right is a former sand and gravel mining operation.

The water right holder considered donating this water right certificate to the Trust Water Rights Program three years ago but did not proceed. At that time, Ecology reviewed a beneficial use assessment conducted on behalf of the water right holder. Ecology confirmed the assessment,

which specified an associated beneficial use of as much as 106 AFY, with a consumptive portion of 54 AFY.

Initial outreach was completed by WWT and the water right holder is open to further discussions. Additional information is included in the project profile in Appendix H.

Project Name: Covington Water District Managed Aquifer Recharge (9-C-W4)

Project Description: Covington Water District (CWD) is proposing the placement of a managed aquifer recharge (MAR) infiltration facility on their property in King County, Washington. The project concept includes diverting water annually from CWD's existing drinking water pipeline, which runs along the northern site boundary, between approximately November 1 and April 30 when water is available using existing water rights. Diverted water would be conveyed from CWD's existing pipeline and piped to a constructed MAR facility. This diverted water infiltrates into the shallow aquifer, is transported down-gradient, and ultimately discharges to Covington Creek as re-timed groundwater baseflow. The goal of the project is to increase baseflow to Covington Creek, a tributary to Soos Creek and the Green River, by recharging the aquifer adjacent to the creek and providing additional groundwater discharge to the creek through MAR.

Initial calculations indicate the CWD MAR project could infiltrate approximately 357 acre-feet annually. Additional information is included in the project description in Appendix H.

Upper Middle Green River Subbasin

Project Name: Green River Managed Aquifer Recharge (9-UMG-W5)

Project Description: The Green River MAR project concept includes diverting surface water annually from the Green River during high flow periods when excess water may be available. Diverted water would be conveyed through a collector well adjacent to the river (e.g. Ranney Collector well) or through an instream surface water intake and piped to a constructed MAR facility. This diverted surface water infiltrates into the shallow aquifer, is transported down-gradient, and ultimately discharges back to surface water as re-timed groundwater baseflow. The goal of the project is to increase baseflow to the Green River by recharging the aquifer adjacent to the river and providing additional groundwater discharge to the river through MAR.

Several potential sites were identified in WRIA 9, including the Tacoma Water Green River Filtration facility and Kanaskat-Palmer state park.

The Committee chose 114 AFY as the offset volume to account for uncertainties related to diversion rate, period of diversion, and timing of streamflow benefits. Additional information is included in the project description in Appendix H.

Upper Green River Subbasin

Project Name: Tacoma Water Streamflow Augmentation and Eagle Lake Siphon (9-UG-W6)

Project Description: The Tacoma Water Streamflow Augmentation and Eagle Lake Siphon project would augment streamflow through the release of 2 cubic foot per second (cfs) of raw, untreated water for a period of 90 days (during the summer low-flow period) into the mainstem Green River using Tacoma Water's existing water rights. Tacoma Water envisions this

could be done by requesting the Army Corps of Engineers release 2 cfs more water than what Tacoma Water withdraws as part of regular Howard Hanson Dam flow coordination. The commitment to release an additional 2 cfs to the Green River would be contingent on Tacoma Water securing a water right for up to 1,000 AFY of dead storage out of Eagle Lake to use as needed.

This project is expected to improve streamflows in the Green River in summer when surface flows are generally lowest. The anticipated water offset is up to 357 acre-feet per year. Additional information is included in the project description in Appendix H.

5.2.2 Habitat Projects

Table 5.2 provides a summary of ten habitat projects identified by the Committee to provide ecological benefits to WRIA 9. The habitat projects included in the plan are all tier 1 projects because they are in priority subbasins, have project sponsors, and are expected to be implemented within the planning horizon. More detailed habitat project descriptions are provided in Appendix H.

Although many of these projects have potential streamflow benefits, the Committee has elected not to quantify water offsets from habitat projects.

To ensure that all instream and floodplain management habitat projects meet hydrological performance standards, a Beaver Management Plan should be included, when appropriate. A Beaver Management Plan[18] should identify key flood levels (long and short term allowable flooding elevations and onsite/offsite key protected infrastructure flood level elevations); and standards for when, where, and what methods of beaver deterrence should be used that comply with state and county requirements. In areas where multiple projects are proposed, the benefit of funding multiple projects to maximize biological benefit should be addressed.

[18] Contact the local WDFW Habitat Biologist for more information on Beaver Management Plans.

Table 5.2: WRIA 9 Habitat Projects

Project Number	Project Name	Project Description	Subbasin(s)	Anticipated Ecological Benefits	Project Sponsor	Estimated Cost	Project Tier
9-LG-H7	Mill Creek Stormwater Retrofit	Stormwater infiltration retrofits or enhancements to redirect surface runoff to groundwater, delaying contribution to streamflow, and protecting and restoring water quality.	Lower Green	Protect and restore water quality, increase groundwater recharge.	King County	Unknown	1
9-S-H8	Lower Soos Creek Restoration	Stream, riparian, and wetland restoration on Lower Soos Creek, including wood placement.	Soos	Increase hydraulic diversity, restore native vegetation, restore water temperature, provide erosion abatement.	King County	$1,500,000	1
9-LMG-H9	Turley Levee Setback	Acquire land, remove levee, and construct revetment away from river to create 40 acres of new floodplain habitat. Restoration includes installation of riparian plantings, large woody debris (LWD), and gravel substrate within river channel.	Lower Middle Green	Floodplain restoration, improve spawning and rearing habitat.	King County	$6,000,000	1

Project Number	Project Name	Project Description	Subbasin(s)	Anticipated Ecological Benefits	Project Sponsor	Estimated Cost	Project Tier
9-LMG-H10	Hamakami Levee Setback	Acquire land, remove levee, and construct revetment away from river to create 35 acres of new floodplain habitat. Restoration includes installation of riparian plantings, LWD, and gravel substrate within river channel.	Lower Middle Green	Floodplain restoration, improve spawning and rearing habitat.	King County	$6,000,000	1
9-LMG-H11	Burns Creek Restoration	Property acquisition, installation of LWD and riparian plantings. The estimated acreage of restored riparian zone: 28.	Lower Middle Green	Restoration of fish and wildlife habitat, wetlands, and water quality in an area which is very important for over-wintering salmon.	King County	$2,000,000	1
9-MMG-H12	Crisp Creek Watershed Protection Project	Property acquisition of undeveloped forest lands to benefit the hydrologic integrity of the subbasin and protect the water supply and water rights for the Muckleshoot Indian Tribe's Keta Creek Hatchery.	Mid Middle Green	Protect hydrologic integrity of the basin.	Muckleshoot Indian Tribe	Unknown	1

Project Number	Project Name	Project Description	Subbasin(s)	Anticipated Ecological Benefits	Project Sponsor	Estimated Cost	Project Tier
9-MMG-H13	Flaming Geyser Revegetation	Restoration includes installation of riparian plantings, LWD and gravel substrate within river channel. The total project area proposed for restoration is approximately 42 acres.	Mid Middle Green	Increased shade will moderate water temperatures, reduce evaporation, and enhance fish habitat.	King County	$1,500,000	1
9-N-H14	Newaukum Creek Riparian Revegetation and Beaver Colonization	Restoration along Newaukum Creek at three sites: Brandjes, Gaddy, and Gwerder. Removing structures and installation of riparian plantings. This project will plant native trees and shrubs across 61 acres of riparian zone/wetland habitat.	Newaukum	Maintain streamflows, moderate water temperature, reduce evaporation and create habitat.	King County	Unknown	1
9-N-H15	Newaukum Creek Tributary Restoration (Gwerder, et al)	Excavation and restoration of wetland and stream channels of Newaukum Creek. Includes installation of LWD and riparian vegetation. Total acreage proposed for riparian and wetland restoration is approximately 50 acres.	Newaukum	Maintain streamflows, moderate water temperature, reduce evaporation, and create habitat.	King County	Unknown	1

Project Number	Project Name	Project Description	Subbasin(s)	Anticipated Ecological Benefits	Project Sponsor	Estimated Cost	Project Tier
9-MG-H16	Middle Green River Open Space Acquisitions	Property acquisitions to protect the hydrologic integrity of the basin. If acquired land was previously developed, structures would be removed including homes, septic systems, and wells.	Soos, Jenkins, Covington, Lower Middle Green, Mid Middle Green, Upper Middle Green, Newaukum	Protect hydrologic integrity of the basin.	King County	Unknown	1

5.2.3 Prospective Projects and Actions

In addition to the projects described in this chapter, the WRIA 9 Committee supports projects and actions that achieve the following goals:

- Acquisition of water rights to increase streamflows and offset the impacts of PE wells. Water rights should be permanently and legally held by Ecology in the Trust Water Rights Program to ensure that the benefits to instream resources are permanent.

  The WRIA 9 Committee acknowledges that all water right transactions rely on willing sellers and willing buyers. The WRIA 9 Committee recognizes the importance of water availability for farmers and the limited available water supply within the Agricultural Production Districts. The WRIA 9 Committee supports the current King County policy to encourage the maintenance and preservation of agriculture water rights for agriculture purposes, and supports the acquisition of irrigation water rights within designated Agricultural Production Districts if the properties underlying the water rights have access to an alternative water source, such as reclaimed water, that can be reliably supplied to the properties at a rate that is comparable to the cost of current irrigation management.

- Projects or programs that support connections to public water systems. Projects could provide financial incentives for homes using PE wells to connect to public water service and decommission the well; and/or provide financial support for water purveyors to extend water distribution systems further into their individual service areas, particularly where PE wells are concentrated or rapid rural growth is anticipated.

- Projects or programs that provide outreach and incentives to rural landowners with wells in order to lower indoor and outdoor water use through water conservation best practices, and comply with drought and other water use restrictions. Programs would encourage the following types of water conservation strategies and best practices: natural lawn care; irrigation efficiency; rainwater catchment and storage; drought resistant and native landscaping; smaller lawn sizes; forest, meadow and wetland conservation; indoor water conservation; and voluntary metering. Conservation and water use efficiency projects that involve water rights should permanently convey the saved water to Ecology to be held in the Trust Water Rights Program for instream flow purposes.

- Projects that beneficially switch the source of withdrawal from surface to groundwater, or other beneficial source exchanges such as a source switch to reclaimed water. The benefits of a source exchange project may depend on the connection between the sources, benefits to instream resources (e.g. a surface to groundwater source switch may have negative impacts on fish if the groundwater baseflow provides refuge areas in streams with high water temperature issues), and should take into consideration the possible consequences of unsustainable withdrawals from the affected aquifer.

- Projects that provide streamflow and habitat benefits by returning stream habitat to a more natural state, such as through levee setback or removal, river-floodplain restoration, and instream habitat restoration.

- Projects that enable the development and use of reclaimed water to provide an alternative source to PE wells or other water rights and for streamflow restoration projects, other than direct stream augmentation.
- Projects that contribute to offsetting consumptive use in the following subbasins with higher projected PE wells and consumptive use: Soos, Jenkins, Covington, Lower Middle Green, Mid Middle Green, Upper Middle Green, Newaukum, and Coal/Deep.
- A voluntary five-year program in one or more WRIA 9 subbasins to meter PE wells (indoor and outdoor residential use). A non-profit organization, university, or government agency could pilot a voluntary PE well metering program and collect data to inform (1) growth policies and patterns, (2) where to target incentives and education/outreach programs, and (3) where to place resources across subbasins to help improve streamflow, water levels, and temperature. This program would increase confidence in assumptions made regarding the average water use of individual PE well users to inform the adaptive management process and future water management and planning efforts. The voluntary metering program should be combined with a robust education and community engagement program about water consumption and conservation, described above.
- Projects that monitor Puget Sound Chinook abundance and juvenile productivity within streams or rivers in the Green River watershed to assess the cumulative effects, trends, and recovery actions on juvenile salmon abundance, health, and productivity over time.

5.3 Project Implementation Summary

5.3.1 Summary of Projects and Benefits

Per RCW 90.94.030(3), this plan must include actions necessary to offset potential impacts to instream flows associated with new PE well water use and result in a net ecological benefit to instream resources within the WRIA.

As specified in Chapter 4, the Committee estimated 247.7 AFY of consumptive use from new PE wells over the planning horizon. As discussed in section 4.5, the Committee developed an offset target of 495.4 AFY to address uncertainty in the consumptive use estimate and project implementation, and ensure that projects and actions in the plan would offset consumptive use.

The plan includes three water right acquisitions projects, two managed aquifer recharge projects, and one streamflow augmentation project to offset consumptive use. These water offset projects included in Table 5.1 provide an estimated offset of 1,075 AFY and exceed the offset target.

A total of ten habitat projects have been identified by the Committee and are included in Table 5.2. Ecological benefits associated with these projects are myriad and include floodplain restoration, wetland reconnection, availability of off-channel habitat for juvenile salmonids, increase in groundwater levels and baseflow, and increase in channel complexity. While many of these projects have potential streamflow benefits, water offset from habitat projects are not

accounted for in this plan. The ecological and streamflow benefits from habitat projects are supplemental to the quantified water offsets.

5.3.2 Cost Estimate for Offsetting New Domestic Water Use Over 20 Year Planning Horizon

Per RCW 90.94.030(3)(d), this watershed plan must include an evaluation or estimation of the cost of offsetting new domestic water uses over the subsequent twenty years. To satisfy this requirement, the Committee relied on Ecology to develop cost estimates for each of the water offset projects listed in Table 5.1. The Committee also included costs estimates for habitat projects in Table 5.2, when that information was provided by the project sponsor.

Cost estimates for water offset projects included in the plan are planning level cost estimates only. Ecology developed the cost estimates by reviewing recent streamflow restoration grant program applications for similar project types and recently completed water right acquisitions. For all water right acquisitions, an extent and validity determination will need to be completed to establish the quantity of water that can be permanently protected through transfer to Ecology's Trust Water Rights program. The price for these water rights will be negotiated between the willing seller and the willing buyer. Project costs for other water offset project types will be further developed after the plan is submitted, when the project sponsors seek funding and prepare grant applications.

The total estimated cost for implementing the water offset projects listed and described in this chapter is $3,389,300.

The estimated cost for implementing individual habitat projects range from $1.5 million to $6 million, with several of the project costs unknown.

5.3.3 Certainty of Implementation

The WRIA 9 Committee used a tiering process to identify the projects that are more likely to be implemented in the short term. Tier 1 projects are more likely to be implemented and provide benefits in the near-term because those projects have project sponsors. For water rights acquisitions included in tier 1, initial outreach to water right holders has occurred and those water right holders indicated interest in further discussions. For the tier 2 water right acquisition project (Pre-Identified Water Right No. 6), Washington Water Trust initiated outreach to the water right holder, but at the time of this plan, did not receive a response. The habitat projects included in the plan are all tier 1 projects because they are in priority subbasins, have project sponsors, and are expected to be implemented within the planning horizon.

The WRIA 9 Committee identified funding availability, especially for larger capital projects, as an implementation challenge. The WRIA 9 Committee recommends projects that infiltrate water (e.g. managed aquifer recharge projects and stormwater projects) include estimated operations and maintenance costs in applications for streamflow restoration funding.

The WRIA 9 Committee also developed adaptive management recommendations to increase reasonable assurance that the projects and actions in the plan will be implemented.

Chapter Six: Adaptive Management and Implementation Recommendations

6.1 Plan Implementation and Adaptive Management Recommendations

The WRIA 9 Committee recommends an adaptive management process for implementation of the WRIA 9 watershed plan. Adaptive management is defined in the Final NEB Guidance as "an iterative and systematic decision-making process that aims to reduce uncertainty over time and help meet project, action, and plan performance goals by learning from the implementation and outcomes of projects and actions."

Adaptive management is intended to help address uncertainty, provide more reasonable assurance for plan implementation, and to ensure that 1) water use from new PE wells is adequately offset, as required by RCW 90.94.030, and 2) implementation of the watershed plan produces a net ecological benefit to the watershed, as required by RCW 90.94.030. The periodic review in this adaptive management process will provide a verifiable process for plan monitoring and ensure transparency in plan implementation.

Existing Challenges

The WRIA 9 Committee identified the following challenges in the planning process and seeks to address these challenges through monitoring and adaptive management:

- This watershed plan includes projected, not actual, PE well water use by subbasin. Many factors could influence the consumptive water use from new PE wells in the future, including water system infrastructure expansion, policies or programs to require or incentivize homes to connect to public water systems, and programs that provide education and incentives for homeowners to conserve water. Monitoring the number of new PE wells, actual PE well water use, and associated consumptive water use would provide data for comparison and adjustments, as needed, in planning for ongoing offsets to ensure the mandates of RCW 90.94 are being met.
- The watershed plan includes water offset and habitat projects, and estimated benefits associated with each, by subbasin. The WRIA 9 Committee used a tiering process to identify projects with greater implementation certainty, however that will likely change over time. Measuring and tracking project implementation and actual water offsets and habitat benefits by subbasin, to the extent possible, can be used to verify intended streamflow benefits.
- Our global climate is changing. While the effects of climate change over the 20-year life of this plan cannot be precisely known, shifts in climatic conditions will influence the hydrologic regime in the watershed and will impact instream flows. Rainfall, snowmelt, and evapotranspiration have been identified as the primary natural mechanisms driving changes in groundwater storage. These mechanisms will be affected by a changing climate. Air and water temperatures will increase and summer streamflows will be

reduced. Groundwater pumping and indirect effects of irrigation and land use changes will impact groundwater resources and the availability for future water supply and instream flows. The Committee recognizes that a successful plan must acknowledge that the climate is changing and include recommendations to ensure that the statutory requirements to offset water withdrawals by new PE wells and provide a net ecological benefit will be met under future climatic conditions. Monitoring actual water use and the amount of offset water actually generated will inform this determination.

- Projects identified in the plan are expected to increase groundwater storage, augment streamflows, and provide aquatic habitat benefits. Water offset projects should be monitored in order to ensure that they continue to function as designed, and generate instream water to offset new PE wells under a changing climate. Habitat projects should be analyzed for their resilience to changing conditions. The WRIA 9 Committee chose to apply an overall safety factor to help address these concerns. The adaptive management recommendations in this plan will help to monitor and assess the validity of the projections identified to determine whether projects are functioning as designed even under climate change conditions, and to allow for course corrections where needed.

To address the above challenges, the WRIA 9 Committee added a margin of safety to the consumptive use estimate and recommends the following adaptive management strategies.

6.1.1 Tracking and Monitoring

The WRIA 9 Committee recommends that the Washington Department of Ecology (Ecology) monitor watershed plan implementation, in consultation with the Washington Department of Fish and Wildlife (WDFW), and King County. Specifically, the Committee recommends that Ecology, in consultation with WDFW and King County, review actions resulting from watershed plans to ensure the mandates of RCW 90.94 are being met, including:

- Track annual new permit-exempt wells by subbasin;
- Track project implementation and the actual amount of offset water generated, or reasonably certain to be generated, by subbasin; and
- Develop a process to adaptively manage implementation if net ecological benefit is not being met as envisioned by the watershed plan.

Tracking streamflow restoration projects and new permit-exempt domestic wells will:

- Improve the capacity to conduct implementation monitoring of streamflow restoration projects and actions,
- Build grant funding opportunities and track streamflow restoration associated costs, and
- Provide a template for adaptively managing emergent restoration needs.

The WRIA 9 Committee recommends WDFW, in collaboration with Ecology and the Recreation and Conservation Office (RCO), pilot the Salmon Recovery Portal

(https://srp.rco.wa.gov/about), managed by RCO, for tracking streamflow restoration projects and new permit-exempt domestic wells.[19] To improve harmonization of streamflow restoration with ongoing salmon recovery efforts, local salmon recovery Lead Entity Coordinators shall be consulted prior to entering streamflow restoration projects into the portal. While input and oversight is welcomed, no commitment of additional work is required from Lead Entity Coordinators. University of Washington data stewards will be employed to conduct data entry, quality assurance, and quality control.

Using the Salmon Recovery Portal to track streamflow restoration projects and new permit-exempt domestic wells will:

- Provide a centralized database that includes project status and cost, sources of funding, and project sponsors.
- Facilitate project reporting and public outreach.
- Encourage collaboration and coordination between projects by geographic area.

Table 6.1 summarizes the entities responsible for carrying out this recommendation and associated funding needs.

Table 6.1: Implementation of Tracking and Monitoring Recommendation

Action	**Entity or Entities Responsible**	**Funding Considerations**
Track building permits issued with permit-exempt wells.	Ecology (via reporting from counties and cities[20])	The number of building permits and associated fees are transmitted to Ecology annually. No additional funding is needed.
Maintain an ongoing list and map of new PE wells within each subbasin.	Ecology	Update the existing Ecology well report tracking database. No additional funding is needed.
Maintain a summary of the status of implementation for each project.	WDFW using the Salmon Recovery Portal	WDFW may need additional funding to support maintaining the Salmon Recovery Portal.

6.1.2 Oversight and Adaptation

The WRIA 9 Committee recommends Ecology issue four watershed plan implementation reports, one each in 2027, 2032, 2037, and 2042 detailing the successes, challenges, and gaps related to implementation of the watershed plan. Each report should cover the five-year period

[19] See Supplemental Document: Project Tracking for WRE Plans for further details on project tracking procedures using the Salmon Recovery Portal.

[20] Ecology provided guidance on the timing and details to include in the annual reporting to local jurisdictions in WRIA 9.

occurring immediately prior to the year of issuance, except the first reporting period, which should start when the plan is adopted by Ecology. The report should include information on whether the watershed plan is on track to achieve the expected net ecological benefit and water offsets as well as streamflow conditions, including identifying subbasins with known impacts that have not yet implemented water offset or habitat projects. In addition, the report should include an estimate of the anticipated costs required to implement water offset projects in subbasins with an offset deficit (subbasins with more consumptive use impacts than offsets). The report should also include information on any discretionary programs that were implemented, including for example, water conservation education and outreach, incentives for public water service connections, and voluntary PE well metering.

Ecology's report should include recommendations to adjust the projects and actions if the adopted goals of the watershed plans are not on track to being met in the plan's 20-year timeframe. A notice of action to adjust the plan should be sent to members of the WRIA 9 Committee for comment. Members of the WRIA 9 Committee may reconvene, if needed. However, members of the WRIA 9 Committee are not expected to reconvene after approving the plan. Final adjustments and amendments shall be at the sole determination of Ecology after public input.

The report should be sent to all members of the WRIA 9 Committee, King County Council, all local jurisdictions within the watershed, and any additional stakeholders identified at the time of reporting.

Preference for funding of new projects should be given to projects in subbasins that have not offset permit-exempt water use.

Table 6.2 summarizes the entities responsible for carrying out this recommendation and associated funding needs.

Table 6.2: Implementation of Oversight and Adaptation Recommendation

Action	**Entity or Entities Responsible**	**Funding Considerations**
Develop and distribute Watershed plan implementation report, including any recommended adjustments to projects and actions	Ecology	Ecology may need additional funding to support development of the report.
Revise Streamflow Restoration Grant Guidance to prioritize projects in subbasins that have not offset permit-exempt water use	Ecology	No additional funding is needed.

6.1.3 Funding

The WRIA 9 Committee recommends funding plan implementation and adaptive management from a variety of sources, including the Washington State Legislature and other sources of public and private funding. Funding and staffing at local, county and state levels is likely to see continued shortfalls due to COVID-19 related impacts over the next several years. The Committee urges a collaborative approach to fund Ecology and WDFW to ensure plan implementation and monitoring, streamflow health, water offsets, net ecological benefit, and full compliance with the mandates found in RCW 90.94.

6.2 Policy and Regulatory Recommendations

The Streamflow Restoration law lists optional elements committees may consider including in the plan to manage water resources for the WRIA or a portion of the WRIA (RCW 90.94.030(3)(f)). The WRIA 9 Committee initially identified potential policy and regulatory recommendations to include in the plan. After iterative rounds of discussion, the Committee did not have full support for including policy and regulatory recommendations in the plan.

Chapter Seven: Net Ecological Benefit

7.1 Introduction to Net Ecological Benefit Evaluation

Watershed Restoration and Enhancement Plans must identify projects and actions to offset the potential consumptive impacts of new permit-exempt domestic groundwater withdrawals on instream flows over 20 years (2018-2038) and provide a net ecological benefit to the WRIA. The Final NEB Guidance establishes Ecology's interpretation of the term "net ecological benefit" as "the outcome that is anticipated to occur through implementation of projects and actions in a plan to yield offsets that exceed impacts within: a) the planning horizon; and, b) the relevant WRIA boundary" (Ecology 2019).

The Final NEB Guidance states that "planning groups are expected to include a clearly and systematically articulated NEB evaluation in the watershed plan" and provides guidance for planning groups on what to include in the NEB evaluation (Ecology 2019). The Final NEB Guidance also states that "a watershed plan that includes a NEB evaluation based on this guidance significantly contributes to the reasonable assurances that the offsets and NEB within the plan will occur. Ecology will review any such plan with considerable deference in light of the knowledge, insights, and expertise of the partners and stakeholders who influenced the preparation of their plan. Ecology will make the NEB determination as part of this review" (Ecology 2019).

The WRIA 9 Committee completed a NEB evaluation for the watershed plan and the results of that evaluation are included in this chapter.

7.2 Water Offsets

The WRIA 9 Committee projects that a total of 632 new PE wells will be installed within WRIA 9 during the planning horizon. The WRIA 9 Committee used this 20-year PE well projection to estimate 247.7 AFY of new consumptive water use in WRIA 9, as described in detail in Chapter 4. The WRIA 9 Committee sought projects to offset at least 495.4 AFY, a safety factor of two times the consumptive use estimate. This offset target accounts for uncertainties in the planning process related to the PE well projection, consumptive use assumptions, and project implementation. If the plan is implemented, the WRIA 9 Committee projects a total water offset of 1,075 AFY from six water offset projects (described in Chapter 5 and listed in Table 7.1), a surplus offset of 827.3 acre-feet above the consumptive use estimate and 579.6 acre-feet above the offset target. Through this comparison, the WRIA 9 Committee has determined that this plan, if implemented, succeeds in offsetting consumptive use impacts at the WRIA scale.

Table 7.1: Summary of WRIA 9 Water Offset Projects included in NEB analysis

Project Number	Project Name	Project Short Description	Subbasin	Estimated Water Offset Benefits (AFY)	Timing of Benefit[1,2]	Project Tier
9-S-W1	Soos Creek Park Water Right Acquisition (Pre-Identified Water Right No. 5)	Acquisition of one surface water certificate previously used for fish propagation and irrigation	Soos	11	Irrigation Season	1
9-S-W2	Pre-Identified No. 6 Water Right Acquisition	Acquisition of three groundwater certificates used for golf course irrigation	Soos	182	Year-round	2
9-C-W3	Pre-Identified No. 2 Water Right Acquisition	Acquisition of one surface water certificate used for industrial/ processing of mineral products	Covington	54	Year-round	1
9-C-W4	Covington Water District Managed Aquifer Recharge	Diversion of water from an existing drinking water pipeline for infiltration at a constructed MAR facility	Covington	357	Year-round	1
9-UMG-W5	Green River Managed Aquifer Recharge	Diversion of water from the Green River for infiltration at a constructed MAR facility	Upper Middle Green	114	Low flow period (typically summer and early fall)[3]	1
9-UG-W6	Tacoma Water Streamflow Augmentation and Eagle Lake Siphon	Release of raw, untreated water during the summer low-flow period into the mainstem Green River	Upper Green	357	90 days during summer low flow period	1

Project Number	Project Name	Project Short Description	Subbasin	Estimated Water Offset Benefits (AFY)	Timing of Benefit[1,2]	Project Tier
			Tier 1 subtotal	**893**		
			Total	**1,075**		

Notes:

[1] The water right project profiles in Appendix H indicate the period of use associated with the water right. For water rights that rely on surface water, the timing of benefit is assumed to be the same as the period of use. For water rights that rely on groundwater, the timing of benefit is assumed to be year-round, due to the lag time between well pumping and streamflow impact. Irrigation season is typically April through October, but the specific period of use is different for each water right.

[2] Managed Aquifer Recharge Projects are expected to provide benefits year-round. Streamflow augmentation benefits will continue to discharge to the river after each year's storage window closes because of the lag time of water moving through an aquifer and the distance of the flow path to the river. The temporal distribution and absolute value of those benefits will be estimated during the feasibility study that has to be conducted before a MAR project can proceed to construction and operation.

[3] The Green River Managed Aquifer Recharge Project is expected to increase streamflow year-round. However, the goal of the project is to increase baseflow to the Green River during the low flow period (typically late summer and early fall).

The WRIA 9 Committee used a tiering process to identify projects with greater implementation certainty (tier 1). Tier 1 projects all have project sponsor. For tier 1 water right acquisition projects, discussions were initiated with the water right holders. The tier 1 projects provide a water offset of 893 AFY.

Estimated consumptive use and potential water offset are compared at the subbasin scale in Table 7.2 for both tier 1 and tier 2 projects. Surplus water offset is achieved in a total of four subbasins (Soos Creek, Covington Creek, Upper Middle Green River, and Upper Green River), ranging from 87.1 AFY in the Upper Middle Green River subbasin to 389.5 AFY in the Covington Creek subbasin. Neutral water offset occurs in the Central Puget Sound and Duwamish River subbasins, both with zero estimated consumptive use. A deficit in water offset occurs in a total of six subbasins (Lower Green River, Jenkins Creek, Lower Middle Green River, Mid Middle Green River, Newaukum Creek, and Coal/Deep Creek), ranging from 2.1 AFY in the Lower Green River subbasin to 51.0 AFY in the Lower Middle Green River subbasin. However, the Committee assumes that the water offset projects in the Upper Green and Upper Middle Green subbasins will contribute to offsetting consumptive use downstream in the Mid Middle Green, Lower Middle Green, and Lower Green River subbasins. See Figure 5.1 in Chapter 5 for a map of water offset projects by subbasin.

Table 7.2: Subbasin Water Offset Totals Compared to Permit-Exempt Well Consumptive Use Estimate

Subbasin	**Offset Project Totals (AFY)**	**PE Well Consumptive Use (AFY)[1]**	**Surplus/Deficit (AFY)[2,3]**
Central Puget Sound	0	0	0
Duwamish River	0	0	0
Lower Green River	0	2.1	-2.1
Soos Creek	193	41.4	+151.6
Jenkins Creek	0	21.2	-21.2
Covington Creek	411	21.5	+389.5
Lower Middle Green River	0	51.0	-51.0
Mid Middle Green River	0	31.9	-31.9
Upper Middle Green River	114	26.9	+87.1
Newaukum Creek	0	39.0	-39.0
Coal/Deep Creek	0	12.6	-12.6
Upper Green River	357	0	+357
WRIA 9 Total Consumptive Use	**1,075**	**247.7**	**+827.3**

Notes:
[1] Values in table have been rounded, which is why totals may differ.
[2] Surplus water offset is associated with a positive value and a deficit in water offset is associated with a negative value.
[3] Water offset projects in the Upper Green and Upper Middle Green subbasins will contribute to offsetting consumptive use downstream, in the Mid Middle Green, Lower Middle Green, and Lower Green River subbasins.

The higher offset target (two times the consumptive use) and potential water offset from tier 1 and tier 2 projects are compared at the subbasin scale in Table 7.3.

Table 7.3: Subbasin Water Offset Totals Compared to Offset Target

Subbasin	**Offset Project Totals (AFY)**	**Offset Target: 2x Consumptive Use (AFY)[1]**	**Surplus/Deficit (AFY)[2,3]**
Central Puget Sound	0	0	0
Duwamish River	0	0	0
Lower Green River	0	4.2	-4.2
Soos Creek	193	82.8	+110.2
Jenkins Creek	0	42.4	-42.4
Covington Creek	411	43	+368
Lower Middle Green River	0	102	-102
Mid Middle Green River	0	63.8	-63.8
Upper Middle Green River	114	53.8	+60.2
Newaukum Creek	0	78	-78
Coal/Deep Creek	0	25.2	-25.2
Upper Green River	357	0	+357
WRIA 9 Total Consumptive Use	**1,075**	**495.4**	**+579.6**

Notes:
[1] Values in table have been rounded, which is why totals may differ.
[2] Surplus water offset is associated with a positive value and a deficit in water offset is associated with a negative value.
[3] Water offset projects in the Upper Green and Upper Middle Green subbasins will contribute to offsetting consumptive use downstream, in the Mid Middle Green, Lower Middle Green, and Lower Green River subbasins.

The water offset projects listed in Table 7.1 provide additional benefits to instream resources beyond those necessary to offset the impacts from new consumptive water use within the WRIA. For the project types planned in WRIA 9, additional benefits could include the following:

- Water right acquisition projects: Aquatic habitat improvements during key seasonal periods; reduction in groundwater withdrawals and associated benefit to aquifer resources; and/or beneficial use of reclaimed water.

- MAR projects: Aquatic habitat improvements during key seasonal periods; increased groundwater recharge; reduction in summer/fall stream temperature; increased groundwater availability to riparian and near-shore plants; and/or contribution to flood control.
- Streamflow Augmentation: Aquatic habitat improvements during key seasonal periods.

7.3 Habitat Benefits

A total of ten habitat improvement projects are included within the plan, as summarized in Table 7.4 and shown in Figure 5.1 in Chapter 5. The habitat projects are all tier 1 because they have project sponsors and are expected to be implemented within the planning horizon. Habitat improvement tactics associated with these projects include a combination of aquatic habitat restoration, riparian vegetation plantings, land acquisition, levee removal, large woody debris (LWD) installation, beaver colonization, and stormwater management. Many of the habitat improvement projects include more than one of these elements. Project distribution is summarized in table 7.4.

Table 7.4: Summary of Habitat Projects by Subbasin

Subbasin	Habitat Projects	Benefiting Stream
Central Puget Sound		
Duwamish River		
Lower Green River	1 project: 9-LG-H7	Green River
Soos Creek	2 projects: 9-S-H8 and 9-MG-H16	Soos Creek
Jenkins Creek	1 project: 9-MG-H16	Jenkins Creek
Covington Creek	1 project: 9-MG-H16	Various
Lower Middle Green River	4 projects: 9-LMG-H9, 9-LMG-H10, 9-LMG-H11, and 9-MG-H16	Green River
Mid Middle Green River	3 projects: 9-MMG-H12, 9-MMG-H13, and 9-MG-H16	Green River
Upper Middle Green River	1 project: 9-MG-H16	Various
Newaukum Creek	2 projects: 9-N-H14 and 9-N-H15	Newaukum Creek
Coal/Deep Creek		
Upper Green River		

Note: Project 9-MG-H17 is within the general Green River watershed, potentially benefitting a number of subbasins and associated streams.

If implemented, these projects are expected to provide additional benefits to instream resources that, together with direct water offsets, are beyond those necessary to offset the impacts from new consumptive water use within the WRIA. These additional benefits include increased hydraulic/aquatic habitat diversity, restored native vegetation, restored water temperature, erosion abatement, improved spawning and rearing habitat, and water quality benefits, among other benefits. Table 7.5 summarizes anticipated benefits from the plan's ten habitat projects.

Table 7.5: Summary of WRIA 9 Habitat Improvement Projects

Project Number	**Project Name**	**Project Short Description**	**Subbasin**	**River Miles Benefitted**	**Other Benefits with Quantifiable Metric** (e.g. structures per mile)	**Habitat Limiting Factor(s) Addressed**[1, 2]
9-LG-H7	Mill Creek Stormwater Retrofit	Stormwater retrofit to protect and restore water quality by reducing stormwater impacts from existing infrastructure and development	Lower Green	Lower Green River	-Increase in recharge/ groundwater levels (monitoring) -Infiltration volume (10 to 100 AFY) -Stormwater retrofit area treated (acres)	-Decreased water quality (pollution and elevated water temperature) -Altered hydrology and streamflow
9-S-H8	Lower Soos Creek Restoration	Stream, riparian, and wetland habitat restoration on Lower Soos Creek	Soos	3 miles of Lower Soos Creek	-Increased hydraulic diversity (mapping of structures) -Restored native vegetation (acres) -Restored water temperature (monitoring) -Erosion abatement (mapping)	-Loss of riparian habitat -Decreased water quality (elevated water temperature) -Altered stream hydrology -Disconnected floodplain habitat -Introduction of non-native plant and animal species -Reduction of LWD and channel complexity

Project Number	**Project Name**	**Project Short Description**	**Subbasin**	**River Miles Benefitted**	**Other Benefits with Quantifiable Metric** (e.g. structures per mile)	**Habitat Limiting Factor(s) Addressed**[1, 2]
9-LMG-H9	Turley Levee Setback	Land acquisition, levee removal, and revetment construction away from river to create 40 acres of new floodplain habitat	Lower Middle Green	1,300 feet of Turley Levee on right bank of Green River	-Aquatic habitat restoration (40 acres) -Levee removal (1,300 feet long by 50 feet wide) -Gravel installation (cubic feet) -LWD installation (mapping of structures) -Improved spawning and rearing habitat (mapping)	-Loss of riparian habitat -Gravel starvation and scouring -Altered stream hydrology -Disconnected floodplain habitat -Reduction of LWD and channel complexity
9-LMG-H10	Hamakami Levee Setback	Land acquisition, levee removal and revetment construction away from river to create 35 acres of new floodplain habitat.	Lower Middle Green	1,200 feet of levee removal on right bank of Green River	-Aquatic habitat restoration (40 acres) -Levee removal (1,200 feet long by 50 feet wide) -Gravel installation (cubic feet) -LWD installation (mapping of structures) -Improved spawning and rearing habitat (mapping)	-Loss of riparian habitat -Gravel starvation and scouring -Altered stream hydrology -Disconnected floodplain habitat -Introduction of non-native plant and animal species -Reduction of LWD and channel complexity

Project Number	**Project Name**	**Project Short Description**	**Subbasin**	**River Miles Benefitted**	**Other Benefits with Quantifiable Metric** (e.g. structures per mile)	**Habitat Limiting Factor(s) Addressed**[1, 2]
9-LMG-H11	Burns Creek Restoration	Property acquisition, installation of LWD, and riparian planting of approximately 28 acres	Lower Middle Green	Lower 2 miles of Burns Creek	-Restoration of fish and wildlife habitat (acres) -LWD installation (mapping of structures) -Wetland restoration (acres) -Water quality benefit (monitoring)	-Loss of riparian habitat -Decreased water quality (elevated water temperature) -Altered stream hydrology -Disconnected floodplain habitat -Introduction of non-native plant and animal species -Reduction of LWD and channel complexity
9-MMG-H12	Crisp Creek Watershed Protection Project	Property acquisition of undeveloped forest lands to benefit the hydrologic integrity of the subbasin and protect the water supply and water rights for the Muckleshoot Indian Tribe's Keta Creek Hatchery	Mid Middle Green	Numerous parcels of forest land within Crisp Creek Watershed	-Property acquisition and protection (in excess of 400 acres)	-Loss of riparian habitat -Decreased water quality (pollution and elevated water temperature) -Altered hydrology and streamflow
9-MMG-H13	Flaming Geyser Revegetation	Installation of riparian plantings, LWD and gravel substrate within river channel	Mid Middle Green	Green River at Flaming Geyser State Park	-Riparian planting (42 acres) -Moderation of water temperatures (monitoring) -Enhanced fish habitat (acres)	-Loss of riparian habitat -Decreased water quality (elevated water temperature) -Introduction of non-native plant and animal species

Project Number	**Project Name**	**Project Short Description**	**Subbasin**	**River Miles Benefitted**	**Other Benefits with Quantifiable Metric** (e.g. structures per mile)	**Habitat Limiting Factor(s) Addressed**[1, 2]
9-N-H14	Newaukum Creek Riparian Revegetation and Beaver Colonization	Removal of structures and installation of riparian plantings along Newaukum Creek at three sites: Brandjes, Gaddy, and Gwerder	Newaukum	Newaukum Creek in King County, north of City of Enumclaw	-Riparian planting (161,000 trees on 61 acres) -Moderation of water temperatures (monitoring) -Enhanced fish habitat (acres) -Streamflow maintenance (monitoring)	-Loss of riparian habitat -Decreased water quality (pollution and elevated water temperature) -Introduction of non-native plant and animal species
9-N-H15	Newaukum Creek Tributary Restoration (Gwerder, et al.)	Excavation and restoration of wetland and stream channels of Newaukum Creek	Newaukum	Newaukum Creek in King County, north of City of Enumclaw	-Riparian planting (75 acres) -Moderation of water temperatures (monitoring) -Enhanced fish habitat (acres) -Streamflow maintenance (monitoring)	-Loss of riparian habitat -Decreased water quality (elevated water temperature) -Altered stream hydrology -Disconnected floodplain habitat -Introduction of non-native plant and animal species -Reduction of LWD and channel complexity

Project Number	**Project Name**	**Project Short Description**	**Subbasin**	**River Miles Benefitted**	**Other Benefits with Quantifiable Metric** (e.g. structures per mile)	**Habitat Limiting Factor(s) Addressed**[1, 2]
9-MG-H16	Middle Green River Open Space Acquisitions	Property acquisitions to protect the hydrologic integrity of the basin	Soos, Jenkins, Covington, Lower Middle Green, Mid Middle Green, Upper Middle Green, Newaukum	Green River watershed	-Property acquisition and protection (acres)	-Loss of riparian habitat -Decreased water quality (pollution and elevated water temperature) -Altered hydrology and streamflow

Notes:

[1] Habitat limiting factors are described in section 2.3.1 Salmonids in WRIA 9.

[2] Altered hydrology includes both high flows and low flows. Decreased water quality includes elevated water temperatures.

7.4 Adaptive Management Recommendations

The WRIA 9 Committee identified a number of challenges related to plan implementation, described in Chapter 6. These challenges include uncertainty in consumptive use estimates, uncertainty in offsets associated with specific project types, project implementation, climate change, and other factors. The WRIA 9 Committee has recommended adaptive management measures in the plan for the purpose of addressing uncertainty in plan implementation. Adaptive management measures include PE well tracking, project implementation tracking, and periodic watershed plan implementation reporting, with recommended adjustments to the plan. As part of adaptive management, the WRIA 9 Committee supports the development and implementation of additional water offsets in the following subbasins with an offset deficit: Lower Green River, Jenkins Creek, Newaukum Creek, and Coal/Deep Creek. These measures, in addition to the surplus water offset and supplemental habitat improvement projects described above, provide reasonable assurance that the plan will adequately offset new consumptive use from PE wells anticipated during the planning horizon.

7.5 NEB Evaluation Findings

The WRIA 9 watershed plan is intended to provide a path forward for offsetting an estimated 247.7 AFY of new consumptive water use in WRIA 9. The plan primarily achieves this offset through a total of six water offset projects with a cumulative offset projection of 1,075 AFY. This projected total water offset yields a surplus offset of 827.3 AFY above the consumptive use estimate of 247.7 AFY in WRIA 9. The projected total water offset exceeds the offset target of 495.4 AFY that the Committee developed to account for uncertainties in the planning process.

Within this plan, water offset projects are complimented by a total of ten habitat improvement projects, which provide numerous additional benefits to aquatic and riparian habitat. While many of these habitat improvement projects have potential streamflow benefits, the WRIA 9 Committee chose to exclude any associated water offset from the plan's accounting due to uncertainty regarding magnitude, reliability, and timing of streamflow benefits.

The WRIA 9 Committee has additionally recommended adaptive management measures to provide reasonable assurance that the plan will adequately address new consumptive use impacts anticipated during the planning horizon, despite inevitable challenges that will arise during project implementation, operation, and maintenance.

Based on the information and analyses summarized in this plan, the WRIA 9 Committee finds that this plan, if implemented, achieves a net ecological benefit, as required by RCW 90.94.030 and defined by the Final NEB Guidance (Ecology 2019).

Appendix

WRIA 9 Duwamish-Green Watershed

The following appendices are linked to this report as an Appendices file at:

https://apps.ecology.wa.gov/publications/SummaryPages/2111009.html

Appendix A – References

Appendix B – Glossary

Appendix C – Committee Roster

Appendix D – Operating Principles

Appendix E – Subbasin Delineation Memo

Appendix F – Permit-Exempt Well Projections Memo

Appendix G – Consumptive Use Memo

Appendix H – Projects