CASCADE
WATER ALLIANCE

January 29, 2010

Subject: Cascade Water Alliance
Lake Tapps Reservoir Water Rights and Supply Project
Notice of Availability and Request for Comments on
Draft Environmental Impact Statement

To Whom It May Concern:

This Notice of Availability and Request for Comments on Draft Environmental Impact Statement (Draft EIS) has been prepared for the Lake Tapps Reservoir Water Rights and Supply Project (Project) in compliance with the Washington State Environmental Policy Act (SEPA) under Chapter 43.21C RCW. Cascade Water Alliance (Cascade) is the project proponent and lead agency.

An Environmental Checklist was prepared for the Project in June 2008. Following review of the Environmental Checklist, the Cascade SEPA Official determined that the Project could have a significant adverse impact on the environment and that an EIS would be required. A Determination of Significance and Request for Comments on Scope of EIS were issued on June 30, 2008.

In February 2008, Cascade's Board of Directors approved an Asset Purchase Agreement with Puget Sound Energy for the acquisition of Lake Tapps Reservoir, associated White River Hydroelectric Project facilities, and the following associated water rights and applications: three municipal water rights applications (S2-29920, R2-29935, and S2-29934), a pre-code water right claim, and a change/transfer application (CS2-160822CL) (collectively known as the "Applications"). On December 18, 2009, the purchase and sale under the Asset Purchase Agreement was completed.

The Proposed Action is for Cascade's Board of Directors to approve Cascade's operation of the Project and to request approval by the Washington State Department of Ecology (Ecology) of the Applications.

The three basic elements of the Project operation are as follows:

- Cascade would divert water from the White River into Lake Tapps Reservoir, store water in, and withdraw water from the reservoir for municipal water supply purposes.
- Cascade would operate the Project in a manner to provide enhanced flows in the White River consistent with the 2008 White River Management Agreement with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe.
- Cascade would operate the Project to store water and maintain the levels of Lake Tapps Reservoir to support recreation consistent with 2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community.

11400 SE 8th Street — Suite 440 — Bellevue, WA 98004
Phone: (425) 453-0930 — Fax: (425) 453-0953
Website: www.cascadewater.org

More specifically, and as described in Table 1-1 of the Draft EIS, Ecology's approval of the Applications would permit the following:

1. Cascade would divert water from the White River into Lake Tapps Reservoir at an average annual rate of up to 75 cubic feet per second (cfs) (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes[1]. Cascade would divert water from the White River at a maximum instantaneous rate of up to 1,000 cfs (this maximum rate would vary by season and would be lower at other times of the year).

2. Cascade would store up to 46,700 acre-feet of water in Lake Tapps Reservoir for municipal, industrial, and commercial water supply purposes.

3. Cascade would withdraw water from Lake Tapps Reservoir at an average annual rate of up to 75 cfs (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes. Cascade would withdraw water from Lake Tapps Reservoir at a maximum instantaneous rate of 135 cfs.

4. Cascade would divert water from the White River, store water in Lake Tapps Reservoir, and release water through the tailrace canal back to the White River in support of the following purposes: hydropower and other beneficial uses including recreational reservoir levels; winter reservoir levels; fish and wildlife habitat protection and enhancement; and maintenance of water quality for recreational purposes in the reservoir and to meet other regulatory requirements. For example, these other beneficial uses include operation of the sedimentation basins, operation of the fish screens and fish bypass pipeline, Spring Refill of Lake Tapps Reservoir, and maintenance of water surface elevations in Lake Tapps Reservoir for recreation purposes.

The Draft EIS examines the Proposed Action and the No Action Alternative.

Comments on the Draft EIS are invited and should be postmarked or e-mailed on or before March 15, 2010. Written comments should be addressed to:

Michael A. Gagliardo, Director of Planning
Cascade Water Alliance
11400 SE 8th Street, Suite 440
Bellevue, WA 98004
contact@cascadewater.org

Sincerely,

Michael A. Gagliardo
Director of Planning

Enclosures

---

[1] As fully described in Chapter 13 of the Draft EIS, the average flow rate of 75 cfs may be increased to an average flow rate of 82 cfs. The 7 cfs is referred to as "Regional Reserved Water". The Regional Reserved Water would not alter or affect the environmental analysis described in the Draft EIS.

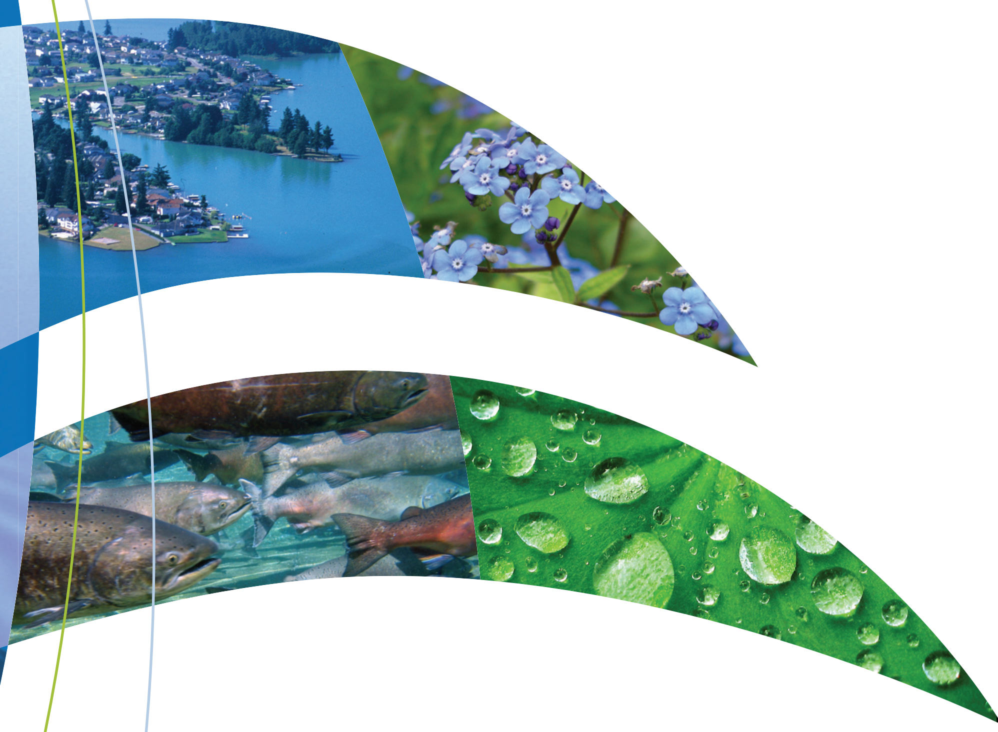
CASCADE
WATER ALLIANCE

Lake Tapps Reservoir Water Rights and Supply Project

DRAFT

Environmental Impact Statement

January 29, 2010



Fact Sheet

Project Title

Lake Tapps Reservoir Water Rights and Supply Project

Project Proponent

The proponent of the Lake Tapps Reservoir Water Rights and Supply Project (Project) is Cascade Water Alliance (Cascade). Cascade is a non-profit corporation composed of municipal corporations and special-purpose municipal corporations in King County that are party to an Interlocal Agreement entered into under the authority of the Interlocal Cooperation Act (Chapter 39.34 RCW[1]) for the purpose of its Members working together to plan, develop, and operate a water supply system and regional assets that will meet Cascade's Members' current and future drinking water needs. The Members of Cascade are as follows:

- City of Bellevue
- City of Issaquah
- City of Kirkland
- City of Redmond
- City of Tukwila
- Covington Water District
- Skyway Water and Sewer District
- Sammamish Plateau Water and Sewer District

Project Description

Project Location and Setting

Lake Tapps Reservoir is located in northern Pierce County, Washington, approximately 30 miles southeast of Seattle and 18 miles east of Tacoma in Section 2, Township 19 North, Range 6 East. The reservoir, approximately 4.5 miles long and 2.5 miles wide, is partially surrounded by private residences and public and private parks.

Background

Puget Sound Energy (Puget) built Lake Tapps Reservoir and the associated hydroelectric power facilities in 1911, generating power there until January 2004. Hydroelectric operations involved diverting a portion of the water in the White River into Lake Tapps Reservoir for storage, sending the water through a powerhouse and turbines to generate electricity for the

[1] RCW 39.34: Interlocal cooperation act. http://apps.leg.wa.gov/RCW/default.aspx?cite=39.34.

electrical network that supplied Seattle and Tacoma, and returning the water to the White River via a tailrace canal.

Because of its concerns about the economic viability of maintaining the White River Hydroelectric Project (Hydro Project) for power production, Puget, together with other members of the Lake Tapps Task Force, considered whether the project could serve as a regional water supply for current and future populations' needs. To facilitate development of Lake Tapps Reservoir as a source of municipal water supply, Puget submitted three municipal water right applications (S2-29920, R2-29935, and S2-29934) to the Washington State Department of Ecology (Ecology) in 2000 and a change/transfer application for its pre-code water right claim (Puget Claim) (CS2-160822CL) in 2005. These four applications are referred to collectively as "the Applications".

When Ecology receives an application for a new water right permit or for a change to or transfer of an existing water right permit, Ecology is required (by RCW 90.03.290[2]) to investigate the application and to document its findings and action for public review. Ecology describes its findings and actions in a Report of Examination (ROE). Ecology published the 2006 Draft ROE and took public comment. The 2006 ROE was drafted following a remand of the earlier ROEs on the three municipal water right applications by the Pollution Control Hearings Board and the submittal of the change/transfer application by Puget.

In February 2008, following issuance of the *Environmental Checklist and State Environmental Policy Act (SEPA) Mitigated Determination of Nonsignificance (MDNS) for the Lake Tapps Reservoir Water Supply Project*, Cascade's Board of Directors approved an Asset Purchase Agreement for the acquisition of Lake Tapps Reservoir, the Puget Claim, the Applications, and associated Hydro Project facilities. In June 2008, Cascade published the *Lake Tapps Reservoir Issuance of New Municipal Water Rights and Change of Use for Existing Claim No. 60822, Determination of Significance and Request for Comments on the Scope of Environmental Impact Statement and Environmental Checklist*. On December 18, 2009, the purchase and sale under the Asset Purchase Agreement was completed and Cascade became the owner of the Project.

[2] RCW 90.03.290: RCW 90.03.290
Appropriation procedure — Department to investigate — Preliminary permit — Findings and action on application. http://apps.leg.wa.gov/RCW/default.aspx?cite=90.03.290.

Cascade's Proposed Action

The Proposed Action is for Cascade's Board of Directors to approve Cascade's operation of the Project and to request approval by Ecology of the Applications.

The three basic elements of the Project operation are as follows:

- Cascade would divert water from the White River into Lake Tapps Reservoir, store water in, and withdraw water from the reservoir for municipal water supply purposes.
- Cascade would operate the Project in a manner to provide enhanced flows in the White River (Recommended Flows) consistent with the 2008 White River Management Agreement with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe[3].
- Cascade would operate the Project to store water and maintain the levels of Lake Tapps Reservoir to support recreation consistent with 2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community.

More specifically, and as described in Table 1-1 of the Draft Environmental Impact Statement (Draft EIS), Ecology's approval of the Applications would permit the following:

1. Cascade would divert water from the White River into Lake Tapps Reservoir at an average annual rate of up to 75 cubic feet per second (cfs) (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes[4]. Cascade would divert water from the White River at a maximum instantaneous rate of up to 1,000 cfs (this maximum rate would vary by season and would be lower at other times of the year).

2. Cascade would store up to 46,700 acre-feet of water in Lake Tapps Reservoir for municipal, industrial, and commercial water supply purposes.

---

[3] Due to the timing of the closing of the Asset Purchase Agreement, the application for a donation of a portion of Puget's Claim into the State Trust Water Rights Program was for a temporary donation rather than a permanent donation. The temporary donation was accepted by Ecology on October 26, 2009 (Ecology 2009a). In anticipation of a future permanent donation application and for purposes of compliance with the State Environmental Policy Act (SEPA) for such permanent donation, the permanent donation is analyzed as a component of the Proposed Action in this Draft EIS. Cascade can provide for flows in accordance with the Recommended Flow Regime with or without Ecology's acceptance of the donation and, therefore, the donation is independent of and does not affect the remainder of the Proposed Action. The donation is intended to provide an additional legal mechanism to ensure implementation of the Recommended Flow Regime and there are no additional impacts beyond those analyzed for the Proposed Action.

[4] As fully described in Chapter 13 of the Draft EIS, the average flow rate of 75 cfs may be increased to an average flow rate of 82 cfs. The 7 cfs is referred to as "Regional Reserved Water". The Regional Reserved Water would not alter or affect the environmental analysis described in the Draft EIS.

3. Cascade would withdraw water from Lake Tapps Reservoir at an average annual rate of up to 75 cfs (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes. Cascade would withdraw water from Lake Tapps Reservoir at a maximum instantaneous rate of 135 cfs.

4. Cascade would divert water from the White River, store water in Lake Tapps Reservoir, and release water through the tailrace canal back to the White River in support of the following purposes: hydropower and other beneficial uses including recreational reservoir levels; winter reservoir levels; fish and wildlife habitat protection and enhancement; and maintenance of water quality for recreational purposes in the reservoir and to meet other regulatory requirements. For example, these other beneficial uses include operation of the sedimentation basins, operation of the fish screens and fish bypass pipeline, Spring Refill of Lake Tapps Reservoir, and maintaining water surface elevations in Lake Tapps Reservoir for recreation purposes.

Project Alternatives

In addition to the Proposed Action, the Draft EIS examines the following alternatives:

No Action Alternative

Under the No Action Alternative, the municipal water rights applications would not be acted upon and Cascade would not build or operate the Project. Because Cascade is a public water supply utility, it could face legal restrictions on owning a reservoir that it could not reasonably use for water supply purposes. Under those circumstances, Cascade would minimize expenditures associated with an operation not central to its core utilities' purposes and would attempt to sell the reservoir system.

Under the No Action Alternative, operation of the White River–Lake Tapps Reservoir system would most likely continue as it has since hydropower generation ceased in 2004.

1. Water would continue to be diverted from the White River at a rate that would maintain certain minimum flow rates in the White River. These minimum flow rates are referred to as the Interim Agency Flows (Interim Flows).[5] The Interim Flows in the White River would range from a high flow rate of 500 cfs from mid-summer into the fall to a low flow rate of 350 cfs through the winter and early spring.

[5] Under the White River Management Agreement (WRMA), Cascade would be obligated to meet the Recommended Flow Regime described in the WRMA so long as Cascade diverted water from the White River. However, for the purposes of the analysis described in the Draft EIS and for Ecology's baseline analysis that will be described in the new Draft ROE, the Interim Agency Flows are used. The use of Interim Agency Flows allows for analysis of greater impacts than would occur under the Recommended Flow Regime.

2. Reservoir surface elevations would be maintained as they have been since 2004. Consistent with an agreement between Puget and the Lake Tapps Community, Normal Full Pool (i.e., a water surface elevation of 541.0 to 542.5 feet National Geodetic Vertical Datum [NGVD] 29) would be maintained from April 15 to October 31, allowing for operational variances required due to forecasts or available precipitation, conditions of water rights, any necessary aquatic plant control, or the terms and conditions of applicable law.

3. No water would be withdrawn from Lake Tapps Reservoir for municipal supply.

On-Site Alternatives

Under the Washington State Environmental Policy Act (SEPA), reasonable alternatives are actions that could feasibly attain or approximate a proposal's objective, but at a lower environmental cost or decreased level of environmental degradation (WAC 197-11-440(5)[6]).

Under the Proposed Action, the Recommended Flows in the White River and recreational surface levels in Lake Tapps Reservoir would be fully provided prior to the diversion of or withdrawal of water for municipal use. Under the Proposed Action, Cascade has reduced the amount of water for diversion and withdrawals for municipal water supply (from the amounts requested in the Applications) to the maximum extent feasible while still providing for the current and projected demands of its Members and the region. Any on-site alternatives that propose further diminishment of diversion and withdrawals would not allow the management of the White River–Lake Tapps Reservoir system for municipal use while maintaining water quality, recreational reservoir levels, and stream flows for fish and wildlife; and thus, would not meet the Project objective and/or would do so at a higher overall environmental cost. Such alternatives would not be reasonable alternatives and were not carried forward for analysis.

Reasonable alternatives may be mitigation measures not included in the Proposed Action (WAC 197-11-792(2)[7]). The conditions and additional mitigation measures from the 2006 Draft ROE were reviewed to determine whether there are any reasonable alternatives that are not already included either in the Proposed Action or among the mitigation measures to be provided in association with the Proposed Action. The following are addressed as part of the Proposed Action and associated mitigation measures, and, therefore, were not carried forward for separate analysis: minimum flows known as "Agency 10(j) Flows"; ramping rates; minimum instream flow (MIF) compliant diversion; flow augmentation; land conservation; Diversion Minimization Plan to identify the minimum diversion from the White River and outflows from Lake Tapps Reservoir that are necessary to maintain water quality in the reservoir; Water Quality Compliance Plan to achieve the goal of complying with the dissolved

[6] WAC 197-11-440: EIS contents. http://apps.leg.wa.gov/wac/default.aspx?cite=197-11-440.
[7] WAC 197-11-792. Scope. http://apps.leg.wa.gov/wac/default.aspx?cite=197-11-792.

oxygen and temperature standards applicable to the White River at the location of the tailrace; tailrace barrier to minimize attraction and block entry of migrating fish to the tailrace discharge; leakage reduction; fish screen installation on any water withdrawal structure; settling basins continued; and conservation. In addition, other mitigation measures are identified in Section 1.4 of the Draft EIS. The only measure not included in the Draft EIS is source exchange, which was determined to be infeasible.

Off-Site Alternatives

Under the Off-Site Alternatives, Cascade would develop an alternative source of supply in lieu of constructing the Project. Sources were evaluated via a multi-criteria analysis, including interim sources and permanent smaller and uncertain sources.

Cascade determined that Lake Tapps Reservoir is the only single source of supply that offers sufficient certainty for development to meet growth over a 50- to 100-year time frame. It is the only source that provides assurances needed to secure a significant increase in contracted supply from Seattle Public Utilities and/or Tacoma Public Utilities in the near-term. These assurances are important because the contracted supplies are designed to serve as a "bridge" supply pending Cascade's development of a permanent, long-term supply in the future. The water suppliers providing the contracted supply need assurances that when the time comes to terminate the contract, the communities served by Cascade will not be dependent on the contracted water. The Lake Tapps Reservoir supply, regardless of when it is developed, has both the certainty and quantity needed to provide assurances to support further contracting. There is no other single potential supply that has both the quantity and certainty needed to provide these assurances. Thus, the Off-Site Alternatives were not carried forward for analysis.

Proposed Date of Implementation

A decision about the Proposed Action will not be made until at least 7 days after issuance of the Final EIS.

SEPA Lead Agency

Cascade Water Alliance is the lead agency for this proposal.

SEPA Responsible Official/Contact Person

Michael A. Gagliardo, Director of Planning
Cascade Water Alliance
11400 SE 8th Street, Suite 440
Bellevue, WA 98004
Phone: 425-453-0930

Permits and Approvals Required for the Proposed Action

Ecology's approval of the Applications is part of the Proposed Action and is required to fully implement the Proposed Action. In addition, a water system plan prepared in accordance with the Washington State Department of Health regulations would be required in future phases of the Project, as well as various state and local permits. These permits and approvals cannot be identified until the required infrastructure components are identified.

Authors and Principal Contributors

The individuals listed below were principal contributors to the preparation of this Draft EIS.

Name	Contribution	Education	Years of Experience
HDR Engineering, Inc.			
Marc Auten	Plants and Wildlife Groundwater	B.S. Environmental Science	7
Leanne Bartle	Graphics	B.A. Graphics (New Media)	10
Joel Darnell	Earth	B.S. Civil Engineering M.S. Ocean Engineering	5
Karissa Kawamoto, AICP	Recreation and Aesthetics	B.A. Urban and Regional Planning	16
Robert D. "Bob" King, P.E.	Project Manager	B.S. Civil Engineering M.S. Civil Engineering	30
John Koreny, PH, RG, PHG, CEG	Surface Water Quality Groundwater	B.S. Environmental Science (Water Chemistry) M.S. Environmental Science (Hydrogeology) M.S. Civil and Environmental Engineering (Water Resources)	20
Bill Mavros	Fisheries	B.E.S. Environmental Sciences M.Sc. Zoology	21
Michael Miller	GIS	B.S. Plant Science B.L.A. Landscape Architecture	17
Mike Stimac, P.E.	EIS Manager Senior Reviewer	B.S. Electrical Engineering M.S. Fisheries	41
Steven M. Thurin, P.E.	Surface Water Quantity Surface Water Quality Climate Change	B.S. Civil Engineering M.S. Civil Engineering (Water Resources)	32
Sara Twitchell	Land and Shoreline Use Climate Change	B.S. Ecology and Evolutionary Biology	4
Barb Whiton	Technical Editor	B.A. Anthropology M.A. Anthropology (Archaeology)	28

Draft EIS Date of Issuance

January 29, 2010

Due Date for Draft EIS Comments

Comments on the Draft EIS are invited and should be postmarked or e-mailed on or before March 15, 2010. Written comments should be addressed to:

Michael A. Gagliardo, Director of Planning
Cascade Water Alliance
11400 SE 8th Street, Suite 440
Bellevue, WA 98004
contact@cascadewater.org

Time and Place of Public Meeting to Receive Comments on the Draft EIS

Cascade does not anticipate holding a public meeting on the Draft EIS.

Locations to Obtain Copies of or to View the Draft EIS

The Draft EIS is available to the public online at www.cascadewater.org.

The Draft EIS is also available on compact disc (CD) for a cost of $5, or printed copy for $200, from the following address:

Cascade Water Alliance
11400 SE 8th Street, Suite 440
Bellevue, WA 98004
Phone: 425-453-0930

Copies of the Draft EIS are available for review at the following libraries:

- King County Library System

  Redmond Regional Branch
  Bellevue Regional Branch
  Issaquah Branch
  Tukwila Branch
  Covington Branch
  Auburn Branch

- Pierce County Library System

  Bonney Lake
  Sumner

- University of Washington Suzzallo Library

Date of Final EIS

Cascade anticipates that the Final EIS will be issued in April or May 2010.

Subsequent Environmental Review

Further actions necessary to use water withdrawn from Lake Tapps Reservoir for municipal supply are known only in general terms and are not part of the Proposed Action. Environmental review under SEPA will be conducted for future actions, as appropriate.

Background Documents

Draft EIS technical reports, background data, adopted documents, and materials incorporated by reference for the Draft EIS are available for public review at the following address:

Cascade Water Alliance
11400 SE 8th Street, Suite 440
Bellevue, WA 98004
Phone: 425-453-0930

This page intentionally left blank.

Table of Contents

Tables

Figures

Appendices

This page intentionally left blank.

Acronyms and Abbreviations

7-DADMax	7 day average daily maximum temperature
2006 DROE	2006 Draft Report of Examination (2006)
2009 Community Agreement	2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community
ACES	Automated Coastal Engineering System
ADD	average daily demand
af/y	acre-feet per year
Cascade	Cascade Water Alliance
CAT	Climate Action Team
cfs	cubic feet per second
CIG	Climate Impacts Group (University of Washington)
CO_2	carbon dioxide
CPNWS	Center for Pacific Northwest Studies
DO	dissolved oxygen
DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
ENSO	El Nino/Southern Oscillation
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
FPC	Federal Power Commission
FR	Federal Register
GCC	Global Climate Change
GHG	greenhouse gas
GIS	geographic information system
GMA	Growth Management Act
GMC	General Circulation Model

gpm	gallons per minute
HIS	habitat suitability indices
Hydro Project	White River Hydroelectric Project
IFIM	instream flow incremental methodology
kW	kilowatt
LiDAR	Light Detection and Ranging
LWD	large woody debris
MDNS	Mitigated Determination of Nonsignificance
MF	minimum flow
mgd	million gallons per day
mg/L	milligrams per liter
MIF	minimum instream flow
MMD	Mud Mountain Dam
MOU	Memorandum of Understanding
mph	miles per hour
n.d.	no date
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NWI	National Wetland Inventory
OCPI	overriding considerations of public interest
PCHB	Pollution Control Hearings Board
PCRC	Pierce County Regional Council
PDO	Pacific Decadal Oscillation
PHS	Priority Habitats and Species
Project	Lake Tapps Reservoir Water Rights and Supply Project
PSCAA	Puget Sound Clean Air Agency
PSRC	Puget Sound Regional Council
Puget	Puget Sound Energy (and its predecessors)
Qa	average annual flow
Q(A)c	Upper Coarse-Grained Unit
Q(A)f	Upper Fine-Grained Unit

Q(B)c	Lower Coarse-Grained Unit
Q(B)f	Lower Fine-Grained Unit
Q(C)u	Unconsolidated/Undifferentiated Deposits
Qi	maximum instantaneous flow
Qva	Vashon Advance Outwash
Qvr	Vashon Recessional Outwash
Qvt	Vashon Glacial Till
RCW	Revised Code of Washington
RM	River Mile
ROE	Report of Examination
SaSI	Salmonid Stock Inventory
Sea-Tac	Seattle-Tacoma International Airport
SEPA	State Environmental Policy Act
sfd	second-foot day
SMA	Shoreline Management Act
SMP	Shoreline Management Program
SR	State Route
TCP	Tacoma–Cascade Pipeline
TMDL	Total Maximum Daily Load
TSP	Cascade's *2004 Transmission and Supply Plan*
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WR	White River
WRCC	Western Regional Climate Center
WRIA	Water Resource Inventory Area

WRMA	2008 White River Management Agreement
WSEL	water surface elevation
WUA	Weighted Useable Area
WWTP	wastewater treatment plant
ybp	years before present

Glossary

2009 Community Agreement	The 2009 Agreement Regarding Lake Tapps between Cascade Water Alliance and the Lake Tapps Community (see Appendix D).
advance outwash	A very dense, stratified deposit of sand and gravel deposited at the front of advancing glaciers.
alluvium	Sediment deposited by water.
anadromous fish	Fish that hatch in fresh water, migrate to the ocean to grow and mature, then return to fresh water to spawn.
Applications	The three municipal water right applications (S2-29920, R2-29935, and S2-29934) that Puget submitted to the Washington State Department of Ecology in 2000, as well as the change/transfer application for its pre-code water right claim (Puget Claim) (CS2-160822CL) submitted in 2005.
aquifer	An underground geologic layer of saturated soil or rock that that can yield significant quantities of water on a long-term basis.
Asset Purchase Agreement	The 2008 agreement between Puget and Cascade for Cascade's purchase of the Hydro Project, including the Hydro Project water right and the three municipal water right applications.
bathymetry	Refers to the measurement of water depth; it essentially describes submerged topography.
bed load	The quantity of silt, sand, and gravel or other debris rolled along the bed of a stream.
cavitation	The formation of bubbles in a liquid and their sudden collapse, which can cause damage in a pump.
closing	Refers to the purchase and sale of Lake Tapps Reservoir, the Puget Claim, the Applications, and associated Hydro Project facilities under the Asset Purchase Agreement on December 18, 2009.
confining unit	A layer of lower-permeability material that overlies an aquifer. Sometimes called an aquitard.
conifer	A cone-bearing woody plant, most of which are trees (e.g., firs, junipers, and cedars).
deciduous	Refers to trees that shed their leaves annually.

dissolved oxygen	The oxygen gas dissolved in water. Fish absorb oxygen directly into their bloodstream through their gills (comparable to land animals breathing oxygen into their lungs). A higher DO content is favorable for fish.
diversion canal	The canal that conveys water from the White River to Lake Tapps Reservoir. The diversion canal consists of flumes, a canal, settling basins, and two large-diameter concrete pipes. Screens on the diversion canal remove fish from the intake area and return them to the river via a bypass conduit.
diversion dam	The timber crib dam near Buckley that diverts water from the White River into the diversion canal. The diversion dam has a concrete intake structure and an upstream migrant fish trap operated by the U.S. Army Corps of Engineers.
embayment	An indentation in the shoreline forming an open bay.
emergent vegetation	Wetland vegetation consisting of erect, rooted, herbaceous plants adapted to living in saturated soils.
escapement	Fish that have survived natural and fishing mortality to constitute the spawning population.
facies	A distinct rock unit for an area or environment; the rock unit's characteristics (for example, grain size) are based on its depositional environment.
Fall Drawdown	The reduction of water level in the fall to help control aquatic vegetation growth and to allow dike maintenance.
fetch	The effective distance over which wind can create waves.
forebay	The area on the west side of Lake Tapps Reservoir where water is collected before it enters the penstocks.
forbs	Broad-leafed, herbaceous flowering plants.
fry	Young salmonids that have emerged from their redds and absorbed their yolk sacs, up to the time they are about 2 inches long.
gaining reach	A section of a stream that is gaining flow from groundwater.
glaciation	The process of ice growth and retreat within a glacier.
groundwater	The water below the ground surface that is free flowing within pore spaces and fractures.
groundwater discharge	Removal of groundwater from an aquifer (for example, by pumping at a well).

groundwater recharge	The process where natural sources (infiltrating rain, snowmelt, or surface water) or pumped water enters and replenishes the groundwater supply.
Group A wells	Groundwater wells that serve 15 or more households.
Group B wells	Groundwater wells that serve 2 to 14 households.
hydraulic conductivity	The ease with which water can move through pore spaces and fractures.
hydraulic gradient	The slope of the water table or potentiometric level, or the change in hydraulic head over the distance between the two monitoring wells.
hydraulic head	A measurement of water pressure above a datum. This measurement can be used to determine a hydraulic gradient between two or more points.
hydrogeology	The distribution and flow of groundwater.
Hydro Project	The White River Hydroelectric Project owned by Puget Sound Energy since 1911 and operated until January 15, 2004.
hypolimnion	The dense, bottom layer of water in a thermally-stratified lake.
Interim Flows	See Table 3-1.
lacustrine	Refers to the area in or along the shoreline of lakes.
Lake Tapps Community	A collective term for the following organizations, all of which are Washington non-profit corporations: Friends of Lake Tapps, dba the Lake Tapps Community Council; the Church Lake Maintenance Company; Driftwood Point Association; Inlet Island Maintenance Company; Snag Island Maintenance Association; Tacoma Point Improvement Club; Tapps Island Association; and West Tapps Maintenance Company.
large woody debris	Logs, limbs, or root wads that are waterward of the ordinary high water line. These areas can create habitat features important to fish life.
leakance	The uncontrolled outflow of water from Lake Tapps Reservoir through the outlet works to the tailrace canal.
listed species	Any species of plant or wildlife that has been determined to be endangered or threatened.
losing reach	A section of a stream where water moves from the stream into the bed and banks to groundwater.
mean sea level (msl)	The sea level established by the National Geodetic Vertical Datum of 1929.

meltwater	Water that comes from melting snow and ice.
mesotrophic	Refers to waters that have moderate levels of nutrients that can support moderate levels of plant life.
natal stream	The stream where a fish was hatched and reared.
Normal Full Pool	A water level between 541.0 feet National Geodetic Vertical Datum (NGVD) 29 and 542.5 feet NGVD 29 (measured at gage 12101000).
oligotrophic	Refers to waters relatively low in nutrients that cannot support much plant life.
outmigration	The downstream movement of juvenile/fry from their freshwater rearing area to the ocean.
palustrine wetlands	Wetlands that are non-tidal and that are dominated by trees, shrubs, emergent vegetation, mosses, or lichens.
passerine	Relating to an order of birds that includes perching birds and songbirds such as finches and sparrows.
penstocks	Long, high-pressure steel pipes that deliver water to the powerhouse.
Pleistocene	A geologic epoch about 2.6 million to 10,000 years ago, characterized by repeated glaciations.
pool	Aquatic habitat in a stream that is deeper and sometimes wider than habitats immediately above or below.
potentiometric level	The top of the saturated zone when the aquifer is overlain by a confining unit.
Puget Claim	Puget Sound Energy's pre-code water right claim (CS2-160822CL).
reach	A portion of a stream's length.
recessional outwash	Stratified sand and gravel deposited at the front of retreating glaciers.
Recommended Flows	See Table 3-2.
recreation season	April 15 to October 31 for the post-hydropower period (after January 2004) (see Cascade and Lake Tapps Community 2009). Memorial Day to Labor Day in the hydropower period (prior to January 2004).

refugia	An area of a stream that provides shelter or safety for aquatic species.
return period	The average time between events of a specified magnitude.
riffle	A shallow stream reach with a broken water surface caused by ripples or waves formed over obstacles or substrate in the streambed.
riparian	Used to describe areas along a watercourse or water body; it may be used to describe vegetation or habitat.
riprap	Man-made armoring (frequently large rocks) placed along a stream bank to prevent erosion.
salmonids	Members of the fish family *Salmonidae*, including salmon, trout, and char.
scrub-shrub vegetation	Consists of woody plants less than 60 feet tall, including shrubs, tree saplings, or stunted trees or shrubs.
second-foot day	The volume of water represented by a flow of 1 cubic foot per second for 24 hours; equal to 86,400 cubic feet.
shoreface	A narrow zone, covered with water, where beach sands and gravels are affected by waves.
smolt	A subadult salmonid that is migrating from fresh water to sea water.
Spring Refill	The late winter or early spring refill of the reservoir to the Normal Full Pool elevation.
stade	A period within a glacial retreat marked by glacial re-advance.
stage	The height of the water surface above an established datum plane.
storage	Active storage is the volume of water that can be released between the normal maximum reservoir level and the level when water stops flowing through the outlet. Inactive storage is the quantity of storage below the elevation of the outlet works. Total storage is the entire storage of the reservoir including both inactive and active storage.
strata	Beds or layers of sedimentary rock that are visually distinguishable from other layers.
substrate	Materials (silt, sand, gravel, and rocks) that form the bottom of streams.
tailrace canal	The canal that returns water to the White River after it has been passed through the powerhouse.

turbidity	Refers to the suspended sediments or floating material that clouds the water and makes it appear dark and muddy. Turbidity may prevent penetration of sunlight and affect production of food in a water body.
till	A dense, non-sorted, non-stratified deposit of silt, sand, gravel, and occasional boulders deposited by a glacier.
understory	Vegetation that grows underneath the shade of taller trees.
water year	Runs from October 1 through the following September 30, and is numbered for the year in which it ends.
wave period	The time required for two successive wave crests to pass a fixed point.
WRMA	The 2008 White River Management Agreement between Cascade and the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe (see Appendix C).

Summary

Introduction

This Draft Environmental Impact Statement (Draft EIS) provides information about the environmental impacts associated with the proposed Lake Tapps Reservoir Water Rights and Supply Project (Project). An EIS describes the existing environment that would be affected by the Proposed Action, analyzes significant adverse environmental impacts of each alternative, and discusses reasonable mitigation measures.

Project Proponent

The proponent of the Project is Cascade Water Alliance (Cascade). Cascade is a non-profit corporation composed of municipal corporations and special-purpose municipal corporations in King County that are party to an Interlocal Agreement entered into under the authority of the Interlocal Cooperation Act (Chapter 39.34 RCW[1]) for the purpose of its Members working together to plan, develop, and operate a water supply system and regional assets that will meet Cascade's Members' current and future drinking water needs. The Members of Cascade are as follows:

- City of Bellevue
- City of Issaquah
- City of Kirkland
- City of Redmond
- City of Tukwila
- Covington Water District
- Skyway Water and Sewer District
- Sammamish Plateau Water and Sewer District

Project Objective

The objective of the Project is to allow Cascade to provide – in a coordinated, cost-effective, and environmentally responsible manner – a safe, reliable, high quality municipal water supply that will meet the current and projected demands of its Members and the Central Puget Sound Region from a source that is sufficiently large, certain, and non-speculative, and is available both for immediate, short-term use and for long-term use over a 50- to 100-year planning period.

[1] Chapter 39.34 RCW: Interlocal Cooperation Act. http://apps.leg.wa.gov/RCW/default.aspx?cite=39.34.

Project Description

Project Location, Setting, and Study Area

Lake Tapps Reservoir is located in northern Pierce County, Washington, approximately 30 miles southeast of Seattle and 18 miles east of Tacoma in Section 2, Township 19 North, Range 6 East. The reservoir, approximately 4.5 miles long and 2.5 miles wide, is partially surrounded by private residences and public and private parks. Lake Tapps Reservoir has a surface area of approximately 2,700 acres and active storage capacity of approximately 46,700 acre-feet. The City of Bonney Lake borders Lake Tapps Reservoir on the south, and much of the limited amount of public land surrounding the reservoir is owned by Pierce County.

Other nearby population centers are the cities of Auburn, Buckley, Pacific, and Sumner. The common Pierce County/King County line runs along the White River east of Lake Tapps Reservoir. The Muckleshoot Indian Reservation is located along the White River southeast of Auburn. Thus, the portion of the White River not diverted into Lake Tapps Reservoir is referred to as the *Reservation Reach*. The White River is a tributary to the Puyallup River.

The study area for the Project is the area that encompasses the White River from the diversion dam near Buckley downstream to the river's confluence with the Puyallup River; Lake Tapps Reservoir; and the Lower Puyallup River from its confluence with the White River to its outlet at Commencement Bay.

Background

Puget Sound Energy (Puget) built Lake Tapps Reservoir and associated hydroelectric power facilities in 1911, generating power there until January 2004. Hydroelectric operations involved diverting a portion of the water in the White River into Lake Tapps Reservoir for storage, sending the water through a powerhouse and turbines to generate electricity for the electrical network that supplied Seattle and Tacoma, and returning the water to the White River via a tailrace canal.

Because of its concerns about the economic viability of maintaining the White River Hydroelectric Project (Hydro Project) for power production, Puget, together with other members of the Lake Tapps Task Force, considered whether the Project could serve as a regional water supply for current and future populations' needs. To facilitate development of Lake Tapps Reservoir as a source of municipal water supply, Puget submitted three municipal water rights applications (S2-29920, R2-29935, and S2-29934) to the Washington State Department of Ecology (Ecology) in 2000.

When Ecology receives an application for a new water right permit or for a change to or transfer of an existing water right permit, Ecology is required (by RCW 90.03.290[2]) to investigate the application and to document its findings and action for public review. Ecology describes its findings and actions in a Report of Examination (ROE).

In 2003, Ecology published three Draft ROEs and took public comment. These ROEs were appealed by the Muckleshoot Indian Tribe, the Puyallup Tribe of Indians, the City of Auburn, the City of Buckley, and others to the Pollution Control Hearings Board. The 2003 ROEs were remanded back to Ecology when Puget announced it was ceasing hydropower generation. Thereafter, in 2005, Puget submitted the change/transfer application for its pre-code water right claim (Puget Claim) (CS2-160822CL). The four applications are referred to collectively as the "Applications" (see Appendix A).

In 2006, Ecology published the 2006 Draft Report of Examination (2006 DROE) (Ecology 2006a) and took public comment. The 2006 DROE remains on Ecology's Web site[3].

In February 2008, following issuance of the *Environmental Checklist and State Environmental Policy Act (SEPA) Mitigated Determination of Nonsignificance (MDNS) for the Lake Tapps Reservoir Water Supply Project* (Cascade 2008a), Cascade's Board of Directors approved an Asset Purchase Agreement for the acquisition of Lake Tapps Reservoir, the Puget Claim, the Applications, and associated Hydro Project facilities. In June 2008, Cascade published the *Lake Tapps Reservoir Issuance of New Municipal Water Rights and Change of Use for Existing Claim No. 60822, Determination of Significance and Request for Comments on the Scope of Environmental Impact Statement and Environmental Checklist* (Cascade 2008b).

In August 2008, Cascade entered into the 2008 White River Management Agreement (WRMA) (Cascade 2008c) (see Appendix C) with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe and individual settlement agreements with each Tribe: the Lake Tapps Water Rights Settlement Agreement (Cascade 2008e) with the Muckleshoot Indian Tribe and the Natural Resources Enhancement Agreement (Cascade 2008d) with the Puyallup Tribe of Indians. The WRMA includes a Recommended Flow Regime for the White River.

In May 2009, following extensive public negotiations with the Lake Tapps Community, Cascade entered into the 2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community (2009 Community Agreement) (Cascade 2009a) (see Appendix D). The 2009 Community Agreement includes maintenance of Lake Tapps

[2] RCW 90.03.290: RCW 90.03.290
Appropriation procedure — Department to investigate — Preliminary permit — Findings and action on application. http://apps.leg.wa.gov/RCW/default.aspx?cite=90.03.290.
[3] See http://www.ecy.wa.gov/programs/WR/swro/images/pdf/lktapps_draft_roe_09202006.pdf.

Reservoir's surface level within a range of elevations called Normal Full Pool during specified periods of the year, depending on whether or not Cascade has begun to withdraw water for municipal water supply purposes.

On December 18, 2009, the purchase and sale under the Asset Purchase Agreement was completed (this is referred to as the "closing").

Public Involvement/Scoping

In addition to the litigation and negotiations described above, there have been several opportunities for public involvement related to the use of Lake Tapps Reservoir as a municipal water supply. In 2003, Cascade published a State Environmental Policy Act (SEPA) Environmental Checklist (Cascade 2003a) for the proposed Lake Tapps Water Supply Project and issued a Mitigated Determination of Nonsignificance (MDNS) (Cascade 2003b) for the project. As mentioned above, Ecology issued a *Draft Report of Examination for Lake Tapps Reservoir Water Supply Project Application S2-29934* (Ecology 2006a) for public comment in September 2006, and Cascade published an Environmental Checklist and SEPA MDNS for the Lake Tapps Reservoir Water Supply Project (Cascade 2008a) in February 2008, prior to its acquisition of the Project.

As noted above, in June 2008, Cascade published the *Lake Tapps Reservoir Issuance of New Municipal Water Rights and Change of Use for Existing Claim No. 60822, Determination of Significance and Request for Comments on the Scope of Environmental Impact Statement and Environmental Checklist* (Cascade 2008b). To invite public comment on the proposed Project and its environmental impacts, Cascade completed the following:

- Published the Determination of Significance and Request for Comments on Scope of EIS in *The Daily Journal of Commerce*, *The Seattle Times*, and *The News Tribune*.
- Posted three notice boards in the Project area.

Written comments were received from the cities of Auburn, Bonney Lake, Buckley, and Sumner; the Lake Tapps Community Council; the Puyallup Tribe of Indians; and K.W. Castile. The comments identified the following as topics that should be addressed by the EIS:

- Impacts on the ability of local utilities to develop sources of supply and meet future water demands.
- How climate change would affect the Project.
- The nature of agencies' involvement, including specific agreements or plans establishing the terms of the relationship between Cascade and those public entities.

- Impacts on parks and recreation.
- Impacts on shoreline erosion of Lake Tapps Reservoir.
- Impacts on existing wells, springs, and water rights.
- Need for dredging.
- The baseline against which the impacts of the Project are evaluated (should represent the current environment).
- Discharges into the White River and impacts on water quality.
- Control of aquatic plant growth in Lake Tapps Reservoir.

Alternatives

No Action Alternative

Under the No Action Alternative, the municipal water rights applications would not be acted upon and Cascade would not build or operate the Project. Because Cascade is a public water supply utility, it could face legal restrictions on owning a reservoir that it could not reasonably use for water supply purposes. Under those circumstances, Cascade would minimize expenditures associated with an operation not central to its core utilities' purposes and would attempt to sell the reservoir system.

Under the No Action Alternative, operation of the White River–Lake Tapps Reservoir system would most likely continue as it has since hydropower generation ceased in 2004.

1. Water would continue to be diverted from the White River at a rate that would maintain certain minimum flows in the White River. These minimum flows are referred to as the Interim Agency Flows.[4] The Interim Agency Flows in the White River would range from a high flow rate of 500 cfs from mid-summer into the fall to a low flow rate of 350 cfs through the winter and early spring.
2. Reservoir surface elevations would be maintained as they have been since 2004. Consistent with an agreement between Puget and the Lake Tapps Community, Normal Full Pool (i.e., a water surface elevation of 541.0 to 542.5 feet National Geodetic Vertical Datum [NGVD 29]) would be maintained from April 15 to October 31, allowing for

[4] Under the White River Management Agreement, Cascade would be obligated to meet the Recommended Flow Regime described in the WRMA, so long as Cascade diverted water from the White River. However, for the purposes of the analysis described in this Draft EIS and for Ecology's baseline analysis that will be described in the new Draft ROE, the Interim Agency Flows are used. The use of Interim Agency Flows allows for analysis of greater impacts than would occur under the Recommended Flow Regime.

operational variances required due to forecasts or available precipitation, conditions of water rights, any necessary aquatic plant control, or the terms and conditions of applicable law.

3. No water would be withdrawn from Lake Tapps Reservoir for municipal supply.

Proposed Action

The Proposed Action is for Cascade's Board of Directors to approve Cascade's operation of the Project and to request approval by Ecology of the Applications.

The three basic elements of the Project operation are as follows:

- Cascade would divert water from the White River into Lake Tapps Reservoir, store water in, and withdraw water from the reservoir for municipal water supply purposes.
- Cascade would operate the Project in a manner to provide enhanced flows in the White River (Recommended Flows) consistent with the 2008 White River Management Agreement with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe[5] (see Appendix C).
- Cascade would operate the Project to store water and maintain the levels of Lake Tapps Reservoir to support recreation consistent with 2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community (see Appendix D).

[5] Due to the timing of the closing of the Asset Purchase Agreement, the application for a donation of a portion of Puget's Claim into the State Trust Water Rights Program was for a temporary donation rather than a permanent donation. The temporary donation was accepted by Ecology on October 26, 2009 (Ecology 2009a). In anticipation of a future permanent donation application and for purposes of compliance with the State Environmental Policy Act (SEPA) for such permanent donation, the permanent donation is analyzed as a component of the Proposed Action in this Draft EIS. Cascade can provide for flows in accordance with the Recommended Flow Regime with or without Ecology's acceptance of the donation and, therefore, the donation is independent of and does not affect the remainder of the Proposed Action. The donation is intended to provide an additional legal mechanism to ensure implementation of the Recommended Flow Regime and there are no additional impacts beyond those analyzed for the Proposed Action.

More specifically, and as shown in Figure S-1, Ecology's approval of the Applications would permit the following:

1. Cascade would divert water from the White River into Lake Tapps Reservoir at an average annual rate of up to 75 cubic feet per second (cfs) (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes[6]. Cascade would divert water from the White River at a maximum instantaneous rate of up to 1,000 cfs (this maximum rate would vary by season and would be lower at other times of the year).

2. Cascade would store up to 46,700 acre-feet of water in Lake Tapps Reservoir for municipal, industrial, and commercial water supply purposes.

3. Cascade would withdraw water from Lake Tapps Reservoir at an average annual rate of up to 75 cfs (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes. Cascade would withdraw water from Lake Tapps Reservoir at a maximum instantaneous rate of 135 cfs.

4. Cascade would divert water from the White River, store water in Lake Tapps Reservoir, and release water through the tailrace canal back to the White River in support of the following purposes: hydropower and other beneficial uses including recreational reservoir levels; winter reservoir levels; fish and wildlife habitat protection and enhancement; and maintenance of water quality for recreational purposes in the reservoir and to meet other regulatory requirements. For example, these other beneficial uses include operation of the sedimentation basins, operation of the fish screens and fish bypass pipeline, Spring Refill of Lake Tapps Reservoir, and maintaining water surface elevations in Lake Tapps Reservoir for recreation purposes.

On-Site Alternatives

Under SEPA, reasonable alternatives are actions that could feasibly attain or approximate a proposal's objective, but at a lower environmental cost or decreased level of environmental degradation (WAC 197-11-440(5)[7]).

Under the Proposed Action, the Recommended Flows in the White River and recreational surface levels in Lake Tapps Reservoir would be fully provided prior to the diversion of or withdrawal of water for municipal use. Under the Proposed Action, Cascade has reduced the amount of water for diversion and withdrawals for municipal water supply (from the amounts requested in the Applications) to the maximum extent feasible while still providing for the

[6] As fully described in Chapter 13 of this Draft EIS, the average flow rate of 75 cfs may be increased to an average flow rate of 82 cfs. The 7 cfs is referred to as "Regional Reserved Water". The Regional Reserved Water would not alter or affect the environmental analysis described in this Draft EIS.

[7] WAC 197-11-440: EIS contents. http://apps.leg.wa.gov/wac/default.aspx?cite=197-11-440.

current and projected demands of its Members and the region. Any on-site alternatives that propose further diminishment of diversion and withdrawals would not allow the management of the White River–Lake Tapps Reservoir system for municipal use while maintaining water quality, recreational reservoir levels, and stream flows for fish and wildlife; and thus, would not meet the Project objective and/or would do so at a higher overall environmental cost. Such alternatives would not be reasonable alternatives, and were not carried forward for analysis.

Reasonable alternatives may be mitigation measures not included in the Proposed Action (WAC 197-11-792(2)[8]). The conditions and additional mitigation measures from the 2006 Draft ROE were reviewed to determine whether there are any reasonable alternatives that are not already included either in the Proposed Action or among the mitigation measures to be provided in association with the Proposed Action. The following are addressed as part of the Proposed Action and associated mitigation measures, and, therefore, were not carried forward for separate analysis: minimum flows known as "Agency 10(j) Flows"; ramping rates; minimum instream flow (MIF) compliant diversion; flow augmentation; land conservation; Diversion Minimization Plan to identify the minimum diversion from the White River and outflows from Lake Tapps Reservoir that are necessary to maintain water quality in the reservoir; Water Quality Compliance Plan to achieve the goal of complying with the dissolved oxygen and temperature standards applicable to the White River at the location of the tailrace; tailrace barrier to minimize attraction and block entry of migrating fish to the tailrace discharge; leakage reduction; fish screen installation on any water withdrawal structure; settling basins continued; and conservation. In addition, other mitigation measures are identified in Section 1.4 of this Draft EIS. The only measure not included in the Draft EIS is source exchange, which was determined to be infeasible.

[8] WAC 197-11-792. Scope. http://apps.leg.wa.gov/wac/default.aspx?cite=197-11-792.

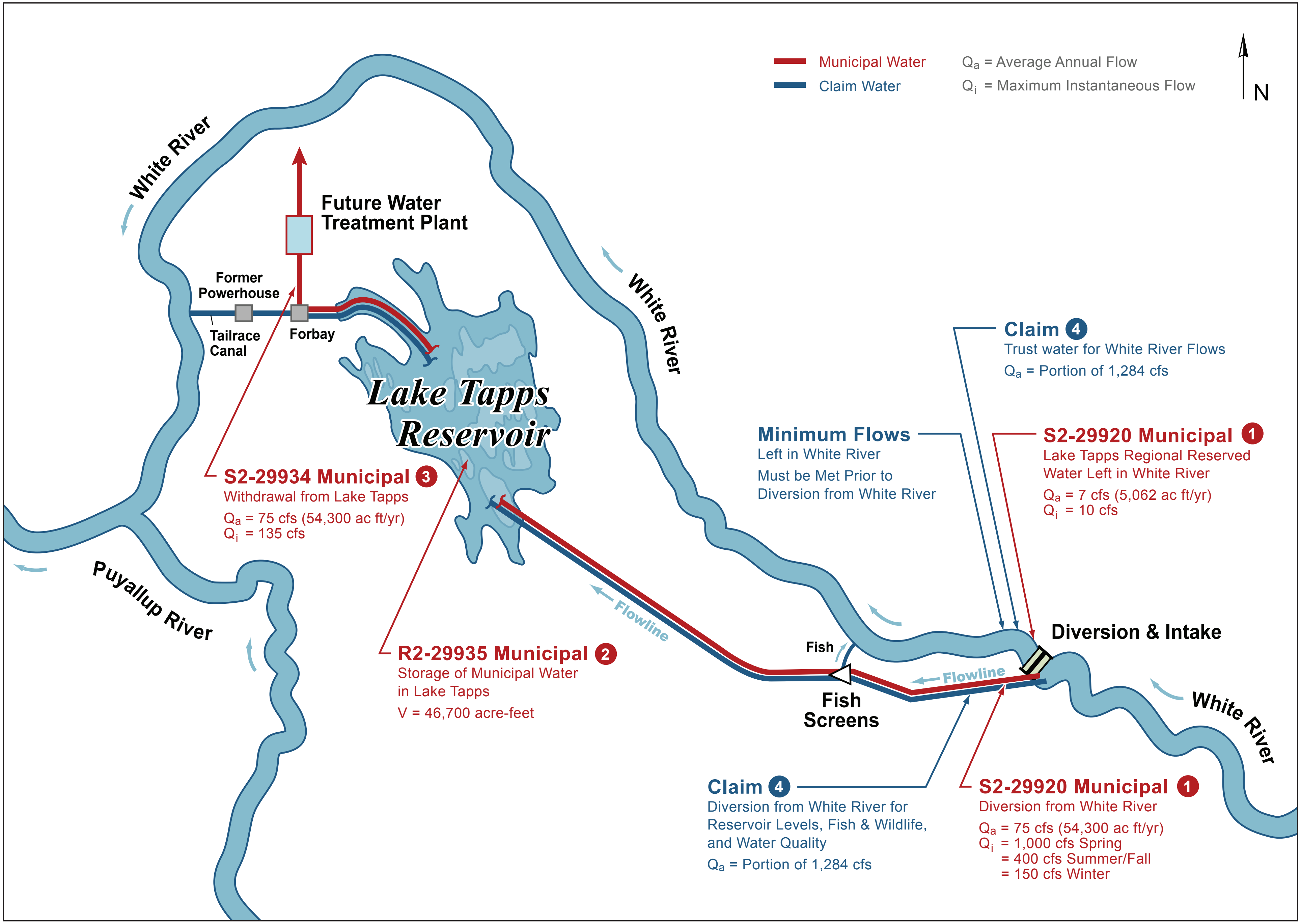


Figure S-1. Schematic of the Water Right Applications and Change of Use Application

Lake Tapps Water Rights and Supply Project

Off-Site Alternatives

Under the Off-Site Alternatives, Cascade would develop an alternative source of supply in lieu of constructing the Project. Sources were evaluated via a multi-criteria analysis, including interim sources and permanent smaller and uncertain sources (see Appendix E).

Cascade determined that Lake Tapps Reservoir is the only single source of supply that offers sufficient certainty for development to meet growth over a 50- to 100-year time frame. It is the only source that provides assurances needed to secure a significant increase in contracted supply from Seattle Public Utilities and/or Tacoma Public Utilities in the near-term. These assurances are important because the contracted supplies are designed to serve as a "bridge" supply pending Cascade's development of a permanent, long-term supply in the future. The water suppliers providing the contracted supply need assurances that when the time comes to terminate the contract, the communities served by Cascade will not be dependent on the contracted water. The Lake Tapps Reservoir supply, regardless of when it is developed, has both the certainty and quantity needed to provide assurances to immediately support further contracting. There is no other single potential supply that has both the quantity and certainty needed to provide these assurances. The Off-Site Alternatives were not carried forward for analysis.

Thus, this Draft EIS examines only the Proposed Action and the No Action Alternative.

Potential Environmental Impacts and Mitigation Measures

Table S-1 summarizes the environmental impacts that could occur as a result of constructing and operating the Project, and the measures that would be employed to mitigate these impacts.

Table S-1. Summary of Potential Environmental Impacts and Mitigation Measures for the Proposed Action

Element of the Environment	Potential Impacts of the Proposed Action (Compared with the potential impacts of the No Action Alternative)			Mitigation Measures*
	Direct	Indirect	Cumulative	
Earth	None	None	None	None
Surface Water Quantity	None	None	None	A Deferred Development B Improve Flow and Quality Gaging C Reduced Diversion Quantity D Seasonal Diversion Limits E Puyallup River Spring Flows F Ramping Rates G Maintain Lake Levels H Minimize Powerhouse Leakance I Shortage Management J Water Conservation K Water Trust Donation
Surface Water Quality	Slight (non-significant) increase in temperature in Reservation Reach of White River	None	None	A Deferred Development B Improve Flow and Quality Gaging C Reduced Diversion Quantity D Seasonal Diversion Limits E Puyallup River Spring Flows F Ramping Rates H Minimize Powerhouse Leakance I Shortage Management J Water Conservation K Water Trust Donation L Tailrace Water Quality Study M Maintain Settling Basins
Groundwater	None	None	None	A Deferred Development B Improve Flow and Quality Gaging G Maintain Lake Levels I Shortage Management J Water Conservation K Water Trust Donation N Land Conservation
Plants and Wildlife	None	None	None	N Land Conservation

Element of the Environment	Potential Impacts of the Proposed Action (Compared with the potential impacts of the No Action Alternative)			Mitigation Measures*
	Direct	Indirect	Cumulative	
Fisheries	None	None	None	A Deferred Development B Improve Flow and Quality Gaging C Reduced Diversion Quantity D Seasonal Diversion Limits E Puyallup River Spring Flows F Ramping Rates H Minimize Powerhouse Leakance I Shortage Management J Water Conservation K Water Trust Donation L Tailrace Water Quality Study M Maintain Settling Basins N Land Conservation O Fishery Enhancement Funds P Operate and Maintain Fish Screens Q Tapps Fish Escapement Study R Tailrace Fish Delay Study
Recreation and Aesthetics	None	None	None	B Improve Flow and Quality Gaging C Reduced Diversion Quantity D Seasonal Diversion Limits E Puyallup River Spring Flows F Ramping Rates G Maintain Lake Levels H Minimize Powerhouse Leakance I Shortage Management J Water Conservation K Water Trust Donation M Maintain Settling Basins N Land Conservation
Land and Shoreline Use	None	None	None	G Maintain Lake Levels N Land Conservation
Climate Change	None	None	None	C Reduced Diversion Quantity D Seasonal Diversion Limits I Shortage Management

* See below for descriptions of mitigation measures.

A Deferred Development. Cascade would seek to defer development of Lake Tapps Reservoir for municipal water supply purposes to the extent that regional wholesale supplies are available to meet Cascade's demands.

B Improve Flow and Quality Gaging. Cascade would develop and implement a plan for the replacement of the current flow gaging and water quality monitoring equipment with state-of-the-art equipment capable of providing real-time data consistent with the White River Management Agreement (WRMA) (Appendix C).

C Reduced Diversion Quantity. Cascade has reduced the maximum annual amount of water requested for diversion from the White River in the municipal water right applications to 54,300 acre-feet, from the 72,400 acre-feet that Puget originally applied for in 2000.

D Seasonal Diversion Limits. Cascade would divert water from the White River only as needed to meet recreational lake level targets and municipal water supply needs, while limiting the peak instantaneous amount of water diverted from the White River consistent with the WRMA (Appendix C).

E Puyallup River Spring Flows. From February 15 through March 31 of each year, Cascade would reduce the quantity of flow diverted from the White River for municipal water supply purposes up to the amount of water actually being withdrawn from Lake Tapps Reservoir for municipal water supply purposes. This reduction by Cascade would be intended to help attain the State's minimum instream flows for the Lower Puyallup River.

F Ramping Rates. Cascade would incorporate ramping rates protective human safety and the environment, consistent with the WRMA (Appendix C).

G Maintain Lake Levels. Cascade would maintain water surface levels in Lake Tapps Reservoir in support of recreational use of Lake Tapps consistent with the 2009 Lake Tapps Management Agreement (Appendix D).

H Minimize Powerhouse Leakance. Cascade would make improvements to minimize leakance from the former White River Hydroelectric Project powerhouse.

I Shortage Management. Cascade would develop and implement a shortage management plan intended to reduce and minimize the need for water for municipal water supply purposes when the region is experiencing drought conditions.

J Water Conservation. Cascade would implement Conservation Planning Requirements, Guideline and Requirements for Public Water Systems Regarding Water Use Reporting, Demand Forecasting Methodology, and Conservation Programs, July 1994, and as revised. Cascade would prepare and implement a water conservation plan under RCW 90.03.005 and 90.54.020(6).

K Water Trust Donation. Cascade would donate a portion of the Puget Claim into the State Trust Water Rights Program consistent with the WRMA (Appendix C).

L Tailrace Water Quality Study. Cascade would conduct a study of the tailrace canal from the powerhouse to the White River to assess the water quality released from Lake Tapps Reservoir, and thereafter develop and implement a plan, if necessary, consistent with the WRMA (Appendix C).

M Maintain Settling Basins. Cascade would continue to operate and maintain the settling basins located in the diversion canal for the purpose of protecting water quality in Lake Tapps Reservoir.

N Land Conservation. As a condition of closing of the Asset Purchase Agreement with Puget, Cascade required that certain grants, easements, conveyances, or encumbrances be conveyed to preserve a portion of the property to be retained by Puget for natural and/or conservation purposes. In lieu of an actual transfer occurring, Puget recorded a restrictive covenant on the 500 acres of riparian corridor.

O Fishery Enhancement Funds. Cascade would provide $19.8 million to fund implementation of extensive fishery enhancement activities pursuant to the Lake Tapps Water Rights Settlement Agreement with the Muckleshoot Indian Tribe, and the Natural Resources Enhancement Agreement with the Puyallup Tribe of Indians. This funding would be permanently dedicated to these programs.

P Operate and Maintain Fish Screens. Cascade would continue to operate and maintain the existing fish screens and fish bypass pipeline that returns fish to the White River that is located in the diversion canal, in accordance with the WRMA (Appendix C).

Q Tapps Fish Escapement Study. Cascade would conduct a study to assess the potential and likelihood of undesirable fish escaping from Lake Tapps Reservoir and gaining access to the White River and remedy such occurrence if it is determined that this is a likelihood, consistent with the WRMA (Appendix C).

R Tailrace Fish Delay Study. Cascade would conduct a study of the tailrace canal to assess the occurrence of entry, delay, stranding and/or delayed migration of salmonids into the tailrace canal and thereafter develop and implement a plan to improve conditions, if it is determined that remediation is necessary, consistent with the WRMA (Appendix C).

Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts would be anticipated under the Proposed Action or the No Action Alternative.

Decisions to be Made

The following decisions must be made: (1) Cascade's Board of Directors must decide whether or not to operate the Project; (2) Cascade's Board of Directors must decide whether or not to approve Cascade's operation of the Project as set forth in the Proposed Action; and (3) Cascade's Board of Directors must decide whether or not to seek Ecology's approval of the Applications as set forth in the Proposed Action.

Cascade's Future Actions

Further actions necessary to use water withdrawn from Lake Tapps Reservoir for municipal water supply are known only in general terms and are not part of this Proposed Action. See Chapter 3 of this Draft EIS for an explanation of why construction is not imminent and, therefore, is not part of this Draft EIS. See also these documents: (1) *2004 Transmission and Supply Plan* (Cascade 2005); (2) *Final Environmental Impact Statement, Tacoma-Cascade Pipeline* (Cascade 2007); (3) *Environmental Checklist and SEPA Mitigated Determination of Nonsignificance (MDNS) for the Lake Tapps Water Supply Project* (Cascade 2008a); and (4) *Lake Tapps Reservoir Issuance of New Municipal Water Rights and Change of Use for Existing Claim No. 60822, Determination of Significance and Request for Comments on Scope of Environmental Impact Statement and Environmental Checklist* (Cascade 2008b).

Cascade anticipates submitting an application for a permanent donation of a portion of Puget's Claim into the State Trust Water Rights Program. In anticipation of that future permanent donation application and for purposes of compliance with SEPA for such permanent donation, the permanent donation is analyzed as a component of the Proposed Action in this Draft EIS. Environmental review under SEPA will be conducted for other future actions, as appropriate.

This page intentionally left blank.

CASCADE WATER ALLIANCE

Chapter 1: Introduction

This chapter describes the project and introduces topics that are discussed in more detail in subsequent chapters.

1.1 Project Proponent

The proponent of the Lake Tapps Reservoir Water Rights and Supply Project (Project) is Cascade Water Alliance (Cascade). Cascade is a non-profit corporation composed of municipal corporations and special-purpose municipal corporations in King County that are party to an Interlocal Agreement entered into under the authority of the Interlocal Cooperation Act (Chapter 39.34 RCW[1]) for the purpose of its Members working together to plan, develop, and operate a water supply system and regional assets that will meet Cascade's Members' current and future drinking water needs. The Members of Cascade are as follows:

- City of Bellevue
- City of Issaquah
- City of Kirkland
- City of Redmond
- City of Tukwila
- Covington Water District
- Skyway Water and Sewer District
- Sammamish Plateau Water and Sewer District

1.2 Project Objective

The objective of the Project is to allow Cascade to provide – in a coordinated, cost-effective, and environmentally responsible manner – a safe, reliable, high quality municipal water supply that will meet the current and projected demands of its Members and the Central Puget Sound Region from a source that is sufficiently large, certain, and non-speculative, and is available both for immediate, short-term use and for long-term use over a 50- to 100-year planning period.

[1] Chapter 39.34 RCW: Interlocal cooperation act. http://apps.leg.wa.gov/RCW/default.aspx?cite=39.34.

1.3 Proposed Action

As further detailed in Chapter 2, Puget Sound Energy (Puget[2]) built Lake Tapps Reservoir and associated hydroelectric power facilities in 1911, generating power there until January 2004. Because of its concerns about the economic viability of maintaining the White River Hydroelectric Project (Hydro Project) for power production, Puget, together with other members of the Lake Tapps Task Force, considered whether the project could serve as a regional water supply for current and future populations' needs. To facilitate development of Lake Tapps Reservoir as a source of municipal water supply, Puget submitted three municipal water rights applications (S2-29920, R2-29935, and S2-29934) to the Washington State Department of Ecology (Ecology) in 2000.

In 2003, Ecology published three Draft ROEs and took public comment. These ROEs were appealed by the Muckleshoot Indian Tribe, the Puyallup Tribe of Indians, the City of Auburn, the City of Buckley, and others to the Pollution Control Hearings Board. The 2003 ROEs were remanded back to Ecology when Puget announced it was ceasing hydropower generation. Thereafter, in 2005, Puget submitted the change/transfer application for its pre-code water right claim (Puget Claim) (CS2-160822CL). The four applications are referred to collectively as the "Applications".

In 2006, Ecology published the 2006 Draft Report of Examination (2006 ROE) and took public comment. The 2006 DROE remains on Ecology's Web site[3].

In February 2008, following issuance of the *Environmental Checklist and State Environmental Policy Act (SEPA) Mitigated Determination of Nonsignificance (MDNS) for the Lake Tapps Reservoir Water Supply Project* (Cascade 2008a), Cascade's Board of Directors approved an Asset Purchase Agreement for the acquisition of Lake Tapps Reservoir, the Puget Claim, the Applications, and associated Hydro Project facilities. In June 2008, Cascade published the *Lake Tapps Reservoir Issuance of New Municipal Water Rights and Change of Use for Existing Claim No. 60822, Determination of Significance and Request for Comments on the Scope of Environmental Impact Statement and Environmental Checklist* (Cascade 2008b).

In August 2008, Cascade entered into the 2008 White River Management Agreement (WRMA) (Cascade 2008c) (see Appendix C) with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe and individual settlement agreements with each Tribe: the Lake Tapps Water Rights Settlement Agreement (Cascade 2008e) with the Muckleshoot Indian Tribe and the Natural Resources Enhancement Agreement (Cascade 2008d) with the

[2] The company that is today's Puget Sound Energy, Inc. has changed names many times. Over 20 years ago, Wing (1987) noted that the company's family tree involved a "succession of mergers and consolidations lasting more than 50 years and involving more than 150 companies." In 1997, another merger combined Puget Sound Power & Light Company and Washington Energy Company (Puget 2008).

[3] See http://www.ecy.wa.gov/programs/WR/swro/images/pdf/lktapps_draft_roe_09202006.pdf.

Puyallup Tribe of Indians. The WRMA includes a Recommended Flow Regime for the White River.

In May 2009, following extensive public negotiations with the Lake Tapps Community, Cascade entered into the 2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community (2009 Community Agreement) (Cascade 2009a) (see Appendix D). The 2009 Community Agreement includes maintenance of Lake Tapps Reservoir's surface level within a range of elevations called Normal Full Pool during specified periods of the year, depending on whether or not Cascade has begun to withdraw water for municipal water supply purposes.

On December 18, 2009, the purchase and sale under the Asset Purchase Agreement was completed and Cascade became the owner of the Project (this is referred to as the "closing").

Cascade's Proposed Action

The Proposed Action is for Cascade's Board of Directors to approve Cascade's operation of the Project and to request approval by Ecology of the Applications.

The three basic elements of the Project operation are as follows:

- Cascade would divert water from the White River into Lake Tapps Reservoir, store water in, and withdraw water from the reservoir for municipal water supply purposes.
- Cascade would operate the Project in a manner to provide enhanced flows in the White River (Recommended Flows) consistent with the 2008 White River Management Agreement with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe[4] (see Appendix C).
- Cascade would operate the Project to store water and maintain the levels of Lake Tapps Reservoir to support recreation consistent with 2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community (see Appendix D).

[4] Due to the timing of the closing of the Asset Purchase Agreement, the application for a donation of a portion of Puget's Claim into the State Trust Water Rights Program was for a temporary donation rather than a permanent donation. The temporary donation was accepted by Ecology on October 26, 2009 (Ecology 2009a). In anticipation of a future permanent donation application and for purposes of compliance with the State Environmental Policy Act (SEPA) for such permanent donation, the permanent donation is analyzed as a component of the Proposed Action in this Draft EIS. Cascade can provide for flows in accordance with the Recommended Flow Regime with or without Ecology's acceptance of the donation and, therefore, the donation is independent of and does not affect the remainder of the Proposed Action. The donation is intended to provide an additional legal mechanism to ensure implementation of the Recommended Flow Regime and there are no additional impacts beyond those analyzed for the Proposed Action.

More specifically, and as shown in Figure 1-3, Ecology's approval of the Applications would permit the following:

1. Cascade would divert water from the White River into Lake Tapps Reservoir at an average annual rate of up to 75 cubic feet per second (cfs) (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes[5]. Cascade would divert water from the White River at a maximum instantaneous rate of up to 1,000 cfs (this maximum rate would vary by season and would be lower at other times of the year).

2. Cascade would store up to 46,700 acre-feet of water in Lake Tapps Reservoir for municipal, industrial, and commercial water supply purposes.

3. Cascade would withdraw water from Lake Tapps Reservoir at an average annual rate of up to 75 cfs (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes. Cascade would withdraw water from Lake Tapps Reservoir at a maximum instantaneous rate of 135 cfs.

4. Cascade would divert water from the White River, store water in Lake Tapps Reservoir, and release water through the tailrace canal back to the White River in support of the following purposes: hydropower and other beneficial uses including recreational reservoir levels; winter reservoir levels; fish and wildlife habitat protection and enhancement; and maintenance of water quality for recreational purposes in the reservoir and to meet other regulatory requirements. For example, these other beneficial uses include operation of the sedimentation basins, operation of the fish screens and fish bypass pipeline, Spring Refill of Lake Tapps Reservoir, and maintaining water surface elevations in Lake Tapps Reservoir for recreation purposes.

1.4 Cascade's Mitigation Measures

Cascade has provided or would provide the following mitigation measures:

A **Deferred Development.** Cascade would seek to defer development of Lake Tapps Reservoir for municipal water supply purposes to the extent that regional wholesale supplies are available to meet Cascade's demands.

B **Improve Flow and Quality Gaging.** Cascade would develop and implement a plan for the replacement of the current flow gaging and water quality monitoring equipment with state-of-the-art equipment capable of providing real-time data consistent with the White River Management Agreement (WRMA) (Appendix C).

---

[5] As fully described in Chapter 13 of this Draft EIS, the average flow rate of 75 cfs may be increased to an average flow rate of 82 cfs. The 7 cfs is referred to as "Regional Reserved Water". The Regional Reserved Water would not alter or affect the environmental analysis described in this Draft EIS.

C **Reduced Diversion Quantity.** Cascade has reduced the maximum annual amount of water requested for diversion from the White River in the municipal water right applications to 54,300 acre-feet, from the 72,400 acre-feet that Puget originally applied for in 2000.

D **Seasonal Diversion Limits.** Cascade would divert water from the White River only as needed to meet recreational lake level targets and municipal water supply needs, while limiting the peak instantaneous amount of water diverted from the White River consistent with the WRMA (Appendix C).

E **Puyallup River Spring Flows.** From February 15 through March 31 of each year, Cascade would reduce the quantity of flow diverted from the White River for municipal water supply purposes up to the amount of water actually being withdrawn from Lake Tapps Reservoir for municipal water supply purposes. This reduction by Cascade would be intended to help attain the State's minimum instream flows for the Lower Puyallup River.

F **Ramping Rates.** Cascade would incorporate ramping rates protective human safety and the environment, consistent with the WRMA (Appendix C).

G **Maintain Lake Levels.** Cascade would maintain water surface levels in Lake Tapps Reservoir in support of recreational use of Lake Tapps consistent with the 2009 Lake Tapps Management Agreement (Appendix D).

H **Minimize Powerhouse Leakance.** Cascade would make improvements to minimize leakance from the former White River Hydroelectric Project powerhouse.

I **Shortage Management.** Cascade would develop and implement a shortage management plan intended to reduce and minimize the need for water for municipal water supply purposes when the region is experiencing drought conditions.

J **Water Conservation.** Cascade would implement Conservation Planning Requirements, Guideline and Requirements for Public Water Systems Regarding Water Use Reporting, Demand Forecasting Methodology, and Conservation Programs, July 1994, and as revised. Cascade would prepare and implement a water conservation plan under RCW 90.03.005 and 90.54.020(6).

K **Water Trust Donation.** Cascade would donate a portion of the Puget Claim into the State Trust Water Rights Program consistent with the WRMA (Appendix C).

L **Tailrace Water Quality Study.** Cascade would conduct a study of the tailrace canal from the powerhouse to the White River to assess the water quality released from Lake Tapps Reservoir, and thereafter develop and implement a plan, if necessary, consistent with the WRMA (Appendix C).

M **Maintain Settling Basins.** Cascade would continue to operate and maintain the settling basins located in the diversion canal for the purpose of protecting water quality in Lake Tapps Reservoir.

N **Land Conservation.** As a condition of closing of the Asset Purchase Agreement with Puget, Cascade required that certain grants, easements, conveyances, or encumbrances be conveyed to preserve a portion of the property to be retained by Puget for natural and/or conservation purposes. In lieu of an actual transfer occurring, Puget recorded a restrictive covenant on the 500 acres of riparian corridor.

O **Fishery Enhancement Funds.** Cascade would provide $19.8 million to fund implementation of extensive fishery enhancement activities pursuant to the Lake Tapps Water Rights Settlement Agreement with the Muckleshoot Indian Tribe, and the Natural Resources Enhancement Agreement with the Puyallup Tribe of Indians. This funding would be permanently dedicated to these programs.

P **Operate and Maintain Fish Screens.** Cascade would continue to operate and maintain the existing fish screens and fish bypass pipeline that returns fish to the White River that is located in the diversion canal, consistent with the WRMA (Appendix C).

Q **Tapps Fish Escapement Study.** Cascade would conduct a study to assess the potential and likelihood of undesirable fish escaping from Lake Tapps Reservoir and gaining access to the White River and remedy such occurrence if it is determined that this is a likelihood, consistent with the WRMA (Appendix C).

R **Tailrace Fish Delay Study.** Cascade would conduct a study of the tailrace canal to assess the occurrence of entry, delay, stranding, and/or delayed migration of salmonids into the tailrace canal and thereafter develop and implement a plan to improve conditions, if is determined that remediation is necessary, consistent with the WRMA (Appendix C).

Cascade's Future Actions

Further actions necessary to use water withdrawn from Lake Tapps Reservoir for municipal water supply are known only in general terms and are not part of this Proposed Action. See Chapter 3 of this Draft EIS for an explanation of why construction is not imminent and therefore is not part of this Draft EIS. See also these documents: (1) *2004 Transmission and Supply Plan* (Cascade 2005); (2) *Final Environmental Impact Statement, Tacoma-Cascade Pipeline* (Cascade 2007); (3) *Environmental Checklist and SEPA Mitigated Determination of Nonsignificance (MDNS) for the Lake Tapps Water Supply Project* (Cascade 2008a); and (4) *Lake Tapps Reservoir Issuance of New Municipal Water Rights and Change of Use for Existing Claim No. 60822, Determination of Significance and Request for Comments on Scope of Environmental Impact Statement and Environmental Checklist* (Cascade 2008b).

Cascade anticipates submitting an application for a permanent donation of a portion of Puget's Claim into the State Trust Water Rights Program. In anticipation of that future permanent donation application and for purposes of compliance with SEPA for such permanent donation, the permanent donation is analyzed as a component of the Proposed Action in this Draft EIS. Environmental review under SEPA will be conducted for other future actions, as appropriate.

1.5 Project Location and Setting

Lake Tapps Reservoir is located in northern Pierce County, Washington, approximately 30 miles southeast of Seattle and 18 miles east of Tacoma in Section 2, Township 19 North, Range 6 East (see Figure 1-1). The reservoir, approximately 4.5 miles long and 2.5 miles wide, is in the Puyallup/White River watershed, Water Resources Inventory Area (WRIA) 10.

The reservoir's irregular shoreline has numerous inlets and peninsulas, and several small islands are present in the reservoir, some forested with conifer and deciduous trees. The area is known for its stunning views of Mount Rainier and for its recreational resources – boating, water skiing, fishing, and swimming are popular activities on Lake Tapps Reservoir. Private residences and public and private parks surround most of the reservoir. Many waterfront homes and some public and private parks have boat launch facilities and docks.

The City of Bonney Lake borders Lake Tapps Reservoir on the south, and much of the limited amount of public land surrounding the reservoir is owned by Pierce County. Other nearby population centers are the cities of Auburn, Buckley, Pacific, and Sumner. The common Pierce County/King County line runs along the White River east of Lake Tapps Reservoir.

The Muckleshoot Indian Reservation is located along the White River southeast of Auburn (see Figure 1-1). Thus, the portion of the White River not diverted into Lake Tapps Reservoir is known as the *Reservation Reach* (see Figure 1-2). The Puyallup Tribe of Indians' Administrative Offices and other facilities are located primarily in northern Pierce County and in the City of Tacoma.

1.6 Study Area

The study area for this project is the area that could be affected if the Application are approved. Unless otherwise noted, the study area encompasses the White River from the diversion dam near Buckley downstream to the river's confluence with the Puyallup River; Lake Tapps Reservoir; and the Lower Puyallup River to its outlet at Commencement Bay (see Figure 1-2).

1.7 Water Rights

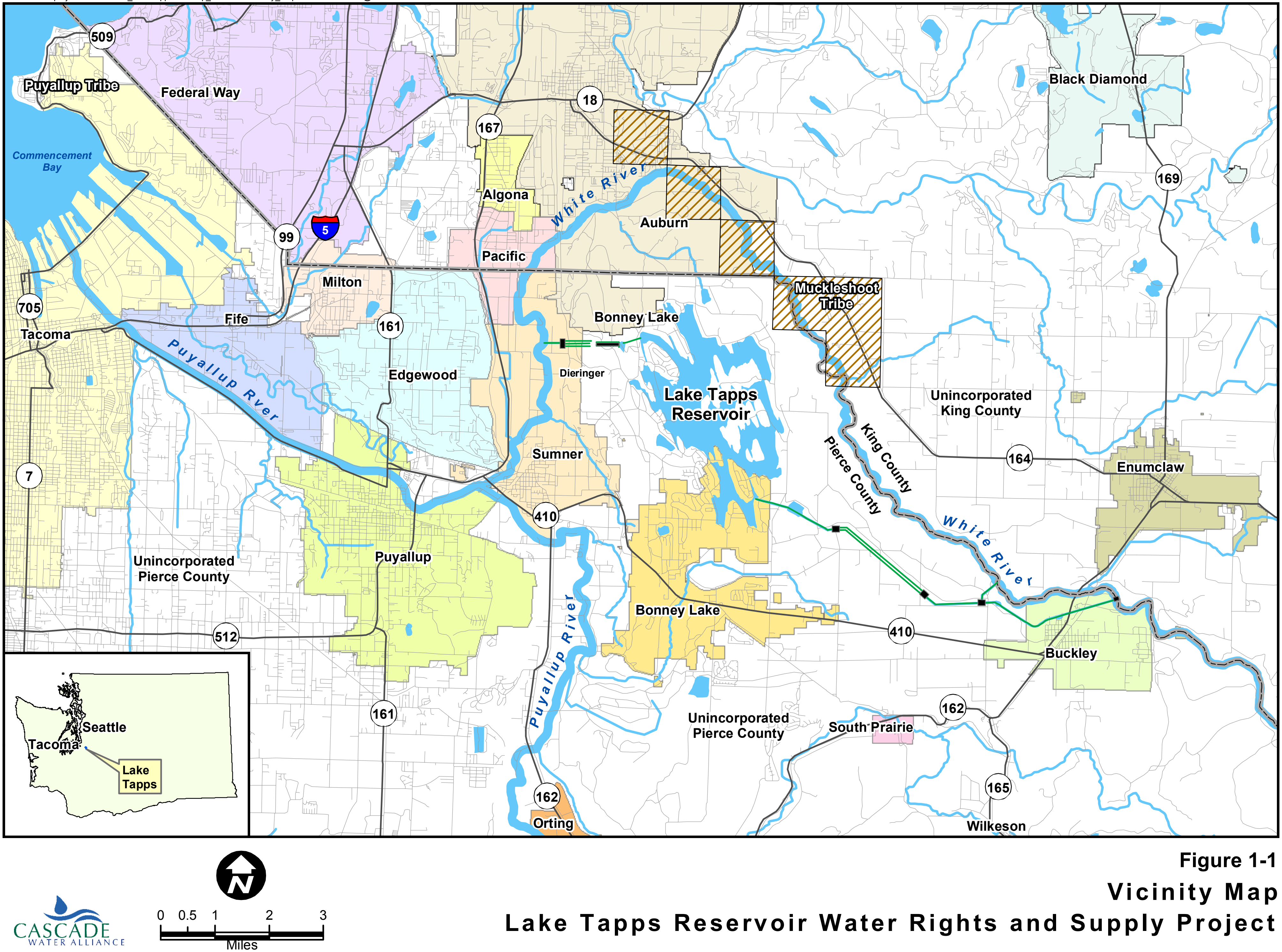
A *water right* is a legal authorization to use a specific quantity of public water for a designated purpose. This purpose must qualify as a beneficial use. Beneficial use involves the application of a reasonable quantity of water to a non-wasteful use such as supplying domestic water, irrigation, or generating power (Ecology n.d.(a)). Applications for water rights and changes to existing water rights must be approved by Ecology.

Under Washington's Water Code[6], a water right is required to divert or withdraw water from a natural source such as a river or aquifer. While pre-code rights exist, the only way to obtain a new water right is to apply to Ecology under an administrative permitting process (see RCW 90.03.010[7]). Upon approval of an application, Ecology issues a permit that authorizes the appropriation. The holder of the water right perfects the right upon actual beneficial use of the water, at which point Ecology issues a certificate. Until a water right is perfected, the water right holder can continue to develop the water right to the allowed quantities and uses provided that reasonable diligence is exercised. In most regions of the state, new water rights are either not available or may be issued only after a lengthy application process and provision of mitigation by the applicant.

[6] The Water Code includes, among other provisions, the Surface Water Code (Chapter 90.03 RCW), the Groundwater Code (Chapter 90.44 RCW), the Water Resources Act (Chapter 90.54 RCW), and statues governing water rights registration and relinquishment (Chapter 90.14 RCW).

[7] RCW 90.03.010: Appropriation of water rights — Existing rights preserved. http://apps.leg.wa.gov/RCW/default.aspx?cite=90.03.010.

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\vicinity_map.mxd - 1/19/2010 @ 3:40:17 PM



CASCADE WATER ALLIANCE

Figure 1-1

Vicinity Map

Lake Tapps Reservoir Water Rights and Supply Project

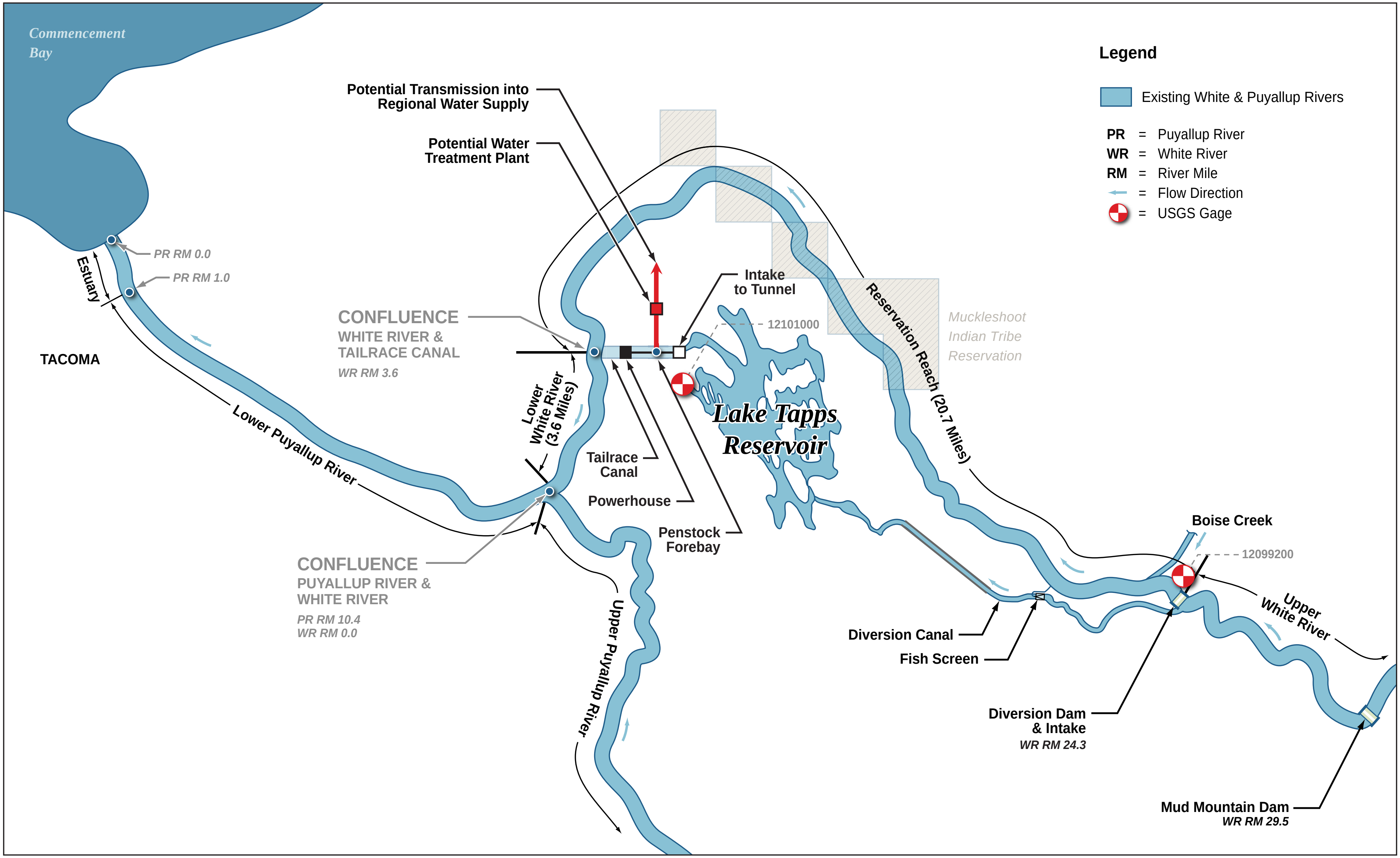


Figure 1-2. Stream Reaches of the White and Puyallup Rivers
Lake Tapps Water Rights and Supply Project

The fundamental attributes of a water right in Washington include the following:

- Quantity of water the holder may use, which is expressed in both annual and instantaneous quantities.
- The purpose of use to which the water can be put.
- Point of diversion or withdrawal from which the water can be taken.
- Place of use, or the location in which the right can be exercised.

With Ecology's regulatory approval, water rights may be amended to allow new points of diversion, to change the purpose of use, and to transfer to a new place or location of use.

As noted in Section 1.3, Puget submitted three interrelated municipal water supply applications and a change of use application to Ecology for an existing claim to facilitate development of Lake Tapps Reservoir (see Appendix A). The three new water right applications were necessary because state waters collectively belong to the public, and individuals or groups must apply to the state for rights to use them.

Puget also submitted an application for a change in use to the Puget Claim to confirm that it has the right to divert and use the water for multiple beneficial purposes, including, but not limited to recreation, reservoir maintenance, fish passage, flow augmentation, and water quality.

To approve these applications, Ecology must find that each of the following four requirements of RCW 90.03.290[8] has been satisfied:

1. Water is available for appropriation;
2. The proposed use would be a beneficial use;
3. The proposed appropriation would not impair existing water rights; and
4. The proposed appropriation would not be detrimental to the public interest.

Table 1-1 lists the water right applications and the change of use application. Figure 1-3 is a schematic of the water right applications and change of use application.

[8] RCW 90.03.290: Appropriation procedure — Department to investigate — Preliminary permit — Findings and action on application. http://apps.leg.wa.gov/RCW/default.aspx?cite=90.03.290.

As previously mentioned, Cascade became the owner of the Project on December 18, 2009. Cascade's use of Lake Tapps Reservoir as a municipal water supply is contingent upon Ecology's approval of the Applications.

The White River was closed to further consumptive uses in 1980 per state law (WAC 173-510-040(3)[9]). Therefore, to approve the three new water right applications, Ecology must override this stream closure ruling; Ecology must find "overriding considerations of public interest" (OCPI) (RCW 90.54.020(3)[10]).

[9] WAC 173-510-040: Surface water source limitations to further consumptive appropriations. http://apps.leg.wa.gov/WAC/default.aspx?cite=173-510-040.

[10] RCW 90.54.020: General declaration of fundamentals for utilization and management of waters of the state. http://apps.leg.wa.gov/RCW/default.aspx?cite=90.54.020.

Table 1-1. Water Rights Applications and Change of Use Application

Surface Water Application No. (Filing Date)	Type	Description – Original Application Request	Description – Current Application Proposal
S2-29920[a] (June 20, 2000)	Permit for: Diversion from the White River	Quantity: Qa = Average Annual Flow Qa = 100 cfs (72,400 acre-feet/year) Qi = Maximum Instantaneous Flow Qi = 2,000 cfs Purpose: Public water supply for consumptive municipal, industrial, and commercial purposes.	Quantity:[b] Qa = 75 cfs (54,300 acre-feet/year) Qi = 1,000 cfs (from February 15 until the Spring Refill date or July 1, whichever is earlier) (WRMA) Qi = 400 cfs (from the Spring Refill date until September 15 or the subsequent date the Fall Drawdown commences, whichever is later) (WRMA) Qi = 150 cfs (from the date the Fall Drawdown commences to February 15) (WRMA) Purpose: Unchanged from Original Application.
R2-29935 (Sept. 15, 2000)	Permit for: Storage in Lake Tapps Reservoir	Quantity: Storage of up to 46,700 acre-feet of water in Lake Tapps Reservoir Purpose: Public water supply for consumptive municipal, industrial, and commercial purposes.	Quantity: Unchanged from Original Application. Purpose: Unchanged from Original Application.
S2-29934 (Sept. 15, 2000)	Permit for: Withdrawal from Lake Tapps Reservoir	Quantity: Qa = 100 cfs (72,400 acre-feet/year) Qi = 150 cfs Purpose: Public water supply for consumptive municipal, industrial, and commercial purposes.	Quantity: Qa = 75 cfs (54,300 acre-feet/year) Qi = 135 cfs Purpose: Unchanged from Original Application.
CS2-160822CL (Nov. 22, 2005)	Change of: Puget Claim	Quantity: Qa = 2,000 cfs (1,440,000 acre-feet/year) Qi = 2,000 cfs Purpose: Hydropower and other beneficial uses including recreational reservoir levels; winter reservoir levels to maintain reservoir; protection and enhancement of fish and wildlife habitat; and maintenance of water quality for recreational purposes in the reservoir and to meet other regulatory requirements.	Quantity[c]: Qa = 1,284 cfs (929,654 acre-feet/year) Qi = 2,000 cfs (perfected) Note: The Qi to be diverted from the White River under the changed Claim will be identical to the Qi described above for the application No. S2-29920 (WRMA). Purpose: Unchanged from Original Application.

[a] Application S2-29920 is also referred to as S2-29921.

[b] The total quantity requested in this application is the sum of the amount to be diverted by Cascade (i.e., 75 cfs average annual flow) and the Lake Tapps Regional Reserved Water (Qa(res) = 7 cfs and Qi(res) = 10 cfs). The Lake Tapps Regional Reserved Water will not be diverted from the White River, but rather will remain in the White River for the purpose of mitigation of impacts to the White River relating to future applications to be proposed by cities in the region. See Chapter 13.

[c] An application for a temporary donation of a portion of CS2-160822CL into the State Trust Water Rights Program was accepted by Ecology on October 26, 2009. In anticipation of a future permanent donation application, the permanent donation is analyzed in this Draft EIS. See footnote 4 of this chapter.

This page intentionally left blank.

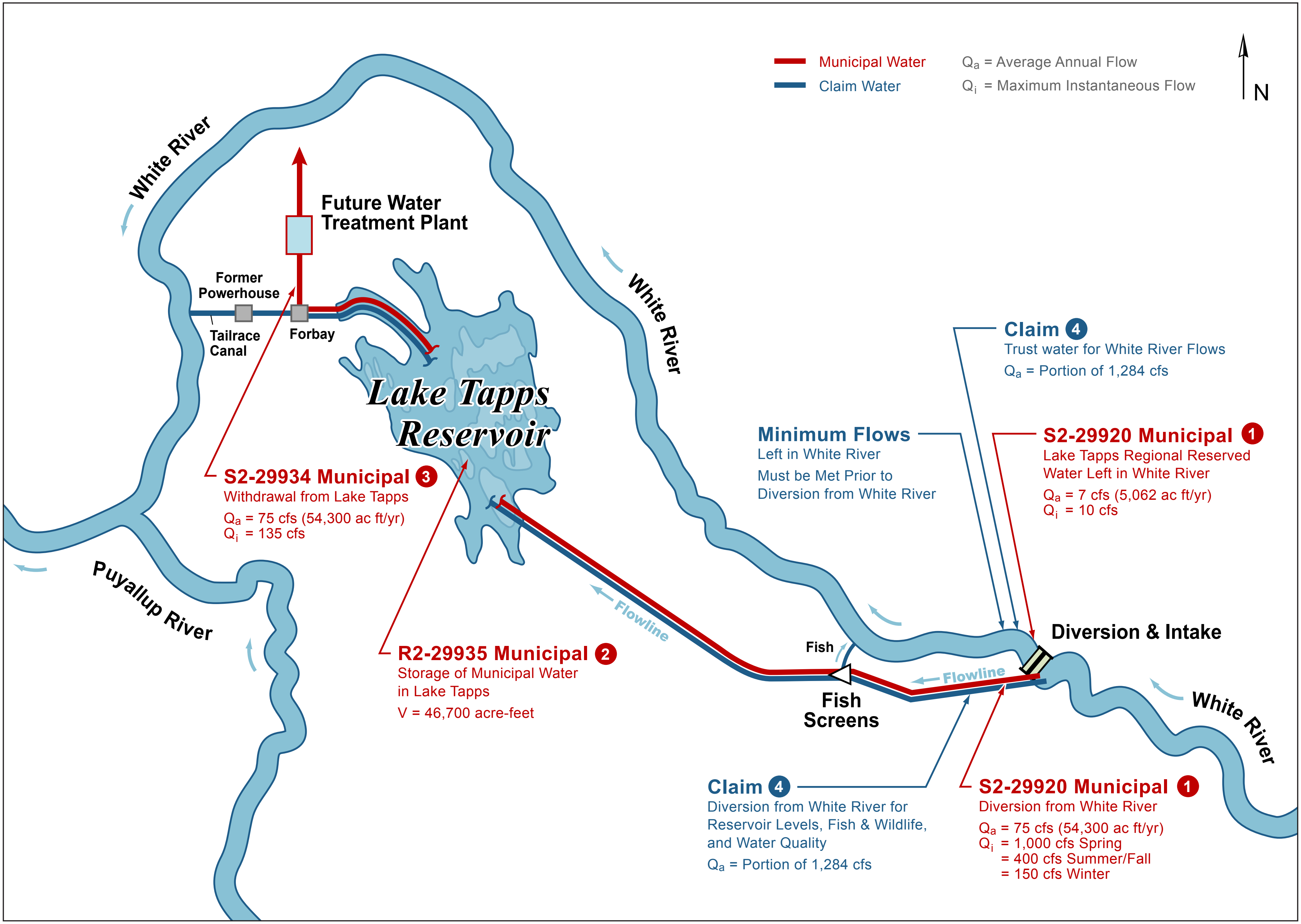


Figure 1-3. Schematic of the Water Right Applications and Change of Use Application

Lake Tapps Water Rights and Supply Project

1.8 Historic Hydroelectric Operations

Building the Hydro Project on the White River in 1911 was feasible because of the local geography (for more information on the historic background of the Hydro Project, see Chapter 2). The White River is fed by the glaciers on Mount Rainier, flows westward on a plateau near Buckley, then drops to the floor of the Stuck Valley (NOAA 2003). The Pacific Coast Power Company created the reservoir on the plateau by combining four lakes – Lake Tapps, Kirtley Lake, Crawford Lake, and Church Lake – into a single water body. Dikes were constructed where necessary, raising the water level over the area of the four lakes (Kramer 1986).

Upstream of the valley, the Pacific Coast Power Company built a diversion dam near Buckley to divert a portion of the water in the White River into a diversion canal and into the reservoir for storage (see Figure 1-4). At the western end of the reservoir, the elevation drop between the reservoir and the valley floor was used to help generate electricity. Water flowed through an intake, a tunnel, and a control house to a forebay. Water collected in the forebay was sent through steel penstocks to a powerhouse located on the valley floor near Dieringer. The powerhouse was equipped with turbine generator units. Transmission lines carried the electricity to the electrical system network that supplied Tacoma and Seattle. The water was then returned to the Lower White River via a tailrace canal. The distance from the diversion dam to the end of the tailrace canal is approximately 14 miles (Kramer 1986). Water that was not diverted into Lake Tapps Reservoir remained in the White River and flowed approximately 21 miles in the Reservation Reach of the White River before joining the outflow of the tailrace canal at Dieringer (see Figure 1-2).

Terms:

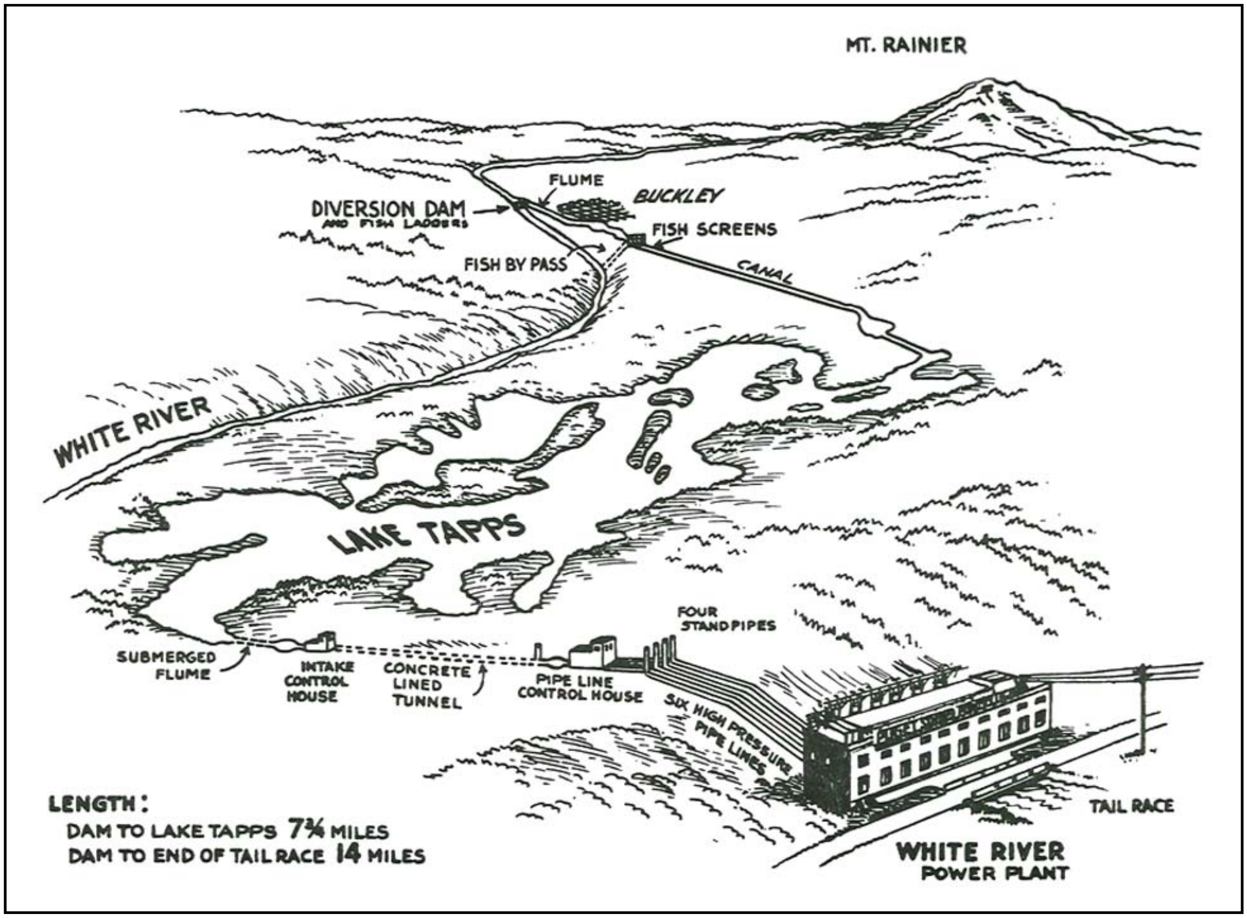
Diversion dam: The timber crib dam near Buckley that diverts water from the White River into the diversion canal. The diversion dam has a concrete intake structure and an upstream migrant fish trap operated by the U.S. Army Corps of Engineers.

Diversion canal: The canal that conveys water from the White River to Lake Tapps Reservoir. The diversion canal consists of flumes, a canal, settling basins, and two large-diameter concrete pipes. Screens on the diversion canal remove fish from the intake area and return them to the river via a bypass conduit.

Forebay: The area on the west side of Lake Tapps Reservoir where water is collected before it enters the penstocks.

Penstocks: Long, high-pressure steel pipes that deliver water to the powerhouse.

Tailrace canal: The canal that returns water to the White River after it has been passed through the powerhouse.



Source: Kramer 1986

Figure 1-4. Historic Hydroelectric Facilities

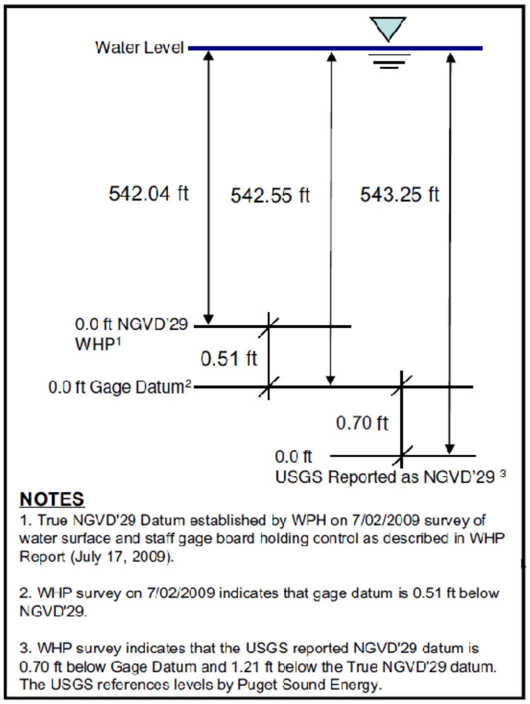
During the years of Hydro Project operation, Puget managed the amount of water in Lake Tapps Reservoir based on various factors: "Historically, the lake has not been managed on a strict schedule of lake levels and releases, but rather as necessary to meet essential goals of power production demand, recreational lake levels, maintenance, and control the growth of aquatic plants" (Ecology 2006a). Without the Hydro Project operation, the White River–Lake Tapps Reservoir system is managed to maintain water quality and recreational levels and to control the growth of aquatic plants. Managing the system includes varying the amount of water in the reservoir by season, resulting in a yearly pattern of "pool" elevations:

- **Spring Refill.** The late winter or early spring refill of the reservoir to the Normal Full Pool elevation.
- **Normal Full Pool.** A water level between 541.0 feet National Geodetic Vertical Datum (NGVD) 29 and 542.5 feet NGVD 29 (measured at gage 12101000; see Figure 1-2).
- **Fall Drawdown.** The reduction of water level in the fall to help control aquatic vegetation growth and to allow dike maintenance.

Lake Tapps Reservoir Elevations

Cascade conducted topographic surveys at Lake Tapps Reservoir to help identify any potential impacts of the Proposed Action on shorelines and to compute reservoir storage volumes. During these surveys, surveyors found that their measurements of water surface elevations differed from the elevations concurrently reported at USGS Station 12101000. Subsequent investigation showed that the USGS gage did not accurately reference the National Geodetic Vertical Datum of 1929 (NGVD 29). Thus, water surface elevations were incorrectly reported at the USGS gage. Note that the same water surface elevation can be represented by different numbers, depending on the datum used for measurement.

The figure and table below show the relationships of the datums at Normal Full Pool elevations as indicated by the surveyor, WHPacific (Aero-Metric 2009).



Comparison of Equivalent Water Levels*

Normal Range of Full Pool	Aerometric[1] (True NGVD'29) (ft)	Gage Datum[2] (ft)	USGS Reported[3] (ft)
High	542.5	543.0	543.7
Low	541.0	541.5	542.2

*Refer to notes in Datum Sketch.

Cascade has used the True NGVD 29 datum for the elevations reported in this document.

USGS reviewed the information provided by the surveyor and will correct the elevations reported at USGS Station 12101000 (USGS 2009).

1.9 Minimum Instream Flows

The amount of flow in a stream (instream flow) affects not only the quality of fish and wildlife habitat but also the stream's scenic and aesthetic values. In 1980, Ecology adopted by rulemaking an Instream Resources Protection Program for the Puyallup/White River watershed. However, because the water rights for the Hydro Project predated the instream flow rule, the Hydro Project was not required to comply with the flows established in the rule for the Lower Puyallup River. The rule also "closed" the White River to any further appropriations (see Section 1.7), but did not establish the minimum instream flows for the White River, as was done for the Puyallup River. No state rules govern the minimum amount of water that is to remain in the White River rather than being diverted under Puget's Claim. The minimum instream flows for the Puyallup River (Puyallup River MIFs) are described in Chapter 5.

Although White River minimum instream flows have not been established by state rulemaking, they are addressed as follows: (1) in a 1910 Pierce County Superior Court decree requiring the Pacific Coast Power Company (Puget's predecessor) to maintain instream flows of at least 30 cfs below the diversion dam (FERC 1992); (2) in a 1986 settlement agreement between Puget and the Muckleshoot Indian Tribe that established a minimum instream flow for the Reservation Reach of 130 cfs and a 3,650 second-foot day (sfd)[11] water budget for fish transport; and (3) in a March 2005 letter from the National Marine Fisheries Service (NMFS) addressed to the U.S. Army Corps of Engineers establishing minimum flows, referred to in this document as the "Interim Agency Flows" (NMFS 2005). The instream flows for the White River are presently measured at the U.S. Geological Survey (USGS) gage No. 12099200 above Boise Creek at Buckley (see Chapter 5).

1.10 Fisheries

Fish collection facility at the diversion dam October 2008

Fish migrate within and through various reaches of the White and Puyallup River systems, and spring and fall Chinook, coho, chum, and pink salmon and steelhead and bull trout are native to the watershed (NOAA 2003).

For downstream-migrating fish, no fish screens were present at the diversion canal on the White River until 1939, and fish could pass into Lake Tapps Reservoir. Because the only exit from Lake Tapps Reservoir was through the powerhouse turbines, the result was a high mortality rate for fish (NOAA 2003). In 1939, a rotating drum fish screen and bypass conduit were installed on the diversion canal to remove fish from the diversion canal and return them to the White River. In 1996, the rotating drum fish screen was replaced with new fish screens.

For upstream-migrating fish, Mud Mountain Dam (MMD) represents an impassable barrier to fish (NOAA 2003). At the beginning of construction of MMD in 1948, the U.S. Army Corps of Engineers began operating (and continues to operate) a "trap and haul" operation that collects fish at the diversion dam and transports them upstream above MMD (see Chapter 9).

[11] The volume of water represented by a flow of 1 cubic foot per second for 24 hours; equal to 86,400 cubic feet.

Chapter 2: Background

Over its nearly 100-year history, the White River–Lake Tapps Reservoir system has been the subject of legal and environmental issues, particularly in regard to operation of the White River Hydroelectric Project (Hydro Project). These past concerns affect the Proposed Action and the No Action Alternative. This chapter highlights major issues in Lake Tapps' history; for additional details, see the chronology in Appendix B.

Construction of outlet canal from Lake Tapps to powerhouse, July 18, 1910 (UW n.d.)

2.1 1890s – 1950s

White River Hydroelectric Project (Hydro Project)

Near the turn of the 20th Century, most utility and transportation companies operating in the Puget Sound area were small, privately-owned concerns. These small concerns included the White River Power Company of New York, which secured water rights on the White River in 1895 and 1901. In 1906, the Seattle–Tacoma Power Company purchased the assets of the White River Power Company, following the trend in the 1890s and early 1900s to consolidate local utility and transportation companies. In turn, the Seattle–Tacoma Power Company quit-claimed the lands formerly held by the White River Power Company in 1908 to the Pacific Coast Power Company, a subsidiary of the Seattle Electric Company (Wing 1987).

Construction of a railroad trestle across a northern arm of Lake Tapps, June 1, 1910 (UW n.d.)

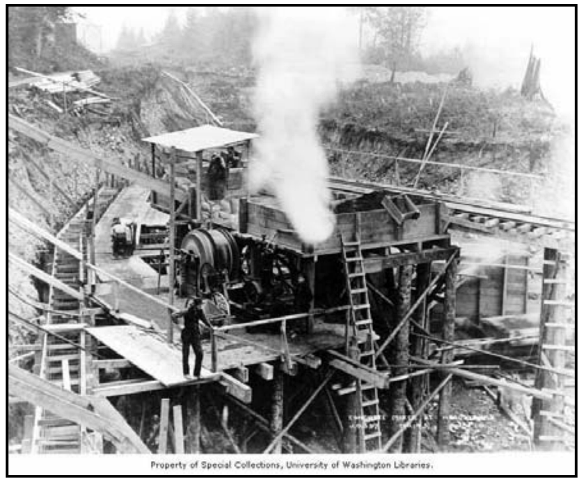
The Pacific Coast Power Company "established control over the land and operations of the Tacoma Power Company, including pending construction of a hydro-electric plant at White River" (CPNWS n.d.). Through various mergers, the company (which incorporated as Puget Sound Traction, Light and Power in 1912) controlled three major hydroelectric plants:

(1) Snoqualmie Falls (completed in 1898);
(2) Electron (completed in 1904); and
(3) White River (which was "harnessed in 1911 to meet the demands of electric transportation companies linking Tacoma, Seattle, Everett, Bellingham, and Mount Vernon") (Dorpat and McCoy 1998). Growing demand for electrical power was the impetus behind developing a hydroelectric plant on the White River:

"By 1910 the plants at Snoqualmie Falls and Electron could not keep up with the ever-increasing load demand of the Puget Sound population. Fluctuations in river flow were greater than had been anticipated, and neither installation had adequate storage facilities to provide reliable uninterrupted current. Dependable service was restored in 1911 with the coming on line of the White River installation at Dieringer, between Auburn and Sumner" (Dorpat and McCoy 1998).

In the spring of 1909, the Pacific Coast Power Company began construction of the Hydro Project, and the plant was put into service in 1911 (Kramer 1986). The company operated the Hydro Project from 1911 to January 2004.

The Hydro Project greatly reduced the amount of water flowing in the White River between the diversion dam and the confluence of the tailrace canal with the Lower White River (see Figure 1-2 in Chapter 1). This water removal from the White River has been controversial since the Hydro Project's inception. In 1910, Pierce County Superior Court and King County Superior Court issued decrees vesting rights to 2,000 cubic feet of water



Concrete mixer at diversion dam headworks, September 15, 1910 (UW n.d.)

Concrete culvert for flume being built under railroad trestle at Buckley, June 10, 1911 (UW n.d.)

Tailrace west from powerhouse toward the White River, with view of main construction camp, September 22, 1911 (UW n.d.)

per second of time (cfs) that required the Pacific Coast Power Company to maintain instream flows of at least 30 cfs below the diversion dam (FERC 1992). In 1913, the Sumner Lumber & Shingle Company brought suit against the Pacific Coast Power Company, alleging that diverting water from the White River interfered with its ability to float logs from the wooded mountains to its downstream shingle mill. The Washington Supreme Court ruled against the lumber company (Washington Supreme Court 1913). In addition, the water removals depleted natural streamflows along the Muckleshoot Indian Reservation, and this severely affected tribal fisheries resources and community well-being.

In 1920, reflecting the sentiment of the times, Puget issued a souvenir edition of *Hydro-Electric Development, an Illustrated Story of the Power Properties of the Puget Sound Power & Light Company, Showing How the Forces of Nature Have Been Harnessed and Made to Serve Useful and Productive Industry*. This publication described the White River Station as the "largest and most important of this company's hydro-electric developments" (Puget 1920).

Federal Regulation

In that same year (1920), Congress established the Federal Power Commission (FPC) to coordinate hydroelectric projects under federal control (FERC n.d.). The Federal Power Act (FPA) of 1930, the Natural Gas Act of 1938, and subsequent acts gave the FPC authority to regulate the sale and transmission of electricity.

Mud Mountain Dam and White River Valley Flooding

During the late 19th Century and early 20th Century, flooding occurred nearly every year in the White River Valley. Flooding sometimes redefined the course of the water, particularly in the case of the White River and Stuck River. In 1906, a massive flood broke through the narrow barrier between the two rivers and diverted most of the White River water southward (Stein 2001a, 2001b; White River Valley Museum 2001).

Severe flooding in the 1930s prompted the U.S. Army Corps of Engineers (USACE) to begin constructing Mud Mountain Dam to control flooding on the White River. Delayed by World War II, the dam was completed in 1948. Mud Mountain Dam is located upstream of Lake Tapps Reservoir and was the world's highest earth- and rock-filled dam when it was completed (Stein 2001b). The dam is operated as an "empty pool" to allow room for flood water storage. It also traps most woody debris and stores sediment when storing water, which interferes with downstream channel dynamics (NOAA 2003).

Mud Mountain Dam is an impassable barrier to upstream fish migration (NOAA 2003) (see Chapter 9). Beginning upon initiation of construction, USACE operated (and continues to operate) a "trap and haul" facility at the diversion dam to transport migrating fish upstream above Mud Mountain Dam (NOAA 2003).

Land Use

Through the 1940s, the Lake Tapps area remained mostly rural. In 1954, when Puget sold the land surrounding the reservoir to the Lake Tapps Development Company (Puget 1954), the character of the area began a transition to residential use. Puget granted title to the land surrounding Lake Tapps Reservoir above a contour line located at elevation 545 feet above sea level[1], but reserved the right to maintain utility lines and use of roads for access to the reservoir over the conveyed lands. Puget did not convey title to the bed of Lake Tapps Reservoir or to any land up to the 545-foot contour line, and reserved the right to raise the water within the reservoir and to dredge the reservoir bottom. Puget also granted the Development Company right to use Lake Tapps Reservoir for recreation and to allow other limited actions and activities as long as those activities and actions would not impact Puget's full use of the water of the reservoir for its operation.

2.2 1960s – 1980s

Federal Energy Regulatory Commission (FERC) Licensing

The Hydro Project was operated as an unlicensed hydroelectric project for many decades (the project's inception pre-dated the Federal Power Act). However, under pressure from the federal government, Puget submitted its first license application in 1964 (Hadley 1999a). Puget withdrew its license application in 1972 (NOAA 2003). In its extended discussions with the federal government, Puget asserted that the government did not have jurisdiction over the project because the White River was not a navigable waterway, and thus the project did not require a license[2].

In 1977, Congress reorganized the FPC as the Federal Energy Regulatory Commission (FERC) (FERC n.d.). Under the Federal Power Act, FERC's responsibilities included licensing or relicensing hydroelectric projects, overseeing all ongoing project operations, and monitoring environmental concerns. FERC reversed the 1976 findings of an Administrative Law Judge, determining that the Hydro Project was located on navigable waters, and thus FERC had licensing jurisdiction. FERC denied a rehearing on its order in 1978, and in 1981, the U.S. Court of Appeals ruled that the Hydro Project required a license (U.S. Court of Appeals 1981). As a result of this ruling, Puget filed an application with FERC for an original license in 1983 (FERC 1992; NOAA 2003).

Water Rights Registration Act

In 1967, the Washington State Legislature passed the Water Rights Registration Act, codified in Chapter 90.14, Revised Code of Washington (RCW). The Act required all persons who claimed a water right, not based on a permit or certificate issued by the Washington State

[1] The 1954 Deed does not state whether the National Geodetic Vertical Datum (NGVD) of 1929 was used for this elevation. See the information on Lake Tapps Reservoir elevations in Section 1.8 of this document.
[2] The federal government regulates only non-federal hydroelectric projects that affect navigable waters.

Department of Ecology (Ecology) or a predecessor agency, to file a statement of claim by June 1974. A primary purpose of the Act was to document pre-Water Code water rights to improve administration of the state's waters. In June 1974, Puget filed a statement of claim to document its 2,000-cfs Lake Tapps hydropower water right initiated in 1985 (Puget Claim).

Instream Resources Protection Program

In 1980, the Washington State Legislature adopted the Instream Resources Protection Program for the Puyallup River Basin (Chapter 173-510 WAC)[3]. Through agency rulemaking, Ecology established minimum instream flows for the Puyallup River (WAC 173-510-030(4))[4]. At this same time, Ecology closed the White River to further consumptive water right appropriations (WAC 173-510-040(3))[5].

1986 Puget Settlement with the Muckleshoot Tribe

In 1986, Puget and the Muckleshoot Indian Tribe reached a settlement that required Puget to increase the amount of water it left in the White River from 30 cfs to 130 cfs as measured at the Muckleshoot Indian Tribal Reservation boundary (Ecology 2006a). The settlement also included a supplemental flow budget of 3,650 second-foot days[6] or about 7,240 acre-feet annually.

Under the settlement agreement, Puget also financed construction of the Muckleshoot Indian Tribe's White River Hatchery and funded a significant portion of the hatchery's operation and maintenance through 2003. Since that time, the Muckleshoot Indian Tribe has fully funded the hatchery.

2.3 1990s

Agency Consultation

FERC licenses for hydroelectric projects typically include setting conditions for protecting and mitigating impacts to fish and wildlife resources and habitat per Section 10(j) of the FPA. These conditions are to be based on recommendations received from federal and state fish and wildlife agencies (Interagency Task Force n.d.). FERC is also required to ensure that its actions comply with the federal Endangered Species Act (ESA) (FERC 2004).

Responding in 1992 to agency input on Puget's 1983 license application, FERC found that the agency recommendations were "inconsistent with the public interest standard of section

---

[3] Chapter 173-510 WAC: Instream resources protection program – puyallup river basin, water resource inventory area (wria) 10. http://apps.leg.wa.gov/wac/default.aspx?cite=173-510.

[4] WAC 173-510-030: Establishment of instream flows. http://apps.leg.wa.gov/WAC/default.aspx?cite=173-510-030.

[5] WAC 173-510-040: Surface water source limitations to further consumptive appropriations. http://apps.leg.wa.gov/WAC/default.aspx?cite=173-510-040.

[6] The volume of water represented by a flow of 1 cubic foot per second for 24 hours; equal to 86,400 cubic feet.

4(e) and the comprehensive planning standard of section 10(a) of the Federal Power Act" (Shumway 1992). FERC issued the *Environmental Assessment for Hydropower License, White River Hydroelectric Project, FERC Project No. 2494-002* (FERC 1992), in which it considered agency recommendations but disagreed with them. FERC recommended licensing the project with its staff's recommended environmental measures, which included certain ramping rates and minimum instream flows.

In December 1997, FERC issued an original 50-year license to Puget for the Hydro Project, including authorization to install an additional 14,000-kW generating unit. Puget filed several appeals for a rehearing with FERC on articles of the license related to enhancing salmon runs on the White River because Puget believed those conditions could make the Hydro Project uneconomic to operate (Puget 1997, 1998, and 1999; NOAA 2003).

In 1998 and 1999, FERC and Puget met and conferred with NOAA Fisheries regarding licensing issues for the Hydro Project. In 1999, FERC issued a 2-year stay in the license proceeding to allow Puget, state agencies, local governments, and public interest groups to resolve common issues relating to the Hydro Project's continued operation and economics (Puget 1999; The Seattle Times 1999; NOAA 2003). FERC issued additional stays in the license proceedings after 1999.

Federal Register Listing for Chinook Salmon

In 1999, NOAA Fisheries published a Federal Register notice final rule listing the Puget Sound Chinook salmon as a threatened special under the ESA. White River spring and summer/fall run Chinook salmon were included in the listing as well (NOAA 2003).

Community Input

During the 1990s, the Hydro Project became less economically viable for Puget. The Energy Policy Act of 1992 intensified competition among wholesale electricity generators by deregulating electric utilities. Puget faced greater competition for resources and customers from privately-owned independent power producers, exempt wholesale power generators, suppliers of natural gas, and others (Puget 1993). In 1999, Lake Tapps residents voiced concerns about the possibility that Lake Tapps Reservoir could be drained if Puget ceased operating the Hydro Project (Hadley 1999a, 1999b). This concern resulted in formation of several community groups at that time:

- The Save Lake Tapps Coalition, a non-profit community organization. The organization served for 8 years before disbanding. The coalition's efforts are now focused under the charter of the Lake Tapps Community Council (Save Lake Tapps Coalition n.d.).

- The Friends of Lake Tapps, which “broke off from the Save Lake Tapps Coalition, a larger homeowner and community group, to concentrate on researching the legal aspects of the case” (Hadley 1999b).

- The Lake Tapps Task Force, made up of property owners and representatives from state and local government and from Puget.

2.4 2000 – 2009

Water Rights Applications and Reports of Examination

Because of concerns about the economic viability of maintaining the Hydro Project for power production, the Puget, together with other members of the Lake Tapps Task Force, considered whether Lake Tapps Reservoir could serve as a regional water supply for current and future population needs. In 2000, Puget filed three water rights applications with Ecology relating to the diversion, storage, and withdrawal of the water (see Section 1.7). Puget and Cascade signed a Memorandum of Understanding (MOU) in 2001; Puget agreed to work exclusively with Cascade to acquire all of the rights that Puget would obtain under its pending water rights applications.

Ecology issued its Reports of Examination (ROEs) granting Puget’s applications for the three water rights in June 2003. The Muckleshoot Indian Tribe, the Puyallup Tribe of Indians, the City of Auburn, the City of Buckley, and others appealed Ecology’s decision to the Pollution Control Hearings Board (PCHB 2004).

Following Puget’s announcement that it was ceasing hydropower generation (see below), in August 2004 the Pollution Control Hearings Board remanded the 2003 ROEs back to Ecology for modification of the ROEs to reflect the cessation of hydropower generation at the White River Hydroelectric facility (PCHB 2004).

In late 2005, Puget submitted a fourth water right application: the application for change in purpose of use for the Puget Claim. Puget filed the application for change to the Puget Claim to conform the claim document to the historical uses of water over the past century. In September 2006, Ecology developed the *Draft Report of Examination, Lake Tapps Reservoir Water Supply Project Application S2-29934* (2006 DROE) (Ecology 2006a), including the four water right applications, and posted it on the Ecology Web site for an informal review period.

Closing of the Hydro Project

In November 2003, Puget determined that it could no longer continue to economically operate the Hydro Project. Puget’s decision was primarily due to the additional conditions related to minimum flows (see below). Puget notified FERC on December 23, 2003, that it rejected the 1997 license for the Hydro Project. On January 15, 2004, Puget ceased generating electricity at the Hydro Project. Puget was "actively seeking to sell the project to one or more entities interested in maintaining the reservoir for commercial purposes" (Puget 2004).

Since 2004, Puget has continued to divert water from the White River with the intent to maintain water levels and water quality in Lake Tapps Reservoir. The water has been conveyed through the flow line built for the Hydro Project and the annual fees have been paid; however, the facilities have not been used to produce hydropower since 2004.

In 2008, Puget entered into the Lake Tapps Asset Purchase Agreement with Cascade for the sale of the Hydro Project, including the Hydro Project water right and the three municipal water right applications. In February 2008, prior to the Cascade Board's approval of the Agreement, Cascade published the *Environmental Checklist and State Environmental Policy Act (SEPA) Mitigated Determination of Nonsignificance (MDNS) for the Lake Tapps Reservoir Water Supply Project* (Cascade 2008a). The Cascade Water Alliance Board of Directors approved the Lake Tapps Asset Purchase Agreement between Cascade and Puget in March 2008 (Cascade 2008g).

In June 2008, Cascade published *the Lake Tapps Reservoir Issuance of New Municipal Water Rights and Change of Use for Existing Claim No. 60822, Determination of Significance and Request for Comments on Scope of Environmental Impact Statement and Environmental Checklist* (Cascade 2008b).

On December 18, 2009, the purchase and sale under the Asset Purchase Agreement was completed and Cascade became the owner of the Project (this is referred to as the "closing").

Minimum Flows

NOAA Fisheries issued a preliminary draft biological opinion in 2002 and a *Draft Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation* in 2003 (NOAA 2003). Through subsequent consultation, Ecology, the Washington Department of Fish and Wildlife (WDFW), the Puyallup Tribe of Indians, and NOAA Fisheries made recommendations to FERC about minimum flows in the White River under section 10(j) of the FPA (see Ecology 2006a). These recommendations, known as the "Agency 10(j) Flows," were superseded in 2005. In March 2005, by means of a letter addressed to the U.S. Army Corp of Engineers, the National Marine Fisheries Service established instream flows for Puget's operation of its project to be provided at the White River above Boise Creek at the Buckley gage. Under the terms of the 2006 DROE, diversions of water from the White River would be subject to these minimum flows, referred to in the 2006 DROE as "Modified

10(j) Flows" (note that in this document, these flows are referred to as "Interim Agency Flows"; see Chapter 3).

In August 2008, in anticipation of becoming owner of Puget's Lake Tapps Reservoir assets, Cascade entered into the 2008 White River Management Agreement (WRMA) with both the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe and a separate agreement with each Tribe (Cascade 2008d; 2008d; 2008e). One of the central features of the WRMA is the Agreed Flow Regime for the White River, under which Cascade agreed to limit diversion from the White River into Lake Tapps Reservoir in accordance with the Diversion Optimization Plan and the Ramping Rates to achieve or exceed specified minimum flows in the White River downstream of the diversion dam. Under the WRMA, Cascade will endeavor to maintain "Normal Full Pool" in Lake Tapps Reservoir between April 15 and September 14, subject to compliance with the specified minimum flows. Other provisions of the WRMA include enhanced streamflow monitoring; enhanced funding for replacement, maintenance, and operation of gaging equipment; enhanced project maintenance including fish screen maintenance in the diversion canal; outlet modifications to avoid introducing predatory or exotic species from Lake Tapps Reservoir into the White River; sediment trapping; and a tailrace study and plan to improve water quality discharge from Lake Tapps Reservoir and to prevent entry, delay, and/or stranding of salmonids in the tailrace canal. By letter to Ecology, Cascade requested that the Agreed Flow Regime be incorporated into the recommendations of the DROE (Cascade 2008f). In this document, the Agreed Flow Regime is referred to as the "Recommended Flow Regime" or "Recommended Flows".

Another central feature of the WRMA is the requirement that Cascade transfer into the State Water Trust the portion of Puget's Claim in excess of the quantity of water that Cascade is permitted to divert into Lake Tapps Reservoir under the WRMA. If Cascade fails or is unable to complete the transfer, Cascade is required to transfer the Trust Water to the Muckleshoot Indian Tribe and the Puyallup Tribe of Indians (Cascade 2008c). In December 2008, Cascade, with Puget's consent, submitted a Trust Water Right Application for the Temporary Donation of a portion of Puget's Claim. Ecology accepted the temporary donation in October 2009 (Ecology 2009a). Based on the closing of the Asset Purchase Agreement, Cascade will request that Ecology make this donation permanent in the future.

As mentioned above, Cascade entered into the Lake Tapps Water Rights Settlement Agreement with the Muckleshoot Indian Tribe (Cascade 2008e) and the Natural Resources Enhancement Agreement with the Puyallup Tribe of Indians (Cascade 2008d) in August 2008. Implementation of these agreements is contingent upon the issuance by Ecology of the water rights in the Proposed Action. Under the agreements, fishery mitigation and enhancement activities would occur, including $19.8 million of fishery mitigation and activities benefitting the White River watershed.

Agreement with Lake Tapps Community Organizations

In 2004, Puget signed the Lake Tapps Reservoir Management Agreement with the Friends of Lake Tapps, the Save Lake Tapps Coalition, the Church Lake Homeowners, Inlet Island Homeowners, Driftwood Point Maintenance Company, Tacoma Point Improvement Club, Snag Island Maintenance Association, Tapps Island Homeowner Association, and West Tapps Maintenance Company (Save Lake Tapps Coalition n.d.). In response to the Lake Tapps community's concern about the recreational viability of the reservoir, Puget agreed to maintain a Normal Full Pool water elevation (see Section 1.8) during the Annual Recreational Period (defined in the agreement as the period from April 15 through October 31) subject to operational variations that may be required due to forecasts of available precipitation, the terms and conditions of the water right, any necessary milfoil control, FERC requirements, or the terms and conditions of applicable law. Another key element was establishing a management team (including Puget, Lake Tapps community members, and other appropriate persons or entities) to help Puget plan the yearly operations of the project.

In May 2009, Cascade entered into the 2009 Agreement Regarding Lake Tapps between Cascade Water Alliance and the Lake Tapps Community (2009 Community Agreement) with the same or successors of the organizations that entered into the 2004 Agreement with Puget (Cascade 2009a). Those organizations are collectively referred to as the Lake Tapps Community. As Puget did in 2004, Cascade committed to meeting specified reservoir surface elevations. Prior to the use of Lake Tapps Reservoir for municipal water supply, Cascade agreed to maintain Normal Full Pool from April 15 to September 30 and to try to maintain Normal Full Pool until October 31. After commencement of the use of Lake Tapps Reservoir for municipal water supply, that obligation is altered so that from September 16 through September 30, Normal Full Pool must be maintained 90% of the time, measured by the number of days (i.e., no more than 15 days in a rolling 10-year period of time). As Puget provided in its 2004 Agreement, Cascade's obligation to meet the reservoir surface elevations is subject to the terms and conditions of the water rights and the terms and conditions of applicable law and any necessary milfoil control.

Cascade assumed assignment of the 2004 Puget Agreement upon closing of the Asset Purchase Agreement on December 18, 2009. However, the 2009 Community Agreement will replace the 2004 Puget Agreement following acceptance by both the Lake Tapps Community and Cascade of the revised ROEs to be issued by Ecology.

Cascade's obligations under the 2009 Community Agreement is to be implemented with the following priority of interests for use of White River flows: (1) provision of minimum flows in the White River; (2) provision of recreational reservoir surface elevations; and (3) provision of municipal water supply.

Cooperative Agreement with the U.S. Army Corps of Engineers

In September 2004, Puget amended its 1948 contract with USACE to “maintain operation of the White River diversion dam to support [USACE’s] ongoing operation of its Mud Mountain Dam fish passage facilities. The agreement…directs [Puget] to operate the diversion dam in accordance with measures determined by federal agencies to be necessary to protect listed species and habitat” (Puget 2004). Cascade assumed assignment of the 1948 contract and amendment upon closing of the Asset Purchase Agreement on December 18, 2009.

This page intentionally left blank.

Chapter 3: Alternatives

This chapter describes the alternatives that were evaluated for the Lake Tapps Reservoir Water Rights and Supply Project (Project). It provides details about each alternative and presents information that can be used to compare them. The alternatives for the proposed project are as follows:

- No Action Alternative
- Proposed Action
- On-Site Alternatives
- Off-Site Alternatives

This chapter focuses on the differences between the Proposed Action and the No Action Alternative in terms of the way that Cascade would manage the White River–Lake Tapps Reservoir system; subsequent chapters explain additional differences. Managing the system would require controlling two variables: (1) the flow rate of water into and out of the system, and (2) the time when variations in the amount of water in Lake Tapps Reservoir occurred. The flow rate of water into and out of the system would be managed by controlling (a) diversions from the White River into Lake Tapps Reservoir, (b) withdrawals from Lake Tapps Reservoir for municipal water supply, and (c) releases through the tailrace canal. The times when the amount of water in the reservoir varied would be managed by setting the dates for Spring Refill, Normal Full Pool, and Fall Drawdown (see Chapter 1).

The On-Site Alternatives address potential mitigation elements identified in the 2006 Draft Report of Examination (2006 DROE). The Off-Site Alternatives address developing sources of municipal water supply other than Lake Tapps Reservoir.

3.1 No Action Alternative

A No Action Alternative typically describes what would most likely happen if the Proposed Action did not occur. Technically, Cascade could "lock the gate and walk away." This would mean that there would be no further diversions into Lake Tapps Reservoir, and the reservoir as it is now known would disappear and revert to the four former lakes. However, because Lake Tapps Reservoir has an established shoreline with waterfront homes and has been used by the community for recreation for many years, it is doubtful the federal, state, or county governments, and the homeowners, would allow the reservoir to be abandoned or drained.

Under the No Action Alternative, the municipal water rights applications would not be acted upon and Cascade would not build or operate the Project. Because Cascade is a public water supply utility, it could face legal restrictions on owning a reservoir that it could not reasonably use for water supply purposes. Under those circumstances, Cascade would minimize expenditures associated with an operation not central to its core utilities' purposes and would attempt to sell the reservoir system.

Under the No Action Alternative, operation of the White River–Lake Tapps Reservoir system would most likely continue as it has since hydropower generation ceased in 2004.

1. Water would continue to be diverted from the White River at a rate that would maintain certain minimum flows in the White River. These minimum flows (see Table 3-1) are referred to as the Interim Agency Flows (or Interim Flows).[1] The Interim Agency Flows in the White River would range from a high flow rate of 500 cfs from mid-summer into the fall to a low flow rate of 350 cfs through the winter and early spring.

Table 3-1. Interim Agency Flows for the White River [1]

Month	Interim Agency Flows (minimum) in the White River (cfs)
January	350
February	350
March	350
April	400
May	400
June	400
July	500
August	500
September	500
October	500
November	350
December	350

[1] As measured at the Buckley gage (12099200)
cfs = cubic feet per second
Source: Ecology 2006a

[1] Under the White River Management Agreement, Cascade would be obligated to meet the Recommended Flow Regime described in the WRMA, so long as Cascade diverted water from the White River. However, for the purposes of the analysis described in this Draft EIS and for Ecology's baseline analysis that will be described in the new Draft ROE, the Interim Agency Flows are used. The use of Interim Agency Flows allows for analysis of greater impacts than would occur under the Recommended Flow Regime.

2. Reservoir surface elevations would be maintained as they have been since 2004. Consistent with an agreement between Puget and the Lake Tapps Community, Normal Full Pool (i.e., a water surface elevation of 541.0 to 542.5 feet National Geodetic Vertical Datum [NGVD 29]) would be maintained from April 15 to October 31, allowing for operational variances required due to forecasts or available precipitation, conditions of water rights, any necessary aquatic plant control, or the terms and conditions of applicable law.

3. No water would be withdrawn from Lake Tapps Reservoir for municipal supply.

3.2 Proposed Action

The Proposed Action is for Cascade's Board of Directors to approve Cascade's operation of the Project and to request approval by Ecology of the Applications.

The three basic elements of the Project operation are as follows:

- Cascade would divert water from the White River into Lake Tapps Reservoir, store water in, and withdraw water from the reservoir for municipal water supply purposes.
- Cascade would operate the Project in a manner to provide enhanced flows in the White River (Recommended Flows; see Table 3-2) consistent with the 2008 White River Management Agreement with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe[2] (see Appendix C).
- Cascade would operate the Project to store water and maintain the levels of Lake Tapps Reservoir to support recreation consistent with 2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community (see Appendix D).

[2] Due to the timing of the closing of the Asset Purchase Agreement, the application for a donation of a portion of Puget's Claim into the State Trust Water Rights Program was for a temporary donation rather than a permanent donation. The temporary donation was accepted by Ecology on October 26, 2009 (Ecology 2009a). In anticipation of a future permanent donation application and for purposes of compliance with the State Environmental Policy Act (SEPA) for such permanent donation, the permanent donation is analyzed as a component of the Proposed Action in this Draft EIS. Cascade can provide for flows in accordance with the Recommended Flow Regime with or without Ecology's acceptance of the donation and, therefore, the donation is independent of and does not affect the remainder of the Proposed Action. The donation is intended to provide an additional legal mechanism to ensure implementation of the Recommended Flow Regime and there are no additional impacts beyond those analyzed for the Proposed Action.

Table 3-2. Recommended Flows for the White River [1]

Time Period	Minimum Flow Rates in the White River (cfs)	Time Period	Minimum Flow Rates in the White River (cfs)
January 1-14	650	July 1-23	800
January 15-31	525	July 24-31	650
February 1-14	550	August 1-6	650
February 15-29	500	August 7-31	500
March 1-14	550	September 1-14	500
March 15-31	725	September 15-30	500
April 1-14	775	October 1-14	500
April 15-30	825	October 15-31	500
May 1-14	875	November 1-14	500
May 15-31	875	November 15-30	550
June 1-14	800	December 1-14	550
June 15-30	800	December 15-31	600

[1] As measured at the Buckley gage (12099200)
cfs = cubic feet per second
Source: Cascade 2008c

More specifically, and as shown in Table 1-1 and Figure 1-3, Ecology's approval of the Applications would permit the following:

1. Cascade would divert water from the White River into Lake Tapps Reservoir at an average annual rate of up to 75 cubic feet per second (cfs) (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes[3]. Cascade would divert water from the White River at a maximum instantaneous rate of up to 1,000 cfs (this maximum rate would vary by season and would be lower at other times of the year).

2. Cascade would store up to 46,700 acre-feet of water in Lake Tapps Reservoir for municipal, industrial, and commercial water supply purposes.

[3] As fully described in Chapter 13 of this Draft EIS, the average flow rate of 75 cfs may be increased to an average flow rate of 82 cfs. The 7 cfs is referred to as "Regional Reserved Water". The Regional Reserved Water would not alter or affect the environmental analysis described in this Draft EIS.

3. Cascade would withdraw water from Lake Tapps Reservoir at an average annual rate of up to 75 cfs (54,300 acre-feet per year) for municipal, industrial, and commercial water supply purposes. Cascade would withdraw water from Lake Tapps Reservoir at a maximum instantaneous rate of 135 cfs.

4. Cascade would divert water from the White River, store water in Lake Tapps Reservoir, and release water through the tailrace canal back to the White River in support of the following purposes: hydropower and other beneficial uses including recreational reservoir levels; winter reservoir levels; fish and wildlife habitat protection and enhancement; and maintenance of water quality for recreational purposes in the reservoir and to meet other regulatory requirements. For example, these other beneficial uses include operation of the sedimentation basins, operation of the fish screens and fish bypass pipeline, Spring Refill of Lake Tapps Reservoir, and maintaining water surface elevations in Lake Tapps Reservoir for recreation purposes.

To ensure that the minimum instream flow requirements were met for the Puyallup River (Washington State Legislature 1980), Cascade would reduce the flows diverted from the White River, as necessary, from February 15 through March 31 to meet Puyallup River minimum instream flows. This adjustment for low flow rates in the Puyallup River, identified as the Early Spring Avoidance Plan, is discussed in Chapter 5.

Note that per Cascade's agreements with the Tribes and the Lake Tapps Community (see Chapter 2), the Proposed Action includes the following priority of use for the White River flows:

1. Instream flows in the White River (Recommended Flows)
2. Recreational reservoir levels in Lake Tapps Reservoir
3. Municipal water supply

3.3 On-Site Alternatives

Under SEPA, reasonable alternatives are actions that could feasibly attain or approximate a proposal's objective, but at a lower environmental cost or decreased level of environmental degradation (WAC 197-11-440(5)[4]).

Under the Proposed Action, the Recommended Flows in the White River and recreational surface levels in Lake Tapps Reservoir would be fully provided prior to the diversion of or withdrawal of water for municipal use. Under the Proposed Action, Cascade has reduced the amount of water for diversion and withdrawals for municipal water supply (from the amounts

[4] WAC 197-11-440: EIS contents. http://apps.leg.wa.gov/wac/default.aspx?cite=197-11-440.

requested in the Applications) to the maximum extent feasible while still providing for the current and projected demands of its Members and the region. Any on-site alternatives that propose further diminishment of diversion and withdrawals would not allow the management of the White River–Lake Tapps Reservoir system for municipal use while maintaining water quality, recreational reservoir levels, and stream flows for fish and wildlife; and thus, would not meet the Project objective and/or would do so at a higher overall environmental cost. Such alternatives would not be reasonable alternatives, and were not carried forward for analysis.

Reasonable alternatives may be mitigation measures not included in the Proposed Action (WAC 197-11-792(2)[5]). The conditions and additional mitigation measures from the 2006 Draft ROE were reviewed to determine whether there are any reasonable alternatives that are not already included either in the Proposed Action or among the mitigation measures to be provided in association with the Proposed Action. The following are addressed as part of the Proposed Action and associated mitigation measures, and, therefore, were not carried forward for separate analysis: minimum flows known as “Agency 10(j) Flows”; ramping rates; minimum instream flow (MIF) compliant diversion; flow augmentation; land conservation; Diversion Minimization Plan to identify the minimum diversion from the White River and outflows from Lake Tapps Reservoir that are necessary to maintain water quality in the reservoir; Water Quality Compliance Plan to achieve the goal of complying with the dissolved oxygen and temperature standards applicable to the White River at the location of the tailrace; tailrace barrier to minimize attraction and block entry of migrating fish to the tailrace discharge; leakage reduction; fish screen installation on any water withdrawal structure; settling basins continued; and conservation. In addition, other mitigation measures are identified in the Draft EIS in Section 1.4. The only measure not included in the Draft EIS is source exchange, which was determined to be infeasible.

3.4 Off-Site Alternatives

Under the Off-Site Alternatives, Cascade would develop an alternative source(s) of municipal water supply in lieu of constructing the project. For additional detail on sources of supply and demand forecasting, see Appendix E.

Water Demand Forecast

In 2009 Cascade prepared an updated forecast of water demands for the years 2010–2050. The demand forecast was developed as follows:

- Data on water use, rates charged to water customers, and conservation activities were obtained from the eight members of Cascade.

[5] WAC 197-11-792. Scope. http://apps.leg.wa.gov/wac/default.aspx?cite=197-11-792.

- Forecasts of households and employment through 2040 were obtained from Puget Sound Regional Council (PSRC). These forecasts were extended to 2060.

- Statistical analysis was used to determine the relationship between water use per household and factors such as weather conditions, water rates, and household income. For commercial and industrial water uses, similar analysis was done on the basis of water use per employee.

- The PSRC demographic forecasts were combined with the statistical analysis of factors affecting water use, to produce a forecast of water use in future years from 2010 to 2060.

- A range of values were estimated based on expected ranges of key variables. This included analysis of how demands may be affected by climate change, using recent information on climate change available from the University of Washington and other sources.

- Expectations regarding continued implementation of Cascade's water conservation program over the planning period were built into the demand forecast.

Based on this procedure, the demand forecast with conservation and climate change is shown in Table 3-3.

Table 3-3. Demand Forecast

Year	Mean Expected Value	90% Confidence Rating
2010	41 mgd (63 cfs)	40 – 42
2020	44 mgd (68 cfs)	43 – 46
2030	49 mgd (76 cfs)	47 – 52
2040	54 mgd (84 cfs)	51 – 57
2050	60 mgd (93 cfs)	56 – 65
2060	69 mgd (107 cfs)	62 – 76

mgd = million gallons per day
cfs = cubic feet per second

Sources of Supply

Cascade's Members have investigated potential sources of supply for many years, dating to before Cascade was formed. Most Members of Cascade participated in either the East King County or South King County Coordinated Water System Plans in the mid 1990s, which included review of a range of potential water supply sources. Cascade became an active participant in the Central Puget Sound Water Suppliers' Forum shortly after Cascade was organized in 1999, and took part in the Forum's review of water sources as part of the Regional Water Supply Outlook processes carried out in 2000–2001 and again in 2007–2009. Cascade's 2004 *Transmission and Supply Plan* (TSP) (Cascade 2005) met Washington State Department of Health (DOH) requirements for a Source of Supply Analysis. This included review of enhanced water conservation; use of reclaimed water; water rights changes (including Lake Tapps Reservoir and the Snohomish River); interties with adjacent water systems; artificial recharge of subsurface aquifers; and four potential new sources of surface and groundwater supplies (Snoqualmie Aquifer, Sultan River, Lake Washington, and Chambers Creek Ground Water).

Cascade continues to evaluate potential sources of supply. Most recently, sources were evaluated as follows:

- Step 1:   Twenty-eight potential sources of supply were identified, including many of those addressed in prior assessments such as the Coordinated Water System Plans and Regional Water Supply Outlook. A "fatal flaw" analysis was used to eliminate 8 potential sources that were determined unavailable. Twenty potentially viable sources were retained for further consideration.

- Step 2: The remaining 20 sources were then evaluated. Six criteria were developed for this process: (1) financial considerations, (2) reliability, (3) operational considerations, (4) environmental considerations, (5) implementation challenges, and (6) regional/intergovernmental considerations. A decision model was used to develop a consistent basis for comparing all 20 projects using these criteria.

The 20 sources that passed through Step 1 were compared using the multi-criteria analysis described in Step 2; these sources are listed in Table 3-4.

Table 3-4. Sources Analyzed using Multi-Criteria Evaluation

Source	Type	Partners	Annual or Peak Supply	Annual Yield (mgd)	Peak Season Yield (mgd)
Permanent Sources					
Lake Tapps	Surface Water	None	Annual	50	75
Lake Washington	Surface Water	Unknown	Annual	50	75
Snohomish River	Surface Water	Snohomish River RWA	Annual	24	36
OASIS - Phase 3	Aquifer Storage Recovery	Lakehaven Utility District	Peak	9	22
Desalination	Desalination	Lakehaven Utility District, TPU	Annual	15	15
Enhanced Conservation – Option 2	Conservation	None	Annual	8	13
Snoqualmie Aquifer	Groundwater	East King County Regional Water Assn / Seattle Public Utilities	Peak	5	12
Cascade Member ASR	Aquifer Storage Recovery	None	Peak	5	11
Deep Resource Aquifer Withdrawal (DRAW)	Groundwater	None	Annual	8	10
Direct Potable Use of Reclaimed Water (Brightwater)	Reclaimed Water	King County, SPU	Annual	10	10
Enhanced Conservation – Option 1	Conservation	None	Annual	7	9
Brightwater Reclaimed	Reclaimed Water	King County	Peak	1.6	4
Satellite Reclaimed	Reclaimed Water	King County	Peak	1.5	3
Storm Water Capture	Reclaimed Water	None	Peak	0.2	0.5
Interim Sources					
TCP Expanded	Existing Source Management	Tacoma Public Utilities	Annual	20	33
TCP w/ North Segment	Existing Source Management	Tacoma Public Utilities	Annual	10	33
SPU Expanded Block	Existing Source Management	Seattle Public Utilities	Annual	15	28
TCP w/ Wheeling	Existing Source Management	Tacoma Public Utilities	Annual	10	24
Chambers Creek Wells	Groundwater	Pierce County, TPU	Annual	11	14
Tacoma "Light"	Existing Source Management	Tacoma Public Utilities	Annual	1.5	2

mgd = million gallons per day
TCP = Delivery of Tacoma water through Tacoma-Cascade Pipeline

Through the various supply investigations that Cascade and its Members have participated in over a long period of time, Cascade has a thorough understanding of potential water supply opportunities to meet its needs. It is clear that the Lake Tapps Reservoir supply is the only single source capable of meeting the complete set of Project objectives identified in this Draft EIS. The reasons for this are described below.

Interim Sources

Supplies under investigation include both interim supplies that can be used only temporarily, and permanent supplies. The six potential interim sources may be useful as “bridge” supplies, but would not meet the objective of long-term supply to meet growth over a 50- to 100-year time frame.

Cascade’s primary interim water supply is water purchased from Seattle under the 50-year Declining Block Water Supply Agreement (the “Seattle Agreement”) that became effective January 1, 2004, and extends through December 31, 2053. Based on changes in water demand forecasts, Seattle determined that additional water supply would be available for Cascade. Therefore, in December 2008, Cascade and Seattle executed an amendment to the Seattle Agreement that provided for additional water through 2023. The Seattle Agreement entitles Cascade to a specified amount (block) of water supply and transmission each year for a 50-year period ending December 31, 2053, on a “take or pay” basis. At the end of the Seattle Agreement term, Cascade may continue to purchase from Seattle up to 5.3 mgd of water (average daily demand) for Members that cannot be served economically by any other means.

The block of water available to Cascade in each year of the Seattle Agreement, shown as average daily demand in million gallons per day (mgd), is shown in Table 3-5.

Table 3-5. Amount of Water Available to Cascade from Seattle

Year Beginning	Year Ending	Average Daily Demand (mgd)	Change (mgd)
2009	2017	33.3	NA
2018	2023	35.3	+2
2024	2029	25.3	- 10
2030	2034	20.3	- 5
2035	2039	15.3	- 5
2040	2044	10.3	- 5
2045	2053	5.3	- 5

Source: Seattle 50-year Block Contract and Amendment

Cascade has entered into a wholesale water purchase agreement with Tacoma to supplement water purchased from Seattle (the “Tacoma Agreement”). The Tacoma Agreement entitles Cascade to a permanent supply of 4 mgd of water (average daily demand) each year, and an additional guaranteed reserved supply of 6 mgd (average daily demand [ADD]) through 2026, declining to 1 mgd (average daily demand) in 2030 (the “Additional Supply”), and discontinuing thereafter. The Tacoma Agreement includes minimum purchase requirements from 2009 through 2025, and entitles Cascade to additional temporary water, based on availability. Cascade has not taken delivery of water from Tacoma, and would need to complete construction of the Tacoma-Cascade Pipeline to do so.

Water purchased under the Seattle and Tacoma agreements (with the exception of the 5.3 mgd ADD available from Seattle after 2053 and the 4.0 mgd ADD permanent water from Tacoma) is designed to serve as a “bridge” supply pending Cascade’s development of a permanent, long-term supply in the future. These cities are unwilling to provide additional water supply commitment unless Cascade demonstrates its ability to provide for the long-term water needs of the Members so that when the agreements expire, the communities served by Cascade will not be dependent on the contracted water. Seattle has stated that Cascade must demonstrate its ability to provide for the long-term water needs of its Members as of the termination of the contract before Seattle would extend the term of the 50 Year Declining Block Contract or increase the amount of water available under the amendment to that contract (Cascade 2010). Under the Tacoma Agreement, Cascade is obligated to provide Tacoma with a plan by December 1, 2015, that demonstrates Cascade’s ability to provide for the long-term water needs of the Members. If Cascade does not do so, Tacoma may terminate its obligation to provide the Additional Supply. Thus, to secure extensions in the term of the current agreements or increases in the amounts of water available, Cascade will need to provide assurances that it is able to develop independent sources of supply.

Based on this analysis, the interim sources were eliminated for further analysis in this Draft EIS because they do not meet the objective of long-term, permanent, certain supply to meet growth over a 50- to 100-year time frame.

Permanent Smaller and Uncertain Sources

Of the 14 potential sources in the "permanent" category, only 2 potential long-term sources of supply could be large enough to meet Cascade's needs in the 50- to 100-year time frame appropriate to large investments in supply infrastructure. These are Lake Tapps Reservoir and Lake Washington. All other sources would need to be combined in a package of several sources to meet these long-term needs. Given the size of the available sources, there are only one or two combinations that would not require a large source such as Lake Tapps Reservoir or Lake Washington. Cascade determined that assemblage of a large number of sources would provide insufficient operational certainty due to the unwieldy operational and management requirements of several sources. (Note: Desalination is physically capable of delivering large supplies. However, due to the high energy requirements and concerns about public acceptance and operation requirements, Cascade considers desalination to be practical only as part of a supply portfolio and not as a single large supply.) Based on this analysis, the smaller permanent sources were eliminated for further analysis in this Draft EIS because they do not meet the objective of long-term permanent certain supply to meet growth over a 50- to 100-year time frame.

Of the two potential sources in the permanent category that are sufficiently large, Lake Washington was eliminated from further analysis in this Draft EIS because of the high degree of uncertainty presented by environmental considerations, implementation challenges, and regional/intergovernmental considerations, including water right permitting.

Lake Tapps Reservoir is the only single source of supply that offers sufficient certainty for development to meet growth over a 50- to 100-year time frame. It is the only source that provides assurances needed to secure a significant increase in contracted supply from Seattle Public Utilities and/or Tacoma Public Utilities in the near-term. These assurances are important because the contracted supplies are designed to serve as a "bridge" supply pending Cascade's development of a permanent, long-term supply in the future. The water suppliers providing the contracted supply need assurances that when the time comes to terminate the contract, the communities served by Cascade will not be dependent on the contracted water. The Lake Tapps Reservoir supply, regardless of when it is developed, has both the certainty and quantity needed to provide assurances to immediately support further contracting with Seattle and/or Tacoma. There is no other potential supply that has both the quantity and certainty needed to provide these assurances.

An additional objective is to provide improved reliability of regional municipal water supplies for the Central Puget Sound Region. Neither the interim sources listed above nor the smaller permanent sources on the list can satisfy this objective.

Due to the limiting factors described above, the Off-Site Alternatives were not carried forward for further evaluation.

This page intentionally left blank.

Chapter 4: Earth

Changes in the way that water quantity is managed in Lake Tapps Reservoir (as described in Chapter 5) and other man-made factors (e.g., boat wakes) could influence shoreline processes and, therefore, rates and patterns of shoreline erosion. In addition, natural conditions – topography, geology and soils, wind, and waves – directly influence shoreline erosion. This chapter describes the existing conditions along Lake Tapps Reservoir's shorelines and how the Proposed Action could affect them. See Chapter 11 for more information about shoreline use and development.

4.1 Affected Environment

Lake Tapps Reservoir is an impoundment that was created for the purpose of generating hydropower. Dikes were constructed to connect and raise the water surface elevation of four small lakes (see Section 1.8).

The shoreline of Lake Tapps Reservoir is approximately 57.5 miles long and is highly irregular with many bays and inlets. Residences, parks, and undeveloped areas are present along the shoreline (see Chapters 10 and 11). The reservoir's shoreline can be broadly characterized as (a) *armored* with bulkheads or revetments, or with the dikes that were constructed to create the reservoir; or (b) *unarmored*, or composed of earthen fill or the soils that were present when Lake Tapps Reservoir was created (see Section 4.1.1 for more detail).

4.1.1 Shoreline Classifications

To help classify and interpret shoreline conditions, Cascade obtained aerial photos of the study area from 2002, 2003, and 2009. The 2002 aerial photograph was taken when the water surface elevation was near Normal Full Pool; in contrast, the 2003 aerial photograph was taken during an extremely low reservoir level. More recent aerial photos and ground level photos were collected in February 2009. Cascade also obtained existing shoreline location data from Pierce County in the form of geographic information system (GIS) data files. Based on this information, Cascade mapped the reservoir's shoreline according to the following classifications:

- **Bulkhead** – Characterized by vertical structures (e.g., timber, concrete, and retaining walls) fronted in some cases by sediments, but more often intersecting the reservoir surface at Normal Full Pool. Most bulkheads were constructed to protect residential properties.

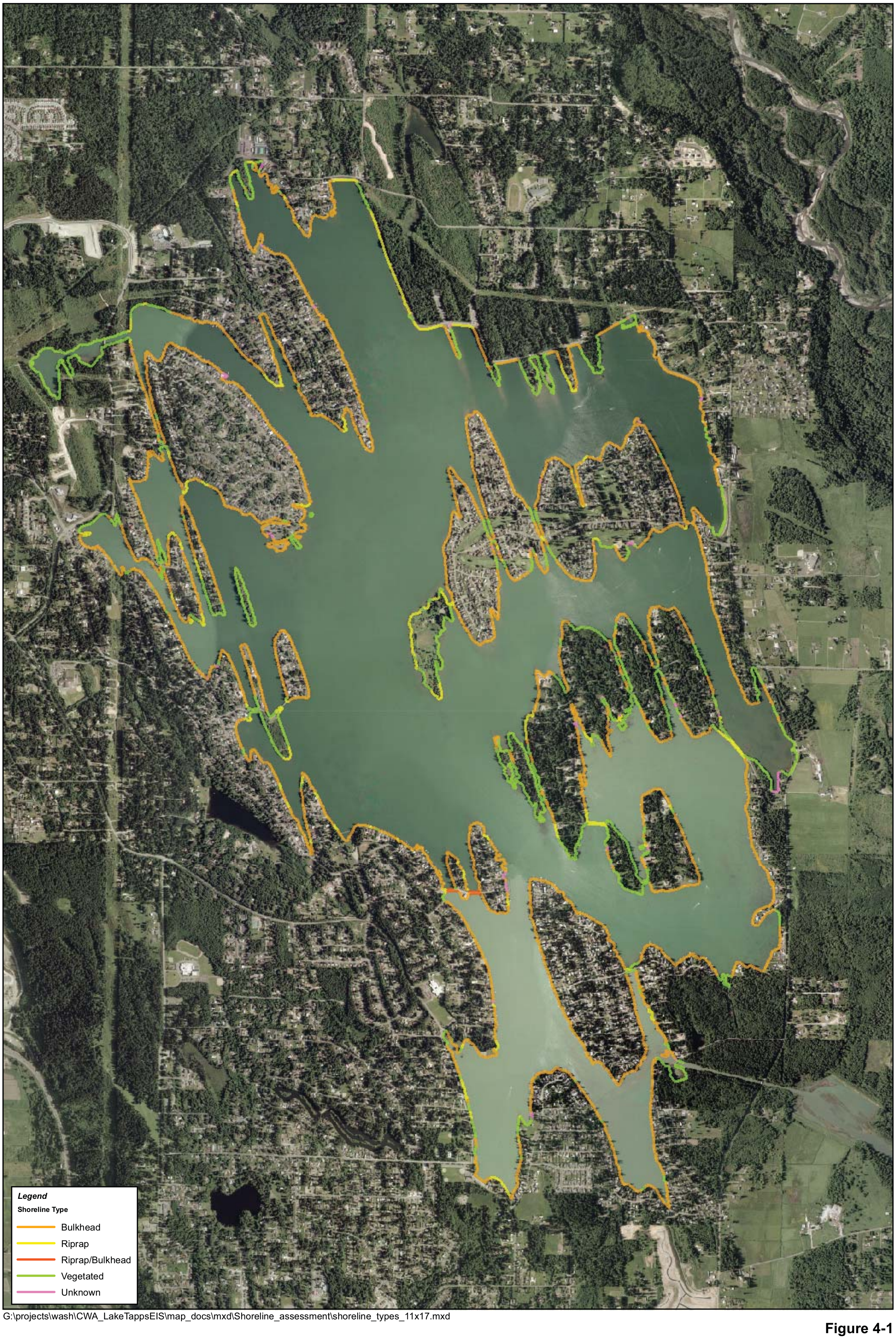
- **Riprap** – Characterized by presence of imported rocks, rubble, or stone blocks located on a slope along the shoreline.
- **Vegetated** – Parts of the shoreline vegetated with trees, shrubs, and grass at the water line. Vegetated areas of the shoreline are present on both developed and undeveloped properties.
- **Other** – Shoreline types such as recreational beaches, boat launches, and miscellaneous features.

Table 4-1 lists the various shoreline classifications and the mapped shoreline lengths. Table 4-1 shows that most shorelines are armored and are characterized by a combination of bulkheads, riprap, and rubble. Other typical shoreline conditions include vegetated shorelines, beaches, and boat launches. Figure 4-1 shows the spatial distribution of the shoreline classification types. Figure 4-2 shows a typical armored shoreline, and Figure 4-3 shows a typical vegetated shoreline.

Table 4-1. Shoreline Classification and Extent at Lake Tapps Reservoir

Shoreline Classification		Length (feet)	Percentage
Armored	Bulkhead	191,144	63.0%
	Riprap	24,310	8.0%
	Bulkhead/riprap	944	0.3%
Unarmored	Vegetated	82,858	27.3%
Other	Beach	3,605	1.2%
	Boat launch	344	0.1%
	Miscellaneous	16	0.0%
	Total length	303,221	100%*

*Rounded value



G:\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Shoreline_assessment\shoreline_types_11x17.mxd

Figure 4-1
Shoreline Type

CASCADE WATER ALLIANCE

Lake Tapps Reservoir Water Rights and Supply Project

Figure 4-2. Typical Armored Shoreline – Retaining Wall and Beach Sediment

Figure 4-3. Typical Vegetated Shoreline (Unarmored) – Shoreline and Beach Sediment

4.1.2 Water Surface Elevation

Since 2004, Puget endeavored to maintain the reservoir's water surface elevation between 541.0 and 542.5 feet from May through October each year (i.e., at Normal Full Pool) (see Chapter 5 for more detail about the management of surface water elevations). Maximum Full Pool is reached at elevation 542.5 feet. In the fall, winter, and spring, the water surface elevation is drawn down to between 525 and 530 feet to control the growth of aquatic plants. The average annual range in water surface elevation is about 20 feet, though in some years the elevation change has varied by more than 20 feet.

The area for potential erosion is near the shoreline where the water surface intersects the shoreface, if the shoreline is not armored. On sloping shores, the zone of erosion varies throughout the year as the water surface elevation fluctuates and the shoreline migrates. Along armored shorelines with vertical profiles, the position of the shoreline is essentially fixed until the water surface elevations drops below the bottom of the structure.

Terms

The **shoreface** is a narrow zone, covered with water, where beach sands and gravels are affected by waves.

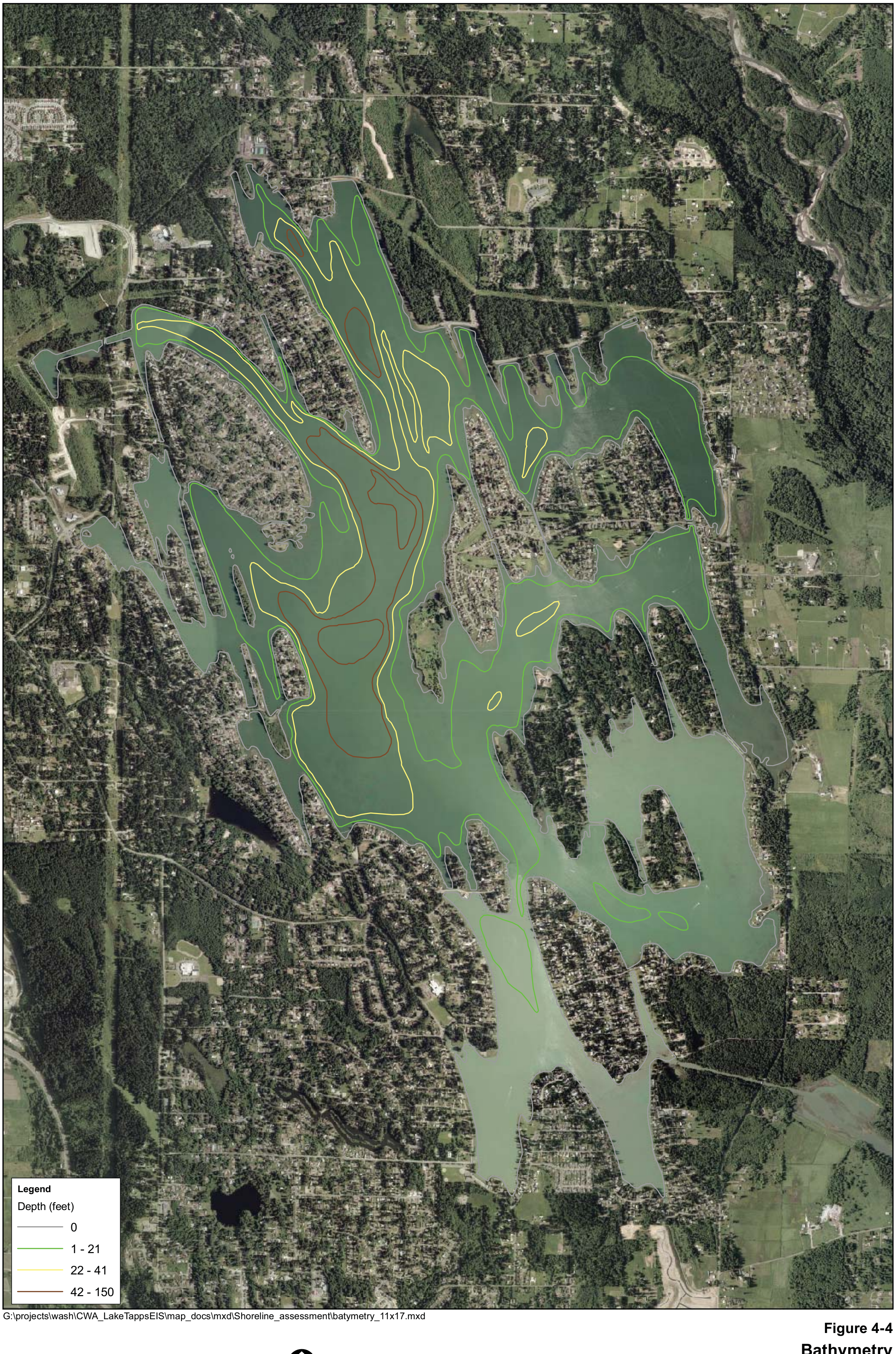
Bathymetry refers to the measurement of water depth; it essentially describes submerged topography.

An **embayment** is an indentation in the shoreline forming an open bay.

4.1.3 Bathymetry

Bathymetry data for Lake Tapps Reservoir were compiled from Washington State Department of Ecology information (1996; 2006b) and supplemented with Light Detection and Ranging (LiDAR) data. Resolution of the data is at a contour interval of 10 feet, as shown in Figure 4-4. At Normal Full Pool, water depths may reach up to 80 feet in the main basin of the reservoir. Smaller embayments are typically shallower, ranging in depth from 10 to 30 feet. Shorelines and shallows areas were surveyed in the winter of 2009 using aerial LiDAR. One-foot contours were generated from the LiDAR data for those areas above the waterline at the time of the survey. Shoreface slopes vary and are often interrupted by armoring and waterfront structures in shallow areas.

Figure 4-5 illustrates two typical shorelines profiles. Based on observations, shoreline slopes vary, but are generally 1:2 to 1:4 (Vertical:Horizontal). Shallow basins and areas with low circulation and wave action are typically characterized by more gradual slopes.



G:\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Shoreline_assessment\batymetry_11x17.mxd

Figure 4-4
Bathymetry

CASCADE WATER ALLIANCE

Lake Tapps Reservoir Water Rights and Supply Project

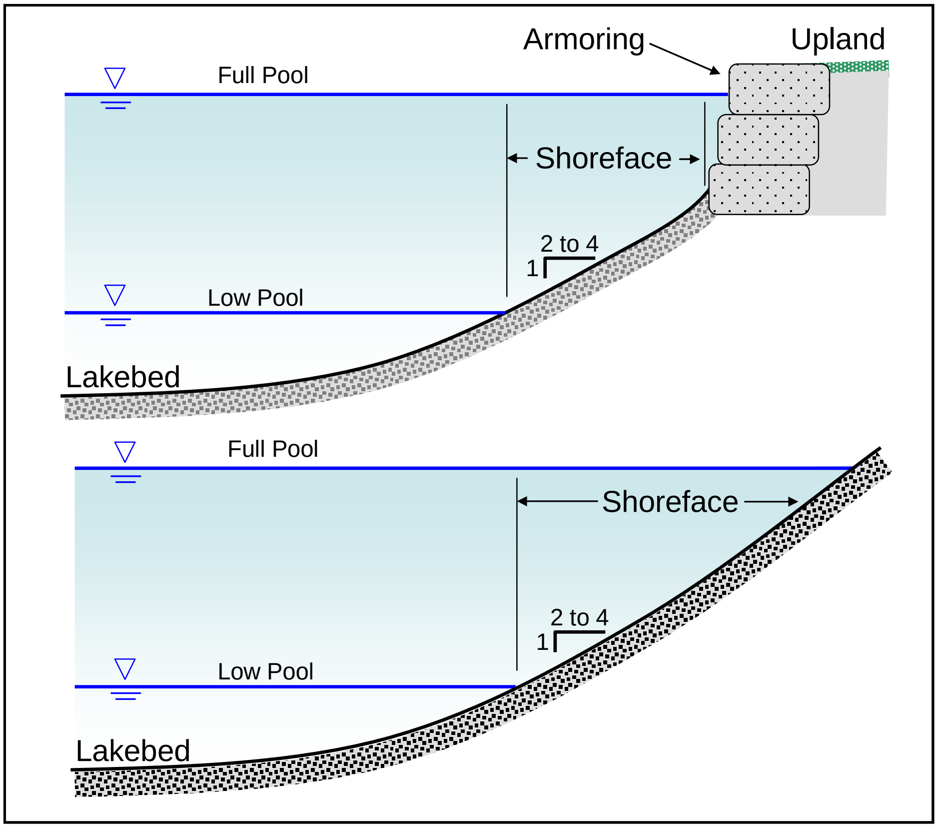


Figure 4-5. Typical Shoreline Profiles at Lake Tapps Reservoir

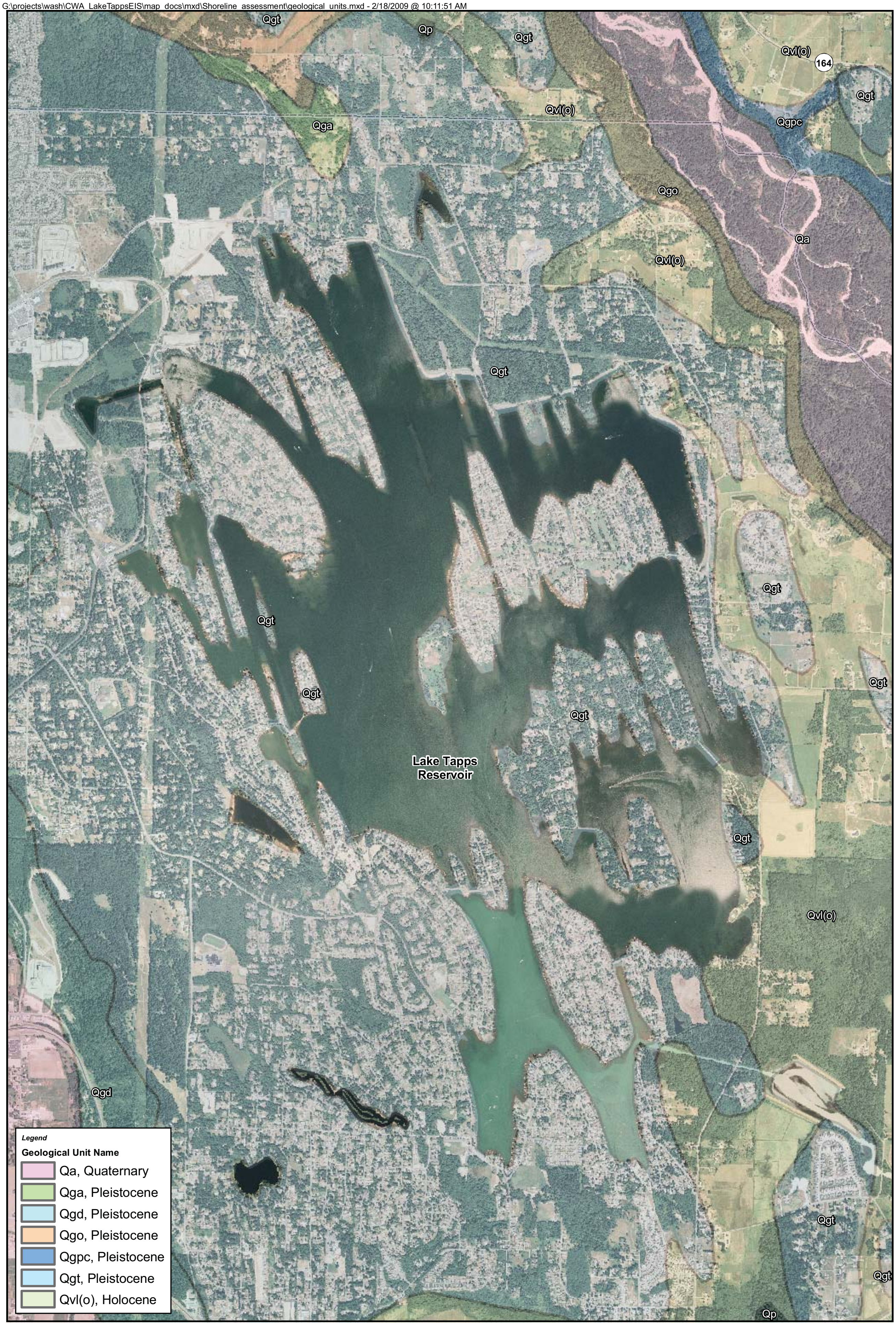
4.1.4 Geology

Figure 4-6 shows the surface geology in the study area. The geologic unit in the vicinity of Lake Tapps Reservoir is the Vashon Glacial Till. Vashon Glacial Till is a dense, cohesive mixture of silt, clay, sand, gravel, and cobbles. When covered by surface soil or beach deposits, the glacial till is resistant to weathering. When saturated and exposed to waves, glacial till begins to ravel and erode and forms eroded scarps, and contributes to the development of the shoreface and nearshore beach profile. For the most part, the glacial till at Lake Tapps Reservoir is covered by beach deposits, soil, or armoring, and is not exposed to wave action or only exposed in the winter when the reservoir is well below Normal Full Pool.

4.1.5 Soils

The predominant soil types along the Lake Tapps Reservoir shoreline include the Alderwood and Buckley soils, which are sandy and gravelly loams. Figure 4-7 shows the location of soil types. These soils are characterized by a grayish-brown color and are composed of silt, sand, and gravel with minor clay. In the immediate vicinity of the reservoir's shoreline, these soils have a higher organic content and silt fraction. These soils are moderately cohesive and somewhat resistant to erosion.

This page intentionally left blank.



Source: Washington State Department of Natural Resources, Division of Geology and Earth Resources (2005)

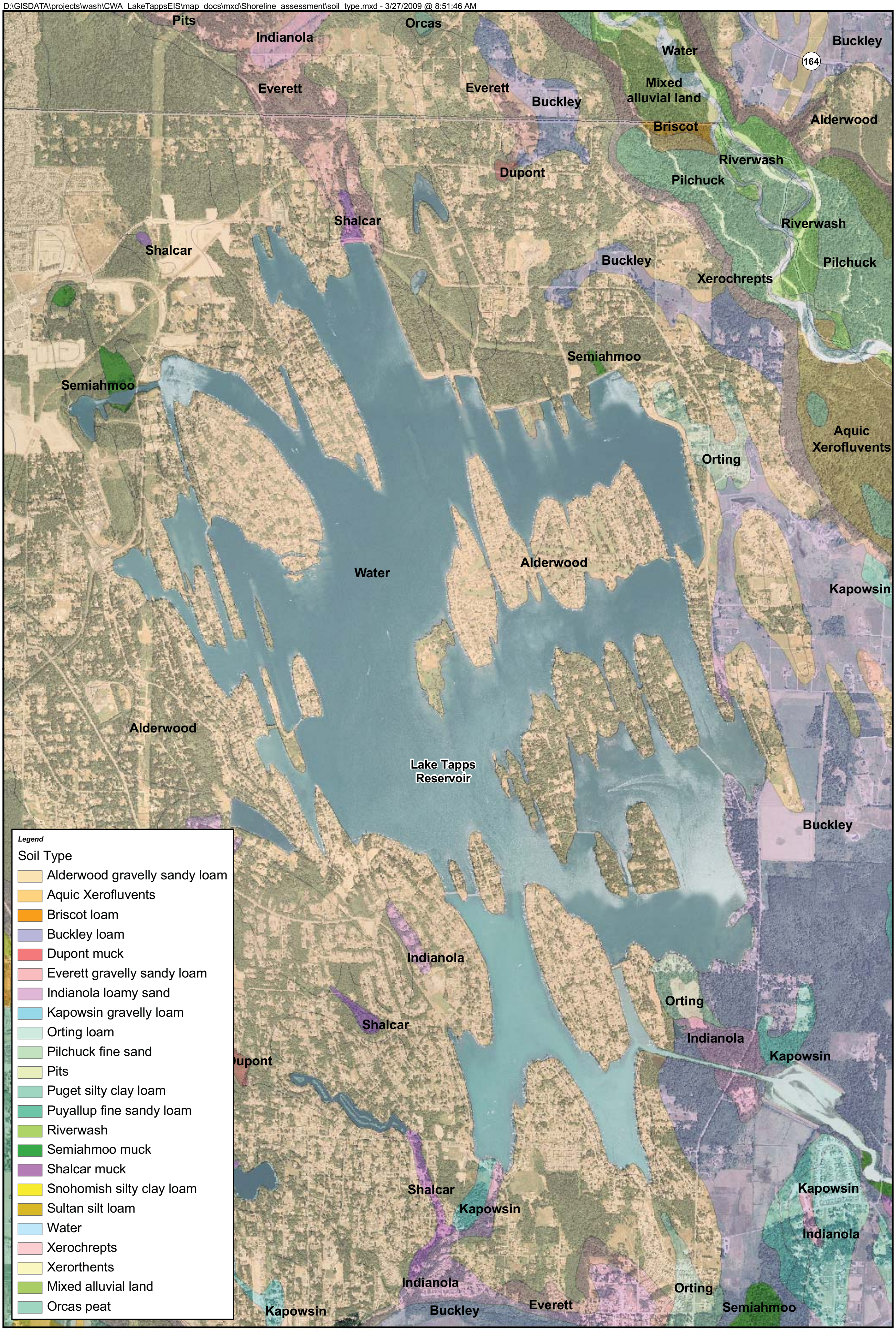
Figure 4-6

Surface Geological Unit Map

0 0.5 1
Miles

Lake Tapps Reservoir Water Rights and Supply Project

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Shoreline_assessment\soil_type.mxd - 3/27/2009 @ 8:51:46 AM



Source: U.S. Department of Agriculture, Natural Resources Conservation Service (2006)

0 0.5 1
Miles

Figure 4-7
Soil Classification in the Vicinity of Lake Tapps Reservoir

Lake Tapps Reservoir Water Rights and Supply Project

CASCADE WATER ALLIANCE

4.1.6 Nearshore and Shoreline Environment

Over time, wave action has sorted out the smaller-sized sediments (sands and fines) and deposited these in deeper areas below the normal low water elevation. Most of the exposed shorelines are characterized by the presence of small surface cobbles and gravels, mixed with some sands. Figure 4-8 shows typical shoreface sediment composition at Lake Tapps Reservoir. In shallow protected areas, such as the ends of channels and near road crossings, silts and fines have accumulated and in some cases emergent vegetation persists along the shore (emergent vegetation is adapted to living in saturated soils). Beneath the surface sediments that have been sorted by wave action, soils types are fill, organic soil, or glacial till.

Figure 4-8. Typical Shoreline Sediments Composed of Cobbles and Gravel, Lake Tapps Reservoir

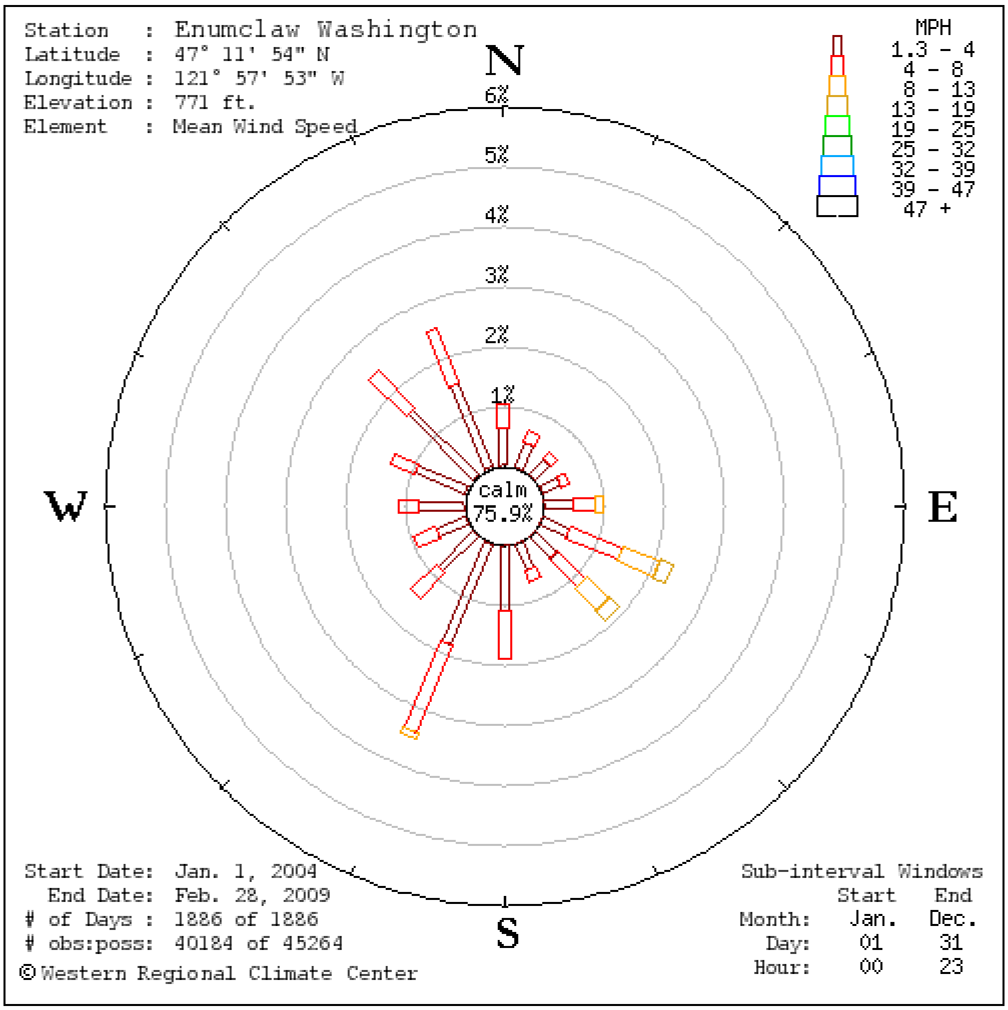
4.1.7 Shoreline Change

Historic or recent shoreline changes caused by physical processes at the reservoir, such as erosion, have not been reported, and to Cascade's knowledge, have not occurred. Minor wave erosion occurs normally, as indicated by the presence of armored shorelines and of small scarps created by minor erosion along unarmored shorelines. Qualitative comparison of aerial photographs from 2002 to 2009 indicates little shoreline change in the recent past. Like most water bodies, the location and composition of unarmored shorelines at Lake Tapps Reservoir likely fluctuate seasonally with water surface elevations.

Natural shoreline processes are interrupted on the upper shoreface by armoring along most of the reservoir. As the shoreface naturally adjusts down (erodes), the presence of vertical structures reduces the ability of the shoreline to adapt to changes in water surface elevations and restricts the supply of sediment that would be available to the shore in the absence of the structure. Scour from breaking waves may also cause localized erosion, as can be seen along some of the older shoreline structures.

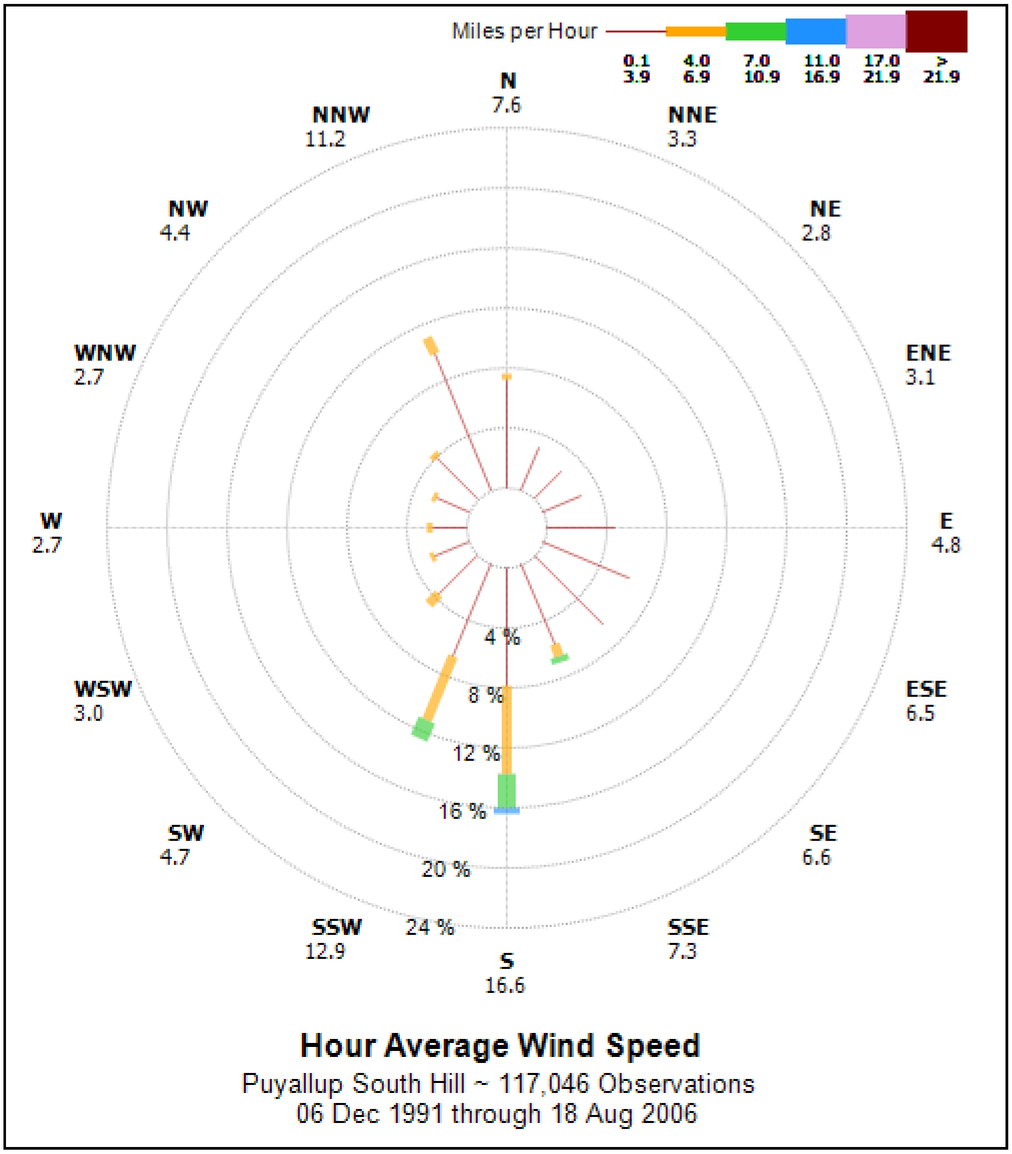
4.1.8 Wind

Sustained winds create waves that drive shoreline processes and shoreline change. Data on local wind speed of sufficient duration are not available for Lake Tapps Reservoir. Detailed continuous wind data are available from Seattle Tacoma International Airport (Sea-Tac) and from McChord Air Force Base (see Table 4-2). The Sea-Tac and McChord information is more regular and continuous than that from the closer Enumclaw and Puyallup meteorological stations, and is more reliable. However, an inspection of overlapping periods for all stations shows similar results. Generally, predominant wind is from the south quadrant, averaging less than 9.0 mph. Figures 4-9 and 4-10 show wind rose diagrams of wind direction and speed for Enumclaw and Puyallup.



Source: WRCC 2009

Figure 4-9. Wind Rose for Enumclaw, Washington



Source: PSCAA 2009

Figure 4-10. Wind Rose for Puyallup, Washington

Table 4-2 compares monthly average wind speed and prevailing direction, and indicates slight seasonal variability. Winds are slightly stronger during the winter months while blowing predominately from the SSE. During the summer months, the average wind speed is approximately 1 to 2 mph lower and from the SW.

Table 4-2. Comparison of Monthly Average Wind Speed and Prevailing Direction

Month	Sea-Tac		McChord Air Force Base	
	Speed (mph)	Direction	Speed (mph)	Direction
January	8.3	S	7.4	S
February	8.2	S	7.3	S
March	8.5	S	8.6	S
April	7.4	S	7.7	S
May	7.3	SSW	7.6	S
June	7.2	SSW	7.5	S
July	7.0	SW	7	S
August	6.4	N	6.5	S
September	6.5	N	6.3	S
October	6.9	S	6.8	S
November	7.5	S	7.1	S
December	8.3	S	7.2	S
Annual	7.5	S	7.2	S

Source: WRCC 2009

Strong windstorms are relatively rare in the study area and are generally associated with North Pacific cyclone activity. These storm systems are most active during the winter months. Table 4-3 shows a monthly summary of storm events resulting in peak gusts of 20 mph or greater measured at Sea-Tac from 1950 to 2004. The majority of strong wind events occur from November to January when the reservoir level and associated potential for shoreline erosion are lowest. Less frequently, strong windstorms occur during the late winter and early spring (February to April) during which time the reservoir level is gradually raised to Normal Full Pool.

For reference, the 2-year return period[1] daily maximum wind speed is approximately 37 mph. The 2-year return period daily average wind speed is approximately 24 mph. Within any 2-year period, there is a 90% probability of a day with an average wind speed of about 24 mph and a maximum sustained wind speed of about 37 mph.

[1] A return period is the average time between events of a specified magnitude.

Table 4-3. Strong Wind Events Measured at Sea-Tac

Month	Events
October	5
November	9
December	13
January	14
February	4
March	3
April	2

4.1.9 Waves

Two types of waves affect shorelines: wind waves and vessel wake. Wind waves are more persistent and affect those areas exposed to wind. Vessel wake is most important in high-traffic areas or shorelines close to the sailing line of vessels.

Wind Waves

Fetch, the effective distance over which wind can create waves, was evaluated based on typical wind conditions and reservoir geometry. Wind wave growth is a function of wind speed, direction, duration, effective fetch, and water depth. Wave growth was computed using the Automated Coastal Engineering System (ACES) software developed by the U.S. Army Corp of Engineers (1992). ACES is a universally accepted wave analysis and software program that is routinely applied for typical coastal engineering analysis and design.

Wind is from the east or west less than 8% of the year, and wind speeds from these directions are typically less than 4 mph, with a maximum hourly average wind speed of less than 7 mph. In addition to low and infrequent wind, the maximum fetch in the east/west direction is approximately 5,000 feet. These conditions result in an average wave height of approximately 0.3 foot with a period[2] of 1.1 seconds. The infrequency of wind in this direction, combined with the limited potential for wave growth, indicates that erosion on east and west exposed shorelines is trivial from wind waves.

[2] Wave period is the time required for two successive wave crests to pass a fixed point.

While the geometry of Lake Tapps Reservoir is complex, it can be characterized by four length scales (see Table 4-4). The eastern half of the reservoir is transected by two distinct island groups that create small protected coves. For winds from the north/south, these protected coves are described by a representative fetch length of about 2,000 feet. The center portion of the reservoir consists of one large main basin oriented north to south. This main basin has an average fetch of about 10,000 feet and a maximum possible fetch of 14,000 feet. The remaining areas of the reservoir, such as locations where peninsulas extend into the main basin and the larger sub-basins, are characterized by an average fetch of approximately 6,000 feet.

Table 4-4. Representative Fetch and Depth for Lake Tapps Reservoir at Normal Full Pool

Description	Fetch (feet)	Average Water Depth (feet)
Protected coves	2,000	20
Average fetch	6,000	25
Main basin	10,000	50
Longest fetch	14,000	60

The fetch lengths listed in Table 4-4 are representative of the conditions at Normal Full Pool. As the reservoir surface elevation varies, the fetch in these various basins changes along with the water depth. Table 4-5 shows the variation of fetch and water depth for the characteristic length scales of the reservoir and the associated average wind waves. An average monthly wind speed of 9 mph was applied for the wave analysis. Because the wind climate is very mild, changes in fetch and depth only slightly affect wind wave conditions. The results shown in Table 4-5 indicate that the effect on average wave height between low water surface elevations and Normal Full Pool is less than 0.1 foot, and there is effectively no change in the wave period between the low water surface elevations and Normal Full Pool. Again, waves are small because winds are mild and fetch does not change much with the reservoir level.

The average wind waves listed in Table 4-5 are not large enough to erode or displace the cobbles and gravels that compose the shorelines. Shoreline structures, properly designed, should not be affected by such mild wave action. It is expected that existing shorelines are relatively resistant to erosion from typical wind waves; this is consistent with observations of armored and unarmored shorelines at Lake Tapps Reservoir. Existing erosion is likely limited to the extreme upper shoreface where vegetation and organic topsoil extend to the water line, such as at Lake Tapps North County Park.

Table 4-5. Variation in Fetch and Wave Conditions between Low Water Surface Elevations and Normal Full Pool at Lake Tapps Reservoir

Reservoir surface elevation (feet)		530	532	534	539	542
Protected coves						
	Fetch (feet)	1,250	1,700	1,760	1,910	2,000
	Water depth (feet)	7	10	12	17	20
	Wave height (feet)	0.2	0.2	0.2	0.2	0.3
	Wave period (seconds)	0.8	0.9	0.9	0.9	0.9
Average fetch						
	Fetch (feet)	5,460	5,700	5,760	5,910	6,000
	Water depth (feet)	12	15	17	22	25
	Wave height (feet)	0.4	0.4	0.4	0.4	0.4
	Wave period (seconds)	1.3	1.3	1.3	1.3	1.3
Main basin						
	Fetch (feet)	9,580	9,700	9,760	9,910	10,000
	Water depth (feet)	37	40	42	47	50
	Wave height (feet)	0.5	0.5	0.5	0.5	0.5
	Wave period (seconds)	1.5	1.5	1.5	1.5	1.5
Longest fetch						
	Fetch (feet)	13,580	13,700	13,760	13,910	14,000
	Water depth (feet)	47	50	52	57	60
	Wave height (feet)	0.6	0.6	0.6	0.6	0.6
	Wave period (seconds)	1.7	1.7	1.7	1.7	1.7

4.1.10 Vessel Wake

Small recreational vessels less than 20 feet long are typical on Lake Tapps Reservoir (see Chapter 10 for a description of recreational use of the reservoir). The numbers of vessels using the reservoir during the peak recreational season is unknown, but is likely on the order of hundreds of vessels per day.

Wake propagates from passing vessels to the shoreline as series of short period waves, causing sediment movement and potential erosion. Vessel wake is a function of vessel speed, hull shape, water depth, and channel geometry in constricted areas. Wakes decrease rapidly in height as they propagate away from the generating vessel.

Wakes were analyzed based on methods presented in Bhowmik et al. (1991) for recreational vessels. Wake height decreases rapidly as it propagates from the vessel, and generally decreases with vessel speed. This is due to the fact that for small recreational vessels, the maximum wake height occurs during the transition from a displacement to planing while the bow of the vessel elevates and the stern is drawn down. Table 4-6 shows typical wake wave heights for a 20-foot recreational vessel at various speeds and reported for a range of distances from the vessel. At Lake Tapps Reservoir, typical distances between the sailing line of a vessel and the shoreline range from 100 to 400 feet. Within smaller residential canals, the shorelines may be as close as 50 feet from the vessel.

Table 4-6. Typical Vessel Wake

	Boat speed (knots)				
	5	10	20	30	40
Distance from vessel (feet)	Wake wave height (feet)				
10	2.4	1.9	1.5	1.3	1.2
20	1.9	1.5	1.2	1.00	0.9
50	1.4	1.1	0.8	0.7	0.7
100	1.1	0.8	0.7	0.6	0.5
500	0.6	0.5	0.4	0.3	0.3
1,000	0.5	0.4	0.3	0.2	0.2

When vessels are present, waves created by boats are larger than the average waves created by wind. Therefore, it is likely that wakes from boats are a large contributor to wave energy in Lake Tapps Reservoir, particularly in more sheltered areas. During the primary recreation season from Memorial Day to Labor Day, both water levels and boat traffic are highest, exposing shoreline vegetation and armoring to the effects of vessel wake.

4.2 Environmental Impacts

4.2.1 Direct Impacts

No significant direct impacts resulting from shoreline erosion would be anticipated under the Proposed Action or the No Action Alternative.

Operation of the proposed Project could affect erosion along both privately developed (armored) and undeveloped (vegetated) shorelines. Changes in shoreline erosion at Lake Tapps Reservoir could result primarily from changes in wind wave energy or boat wake energy on the shorelines. Shorelines are most vulnerable to erosion when water levels are high; the annual range of water surface elevations and the duration of the reservoir level near Normal Full Pool are discussed below.

No Action Alternative

The No Action Alternative represents a management condition where water levels would continue to vary as they have since hydropower generation ceased in 2004.

Proposed Action

Wave Energy and Erosion Changes

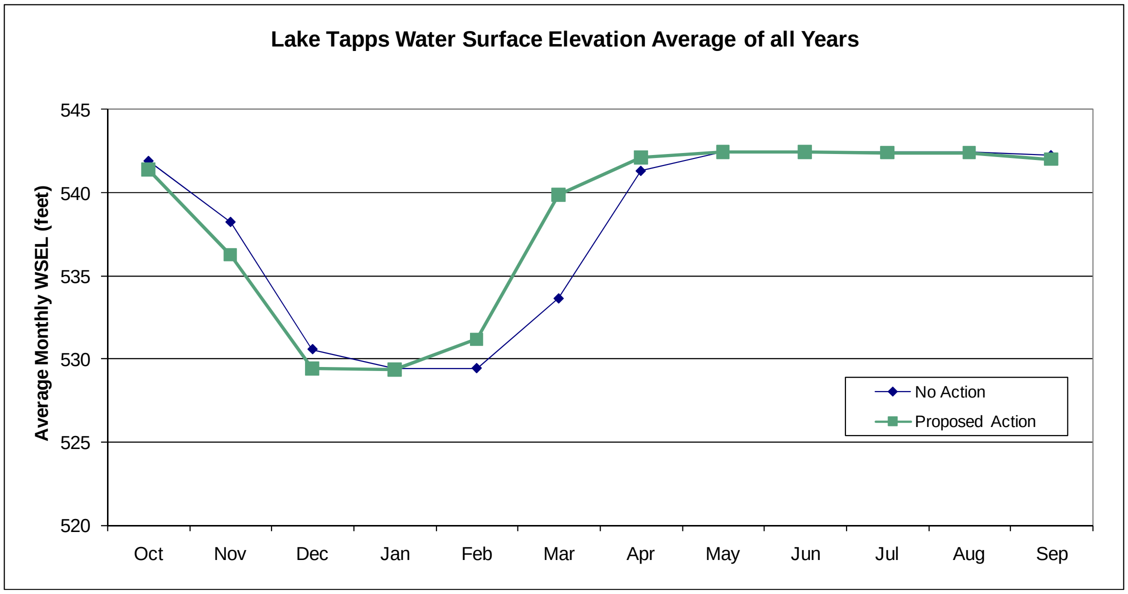
Typical wind waves at Lake Tapps Reservoir are small, and wave height in the reservoir is not sensitive to changes in reservoir level, as discussed above. The Proposed Action would not change the range of reservoir levels, fetch, or water depth; wind wave energy generated within the reservoir would remain the same as for the No Action Alternative. The total amount of wind wave energy reaching the upper shoreface and shoreline structures would slightly increase because the Proposed Action could maintain reservoir level near Normal Full Pool longer than for the No Action Alternative (see Chapter 5); however, this increase in wind wave energy would not be significant in the context of the potential for increased shoreline erosion.

Based on the average wind wave data presented in Table 4-5 and the proposed increased duration of water level at Normal Full Pool, the Proposed Action would increase the total amount of wind wave energy reaching shoreline areas of concern by about 3.5% compared with the No Action Alternative. This slight increase would not translate into significant erosional impacts because of one or more of the following: (a) waves would not be larger than those for existing conditions or for the No Action Alternative, (b) shorelines do not currently experience significant erosion, and (c) properly designed shoreline structures are capable of withstanding the wind wave climate. Because of the timing of the elevated water level change prior to the recreation season, erosion caused by vessel wakes would not be expected to change.

Methods, analysis, and results are discussed in more detail below.

Reservoir Level Range

The annual range of water levels, particularly the Normal Full Pool elevation, would remain the same under the Proposed Action (see Figure 4-11). Those areas exposed to inundation, and wave energy, under the Proposed Action would be the same as those exposed for the No Action Alternative. Therefore, there would be no potential for increased erosion or impact on vegetated, armored, or otherwise modified shorelines due to the range of reservoir level compared with the No Action Alternative.



WSEL = water surface elevation

Figure 4-11. Proposed Action and No Action Alternative Reservoir Levels

Wave Energy Change

Changes in Reservoir Levels and Exposed Shoreline

As shown in Table 4-1, most of the shoreline on Lake Tapps Reservoir is armored by a vertical bulkhead, retaining wall, or a riprap revetment. Based on analysis of available LiDAR survey data from the Puget Sound LiDAR Consortium (2004) and 2009 LiDAR data collected for this analysis, typical residential shoreline structures extend no lower than approximately elevation 539.5 feet.

Wave run-up, or the vertical distance reached by waves above the still water level, also affects shorelines. Wave run-up was computed with the ACES software (USACE 1992) used to develop the wave heights and periods listed in Table 4-5. Wave run-up for average fetch waves is listed in Table 4-5, and for the unarmored profile shown in Figure 4-5 is approximately 0.3 foot. Thus, when reservoir levels are lower than about 539.2 feet, there is little potential for waves to affect existing shoreline structures or the vegetated upper shoreface. Conversely, when water levels exceed this elevation, waves could affect shorelines at elevations of greatest concern.

Figure 4-11 above illustrates the water levels for the No Action Alternative and the Proposed Action at Lake Tapps Reservoir during a normal year. Note that proposed monthly average water levels would be higher in February, March, and April as the reservoir was filled to Normal Full Pool. This situation would be reversed from October to January, when proposed water levels would be slightly lower than those for the No Action Alternative. Overall, the Proposed Action would result in a total of about 237 days/year when structures and the upper shoreface would be exposed to waves, compared with 229 days/year for the No Action Alternative. Therefore, these shorelines would experience about 8 additional days of potential wave exposure each year, or an increase of about 3.5% over the No Action Alternative.

Wave Energy Change from Increased Water Levels

Wave energy flux, a measure of the wave energy transferred to the shoreline through wave breaking, would increase correspondingly with the water level exposure along the upper shoreface. Wave energy is a function of wave height, wave period, and water depth.

Table 4-7 summarizes average wave energy flux at the upper shoreface and compares the Proposed Action and No Action Alternative. The second column in Table 4-7, which represents the mean daily wind wave energy at the shoreline, was computed using ACES software for the average annual wave conditions presented in Table 4-5 as input. The table shows the number of days the upper shoreface would be annually exposed to water levels exceeding elevation 539.2 feet for both the Proposed Action (PA) and the No Action (NA) Alternative.

The total annual wave energy flux is the product of columns two and three for each alternative. The change in annual wave energy is the difference between the Proposed Action and the No Action Alternative. Positive indicates an increase in wave energy at the shoreline. Dividing the change in annual wave energy by the No Action Alternative annual wave energy yields a wave energy increase of about 3.5% for the Proposed Action. This increase is simply a function of the increased exposure of the upper shoreface to higher water levels, since Table 4-5 demonstrates that the size of the waves is not sensitive to normal reservoir level fluctuations.

Table 4-7. Annual Wave Energy Flux for the Proposed Action and No Action Alternative

Basin Type	Mean Daily Wave Energy (ft-kip/s-ft)*	Annual Exposure (days)		Total Annual Wave Energy (ft-kip/ft)		Change in Annual Wave Energy (ft-kip/ft)	Change in Annual Wave Energy (%)
		PA	NA	PA	NA	PA – NA	
Protected coves	138	237	229	32,763	31,657	1,106	3.5
Average fetch	363	237	229	86,003	83,100	2,903	3.5
Main basin	648	237	229	153,576	148,392	5,184	3.5
Longest fetch	1,056	237	229	250,226	241,780	8,446	3.5

PA = Proposed Action
NA = No Action Alternative
*(feet x 1,000 lbs)/s x 1/ft

Wave energy increase or change due to boat wakes is considered insignificant because the higher water levels for the Proposed Action would occur in the spring, outside the normal recreation season. Boat traffic would be minimal; thus, the potential increase in wave energy due to wakes would be negligible.

4.2.2 Indirect and Cumulative Impacts

No indirect or cumulative impacts resulting from shoreline erosion would be anticipated under the Proposed Action or the No Action Alternative.

4.3 Mitigation Measures

No significant direct, indirect, or cumulative impacts resulting from shoreline erosion would be anticipated under the Proposed Action or the No Action Alternative; therefore, no mitigation measures are proposed.

4.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts associated with shoreline erosion would be anticipated. Erosion processes would continue to occur at Lake Tapps Reservoir as they have in the past.

Chapter 5: Surface Water Quantity

Surface water resources – that is, streams, canals, reservoirs, and estuaries – could be affected by changes in the way that the White River–Lake Tapps Reservoir system is managed. Changes in the quantity of water in these surface water resources could have a secondary effect on other environmental resources including water quality, fisheries, and aquatic habitat. This chapter addresses the flow rates in rivers in the study area and in reservoir system facilities, and the water surface elevation of Lake Tapps Reservoir.

5.1 Affected Environment

5.1.1 Surface Water Hydrology

The affected environment for surface water resources consists of the water bodies (and land areas adjacent to them) that are downstream of the diversion dam and that may receive more or less water (or water at a different time) because of changes in the way that the White River–Lake Tapps Reservoir system is managed. These water bodies are the Reservation Reach of the White River, Lake Tapps Reservoir, the Lower White River, and the Lower Puyallup River (see Figure 5-1).

White River

The White River is located in the Puyallup River Basin and drains an area of 494 square miles above its confluence with the Lower Puyallup River at River Mile (RM) 10.4. The White River is approximately 75 miles long and originates from Emmons Glacier on the northern slope of Mount Rainier (see Figure 5-1). Major tributaries upstream of the diversion dam include the Greenwater River, Huckleberry Creek, West Fork White River, and Clearwater River.

Two dams in the project vicinity affect surface water resources of the White River: Mud Mountain Dam (MMD) and the White River diversion dam.

MMD is a flood-storage reservoir constructed on the White River near Enumclaw (RM 29.5). MMD is a U.S. Army Corps of Engineers (USACE) flood control project built in the 1940s to reduce flooding on the White River and Lower Puyallup River. During periods of extremely high flow, water is temporarily stored behind MMD and released after peak flow has subsided. MMD effectively impounds about 4 miles of the White River, from RM 31 to RM 35, just above the confluence with the Clearwater River. MMD is 432 feet high and can store 106,000 acre-feet of water. Most of the time, normal flow in the river is maintained, and the reservoir behind MMD is essentially empty.

The diversion dam on the White River (RM 24.3) is a low, rock-filled, timber-crib dam constructed in 1910. The existing diversion dam, with its associated gates, steel panels, and flashboards, is designed to do the following:

Diversion dam on the White River August 2008

- Allow for passing flows by the diversion dam to achieve minimum instream flow compliance.
- Allow for diversion of the complete, existing 2,000-cfs Puget Claim into the intake.
- Facilitate the passage of bedload sediment past the intake and downstream of the diversion dam.
- Limit the diversion of bedload sediment from the White River into the intake.
- Limit the deposition of bedload sediment from in front of and within the intake.
- Facilitate the removal of deposited sediments from in front of and within the intake.
- Limit the diversion of large floating woody debris from the White River into the intake.
- Serve as an upstream fish passage barrier facilitating USACE's upstream trap and haul fish passage operation.

Stop logs (or "boards") on the diversion dam assist in controlling the river level above the diversion dam and, in combination with two large head gates, control the flow from the river into the diversion canal. Part of the water diverted into the diversion canal is returned to the White River at RM 21 to allow the return to the White River of fish ("bypass fish") that have been screened out of the diversion (see Chapter 9).

The diversion dam is currently in poor condition and is scheduled for replacement by USACE; construction is slated to begin in 2012.

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\surface_water_map.mxd - 1/27/2010 @ 8:21:05 AM

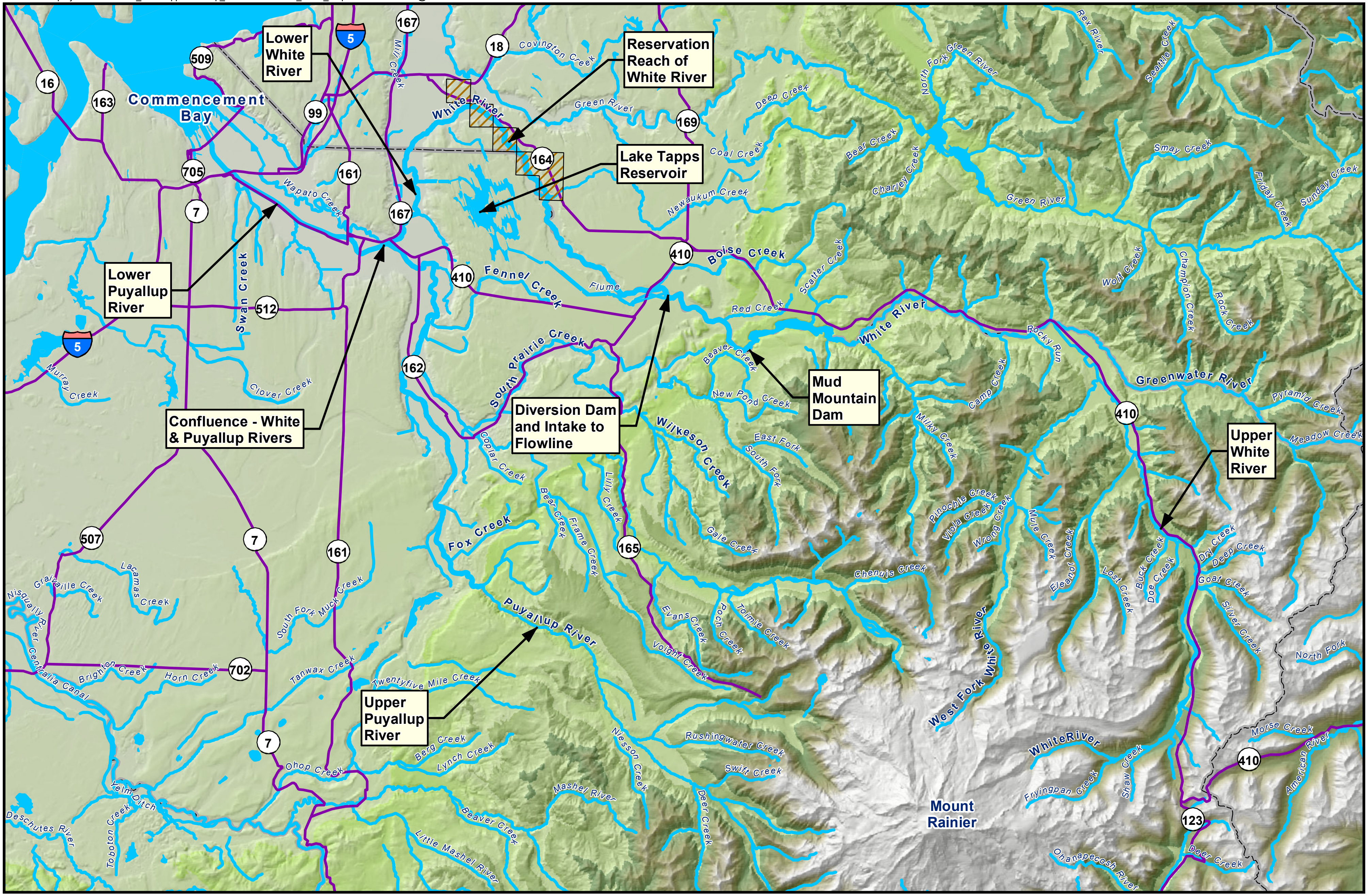


Figure 5-1

Surface Water Map

Lake Tapps Reservoir Water Rights and Supply Project

0 1 2 4 6 8
Miles

CASCADE WATER ALLIANCE

The White River is gravel-bedded with a large bed load originating from sediment deposited by the glaciers of Mount Rainier. Sediments transported by the White River range from the powdery glacial till that gives the river its light gray color to large cobbles and boulders moved only by extremely high flows. During the winter when glaciers remain frozen, water clarity in the White River is relatively high. This compares to the milky, turbid conditions that occur in the summer during active glacial melt. Cloudy water conditions are also produced by the re-suspension of glacial drift near MMD and the Osceola mud flow. Dunne (1986) estimated the annual sediment load in the White River to be approximately 500,000 tons/year.

The moving bed load creates problems in building, rating, and maintaining streamflow gages and in-river facilities. As channel geometry changes, the water surface elevation associated with a given flow of water will change as well. The stream gages and major facilities on the White River and in the remainder of the study area are shown on Figure 5-2 and are described in Section 5.1.2.

White River Reservation Reach **October 2008**

The 21-mile-long reach of White River between the diversion dam and the tailrace canal (see Chapter 1) (RM 24.3 to RM 3.6) is referred to as the Reservation Reach. The river channel in this reach is composed of a sand, gravel, and cobble bed load. There is a significant accumulation of large woody debris and the channel complexity is high. The river meanders and there are significant side channels and a well-developed floodplain and riparian zone. The upper section of the Reservation Reach has a steep gradient and a boulder/cobble bed load. The middle section consists of a braided, broader channel. Levees were constructed on portions of the lower section of the Reservation Reach to protect adjacent lands from flooding. The gradient in the lower section of the reach is not as steep and the channel is broader and braided, and has a gravel/cobble substrate.

The reach of the White River from below the confluence with the tailrace canal to the Lower Puyallup River is referred to as the Lower White River (RM 3.6 to RM 0.0). The Lower White River flows into the Lower Puyallup River near Puyallup, at Puyallup RM 10.4.

Diversion Canal

Water diverted from the White River into Lake Tapps Reservoir flows through a fish screen (including a bypass pipeline that returns fish to the White River), as well as through a series of canals, flumes, sedimentation basins, and pipelines, prior to emptying into the reservoir. At the fish screen, 20 cubic feet per second (cfs) of the diversion canal flow is continuously returned to the White River below the diversion dam via the fish bypass pipeline, thereby transporting fish that have been entrained in the diversion canal (see Chapter 9) back into the White River.


Flume **August 2008**

The 8-mile-long diversion canal includes a flume, five settling basins, a concrete canal, an unlined earthen canal, and a section of twin 10-foot-diameter concrete pipes. Up to the Printz detention basin, the diversion canal has a hydraulic capacity of about 2,000 cfs. Recent construction of a backflow prevention structure near the end of the diversion canal has limited the maximum flow rate from the diversion canal into Lake Tapps Reservoir to about 1,000 cfs. No measurements are available of inflows to, or outflows from, the diversion canal, other than the diversion from the White River.


Diversion canal **August 2008**

Lake Tapps Reservoir

Located at the downstream end of the diversion canal is Lake Tapps Reservoir, a man-made lake located north of Bonney Lake and south of Auburn in Pierce County. The reservoir and associated facilities were originally constructed in the early 20th century for the purpose of generating hydropower. The reservoir was created by diverting water from the White River and using a series of 13 earthen dikes to connect four smaller, natural lakes that were present before the construction of the reservoir (CH2M HILL 2006). Construction of residential housing began along the shoreline of the reservoir in the 1950s.

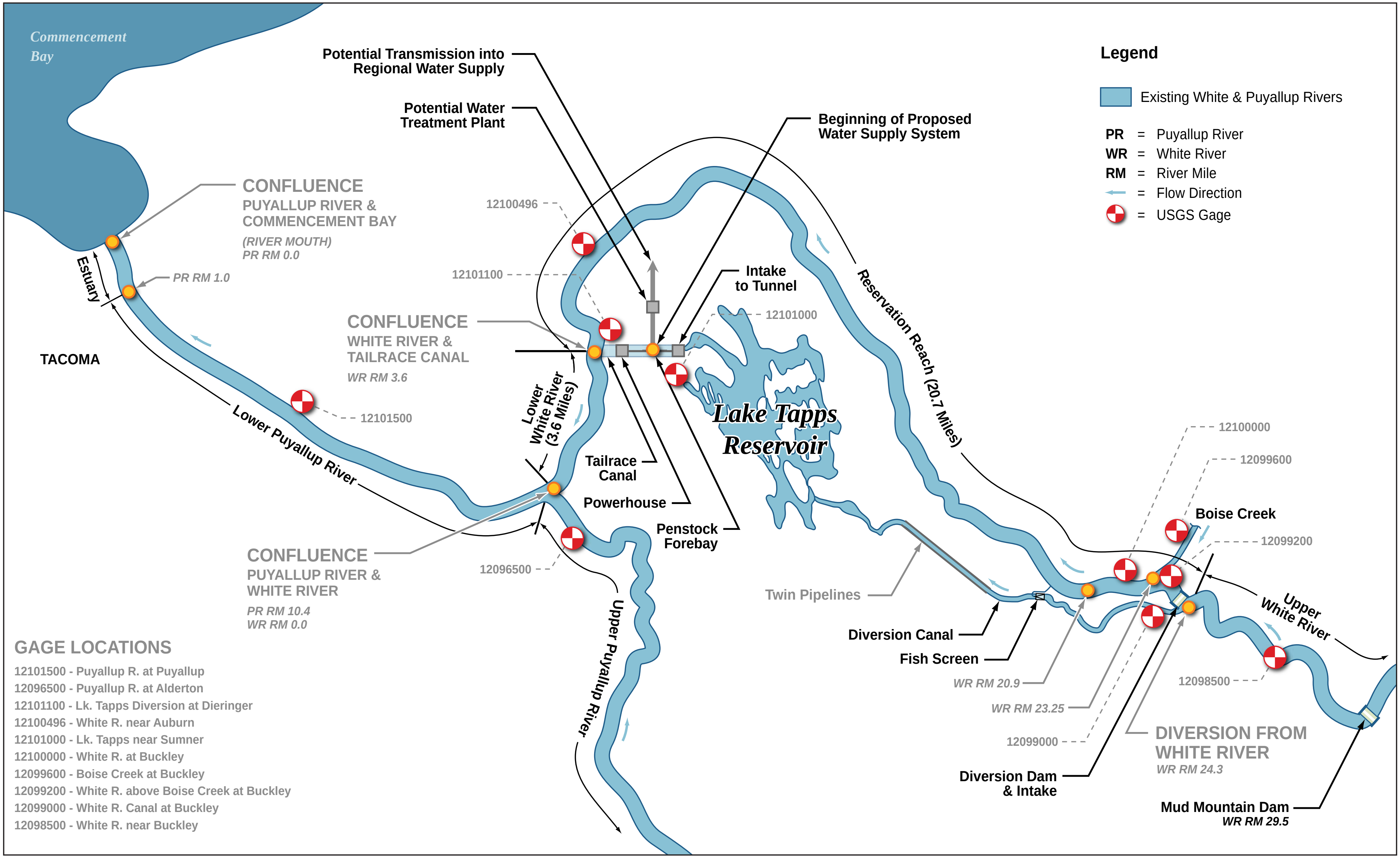


Figure 5-2. Stream Reaches and Gages of the White and Puyallup Rivers

Lake Tapps Water Rights and Supply Project

Lake Tapps Reservoir has an active capacity (or total available) storage volume of 46,700 acre-feet[1]. The reservoir has a minimum active pool elevation of 515 feet (National Geodetic Vertical Datum [NGVD] 29) and a maximum pool elevation of 542.5 feet. The range in the reservoir level during normal operations is from below elevation 530 feet during the winter to the summer Normal Full Pool (defined as being between the maximum storage level of 542.5 feet and the minimum recreational level of 541.0 feet). The reservoir is kept at or near Normal Full Pool elevation during the recreation season (see Chapter 10). Reservoir levels are lowered during the winter to approximately elevation 530 feet to control the excessive growth of nuisance aquatic vegetation (milfoil) (see Chapter 8). During 2003, water levels were allowed to drop to just below elevation 500 feet to allow embankment repairs. This extremely low reservoir level was unusual and is not typical of normal operations.

At Normal Full Pool, the reservoir has a surface area of about 2,740 acres. At normal winter water level (elevation 530 feet), the surface area is about 1,650 acres. At the minimum level (515 feet), the surface area is less than 950 acres.

The storage of water in Lake Tapps Reservoir is based on inflow from the White River, outflow through the outlet works, and the net of the local inflows and losses draining into and out of the reservoir. Increasing or decreasing the volume or timing of flows into and out of the reservoir affects the water surface elevation and storage. Prior to the cessation of hydropower operations in 2004, reservoir levels were influenced by the need to release water through the outlet works to generate electrical power. Reservoir levels are measured by a gage located near the outlet works and converted to storage volume based on a reservoir level-storage volume relationship.

Reservoir Outlet Works and Tailrace Canal

Reservoir outlet works, the outlet for water leaving Lake Tapps Reservoir, is a 2,842-foot-long, 12-foot-diameter, concrete-lined tunnel that conveys water from an intake located on the northwest shore of the reservoir to the former Hydro Project forebay (Figure 5-2). The intake has a minimum invert elevation[2] of 502 feet, although the channel in Lake Tapps Reservoir leading to the outlet reportedly has a much higher invert elevation at about 514.5 feet. From the forebay, the water is conveyed downhill through one of four penstocks (pipelines). The penstocks are no longer used to generate hydropower. One of the penstocks has been modified to control releases from the reservoir.

[1] Active storage is the volume of water that can be released between the normal maximum reservoir level and the level when water stops flowing through the outlet. Inactive storage is the quantity of storage below the elevation of the outlet works. Total storage is the entire storage of the reservoir including both inactive and active storage.
[2] The invert elevation is measured at the lower inside point of a pipe.

Water being discharged out of the penstocks (or, in the future, from the rebuilt outlet works pipes) returns to the White River by means of an unlined 34-foot-wide open channel or tailrace canal. The tailrace canal is 0.5-mile long. The confluence of the tailrace canal with the White River is located at Dieringer, between Sumner and Auburn at White River RM 3.6.

The existing outlet works experience leakage. Although monitoring the leakage is difficult with the existing tailrace gage (Lake Tapps Reservoir Diversion at Dieringer), leakage is estimated to occur at a rate of 36 cfs or more. Under the Proposed Action, the outlet works would be modified to minimize leakage. No modifications to the tailrace canal are proposed, and smaller amounts of water would continue to flow through this feature back to the White River.

Puyallup River

The Puyallup River Basin drains approximately 970 square miles of land on the north and west sides of Mount Rainier. The Carbon River and White River drain into the Puyallup River at RM 17.8 and 10.4, respectively. The Lower Puyallup River discharges into Puget Sound at Commencement Bay in Tacoma. Puyallup River flow variations and hydrology are similar to those of the White River described above. The portion of the Puyallup River between the confluence with the Lower White River and its mouth is referred to as the Lower Puyallup River. Prior to urbanization, the Lower Puyallup River meandered across a broad floodplain from the mouth of the river at sea level to the confluence with the Lower White River at about 50 feet elevation. Urbanization and channelization have confined the Lower Puyallup River to a relatively straight channel with levees on both banks.

Puyallup River Estuary

The lower 2.5 miles of the Lower Puyallup River has been classified as a salt-wedge estuary (Ebbert et al. 1987). A salt-wedge estuary contains a layer of salt water under a layer of river water. The Lower Puyallup River, Clarks Creek, and Swan Creek contribute flow to the Puyallup River as it approaches its terminus at Commencement Bay. The slope of the Puyallup River channel flattens, and the levied channel widens, reaching a maximum width of 800 feet. Within this reach, flows, river levels, and water quality are strongly affected by tidal action. Other than tidal effects (which are not addressed here), flows within the Puyallup River estuary may be considered the same as those in the Lower Puyallup River.

5.1.2 Gaged Hydrology

This section describes the evaluation of surface water conditions after the cessation of hydropower operations in 2004 (the post-hydropower period) and during hydropower operations (the hydropower period). Table 5-1 summarizes the periods of record for the gage data used in the analysis, the quality of the data, and the manipulations necessary to develop consistent records. Flow and water level results are compared in tables and graphs for several different conditions. In some of these, hydrological water year types are compared[3]. The "average" represents the average of all applicable values (measured or simulated) during the period under consideration. "Dry year" represents measured or simulated conditions for a representative dry water year. Similarly, the "wet year" represents measured or simulated conditions for a representative wet water year. In the case of the 2004 – 2008 period, 2007 was selected as wet because the total annual flow at the Buckley gage from October 1 through September 30 was the highest in the period. Compared with the overall 1988 – 2008 period, 2007 is the fifth highest flow year, so it is appropriately wet. The water year 2005 was selected as "dry" because the total flow at Buckley gage was the lowest in the period. This year has a comparable flow to that of the dry year for the longer, 1988 – 2002 period. Similar choices of years were made for the 1988 – 2002 study period. In this period, water year 2001 was selected as dry and 1996 was selected as wet because those water years had the lowest and highest[4] total annual flow at the Buckley gage (respectively). Water year 1998 was selected as "average" because its total annual flow at Buckley was closest to the average for the 15-year period. Every year is hydrologically different. These water year choices were made to simplify the review of conditions and impacts related to streamflow and water level.

[3] A water year runs from October 1 through the following September 30, and is numbered for the year in which it ends.

[4] 1997 has slightly more flow than 1996, but it was judged better to use the first of these two consecutive wet years.

This page intentionally left blank.

Table 5-1. Periods of Record for Gage Data, Data Quality, and Data Manipulation

Summary of USGS Data Used in the Surface Water Baseline Analysis

Gage Name	Gage Number	Gage Rating	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Puyallup River at Puyallup	12101500	Good																					
White River Near Auburn	12100496	Fair																					
White River at Buckley	12100000	Fair																					
White River Near Buckley	12098500	Fair																					
White River Canal at Buckley	12099000	Poor																					
White River above Boise Creek	12099200	Fair																					
Lake Tapps Diversion at Dieringer	12101100	Good																					
Lake Tapps Nr Sumner, Elevation	12101000																						
Lake Tapps Nr Sumner, Storage	12101000																						
Boise Creek at Buckley	12099600	Fair																					

- The data were available from official records. Some flows are interpolated from available data.
- Some data were developed from 12100000 data with local gains calculated from average monthly flow
- The data were developed from 12099200 data, plus Boise Cr inflow
- The data were developed by adding 12099200 data and 12099000 data
- The data were developed by a water balance calculation using 12101000 and 12101100 data, with Lake Tapps losses and gains from Ecology.
- The data were calculated from the Lake Tapps elevation versus storage table.

This page intentionally left blank.

Post-hydropower Period. Table 5-2 summarizes the 2004 – 2008 historical average of all years, wet year, and dry year flow rates at the locations selected for analysis.

Table 5-2. Historical Flow Rates and Water Levels – Post-Hydropower Period (2004 – 2008)

Estimated Average Baseline 2004-2008 Flows in cfs													
Location	**Year Type**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
White River Above Diversion Dam	Average	664	1,629	1,729	1,983	1,257	1,369	1,301	2,387	2,103	1,256	830	688	1,433
	Wet Year - 2007	415	3,318	2,236	1,874	1,551	3,047	1,492	1,696	1,821	1,210	764	587	1,668
	Dry Year - 2005	743	963	1,380	1,790	810	797	1,318	1,779	1,183	982	671	506	1,077
White River Reservation Reach	Average	614	1,591	1,675	1,919	1,144	1,215	1,092	2,186	1,931	1,115	734	535	1,313
	Wet Year - 2007	377	3,222	2,185	1,844	1,544	3,019	1,459	1,356	1,560	1,090	718	553	1,577
	Dry Year - 2005	665	945	1,355	1,707	664	492	759	1,616	990	803	631	459	924
White River Above Tailrace	Average	789	1,895	2,042	2,365	1,398	1,545	1,333	2,533	2,049	1,266	851	713	1,565
	Wet Year - 2007	514	3,888	2,675	2,396	1,916	3,769	1,760	1,597	1,897	1,276	832	642	1,930
	Dry Year - 2005	786	982	1,594	2,088	744	546	842	1,599	931	719	522	418	981
Lower White River	Average	942	2,127	2,188	2,489	1,478	1,629	1,418	2,655	2,157	1,370	920	785	1,680
	Wet Year - 2007	862	4,255	2,731	2,463	1,935	3,798	1,787	1,623	1,923	1,303	864	678	2,018
	Dry Year - 2005	961	1,190	1,796	2,284	929	719	1,003	1,755	1,092	863	560	457	1,134
Diversion Canal	Average	50	38	53	64	113	155	209	201	173	141	95	152	120
	Wet Year - 2007	38	96	51	31	8	27	33	340	261	121	47	34	91
	Dry Year - 2005	78	18	25	83	145	306	559	163	193	179	40	47	153
Tailrace Canal	Average	153	233	145	124	80	84	84	121	108	104	69	72	115
	Wet Year - 2007	348	367	56	67	19	29	26	26	26	27	32	36	88
	Dry Year - 2005	174	208	202	196	185	173	161	156	161	143	38	39	153
Lower Puyallup River	Average	1,857	3,360	2,343	2,839	3,013	2,705	7,252	6,479	4,594	2,877	1,869	3,432	3,552
	Wet Year - 2007	2,368	3,535	4,792	2,847	2,611	2,369	3,844	4,077	2,412	2,769	2,530	3,037	3,099
	Dry Year - 2005	3,775	4,509	4,626	3,230	3,314	4,523	4,076	5,330	3,599	1,980	1,457	3,545	3,664

Estimated Average Baseline 2004-2008 Water Surface Elevation in feet													
Location	**Year Type**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Lake Tapps Water Surface Elevation	Average	540.4	536.3	532.0	530.2	531.4	533.0	536.9	539.3	541.1	541.8	541.9	541.6	537.3
	Wet Year - 2007	537.9	528.6	522.8	522.7	522.3	522.5	522.5	529.2	538.2	541.5	542.1	541.6	531.0
	Dry Year - 2005	540.8	537.0	532.5	527.5	524.4	525.1	537.9	541.7	541.9	542.1	542.0	541.4	536.2

Hydropower Period. Table 5-3 shows the same information during hydropower operations from the 1988 – 2002 historical period. Note that because of the completeness and consistency of the body of data for 1988 through 2002, surface water conditions for the hydropower period are based on this period of data.

Table 5-3. Historical Flow Rates and Water Levels – Hydropower Period (1988 – 2002)

Estimated Average Historical 1988-2002 Flows in cfs														
Location	**Year Type**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
White River Above Diversion Dam	Average	665	1,596	1,731	1,636	1,621	1,348	1,762	2,054	2,078	1,419	862	586	1,446
	Wet Year - 1996	1,158	2,894	3,882	2,820	4,073	1,575	1,503	1,726	1,625	1,217	735	518	1,977
	Dry Year - 2001	849	554	585	763	676	948	1,326	2,095	1,749	996	700	682	994
White River Reservation Reach	Average	216	736	866	675	802	359	518	566	668	419	426	267	543
	Wet Year - 1996	223	2,477	3,420	1,279	3,770	256	815	666	646	264	242	400	1,205
	Dry Year - 2001	141	118	116	116	353	330	314	351	358	246	341	273	255
White River Above Tailrace	Average	287	973	1,113	914	1,091	540	723	702	800	491	494	323	704
	Wet Year - 1996	326	2,835	3,794	1,528	4,575	376	1,028	804	751	346	309	443	1,426
	Dry Year - 2001	210	205	193	202	433	435	460	451	447	282	375	317	334
Lower White River	Average	938	1,789	2,171	1,950	2,139	1,691	1,868	1,772	2,197	1,463	902	659	1,628
	Wet Year - 1996	1,700	3,660	4,388	2,972	5,675	1,649	1,923	1,513	1,750	1,270	788	619	2,325
	Dry Year - 2001	1,104	756	332	1,076	592	905	1,484	1,857	1,679	1,002	698	682	1,014
Diversion Canal	Average	482	861	912	989	867	1014	1234	1490	1406	1028	473	351	926
	Wet Year - 1996	1262	1082	622	1521	389	1329	708	1103	841	994	519	178	879
	Dry Year - 2001	700	445	418	488	347	438	931	1528	1268	737	377	408	674
Tailrace Canal	Average	652	817	1057	1039	1046	1151	1145	1069	1397	972	408	336	924
	Wet Year - 1996	1374	825	594	1443	1101	1274	895	710	998	924	479	176	899
	Dry Year - 2001	894	570	135	873	159	470	1024	1406	1232	720	323	365	681
Lower Puyallup River	Average	1,910	3,927	4,368	4,039	4,122	3,347	3,595	3,506	3,993	2,901	1,945	1,427	3,257
	Wet Year - 1996	8,058	8,480	6,235	10,787	2,929	3,632	3,404	2,978	2,414	1,620	1,209	4,591	4,695
	Dry Year - 2001	1,694	1,289	2,208	1,632	2,162	3,363	3,794	3,602	2,322	2,041	1,626	2,342	2,339
Estimated Average Historical 1988-2002 Water Surface Elevation in feet														
Location	**Year Type**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Lake Tapps Water Surface Elevation	Average	539.3	537.3	536.7	535.4	533.7	529.4	529.7	538.1	542.0	542.0	542.0	541.7	537.3
	Wet Year - 1996	540.7	536.9	536.9	541.3	535.4	529.3	532.4	538.1	542.2	542.2	542.1	541.9	538.3
	Dry Year - 2001	535.3	531.2	535.7	536.3	537.8	539.8	539.0	540.3	542.0	541.9	542.1	541.7	538.6

The Hydro Project operated from 1911 through January 2004. For the period from 1988 through 2002, Puget diverted water from the White River at an average flow rate of 926 cfs and a maximum flow rate of up to 2,000 cfs. Since ceasing hydropower operations in January 2004, Puget has continued operating the White River–Lake Tapps Reservoir system under the terms of an Interim Operating Agreement between Puget and USACE (see Chapter 2).

Since 2004, Puget has diverted water, as needed, to maintain summer recreational levels in Lake Tapps Reservoir and has released water back into the river through the tailrace as a pass-through flow for the purpose of maintaining water quality in the reservoir. During this time, diversions from the White River near Buckley have been limited by the Interim Operating Agreement (see Chapter 2), which specifies minimum flow rate in the Reservation Reach and maximum hourly ramping rates for water levels in the river. The minimum flow rate for the Reservation Reach specified in the Interim Operating Agreement is shown on Figure 5-3. To the extent possible under these flow rate requirements, and for the benefit of recreation, Puget has continued to maintain Normal Full Pool in Lake Tapps Reservoir during the period from April 15 through October 31 per an agreement with the Lake Tapps homeowners. This agreement is described in Section 2.4. Water levels have been maintained between a minimum recreation water surface elevation of 541.0 feet and a Normal Full Pool maximum water surface elevation of 542.5 feet. During this same post-hydropower period, water surface elevations have been lowered below 535 feet during the non-summer season. During this drawdown season, the reservoir bottom of sand, soil, and former forest stumpage is exposed for extended periods of time. This drawdown inhibits the growth of nuisance aquatic vegetation (milfoil).

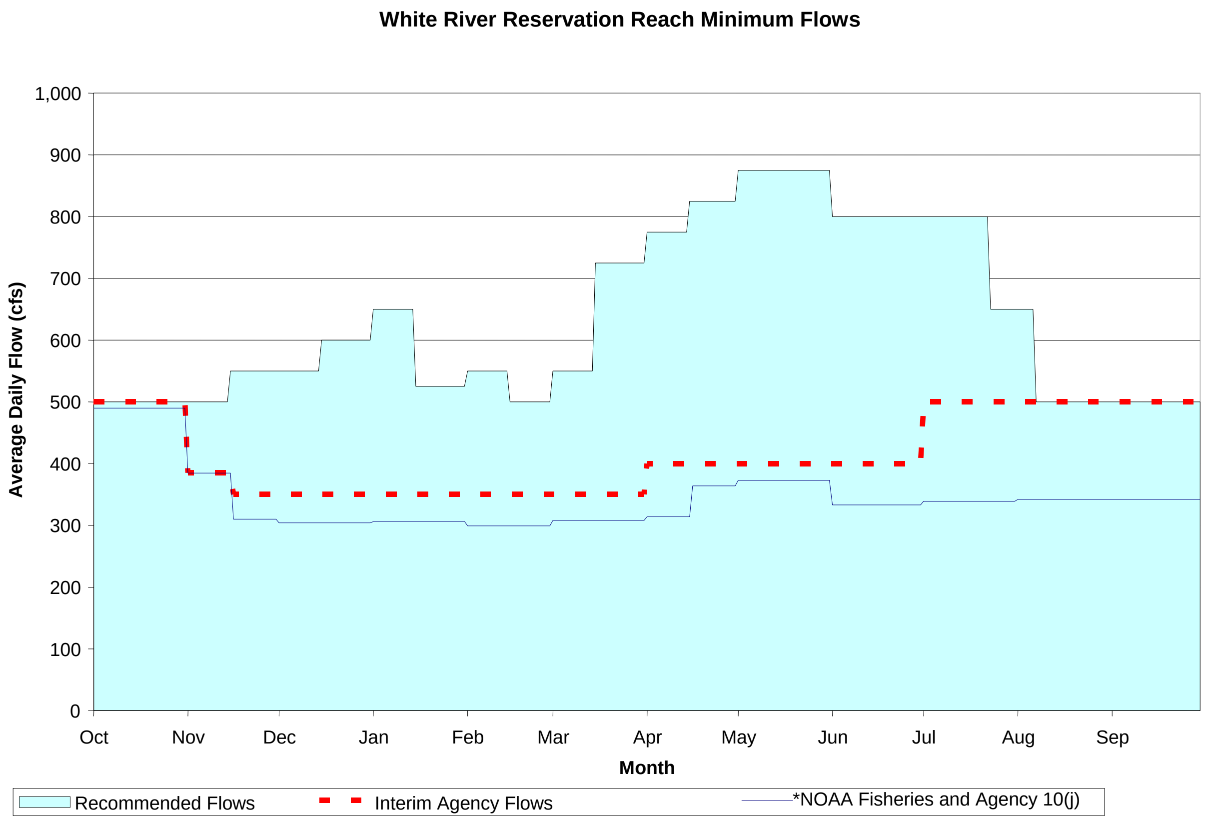


Figure 5-3. Minimum Flow Rate for the White River Reservation Reach

*See Chapter 2 for more information about the NMFS and Agency Recommendation flows.

The flow in the White River is influenced by glacial melt and precipitation reaching the stream from surface runoff or groundwater discharge. Flow in the White River typically peaks twice a year: once in the winter months (when rainfall is most intense) and once in early summer (when snowmelt predominates). The lowest flow occurs from August through October when precipitation is lowest and snowmelt is waning or absent.

Table 5-2 shows that during the post-hydropower period, the diversion canal diverted an average of 120 cfs (8%) of the average of 1,433 cfs of flow available above the diversion. The flow rate immediately below the diversion averaged 1,313 cfs, although a short distance downstream (below the fish bypass return and Boise Creek confluence), the flow rate in the remainder of the Reservation Reach averaged at least 1,365 cfs (Boise Creek averaged 32 cfs, and the flow rate in the fish bypass is assumed to be a constant 20 cfs).

During hydropower operations, an average of 926 cfs (67%) of the average of 1,446 cfs of flow above the diversion was diverted into the diversion canal.. The flow rate immediately below the diversion averaged 543 cfs. This is 41% of the post-hydropower average Reservation Reach flow rate of 1,313 cfs.

The Lower White River flow rate (below the tailrace canal) is not measured. This flow rate is assumed to be the sum of the flow rate in the White River above the tailrace (gaged near Auburn) and the flow rate in the tailrace canal. Table 5-2 shows that the 2004 – 2008 historical flow rate in the Lower White River averaged 1,680 cfs, including 115 cfs from the Lake Tapps Reservoir outlet and the tailrace canal.

The mean annual flow rate in the Lower Puyallup River below the confluence with the White River for the 2004 – 2008 historical period was 3,552 cfs. Table 5-3 shows that during hydropower operations, the average flow rate of the Lower White River was 1,628 cfs, and the average flow rate of the Lower Puyallup River was 3,257 cfs. These numbers are essentially the same for the hydropower and post-hydropower periods.

Storage of water in Lake Tapps Reservoir is based on the inflow from the White River, outflow through the outlet works, and the net of the local inflows and losses draining into and out of the reservoir. Increasing or decreasing the volume or timing of flows into and out of the reservoir affects the water surface elevation and storage. The mean annual inflow and outflow during the 2004 – 2008 period are estimated at 100 cfs (the diversion amount, minus 20 cfs of fish bypass flow) and 115 cfs, respectively, for the period from 2004 through 2008[5]. Table 5-2 presents the 2004 – 2008 historical monthly average of all years and wet year and dry year flow into Lake Tapps Reservoir from the diversion canal.

During hydropower operations, much more water was diverted through Lake Tapps Reservoir to generate power. The mean annual inflow and outflow during the 1988 – 2002 period are estimated at 906 cfs and 924 cfs, respectively. This flow rate is approximately eight times as much as during the post-hydropower period. Table 5-3 shows that wet year and dry year flows into and out of the reservoir were also many times larger during the hydropower operations than during the 2004 – 2008 period.

Tables 5-2 and 5-3 also present the average monthly, wet year, and dry year conditions for the Lake Tapps Reservoir water surface elevation. During the 2004 – 2008 period, the average annual water surface elevation was 537.3 feet. During the 1988 – 2002 period, the average annual water surface elevation was the same (537.3 feet).

[5] The inflow and outflow water balance for Lake Tapps Reservoir does not precisely equalize because between the start of period and end of period, the reservoir contents increase by an amount equivalent to an average flow rate of 3.5 cfs. Other water balance elements include ungaged surface water inflow, groundwater seepage, evaporation, Bowman Creek outflow outlet leakance, and canal losses.

5.2 Environmental Impacts

This section compares simulated flow rates and Lake Tapps Reservoir water levels for the Proposed Action to No Action Alternative conditions. Simulated flow rates and level results are representative of the hydrologic period 1988 – 2002 and were developed using the Lake Tapps Water Supply Project STELLA™ Model described below.

These simulated flow rates represent hydrologic conditions observed in the 1988 – 2002 period, but with the effects of the hydropower operations removed, and the effects of the alternative operation incorporated by hydrologic modeling.

Lake Tapps Water Supply Project STELLA™ Model

A computer model, the STELLA™ Model ("computer model" or "Model"), was developed to simulate operation of the White River–Lake Tapps Reservoir system, including White River and Puyallup River flows and Lake Tapps Reservoir water levels and storage (Aspect unpublished). STELLA allows visualization and simulation of complex river flow and reservoir operations.

The Model calculates 15 years of river flow and lake level and storage on a daily basis using the White River and Puyallup River inflow for the water years 1988 – 2002. This river inflow data represents the water available in the Model for the 1988 – 2002 period. The model predicts the amount of water that can be diverted into the reservoir, the reservoir level and storage, and the flow rates in the White River and Puyallup River below the reservoir diversion point. Operating rules are incorporated into the Model to define when and how much water should be diverted out of the White River into the reservoir, and when and how much water should be released from Lake Tapps Reservoir, either through the outlet works and back to the tailrace and Lower White River, or into the proposed municipal supply. The Model predicts and tracks flow rates at specified locations on a daily basis, and calculates the resulting water surface elevation and storage volume in the reservoir. The following components are included as input to the Model.

- White River flow above the White River diversion
- Stormwater inflow to Lake Tapps Reservoir
- Groundwater seepage from Lake Tapps Reservoir
- Leakance from the Lake Tapps Reservoir outlet works
- Evaporation from Lake Tapps Reservoir
- Precipitation on Lake Tapps Reservoir

- Releases from Lake Tapps Reservoir to Bowman Creek
- Boise Creek inflow to White River
- White River reach gains and losses between diversion dam and White River near Auburn
- Puyallup River flow upstream of White River confluence

The following are results from the Model that are used to predict flow rates and levels in the rivers and the reservoir under the Proposed Action and No Action Alternative conditions:

- White River diversion canal flow
- White River Reservation Reach flow
- Lake Tapps Reservoir level and storage volume
- Releases from Lake Tapps Reservoir to the tailrace canal
- White River flow above the tailrace canal
- Lower White River flow
- Lower Puyallup River flow

The Model incorporates important assumptions about the operation of the water supply project. The Model simulates Lake Tapps Reservoir operations according to the specified operational rules provided to it. This means that (on a daily basis) if the Model operations specify diverting water into the reservoir to keep it full, the Model diverts precisely that amount of water (assuming that there is water in the White River above the minimum flow level that has been specified). Consequently, during the summer, the Model keeps the reservoir exactly full and there may be a relatively large shift in diversion rates on a day-to-day basis. Real-time project operations (both historically and in the future) would likely be somewhat different and less able to precisely match operating rules Diversions into the reservoir would likely not vary as much on a daily basis and the reservoir elevation would likely vary slightly more from day to day.

The Model was used to simulate river flow rates and reservoir storage and water levels throughout the system for the Proposed Action and for the No Action Alternative conditions. Model results were used to compute the difference between the Proposed Action and the No Action Alternative, and, thus, to evaluate the changes that could occur from operation of the Proposed Action. In Section 5.2.1, these simulated results are compared in terms of changes in flow rates and water levels. The assumptions associated with the Proposed Action and the No Action Alternative are described in Chapter 3.

5.2.1 Direct Impacts

No significant direct impacts resulting from changes in surface water quantity would be anticipated under the Proposed Action or the No Action Alternative.

No Action Alternative

As described in Chapter 3, the municipal water rights applications would not be acted upon and Cascade would not build or operate the Project. Because Cascade is a public water supply utility, it could face legal restrictions on owning a reservoir that it could not reasonably use for water supply purposes. Under those circumstances, Cascade would minimize expenditures associated with an operation not central to its core utilities' purposes and would attempt to sell the reservoir system.

Under the No Action Alternative, operation of the White River–Lake Tapps Reservoir system would most likely continue as it has since hydropower generation ceased in 2004.

1. Water would continue to be diverted from the White River at a rate that would maintain the Interim Agency Flows[6] (see Table 3-1 and Figure 5-3). The Interim Agency Flows in the White River would range from a high flow rate of 500 cfs from mid-summer into the fall to a low flow rate of 350 cfs through the winter and early spring.

2. Reservoir surface elevations would be maintained as they have been since 2004. Consistent with an agreement between Puget and the Lake Tapps Community, Normal Full Pool (i.e., a water surface elevation of 541.0 to 542.5 feet National Geodetic Vertical Datum [NGVD 29]) would be maintained from April 15 to October 31, allowing for operational variances required due to forecasts or available precipitation, conditions of water rights, any necessary aquatic plant control, or the terms and conditions of applicable law.

3. No water would be withdrawn from Lake Tapps Reservoir for municipal supply.

Proposed Action

As described in Chapter 3, the Proposed Action is for Cascade's Board of Directors to approve Cascade's operation of the Project and to request approval by Ecology of the Applications.

---

[6] Under the White River Management Agreement, Cascade would be obligated to meet the Recommended Flow Regime described in the WRMA, so long as Cascade diverted water from the White River. However, for the purposes of the analysis described in this Draft EIS and for Ecology's baseline analysis that will be described in the new Draft ROE, the Interim Agency Flows are used. The use of Interim Agency Flows allows for analysis of greater impacts than would occur under the Recommended Flow Regime.

The three basic elements of the Project operation are as follows:

- Cascade would divert water from the White River into Lake Tapps Reservoir, store water in, and withdraw water from the reservoir for municipal water supply purposes.
- Cascade would operate the Project in a manner to provide enhanced flows in the White River consistent with the 2008 White River Management Agreement (WRMA) with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe[7].
- Cascade would operate the Project to store water and maintain the levels of Lake Tapps Reservoir to support recreation consistent with 2009 Agreement Regarding Lake Tapps Between Cascade Water Alliance and the Lake Tapps Community.

More specifically, and as shown in Table 1-1 and Figure 1-3, Ecology's approval of the Applications would permit the following:

1. Cascade would divert water from the White River into Lake Tapps Reservoir at an average annual rate of up to 75 cubic feet per second (cfs) (54,300 acre-feet per year) for municipal, industrial and commercial water supply purposes[8]. Cascade would divert water from the White River at a maximum instantaneous rate of up to 1,000 cfs (this maximum rate would vary by season and would be lower at other times of the year).

2. Cascade would store up to 46,700 acre-feet of water in Lake Tapps Reservoir for municipal, industrial and commercial water supply purposes.

3. Cascade would withdraw water from Lake Tapps Reservoir at an average annual rate of up to 75 cfs (54,300 acre-feet per year) for municipal, industrial and commercial water supply purposes. Cascade would withdraw water from Lake Tapps Reservoir at a maximum instantaneous rate of 135 cfs.

---

[7] Due to the timing of the closing of the Asset Purchase Agreement, the application for a donation of a portion of Puget's Claim into the State Trust Water Rights Program was for a temporary donation rather than a permanent donation. The temporary donation was accepted by Ecology on October 26, 2009 (Ecology 2009a). In anticipation of a future permanent donation application and for purposes of compliance with the State Environmental Policy Act (SEPA) for such permanent donation, the permanent donation is analyzed as a component of the Proposed Action in this Draft EIS. Cascade can provide for flows in accordance with the Recommended Flow Regime with or without Ecology's acceptance of the donation and, therefore, the donation is independent of and does not affect the remainder of the Proposed Action. The donation is intended to provide an additional legal mechanism to ensure implementation of the Recommended Flow Regime and there are no additional impacts beyond those analyzed for the Proposed Action.

[8] As fully described in Chapter 13 of this Draft EIS, the average flow rate of 75 cfs may be increased to an average flow rate of 82 cfs. The 7 cfs is referred to as "Reserved Water". The Reserved Water would not alter or affect the environmental analysis described in this Draft EIS.

4. Cascade would divert water from the White River, store water in Lake Tapps Reservoir and release water through the Tailrace Canal back to the White River in support of the following purposes; hydropower and other beneficial uses including recreational reservoir levels; winter reservoir levels; protect and enhance fish and wildlife; maintenance of water quality for recreational purposes in the reservoir and to meet other regulatory requirements. For example, these other beneficial uses include: operation of the sedimentation basins, operation of the fish screens and fish bypass pipeline, Spring Refill of Lake Tapps Reservoir, and maintaining water surface elevations in Lake Tapps Reservoir for recreation purposes.

Early Spring Avoidance Plan

The Early Spring Avoidance Plan would reduce diversion from the White River whenever flow in the Lower Puyallup River was below the minimum instream flow (MIF). If the MIF requirement for the Lower Puyallup River might be violated, Cascade would curtail diversion from the White River at the diversion dam to the amount being withdrawn from Lake Tapps Reservoir on that day for municipal and industrial water supply purposes. The plan would not limit Cascade's ability to divert water to operate the fish screen or to refill Lake Tapps Reservoir.

Modeling

The STELLA Model was used to simulate operations under the above-listed assumptions regarding the Proposed Action. Estimated river flow rate and water level results are presented in Tables 5-4 and 5-5. Flows rates are summarized for the White River Reservation Reach, the Lower White River, and the Lower Puyallup River. Table 5-4 also shows the differences between the Proposed Action flow rates and the No Action Alternative flow rates. Table 5-5 shows Lake Tapps Reservoir water surface elevations and volumes. Data are shown for the average month, wet water year, and dry water year at each of these locations and are discussed in the following subsections. For each reach, flow rates are compared to No Action Alternative results in terms of the average monthly flow for the 22 years of simulated operations. Average monthly flow is also compared to the No Action Alternative for the driest year and the wettest year in the period. Figures 5-4, 5-5, and 5-7 show the average water year (1998), wet water year, and dry water year simulated flows at selected locations.

Table 5-4. Estimated Average Proposed Action Flow Rates Compared with No Action Alternative Flow Rates

Estimated Average Flows Proposed Action Compared to No Action Alternative in cfs														
Location	**Year Type**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
White River Reservation Reach	Average													
	No Action Alternative	637	1,574	1,742	1,632	1,604	1,036	1,512	1,970	1,986	1,348	824	549	1,366
	Proposed Action	612	1,579	1,707	1,601	1,308	1,087	1,638	1,933	1,934	1,290	756	526	1,330
	Change	-25	6	-35	-32	-296	51	126	-37	-51	-57	-68	-23	-35
	% Change	-4%	0%	-2%	-2%	-18%	5%	8%	-2%	-3%	-4%	-8%	-4%	-3%
	Wet Year - 1996													
	No Action Alternative	1,428	3,539	4,001	2,746	3,986	1,232	1,305	1,711	1,408	1,173	675	527	1,970
	Proposed Action	1,381	3,539	3,964	2,722	3,535	1,412	1,441	1,673	1,365	1,129	621	492	1,933
	Change	-47	0	-36	-24	-452	180	136	-38	-43	-44	-54	-35	-36
	% Change	-3%	0%	-1%	-1%	-11%	15%	10%	-2%	-3%	-4%	-8%	-7%	-1%
	Dry Year - 2001													
	No Action Alternative	780	532	522	672	629	523	1,043	1,809	1,552	872	784	452	849
	Proposed Action	734	532	517	635	621	631	848	1,744	1,510	833	730	452	817
	Change	-46	0	-5	-37	-9	108	-194	-65	-43	-39	-54	0	-32
	% Change	-6%	0%	-1%	-6%	-1%	21%	-19%	-4%	-3%	-4%	-7%	0%	-2%
Lower White River	Average													
	No Action Alternative	746	2,165	2,141	1,887	1,928	1,245	1,744	2,140	2,138	1,461	931	644	1,594
	Proposed Action	687	2,204	1,970	1,830	1,600	1,268	1,846	2,071	2,054	1,368	828	586	1,524
	Change	-59	39	-171	-57	-329	23	103	-69	-85	-93	-104	-59	-71
	% Change	-8%	2%	-8%	-3%	-17%	2%	6%	-3%	-4%	-6%	-11%	-9%	-4%
	Wet Year - 1996													
	No Action Alternative	1,575	4,323	4,543	3,031	4,963	1,388	1,592	1,893	1,549	1,291	777	617	2,284
	Proposed Action	1,499	4,382	4,367	2,978	4,480	1,536	1,721	1,829	1,472	1,211	687	546	2,216
	Change	-76	59	-176	-53	-484	148	129	-64	-78	-79	-90	-71	-68
	% Change	-5%	1%	-4%	-2%	-10%	11%	8%	-3%	-5%	-6%	-12%	-11%	-3%
	Dry Year - 2001													
	No Action Alternative	886	991	756	794	746	664	1225	1946	1679	944	867	532	1,003
	Proposed Action	809	1051	605	723	729	753	995	1847	1606	869	780	496	939
	Change	-76	60	-151	-72	-17	89	-230	-99	-73	-75	-87	-36	-64
	% Change	-9%	6%	-20%	-9%	-2%	13%	-19%	-5%	-4%	-8%	-10%	-7%	-6%
Diversion Canal	Average													
	No Action Alternative	35	6	15	25	28	320	219	50	53	65	64	37	77
	Proposed Action	60	0	50	57	324	269	94	87	105	122	132	60	112
	Change	25	-6	35	32	296	-51	-126	37	51	57	68	23	35
	% Change	71%	-100%	240%	124%	1077%	-16%	-57%	75%	96%	88%	107%	62%	46%
	Wet Year - 1996													
	No Action Alternative	37	0	22	34	28	333	198	38	59	65	67	31	76
	Proposed Action	84	0	58	58	479	153	62	76	103	109	121	67	113
	Change	47	0	36	24	452	-180	-136	38	43	44	54	35	36
	% Change	129%	-	164%	70%	1638%	-54%	-69%	100%	73%	68%	80%	112%	50%
	Dry Year - 2001													
	No Action Alternative	39	0	9	21	22	325	223	50	48	66	57	45	76
	Proposed Action	86	0	14	58	31	217	417	115	90	105	111	45	108
	Change	46	0	5	37	9	-108	194	65	43	39	54	0	32
	% Change	118%	-	57%	179%	40%	-33%	87%	129%	90%	59%	94%	0%	42%
Lower Puyallup River	Average													
	No Action Alternative	1,720	4,276	4,355	4,001	3,938	2,913	3,487	3,883	3,955	2,897	1,979	1,415	3,229
	Proposed Action	1,661	4,315	4,184	3,944	3,609	2,936	3,590	3,814	3,871	2,804	1,876	1,356	3,159
	Change	-59	39	-171	-57	-329	23	103	-69	-85	-93	-104	-59	-71
	% Change	-3%	1%	-4%	-1%	-8%	1%	3%	-2%	-2%	-3%	-5%	-4%	-2%
	Wet Year - 1996													
	No Action Alternative	3,220	8,139	8,635	6,294	10,075	2,668	3,301	3,784	2,778	2,435	1,609	1,208	4,489
	Proposed Action	3,144	8,198	8,460	6,241	9,591	2,815	3,430	3,720	2,700	2,356	1,519	1,137	4,421
	Change	-76	59	-176	-53	-484	148	129	-64	-78	-79	-90	-71	-68
	% Change	-2%	1%	-2%	-1%	-5%	6%	4%	-2%	-3%	-3%	-6%	-6%	-2%
	Dry Year - 2001													
	No Action Alternative	2,161	1,910	1,717	1,926	1,785	1,921	3,104	3,882	3,602	2,264	2,210	1,475	2,332
	Proposed Action	2,085	1,970	1,565	1,855	1,768	2,010	2,874	3,784	3,529	2,189	2,123	1,439	2,268
	Change	-76	60	-151	-72	-17	89	-230	-99	-73	-75	-87	-36	-64
	% Change	-4%	3%	-9%	-4%	-1%	5%	-7%	-3%	-2%	-3%	-4%	-2%	-3%

Table 5-5. Estimated Average Proposed Action Water Levels Compared with the No Action Alternative Water Levels

Estimated Average Simulated Lake Tapps Water Surface Elevation Proposed Action Compared to No Action Alternative in feet													
Location	**Year Type**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Average**
Lake Tapps Water Surface Elevation (1929 NGVD)	Average													
	No Action Alternative	541.9	538.2	530.6	529.4	529.4	533.6	541.3	542.4	542.4	542.4	542.4	542.3	538.1
	Proposed Action	541.4	536.3	529.4	529.4	531.2	539.9	542.1	542.5	542.5	542.4	542.4	542.0	538.5
	Change	-0.5	-2.0	-1.1	-0.1	1.7	6.3	0.8	0.0	0.0	0.0	0.0	-0.2	0.4
	% Change	-2%	-9%	-8%	-1%	13%	35%	3%	0%	0%	0%	0%	-1%	0%
	Wet Year - 1996													
	No Action Alternative	542.5	538.3	530.6	529.4	529.4	533.7	541.3	542.5	542.4	542.4	542.4	542.4	538.1
	Proposed Action	542.4	536.4	529.5	529.5	532.7	542.3	542.5	542.5	542.5	542.5	542.3	542.3	539.0
	Change	0.0	-1.9	-1.1	0.0	3.2	8.6	1.1	0.0	0.0	0.0	-0.1	-0.1	0.8
	% Change	0%	-8%	-7%	0%	23%	48%	4%	0%	0%	0%	0%	0%	4%
	Dry Year - 2001													
	No Action Alternative	542.5	538.3	530.6	529.4	529.4	533.1	541.3	542.4	542.4	542.4	542.4	542.3	538.1
	Proposed Action	542.5	536.4	528.9	529.3	529.1	528.0	537.2	542.4	542.5	542.4	542.5	541.8	536.9
	Change	0.0	-1.9	-1.7	-0.1	-0.4	-5.1	-4.1	0.0	0.0	0.0	0.0	-0.5	-1.2
	% Change	0%	-8%	-11%	-1%	-3%	-29%	-16%	0%	0%	0%	0%	-2%	-5%

White River Reservation Reach

There are two primary differences in flow in the White River Reservation Reach between the No Action Alternative and the Proposed Action: the Proposed Action diverts water to refill Lake Tapps Reservoir earlier in the spring, and the Proposed Action diverts slightly more water in the summer to replace water supply withdrawal from Lake Tapps Reservoir. The other difference is that under the Proposed Action the diversion into Lake Tapps Reservoir is operated so that flow in the Reservation Reach satisfies the Recommended Flows, while the No Action Alternative is operated to meet the Interim Agency Flows.

On average, the flow rate in the Reservation Reach would be very similar under the Proposed Action and No Action Alternative conditions, with an average reduction of just 35 cfs (3%) of the available flow below the diversion dam. Table 5-4 shows that the White River flow rate would be lower in February because the reservoir would be refilled earlier under the Proposed Action. White River flow rates would be slightly lower during the summer, in early October, and during some times in the winter due to diversion into the reservoir to replace water supply withdrawals. Flow rates would be higher under the Proposed Action during certain periods (March and April) when the No Action Alternative flow rates would result in a drop below the rate of the Recommended Flows.

In a wet water year like 1996, the White River flow rate under the Proposed Action would be similar, although the greater flow rate in the Reservation Reach would make the changes smaller on a percentage basis. The flow rate in the reach would be slightly lower (1% to 8%) from May through October and from December through January. The flow rate in February would be 11% lower. The flow rate in March and April would be 15% and 10% higher, respectively. There would be no significant change in flow rate in November.

In a dry water year like 2001, the flow rate would be lower (1% to 7%) from May through August, in October, and from December through February. The flow rate in March would be 21% higher and the flow rate in April would be 19% lower. There would be no significant change in flow rates in September and November.

The average monthly flow rate changes would be small (5% or less) compared with the range of variation in flow rates during the month under No Action Alternative conditions. The Proposed Action would not cause the flow rates in the Reservation Reach to be below the target of the Recommended Flows. Under the Proposed Action, Reservation Reach flows would be below the Recommended Flow only when the flow from upstream was naturally below the flow target.

The Proposed Action's compliance with the minimum flow rate targets was compared with the No Action Alternative's compliance and is summarized in Tables 5-6 and 5-7. Table 5-6 shows that the Proposed Action and No Action Alternative would equally comply with the Interim Agency Flows. Table 5-7 shows that the Proposed Action would meet the Recommended Flows much more frequently[9]. This improvement would occur for both the number of days of non-compliance and the shortfall flow rate. The number of days of minimum flow non-compliance would be reduced from 854 days under the No Action Alternative to 632 days under the Proposed Action. The average of the shortfall days would be reduced from 124 cfs to 111 cfs.

[9] Note that the No Action Alternative is not being operated to attempt to meet the Recommended Flows.

Table 5-6. White River Reservation Reach Minimum Flow Rate Compliance – Interim Agency Flows

Interim Agency Flows

WY	No Action Alternative			Proposed Action		
	Number of Excursions in Days	Total Volume in acre feet	Average Shortfall in cfs	Number of Excursions in Days	Total Volume in acre feet	Average Shortfall in cfs
1988	77	19,620	128	77	19,620	128
1989	39	5,060	65	39	5,060	65
1990	41	9,652	119	41	9,652	119
1991	10	767	39	10	767	39
1992	52	10,953	106	52	10,953	106
1993	37	5,344	73	37	5,344	73
1994	40	3,775	48	40	3,775	48
1995	29	8,125	141	29	8,125	141
1996	15	1,783	60	15	1,783	60
1997	10	1,334	67	10	1,334	67
1998	10	793	40	10	793	40
1999	28	4,975	90	28	4,975	90
2000	25	2,428	49	25	2,428	49
2001	13	3,209	124	13	3,209	124
2002	27	2,834	53	27	2,834	53
Total	**453**	**80,652**	**90**	**453**	**80,652**	**90**

Seasonality of White River Reservation Reach Interim Agency Flow Excursions

Month	Number of Excursions in Days out of 15 years	
	No Action Alternative	**Proposed Action**
January	10	10
February	0	0
March	0	0
April	0	0
May	0	0
June	2	2
July	0	0
August	14	14
September	154	154
October	234	234
November	37	37
December	2	2
Total	**453**	**453**

Note: An "excursion" is defined as a daily occurrence when the MIF requirement is not met. The first table shows the annual statistics for MIF compliance. The second table shows the monthly statistics for MIF compliance. The statistic reported in the second table is the excursions occurring for each respective month for the entire period from 1988 to 2002 (in other words, the January excursion statistic is for all of the excursions occurring in January from 1988 to 2002).

Table 5-7. White River Reservation Reach Minimum Flow Rate Compliance – Recommended Flows

Recommended Flows

WY	No Action Alternative			Proposed Action		
	Number of Excursions in Days	Total Volume in acre feet	Average Shortfall in cfs	Number of Excursions in Days	Total Volume in acre feet	Average Shortfall in cfs
1988	113	47,270	211	104	42,936	208
1989	51	6,711	66	40	5,141	65
1990	52	15,599	151	45	13,883	156
1991	29	5,128	89	12	1,519	64
1992	116	34,781	151	69	13,294	97
1993	62	13,230	108	51	9,652	95
1994	74	14,330	98	65	12,404	96
1995	42	9,959	120	29	8,125	141
1996	30	6,864	115	19	2,668	71
1997	18	5,020	141	15	2,837	95
1998	27	5,271	98	10	793	40
1999	57	11,607	103	39	7,142	92
2000	35	4,319	62	25	2,428	49
2001	115	27,205	119	82	13,557	83
2002	33	3,340	51	27	2,834	53
Total	**854**	**210,634**	**124**	**632**	**139,215**	**111**

Seasonality of White River Reservation Reach Recommended Flow Excursions

Month	Number of Excursions in Days out of 15 years	
	No Action Alternative	**Proposed Action**
January	51	38
February	22	11
March	110	14
April	75	7
May	0	0
June	13	8
July	26	11
August	19	14
September	154	154
October	234	234
November	95	88
December	55	53
Total	**854**	**632**

Note: An "excursion" is defined as a daily occurrence when the MIF requirement is not met. The first table shows the annual statistics for MIF compliance. The second table shows the monthly statistics for MIF compliance. The statistic reported in the second table is the excursions occurring for each respective month for the entire period from 1988 to 2002 (in other words, the January excursion statistic is for all of the excursions occurring in January from 1988 to 2002).

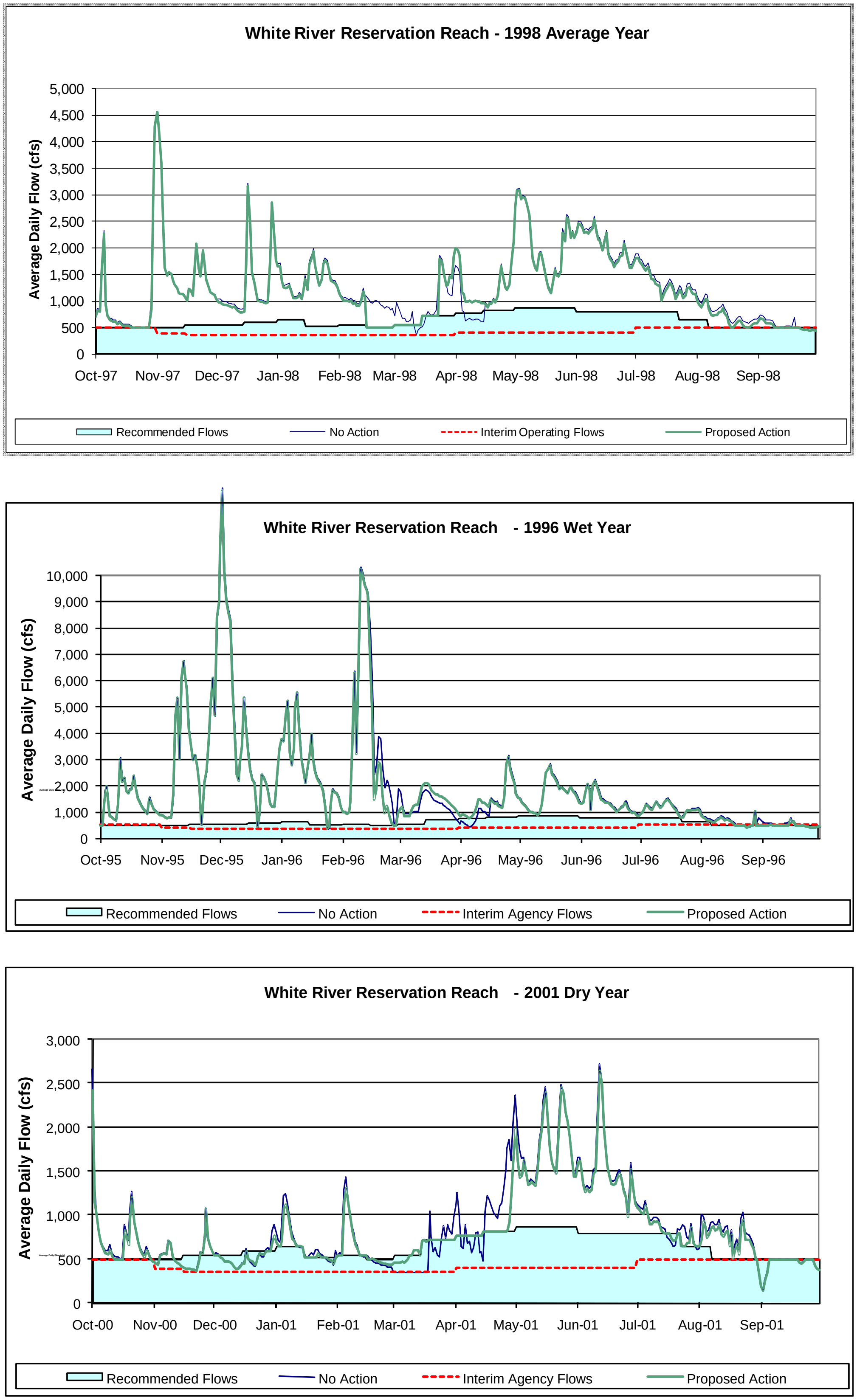


Figure 5-4. Proposed Action Compared with the No Action Alternative and Minimum Flows in the White River Reservation Reach

Lower White River

The effects of the Proposed Action on flow in the Lower White River would include the changes in flow from the Reservation Reach (described above), plus small changes in the amount and timing of releases from Lake Tapps Reservoir into the tailrace canal. The average difference in flow of the Lower White River would be 4%, or 71 cfs. Approximately one-half of this flow difference (35 cfs) would come from higher diversions into Lake Tapps Reservoir, and one-half (35 cfs) would come from lower releases from Lake Tapps Reservoir.

It is predicted that the Proposed Action would result in slightly lower average monthly flow rate in the Lower White River (3% to 6%, 51 to 171 cfs) from May through July, September through October, and in December and January for the average of all years during the period analyzed. On average, the flow rate would be 17% (329 cfs) lower in February and 11% (104 cfs) lower in August. The average flow rate in November and March would be 2% (39 cfs) higher and the average flow rate in April would be 6% (103 cfs) higher. Lower White River flow rates under Proposed Action and No Action Alternative conditions during three year types (average, wet, and dry) are compared in Figure 5-5.

In a wet year (like 1996), the flow rate in the Lower White River would be slightly lower (2% to 10%) from May through July, in December through February, and in October. The flow rate in August and September would be 12% and 11% lower, respectively. The flow rate in November, March, and April would be 1%, 11%, and 8% higher, respectively.

In a dry water year such as 2001, the flow rate would be slightly lower (2% to 10%, 53 to 99 cfs) from May through October and in January and February. Flow rate in March would be 13% (89 cfs) higher and the flow rate in November would be 6% (59 cfs) higher. Flow rates in December and April would be much lower by about 20% (151 cfs) and 19% (230 cfs), respectively. This would be due primarily to the reservoir being lowered by releases for municipal supply, rather than by releases into the Lower White River, as would occur under No Action Alternative conditions. All of the average monthly flow rate changes for the Proposed Action would be small (6% or less) compared with the range of variation in flow rates during the month under No Action Alternative conditions.

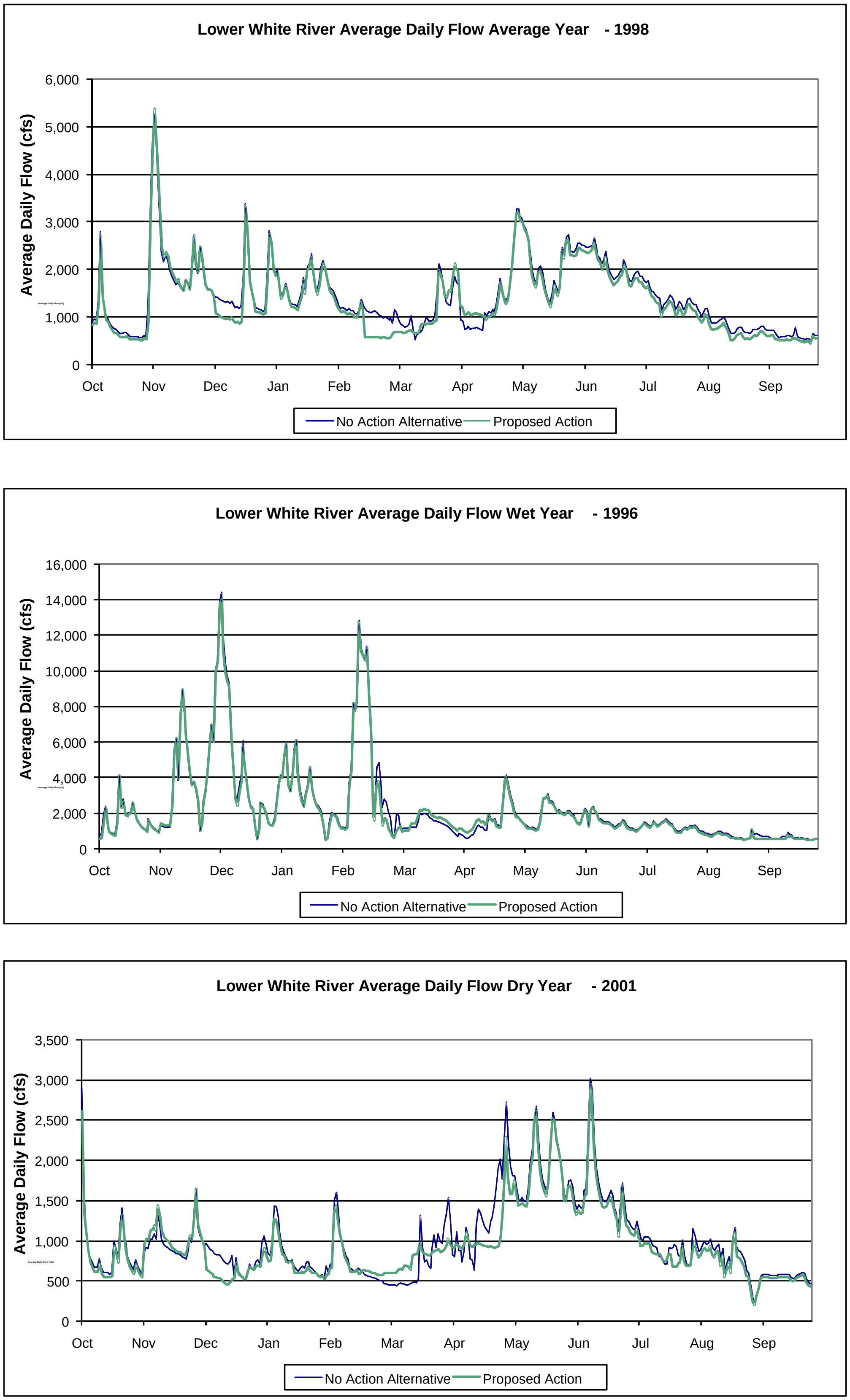


Figure 5-5. Proposed Action – Lower White River Average Daily Flow

Lake Tapps Reservoir

The primary differences in Lake Tapps Reservoir water levels would be that the Proposed Action would incorporate slightly (37 cfs) higher inflow from the White River and slightly (36 cfs) higher total releases than the No Action Alternative. Lake Tapps Reservoir levels under Proposed Action conditions are summarized in Table 5-5. Water levels are compared for the period of the simulation in Figure 5-6. Water levels during three year types (average, wet, and dry) are compared in Figure 5-7. Under average annual conditions over the evaluated period of record, the only differences in the average Lake Tapps Reservoir water surface elevation are as follows: under the Proposed Action, the water surface elevation would drop somewhat earlier in the fall and rise earlier in late winter or early spring. The earlier (and somewhat more extensive) Fall Drawdown would be due to the withdrawal of water for water supply purposes when diversions into the reservoir were curtailed or limited. The average minimum and maximum water levels would be within 0.1 foot of the levels under the No Action Alternative.

Under the Proposed Action, in a wet water year the water surface elevation would drop earlier in the fall and rise earlier in late winter. The water surface elevation under the Proposed Action would increase by 23% and 48% in February and March, respectively. The surface elevation would decrease by 8% and 7% in November and December, respectively. These differences (and those summarized for the average and dry year conditions) would be relatively minor compared with the normal variation in operation of the reservoir, and would be mainly due to the somewhat different operating rules used in the Proposed Action and the No Action Alternative.

In a dry water year like 2001, the water surface elevation would be slightly lower in November through February and in September. Under the Proposed Action, the elevation would decrease by 29% and 16% in March and April, respectively. The water surface elevation would drop somewhat lower in the fall through spring due to releases for municipal supply. Under the Proposed Action, water levels in October of the water year following a dry year like 2001 could be up to 1.2 feet lower than under the No Action Alternative.

During the summer, Lake Tapps Reservoir is heavily used for boating and other recreational activities (see Chapter 10). The water surface level above which recreational use would not be affected (called the recreational level) is between full pool at 542.5 feet and 541.0 feet. Table 5-8 summarizes the number of days that simulations show Lake Tapps Reservoir above or below the recreational level and certain other levels. During the historical recreation season (Memorial Day to Labor Day), the reservoir elevation would stay above the recreational level. From April 15 to October 31, the reservoir level would be below 541.0 feet 6% of the time. The reservoir level would be below 541.0 feet on 12 days during September and 145 days during October over the 15-year simulation period. This compares with the No Action Alternative results that show that the reservoir would never be below 541.0 feet during September, and would be below 541.0 feet on 38 days during October. This would meet the terms of the agreement with the Lakes Tapps community (see Section 2.4) requiring the reservoir level to be maintained at or above the Normal Full Pool 90% of the time.

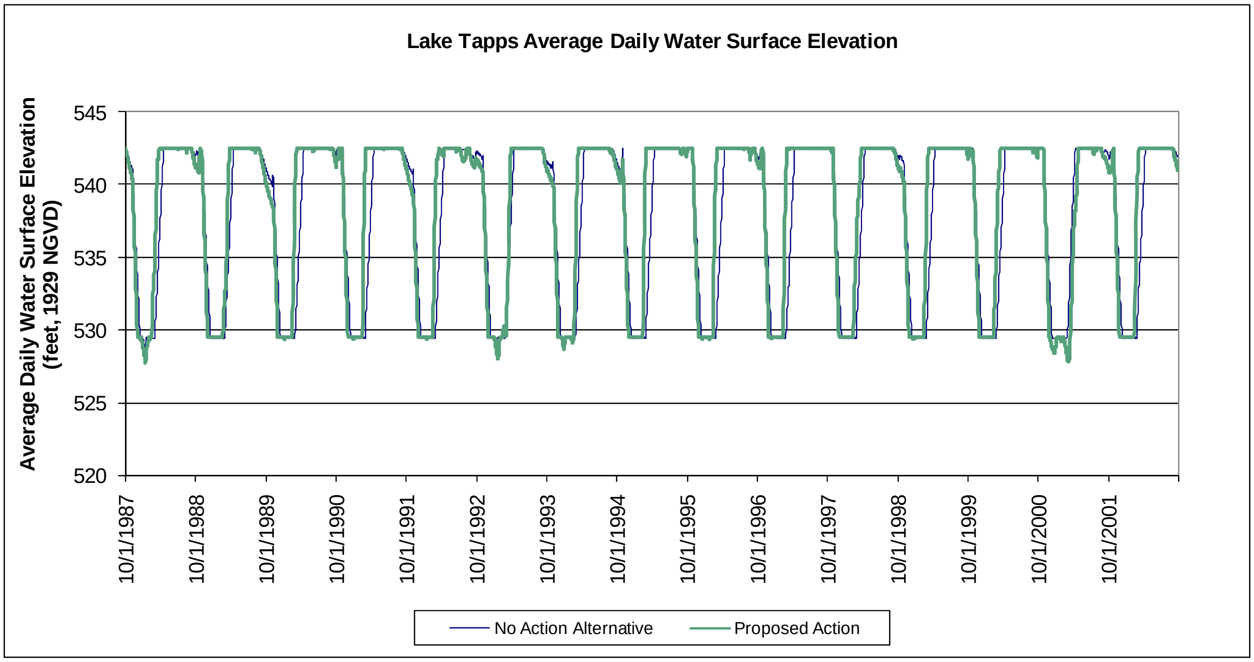


Figure 5-6. Proposed Action – Lake Tapps Reservoir Average Daily Water Surface Elevation

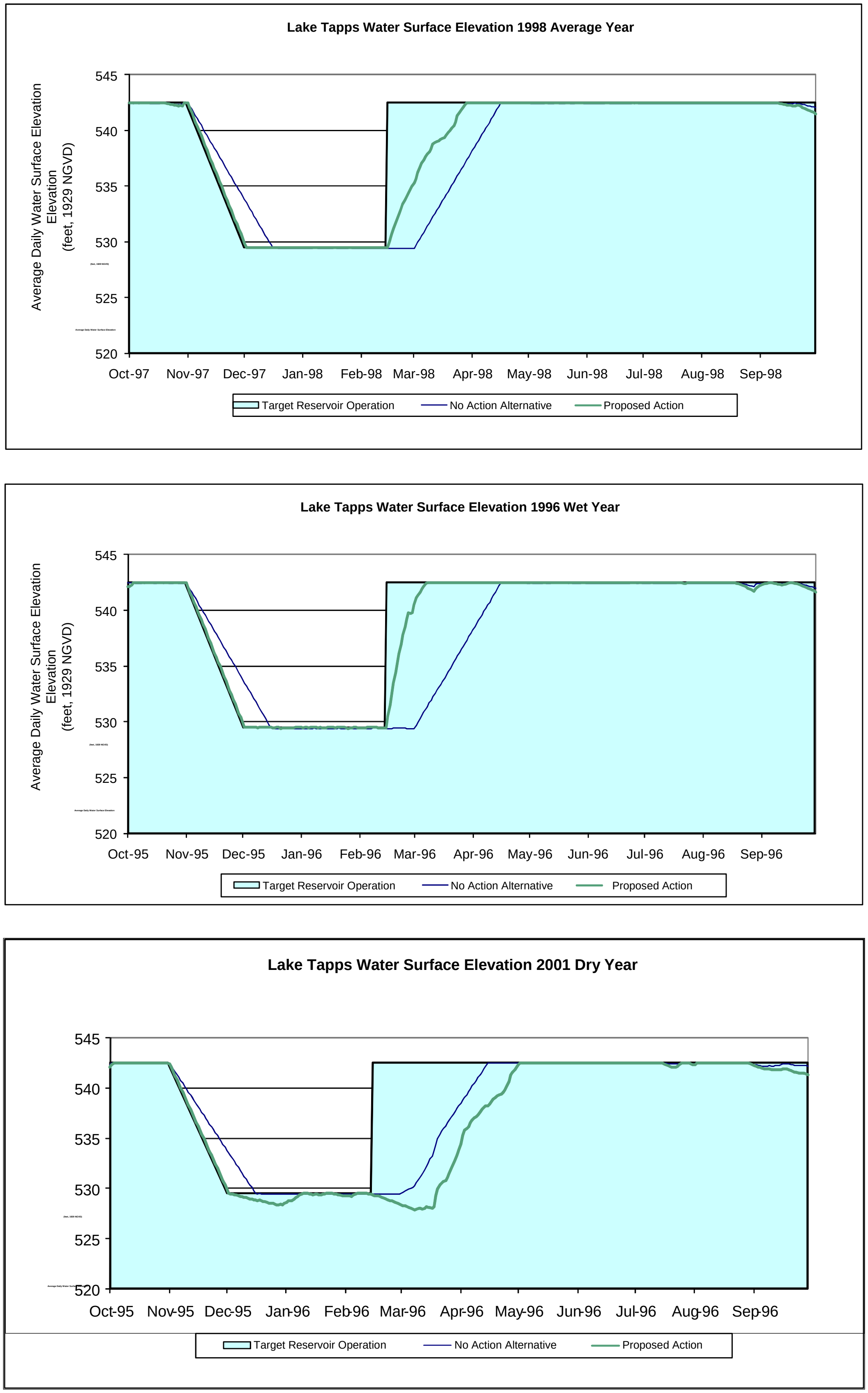


Figure 5-7. Proposed Action – Lake Tapps Reservoir Water Surface Elevations and Target Reservoir Operation

CASCADE WATER ALLIANCE

Table 5-8. Summary of Lake Tapps Reservoir Recreational Water Levels – Proposed Action

Recreational Impacts

No Action

Calendar Year	Historical Recreation Season (May 1 to Labor Day)				April 15 to October 31			
	Number of Days Above 541	Number of Days Below 541	Number of Days Below 540.5 ft	Number of Days Below 540 ft	Number of Days Above 541	Number of Days Below 541	Number of Days Below 540.5 ft	Number of Days Below 540 ft
1987					31	0	0	0
1988	130	0	0	0	200	0	0	0
1989	127	0	0	0	172	28	15	0
1990	126	0	0	0	200	0	0	0
1991	125	0	0	0	195	5	0	0
1992	130	0	0	0	200	0	0	0
1993	129	0	0	0	200	0	0	0
1994	128	0	0	0	195	5	0	0
1995	127	0	0	0	200	0	0	0
1996	125	0	0	0	200	0	0	0
1997	124	0	0	0	200	0	0	0
1998	130	0	0	0	200	0	0	0
1999	129	0	0	0	200	0	0	0
2000	127	0	0	0	200	0	0	0
2001	126	0	0	0	200	0	0	0
2002	125	0	0	0	169	0	0	0
Total Days	**1908**	**0**	**0**	**0**	**2962**	**38**	**15**	**0**
Total % of Days	**100%**	**0%**	**0%**	**0%**	**99%**	**1%**	**1%**	**0%**

Note:
1) Elevations Relative to true NGVD 1929

Recreational Impacts

Proposed Action

Calendar Year	Historical Recreation Season (May 1 to Labor Day)				April 15 to October 31			
	Number of Days Above 541	Number of Days Below 541	Number of Days Below 540.5 ft	Number of Days Below 540 ft	Number of Days Above 541	Number of Days Below 541	Number of Days Below 540.5 ft	Number of Days Below 540 ft
1987					25	6	0	0
1988	130	0	0	0	195	5	0	0
1989	127	0	0	0	158	42	35	28
1990	126	0	0	0	200	0	0	0
1991	125	0	0	0	173	27	19	10
1992	130	0	0	0	197	3	0	0
1993	129	0	0	0	173	27	12	0
1994	128	0	0	0	175	25	13	0
1995	127	0	0	0	200	0	0	0
1996	125	0	0	0	200	0	0	0
1997	124	0	0	0	200	0	0	0
1998	130	0	0	0	187	13	2	0
1999	129	0	0	0	200	0	0	0
2000	127	0	0	0	200	0	0	0
2001	126	0	0	0	179	21	12	11
2002	125	0	0	0	168	1	0	0
Total Days	**1908**	**0**	**0**	**0**	**2830**	**170**	**93**	**49**
Total % of Days	**100%**	**0%**	**0%**	**0%**	**94%**	**6%**	**3%**	**2%**

Note:
1) Elevations Relative to True NGVD 1929

Diversion Canal

When all months are averaged, the diversions from the White River to the reservoir would be much higher from May through October and from December through February. The flow rate would be 16% and 57% lower in March and April, respectively, compared with the No Action Alternative. November flow rate would change by an average of 0 cfs to 6 cfs.

In a wet water year like 1996, the flow rate in the diversion canal would be significantly higher from May through October and from December through February. The flow rate would be 54% and 69% lower in March and April, respectively. There would be no change in flow rate in November.

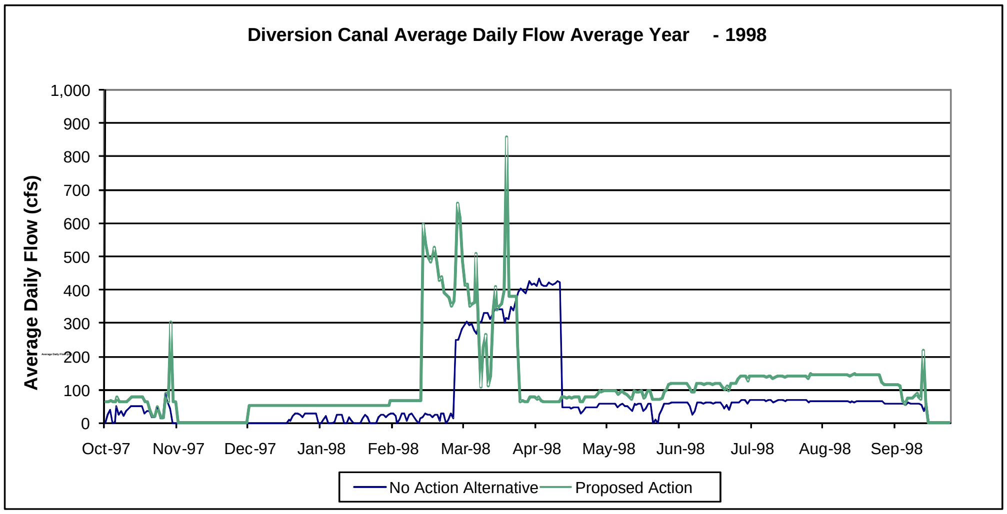
In a dry water year like 2001, the flow rate in the diversion canal would be significantly higher from April through August, in October, and from December through February. The flow rate would be 33% lower in March. There would be no change in flow rate in September and November. Because it is not a natural water body or recreational resource, changes in flow rate in the diversion canal would not be expected to result in environmental impacts. Diversion canal flow rates are summarized in Table 5-4.

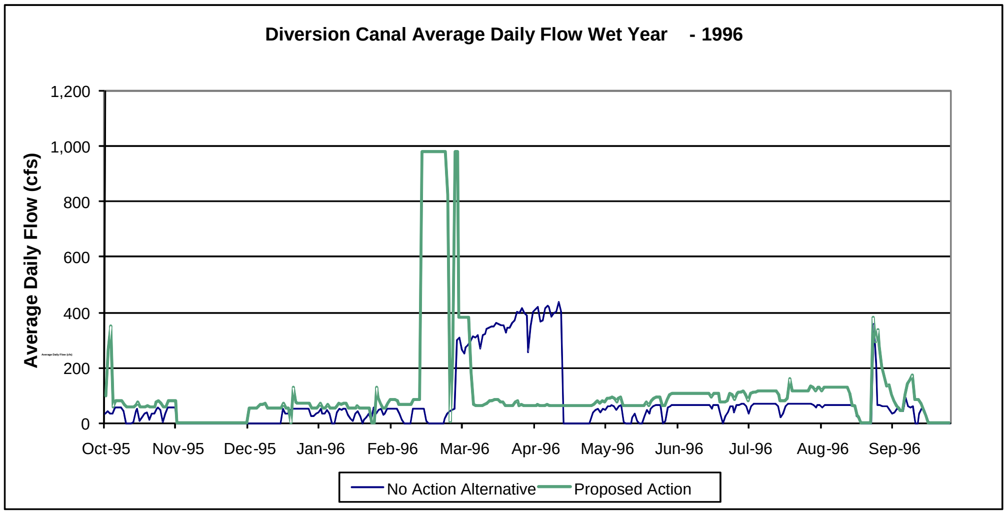
Tailrace Canal

Under average conditions, the tailrace canal flow rate would be much lower throughout the year. Average monthly flow rate in the tailrace canal would vary from 0 cfs to 27 cfs in all months except November. In November, the flow rate would be 397 cfs on average as the reservoir was drawn down.

In a wet water year like 1996, the flow in the tailrace canal would be much lower in all months except November and April. The November flow rate would be 14% higher while the flow rate in April would be 10% lower under the Proposed Action than under the No Action Alternative. In a dry water year like 2001, the flow rate in the tailrace canal would be much lower in all months except November and February. The flow rate in November would be 16% higher. The February flow rate would be 23% lower under the Proposed Action than under the No Action Alternative.

Figures 5-4 through 5-9 show the changes in Lake Tapps Reservoir water surface elevations, Lower White River flow, diversion canal flow, and tailrace canal flow.





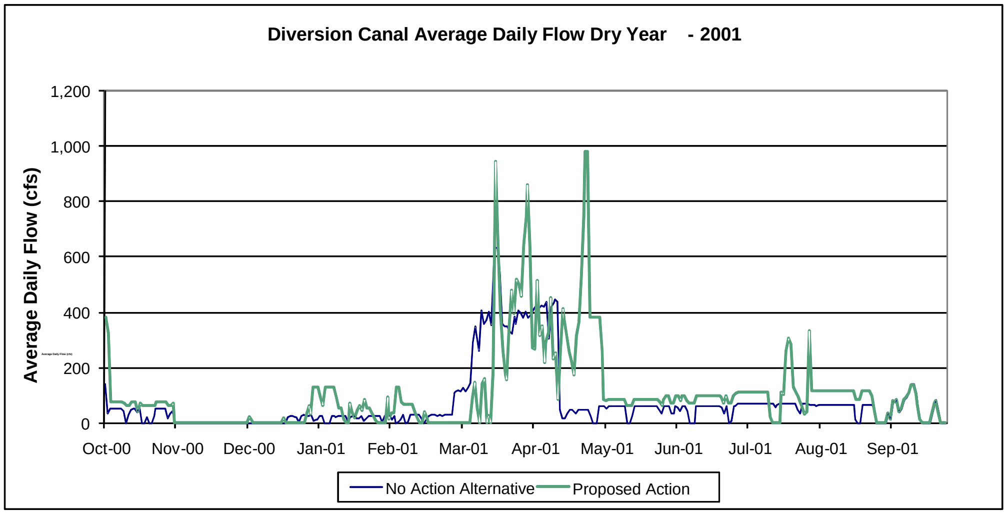
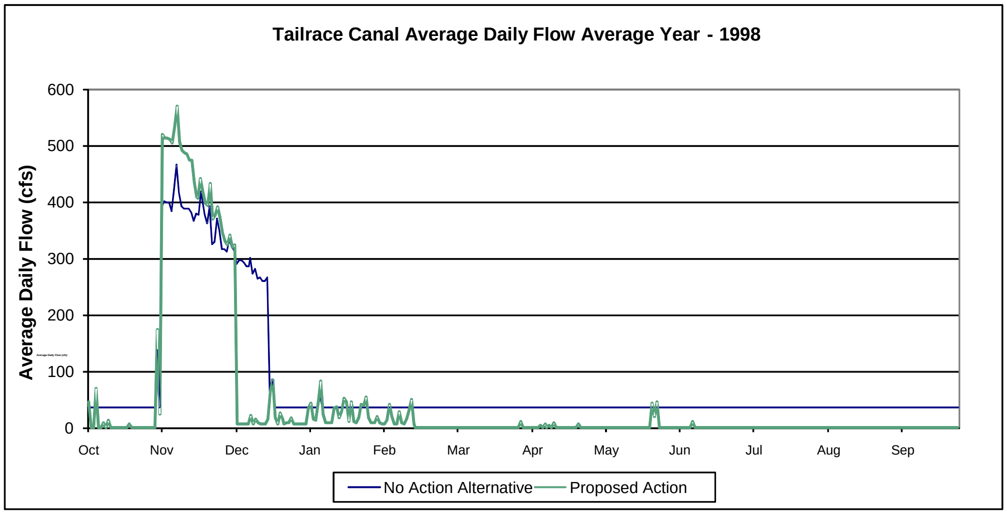
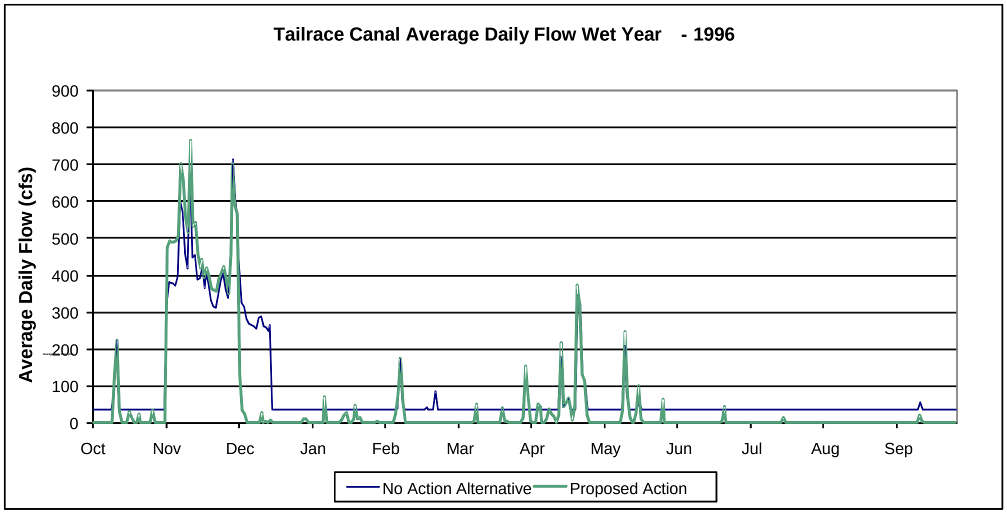


Figure 5-8. Proposed Action – Diversion Canal Daily Flow





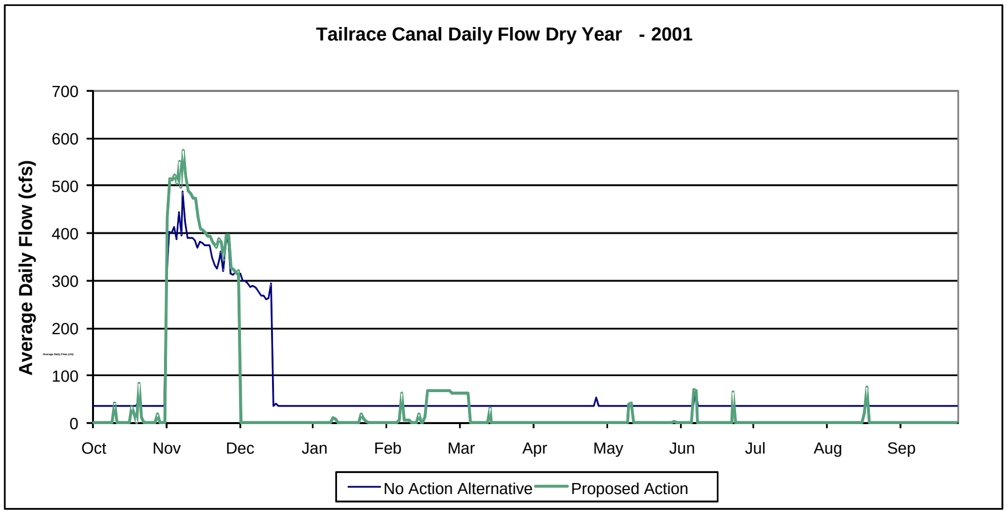


Figure 5-9. Proposed Action – Tailrace Canal Average Daily Flow

Lower Puyallup River

The changes in flow rate in the Lower Puyallup River due to the Proposed Action (compared with the No Action Alternative) would be solely a result of the difference in flow of the Lower White River, decribed previously. The average flow rate would be reduced by 71 cfs, or 2%. Lower Puyallup River flow rates under the Proposed Action are summarized in Table 5-4 and are shown in Figure 5-10. Under conditions representing the average of the 22 years studied, the flow rates in the Lower Puyallup River would be slightly lower (1% to 8%) than those of the Proposed Action from May through October and December through February. The flow rate would be 1% higher in March and November and 3% higher in April.

In a wet water year like 1996, the flow rate in the Lower Puyallup River under the Proposed Action would be slightly lower (1% to 6%) from May through October, and from December through February. The flow rates in March, April, and November would be 6%, 4%, and 1% higher, respectively. In a dry water year like 2001, the flow rate would be slightly lower under the Proposed Action (1% to 9%) from April through October and from December through February. March flow rate would be 5% higher and November flow rate would be 3% higher. Daily flow rates under Proposed Action and No Action Alternative conditions during three year types (average, wet, and dry) are compared in Figure 5-10.

Table 5-9 summarizes and compares the number of days in which the flow rate in the Lower Puyallup River would fail to satisfy the MIFs under Proposed Action and No Action Alternative conditions. Under the operating assumptions used for the Proposed Action, diversions into Lake Tapps Reservoir would be reduced at times when diverting flow out of the White River would cause the Lower Puyallup River (which is downstream) to fall below MIF compliance levels. Because of this, the effect of the Proposed Action on Puyallup River MIF compliance would be small. The total volume of shortfall in MIF compliance would be reduced under the Proposed Action. As shown in Table 5-9, there would be more days, but lower average shortfall under Proposed Action conditions. These differences would tend to be very small and would occur because outflow from Lake Tapps Reservoir to the tailrace canal would be reduced under the Proposed Action. As shown in Figure 5-9, the No Action Alternative minimum tailrace flow rate would be 36 cfs, while the Proposed Action tailrace flow rate would be most frequently zero.

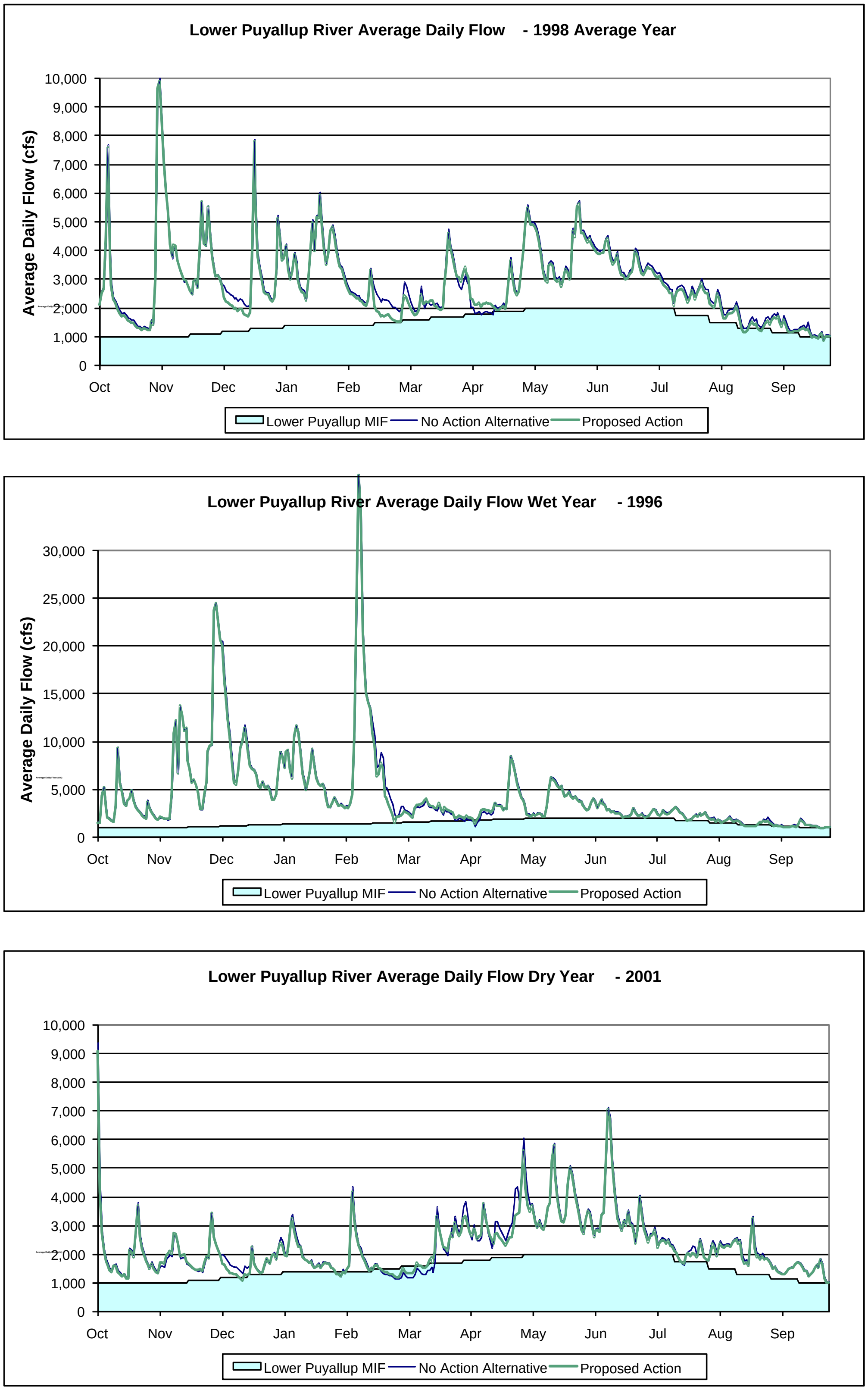


Figure 5-10. Proposed Action – Lower Puyallup River Average Daily Flow

Table 5-9. Proposed Action Results – Lower Puyallup River MIF Compliance

Comparison of MIF Compliance at the Lower Puyallup River

Water Year	No Action			Proposed Action		
	Number of Excursions in Days	Total Volume in acre feet	Average Shortfall in cfs	Number of Excursions in Days	Total Volume in acre feet	Average Shortfall in cfs
1988	77	34,750	228	76	36,672	243
1989	7	613	44	11	1,257	58
1990	27	8,344	156	30	10,354	174
1991	0	-	0	3	50	8
1992	109	52,835	244	116	41,243	179
1993	55	28,783	264	72	31,419	220
1994	56	15,361	138	69	19,865	145
1995	49	20,729	213	48	18,848	198
1996	25	6,602	133	30	6,016	101
1997	4	307	39	4	593	75
1998	11	1,093	50	15	1,992	67
1999	26	4,333	84	21	4,174	100
2000	16	1,970	62	25	3,621	73
2001	35	16,516	238	34	12,251	182
2002	1	23	12	4	143	18
Total	**498**	**192,260**	**195**	**558**	**188,497**	**170**

Seasonality of Lower Puyallup MIF Excursions

Month	Number of Excursions in Days		
	No Action	**Proposed Action**	**Difference**
January	43	48	5
February	38	49	11
March	55	41	-14
April	46	18	-28
May	5	7	2
June	18	21	3
July	18	24	6
August	39	69	30
September	52	84	32
October	137	153	16
November	27	21	-6
December	20	23	3
Total	**498**	**558**	**60**

Note: An "excursion" is defined as a daily occurrence when the MIF requirement is not met. The first table shows the annual statistics for MIF compliance. The second table shows the monthly statistics for MIF compliance. The statistic reported in the second table is the excursions occurring for each respective month for the entire period from 1988 to 2002 (in other words, the January excursion statistic is for all of the excursions occurring in all 15 Januarys from 1988 to 2002).

5.2.2 Indirect and Cumulative Impacts

No significant indirect or cumulative impacts resulting from changes to surface water quantity would be anticipated under the Proposed Action or the No Action Alternative.

5.3 Mitigation Measures

While the Project would not result in significant direct, indirect, or cumulative adverse impacts to surface water quantity, Cascade would provide the mitigation measures listed in Table S-1 (Summary) and Section 1.4 of this Draft EIS.

5.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to surface water quantity would be anticipated under the Proposed Action or the No Action Alternative.

Chapter 6: Surface Water Quality

Water quality can be considered a measure of the suitability of water for a particular use based on selected physical, chemical, and biological characteristics (USGS 2001). In Washington, surface water quality is protected to help “sustain public health and public enjoyment of the waters and the propagation and protection of fish, shellfish, and wildlife” (Ecology n.d.(b)). This chapter describes water quality standards that apply to surface water bodies in the study area, the current water quality status of those water bodies, and how the Proposed Action and the No Action Alternative could affect the White River–Lake Tapps Reservoir system in terms of surface water quality.

Water Quality Uses and Standards

As part of its water quality program, the Washington State Department of Ecology (Ecology) assigns a designated use to water bodies considered Waters of the State[1]. Some examples of designated uses are fish and wildlife habitat, public water supply, recreation, and aesthetics. An example of a designated use for fresh water (like the surface water bodies in the study area) is salmonid spawning and rearing.

To protect these designated uses, Ecology has adopted water quality standards (defined in WAC 173-201A[2]) that implement portions of the federal Clean Water Act[3] (Ecology 2006c). The water quality standards identify certain characteristics of water (see below) and set criteria for allowable limits (Ecology 2008a).

Temperature. Water quality standards for temperature protect the health and survival of native fish and aquatic communities. Water temperature “can affect embryonic development, juvenile growth, adult migration, competition with non-native species, and the relative risk and severity of disease” (Ecology 2008b). Temperature needs for fish vary for major life stages – such as migration and rearing – and are particularly critical during spawning and egg incubation. Individual standards apply to geographic location (including certain reaches of streams and rivers), species, and time of year.

Dissolved Oxygen. Dissolved oxygen (DO) is the oxygen gas dissolved in water. As noted in Chapter 9, fish absorb oxygen directly into their bloodstreams through their gills (comparable to land animals breathing oxygen into their lungs). If the DO concentration in

[1] Waters of the State are lakes, rivers, ponds, streams, inland waters, underground waters, salt waters and all other surface waters and watercourses within the jurisdiction of the state of Washington. RCW 90.48.020: Definitions. http://apps.leg.wa.gov/RCW/default.aspx?cite=90.48.020.
[2] WAC 173-201A: Water quality standards for surface waters of the state of Washington. http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A.
[3] 33 U.S.C. §1251 et seq. (1972). http://epw.senate.gov/water.pdf.

water is too low, the water cannot sustain fish and other forms of aquatic life (WOW 2007). DO concentration is related to temperature – colder water can hold more dissolved oxygen than warmer water, and is thus more optimal for fish.

pH. The pH of water determines the solubility and availability of constituents such as heavy metals (lead, copper, cadmium, etc.) and nutrients (phosphorus, nitrogen, and carbon). For heavy metals, the degree to which they are soluble determines their toxicity. Metals tend to be more toxic at lower pH because they are more soluble (the lower the pH, the more acidic the water, and the higher the pH, the more basic the water). For nutrients, an increase in pH may increase the solubility of a nutrient such as phosphorus, making it more available for plant growth and resulting in a greater long-term demand for DO (WOW 2007).

Additional Characteristics. Additional measurable water quality characteristics are turbidity, total dissolved gas, bacteria, nutrients, toxics, and radioactive substances. Ecology also identifies water quality characteristics that are difficult to specify, but that offend the senses (for example, color and odor). These additional characteristics are not addressed in this Draft EIS because the Proposed Action would not affect them.

6.1 Affected Environment

The specific affected environment for the Lake Tapps Reservoir Water Rights and Supply Project can be generally defined as the surface water bodies (and land areas adjacent to them) that are downstream of the diversion dam located on the White River at River Mile (RM) 24.3. These areas may receive more or less water (or water at a different time or of different quality) under the operation of the Proposed Action or the No Action Alternative. For this project, the four potentially impacted water bodies are listed here and shown on Figure 6-1:

- White River Reservation Reach
- Lower White River
- Lower Puyallup River
- Lake Tapps Reservoir

Table 6-1 summarizes the state water quality standards for temperature, DO, and pH that apply to the water bodies listed above. In addition to state standards, the Puyallup Tribe of Indians has established surface water quality standards for sections of the Lower Puyallup River (RM 0.0 and 7.3) (Puyallup Tribe 1994); these standards have been adopted by the U.S. Environmental Protection Agency (USEPA). State standards do not apply in these reaches.

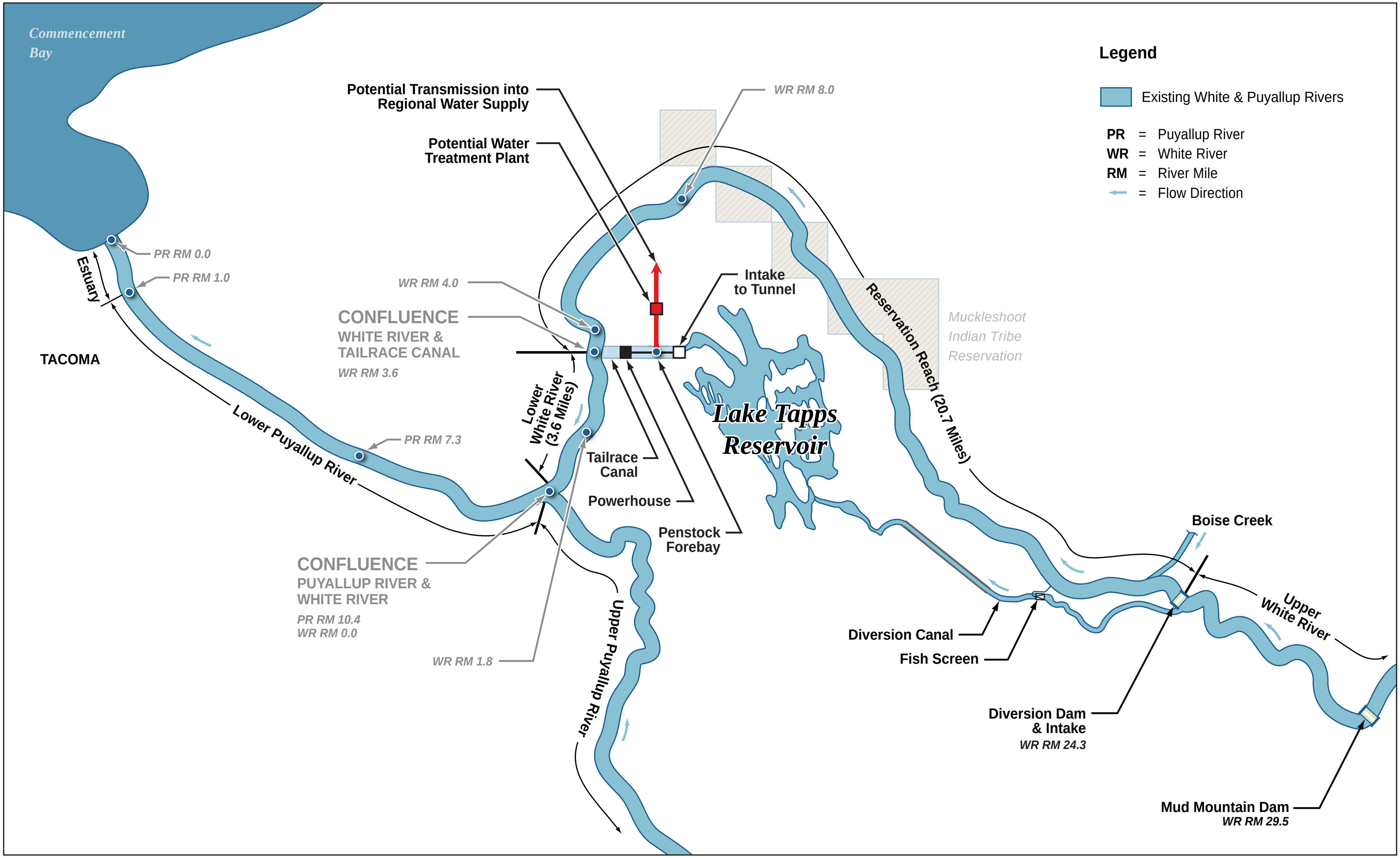


Figure 6-1. Water Quality Reaches of the White and Puyallup Rivers

Lake Tapps Water Rights and Supply Project

Table 6-1. Surface Water Designations and Water Quality Criteria

Water Body	Reach	Approximate RM Designation	Aquatic Life Designated Uses	Maximum Temperature Criteria (°C) [1,2]	Minimum Dissolved Oxygen Criteria (mg/L) [2]	pH
Washington State Water Quality Standards						
White River	Reservation	24.0 to 4.0 [3]	Core summer habitat [3]	16 (7-DADMax)	9.5	6.5 to 8.5
	Reservation	24.0 to 4.0 [3]	Spawning and incubation areas [3]	13 (7-DADMax from Sept. 15 to July 1)	NA	NA
	Lower	4.0 to 0.0	Spawning / rearing	17.5 (7-DADMax)	8.0	6.5 to 8.5
Puyallup River	Lower	10.1 to 7.3	Core summer habitat	16 (7-DADMax)	9.5	6.5 to 8.5
	Estuary	1.0 to 0.0	Rearing/migration only	17.5 (7-DADMax)	6.5	7.0 to 8.5
Lake Tapps Reservoir	NA	NA	Lake	May not increase the 7-day average daily max temperature more than 0.3 °C above natural conditions.	May not decrease DO conc. more than 0.2 mg/L below natural conditions.	NA
Puyallup Tribe Water Quality Standards [4]						
Puyallup River	Lower (fresh water)	7.3 to 1.0	Class A (water supply, salmonid spawning, migra-tion, rearing, etc.)	18	8	6.5 to 8.5
	Lower (marine)[5]	7.3 to 1.0	Class A	16	6.0	6.5 to 8.5
	Estuary	1.0 to 0.0[6]	Class B (water supply, salmonid spawning, migra-tion, rearing, etc.)	21	6.5	6.5 to 8.5

1. 7-DADMax = 7 Day Average Daily Maximum Temperature.
2. Ecology – Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC. Amended November 20, 2006 (Ecology 2006c).
3. The core summer habitat and spawning and incubation areas' designated uses and corresponding water quality criteria apply only to the non-Muckleshoot Indian Tribe Reservation areas of this reach. The USEPA exercises jurisdiction under the Clean Water Act over water quality within the Muckleshoot Indian Reservation (approximately RM 9 to RM 15.8).
4. Puyallup Tribe – Water Quality Standards: Water Quality Standards for Surface Waters of the Puyallup Tribe (Puyallup Tribe 1994).
5. Marine standards apply when average salinity is more than 10 parts per thousand 95% of the time during critical discharge conditions.
6. The salt wedge extends to RM 2.9, with tidal effects beyond RM 5.8.

6.1.1 White River

White River Water Quality Standards

As indicated in Table 6-1, the reach of the White River from the diversion dam (RM 24.3) downstream to about RM 4 is designated as core summer habitat. For this reach, the applicable temperature criterion is 16 °C and the DO criterion is 9.5 milligrams per liter (mg/L). These state standards apply at all times of the year. The state standards for core summer habitat apply only to the non-Muckleshoot Indian Tribe Reservations areas of this reach; the USEPA exercises jurisdiction within the Reservation.

The White River reaches between the diversion dam and the tailrace canal that are not on the Muckleshoot Indian Tribe Reservation are also designated as spawning and incubation areas. Spawning and incubation areas are assigned a stricter 7-DADMax (7-day average daily maximum) temperature criteria of 13 °C from September 15 to July 1 (Ecology 2006d). The White River is designated as spawning/rearing habitat from about RM 4 to the mouth of the river. The applicable temperature criterion is 17.5°C for the 7-DADMax and the DO criterion is a minimum of 8.0 mg/L.

Physical Environment

The hydrology of the White River is described in Chapter 5. The White River has a significant sand/gravel/cobble bedload and a large suspended sediment load (Ecology 1999). The suspended sediment from glacial meltwater during the spring, summer and fall reduces the light penetration in the water column and limits biological productivity and algal growth (Ebbert 2002).

The 7-day average daily maximum (**7-DADMax**) is the average of seven consecutive daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the 3 days prior and the 3 days after that date (WAC 173-201A-020).

Previous Water Quality Studies

Ecology has conducted water quality monitoring for temperature, DO, pH, and nutrients on the White River, as described below.

Temperature

Temperature monitoring was conducted in 2001, 2004, and 2006 at RM 1.8 of the Lower White River, about 1.5 miles downstream of the tailrace canal (see Figures 6-2 and 6-3). Temperature data were also recorded at RM 8 located within the Reservation Reach of the White River, and about 4.5 miles above the tailrace canal in 2002, 2003, and 2008 (see Figures 6-4 and 6-5).

Prior to cessation of hydropower operations in 2004, the White River temperature ranged to as high as about 21°C in July and August (Ecology 2005). Figures 6-2 and Figure 6-4 show that in July and August of 2001, the water temperature ranged up to about 20°C at RM 1.8 and up to about 21°C at RM 8.0, and exceeded the state water quality criteria of 17.5 °C 7-DADMax (see Table 6-1).

After 2004, diversions from the White River into Lake Tapps Reservoir and releases from Lake Tapps Reservoir through the tailrace canal were significantly reduced under the Interim Agency Operating Agreement (see Chapter 2). Reducing diversions from the White River to Lake Tapps Reservoir provided additional water in the river for both the Reservation Reach and the Lower White River. The increased flow reduced warming of the river in the summer.

During the summer, Lake Tapps Reservoir stratifies, and the temperature of the top layer of the reservoir ranges from 21 to 23°C (see Section 6.1.3). Figures 6-2 and 6-4 show that the 7-DADMax temperature during July and August of 2006 and 2008 decreased to about 17 °C to 18°C. Although this exceeded the state water quality criteria of 17.5 °C 7-DADMax, the 2006 and 2008 monitoring data indicated positive effects on water temperature from the change in operations that reduced White River diversions and reservoir releases.

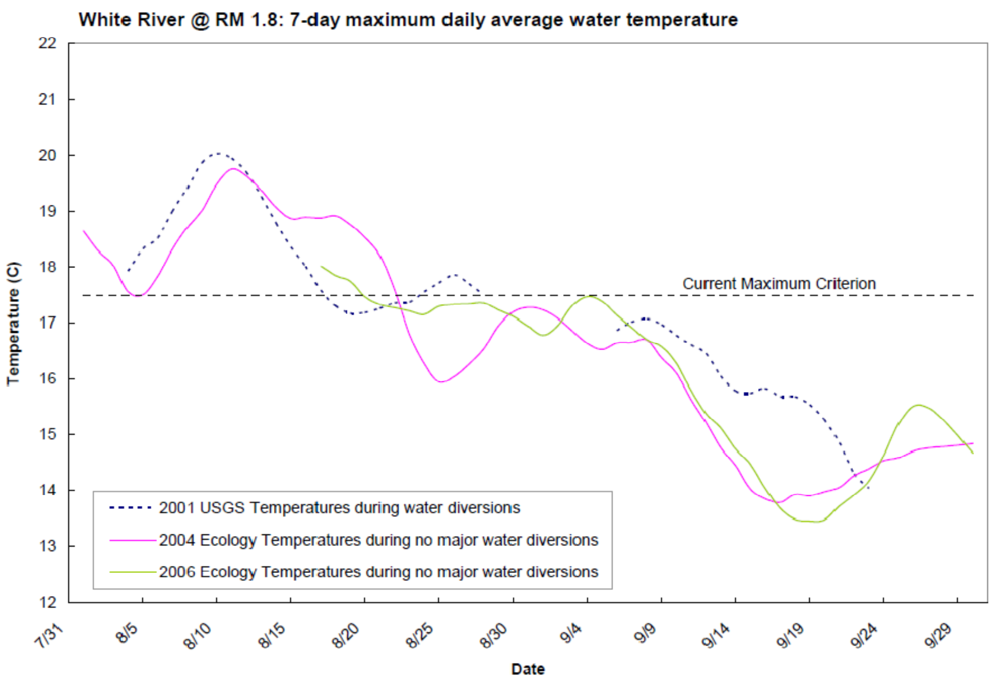
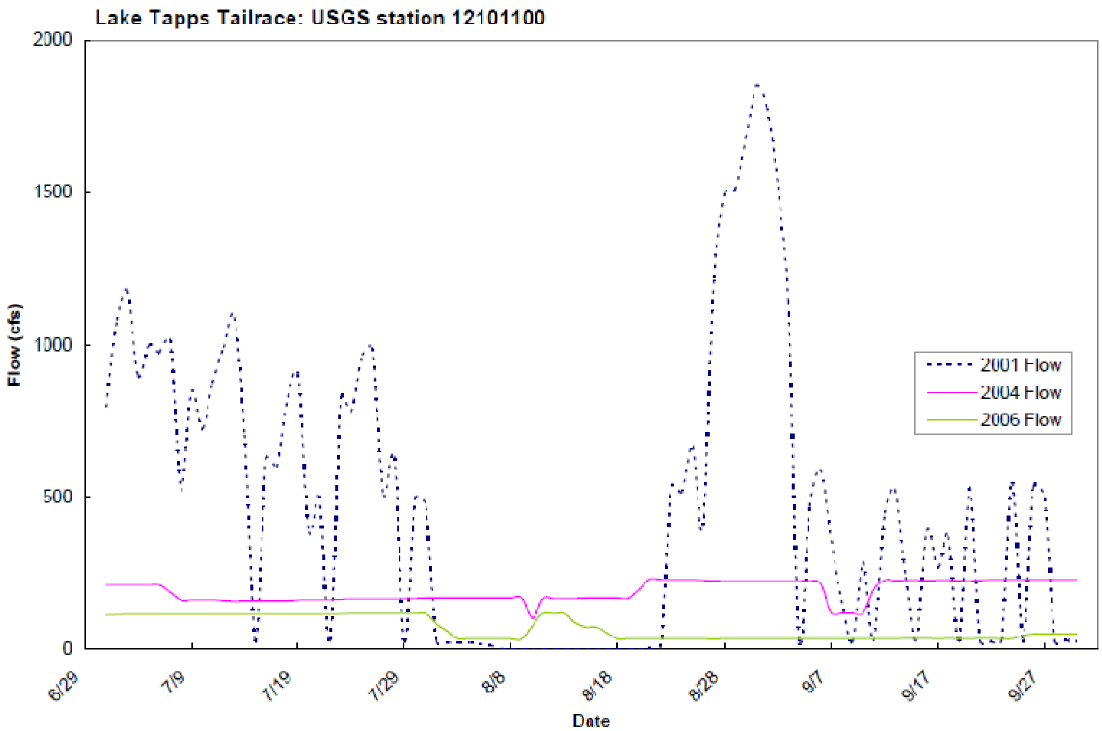


Figure 6-2. White River 7-DADMax Daily Average Water Temperature at RM 1.8 in 2001, 2004, and 2006

Source: Ecology 2008c



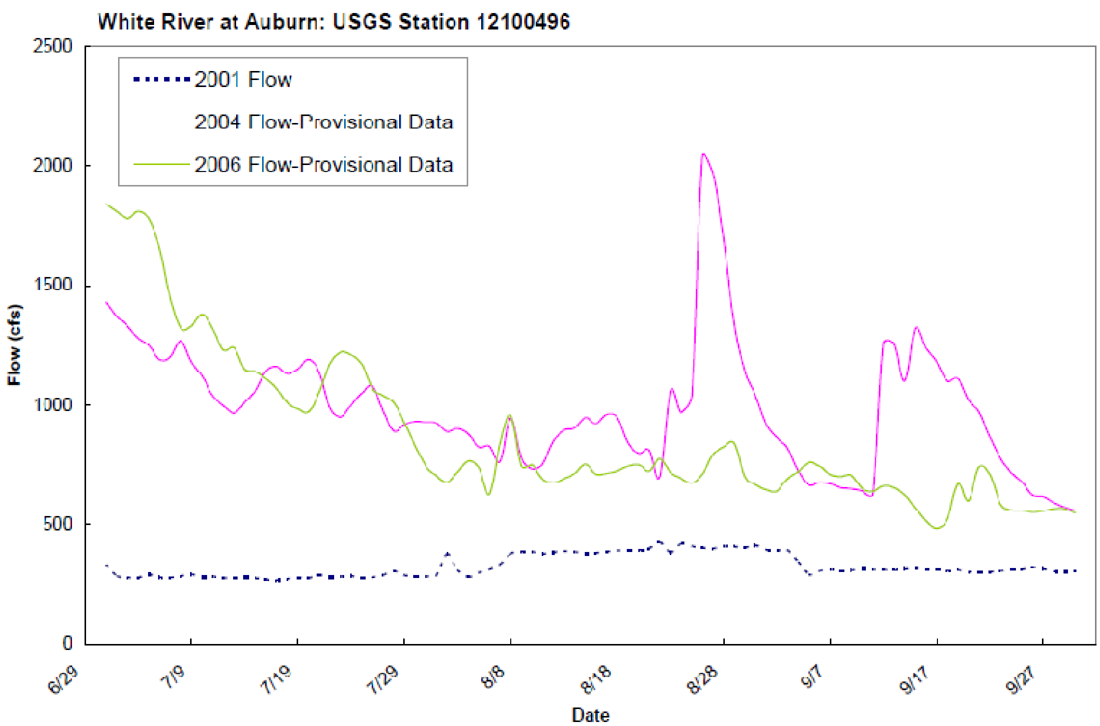


Figure 6-3. Flow in the Tailrace Canal and at the White River near Auburn in 2001, 2004, and 2006

Source: Ecology 2008c

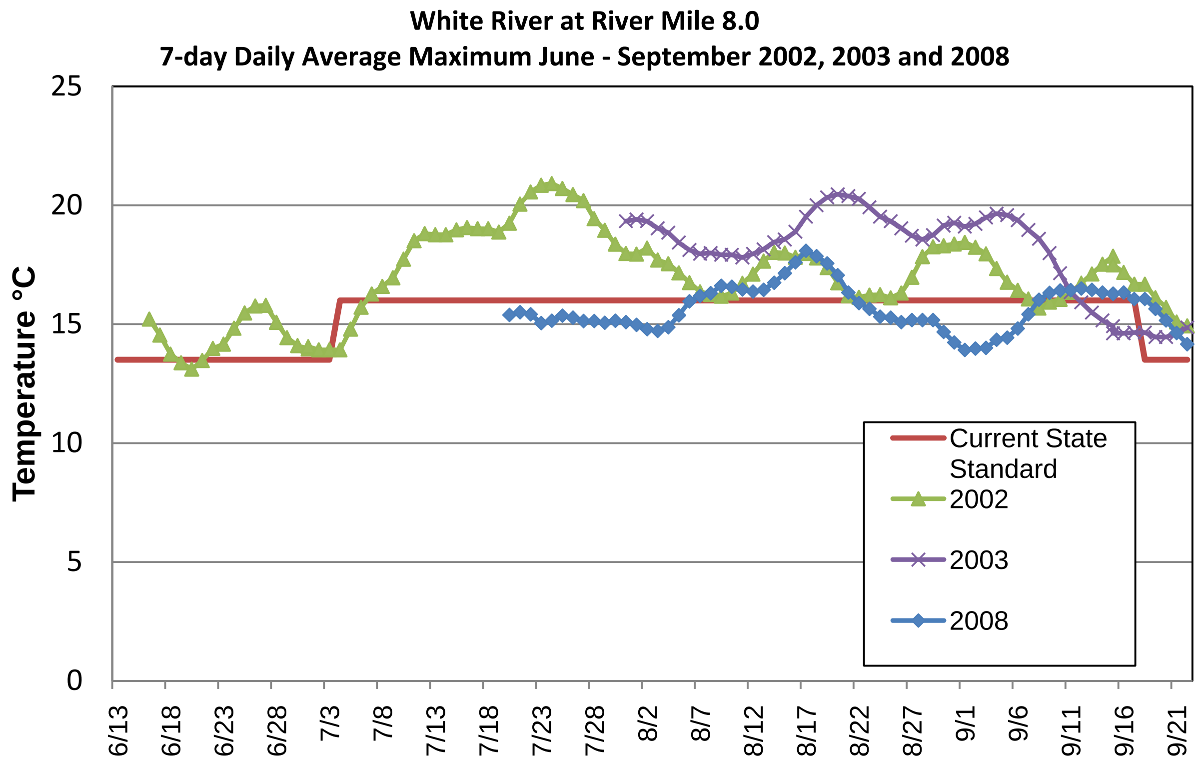
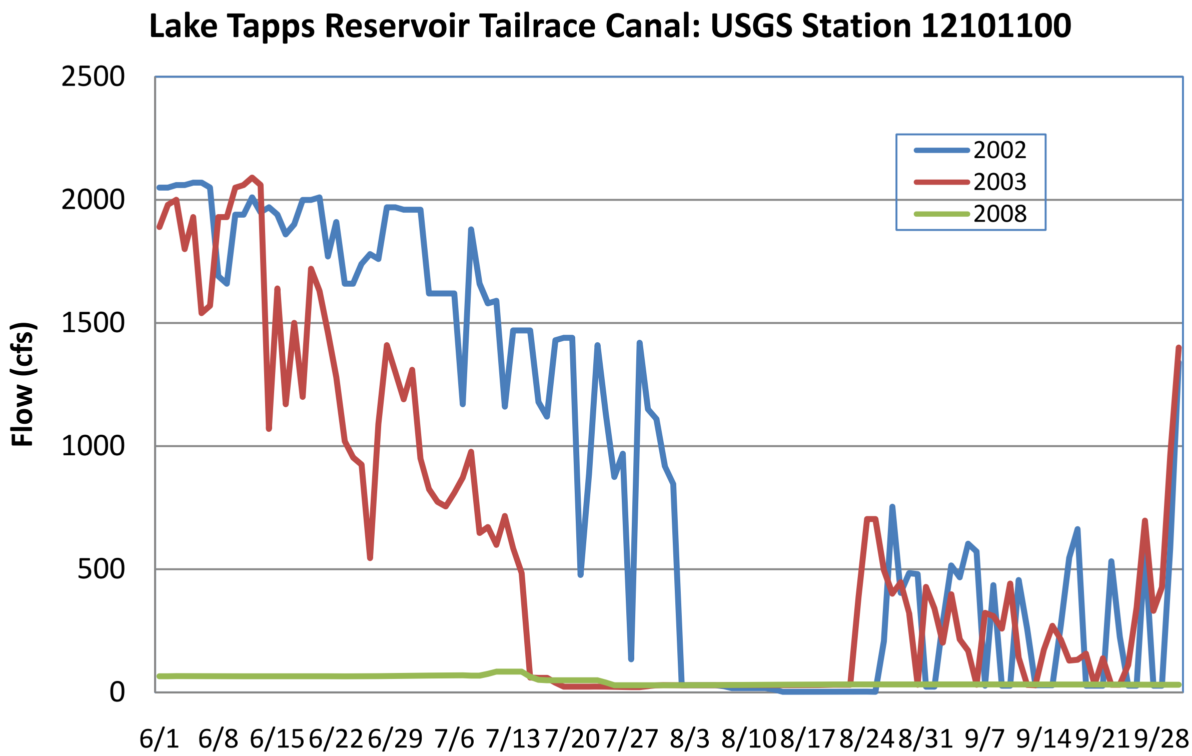


Figure 6-4. 7-DADMax Temperature in the White River at RM 8.0 (Station 10C095) in 2002, 2003, and 2008

Source: Ecology 2009b



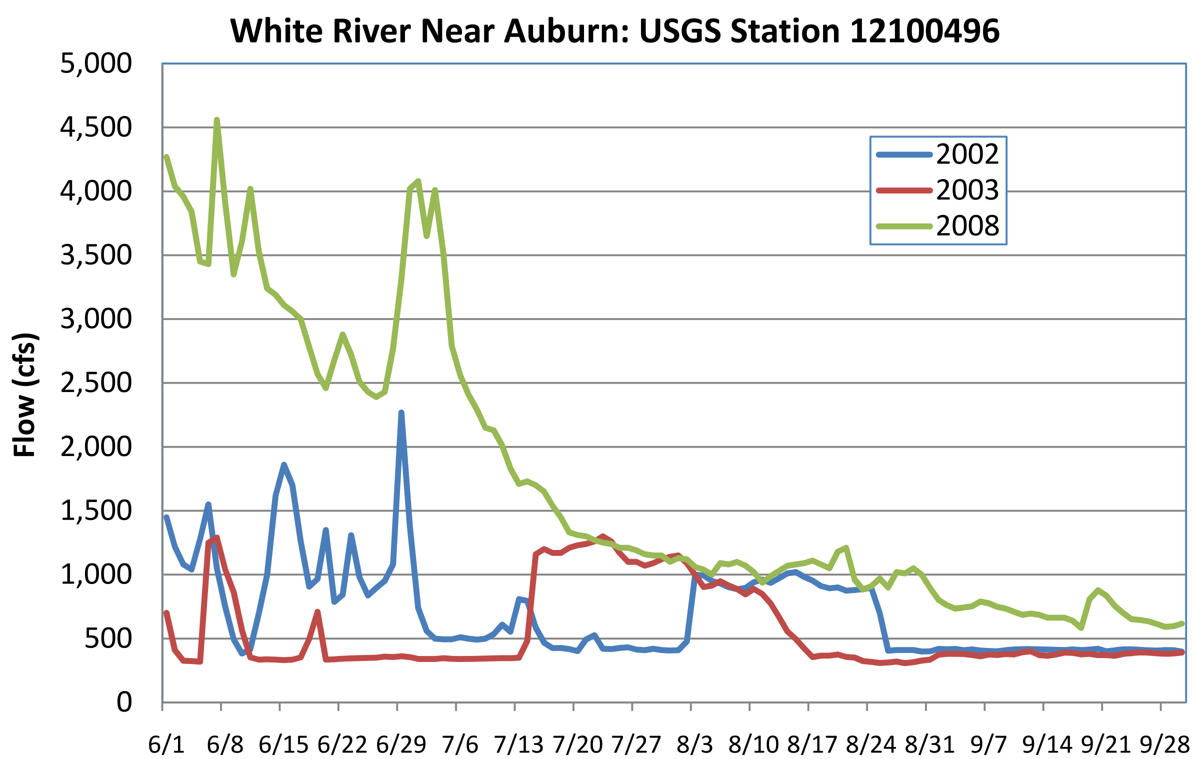


Figure 6-5. Flow at the White River in Auburn and Diversions to Lake Tapps Reservoir in 2002, 2003, and 2008

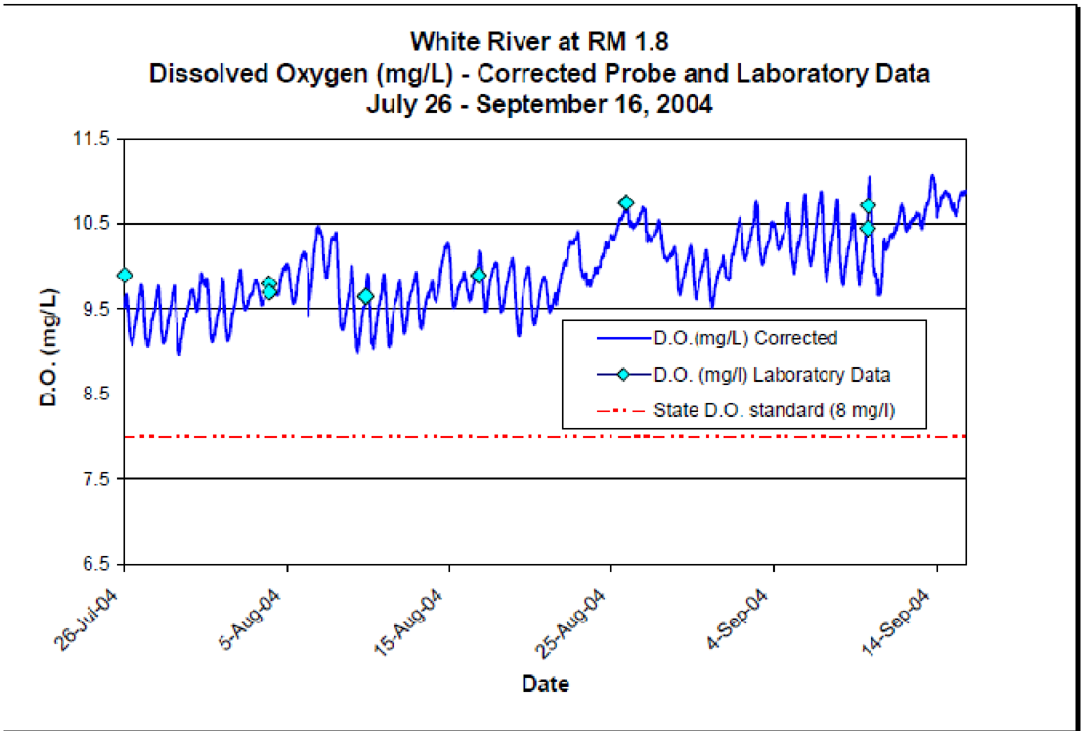
Dissolved Oxygen

DO in the White River was monitored during the summers of 2001, 2002, 2004, and 2006 (Ebbert 2002, 2003; Ecology 2005, 2008c). Water quality monitoring was conducted for the White River at RM 1.8 during these years and at RM 4.9 in 2002. The monitoring data from RM 1.8 is shown in Figures 6-6, 6-7, and 6-8. During the summer of 2006, DO ranged from about 9 mg/L to 11.5 mg/L, with about 1 to 2 mg/L of diurnal (daily) fluctuations. The monitoring data during these years indicates that DO in the Lower White River measured at concentrations above the state minimum DO standard of 8.0 mg/L at all times (see Table 6-1).

pH

The state water quality criterion for pH is 6.5 to 8.5 (see Table 6-1). The pH in the White River occasionally rises above 8.5 in the low flow month of October, as shown in Figure 6-9. Similar pH levels were observed in White River monitoring conducted by Puget in October 2001 of the White River Reservation Reach. Figure 6-9 shows discrete data collected for the month of October for various years. These results are from grab sample data and may not capture peak pH values that occur during afternoon daylight hours. pH has been measured above 8.5 in the White River during all seasons (Ebbert 2003; Erickson 1999; Stuart 2002).

The primary cause of pH fluctuating above or below the water quality criterion is the concentration of phosphorus in the river (Ecology 1999). Phosphorus is one of the primary factors governing the growth and photosynthesis of periphyton (fixed algae). The White River has low alkalinity and buffering capacity. Periphyton growth and photosynthesis decrease the concentration of carbon dioxide (CO_2) and increase the concentration of DO in the water, which affects the diurnal pH swings (Ecology 1999). Nutrient inputs (phosphorus) upstream of the diversion dam and tailrace canal are the primary source of anthropogenic (man-made) nutrient loading to the river (Ecology 1999). Ecology is conducting a Total Daily Maximum Load (TMDL) study to determine how to allocate nutrient loads on the White River. Results from this study are expected to be available in February 2010. A potential source of phosphorus is the discharge from wastewater treatment plants.



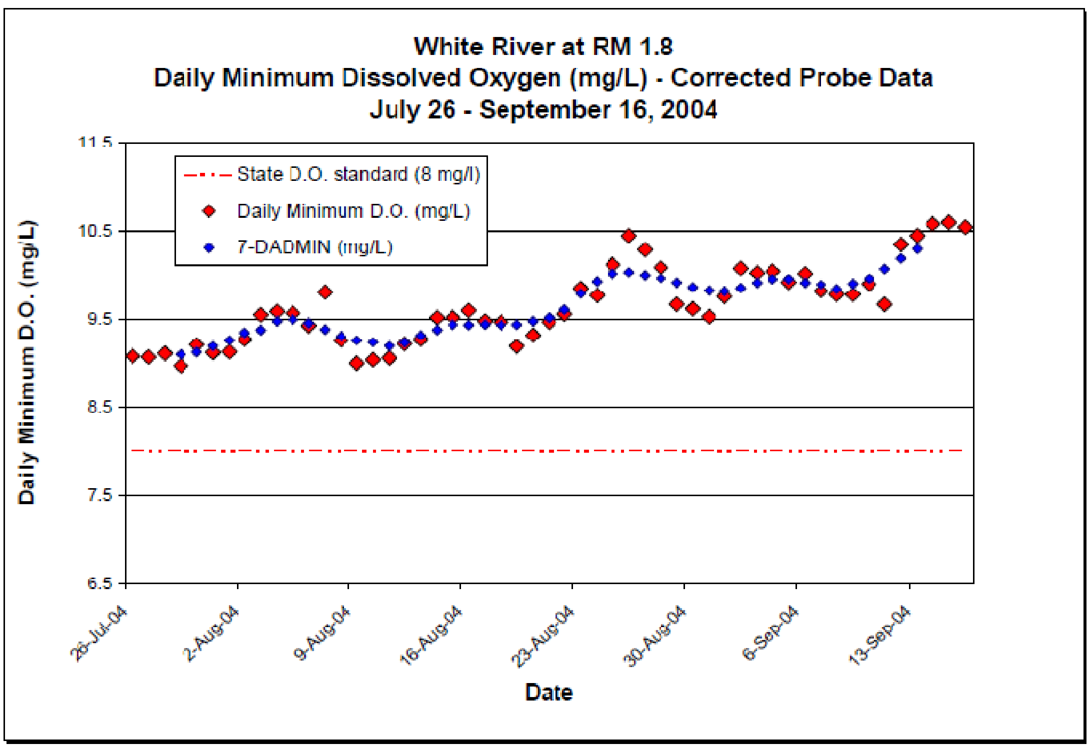


Figure 6-6. Dissolved Oxygen (Daily and Daily Minimum) at White River RM 1.8 in 2004

Source: Ecology 2005

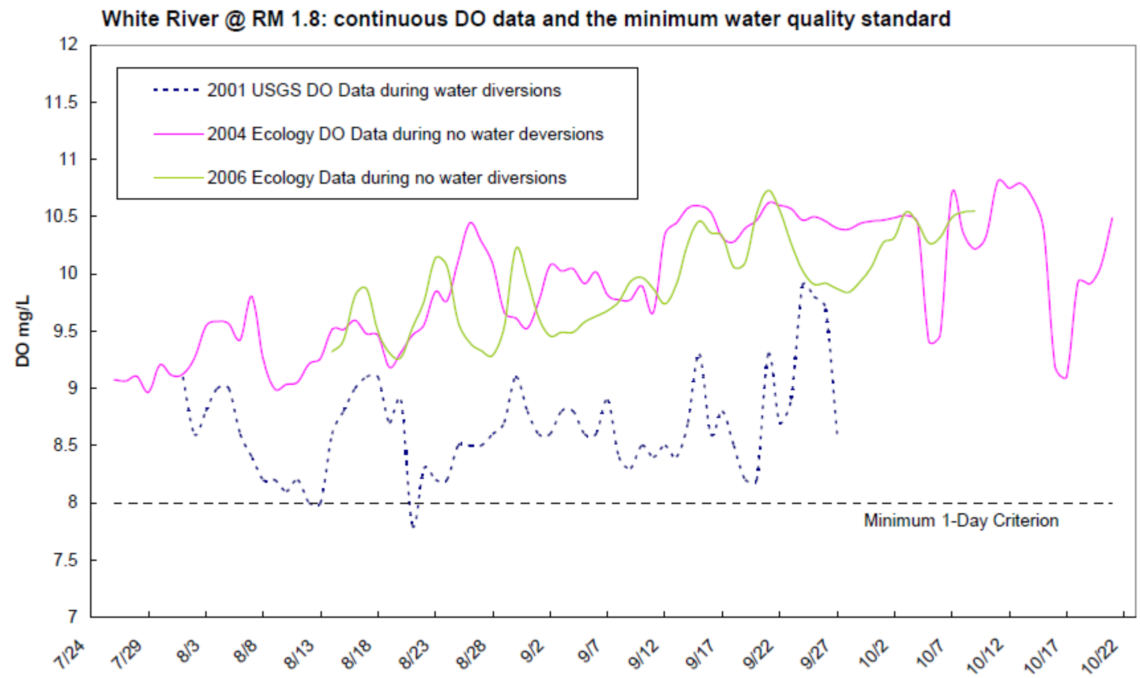


Figure 6-7. White River Minimum Daily Dissolved Oxygen Data at RM 1.8 in 2001, 2004, and 2006

Source: Ecology 2008c

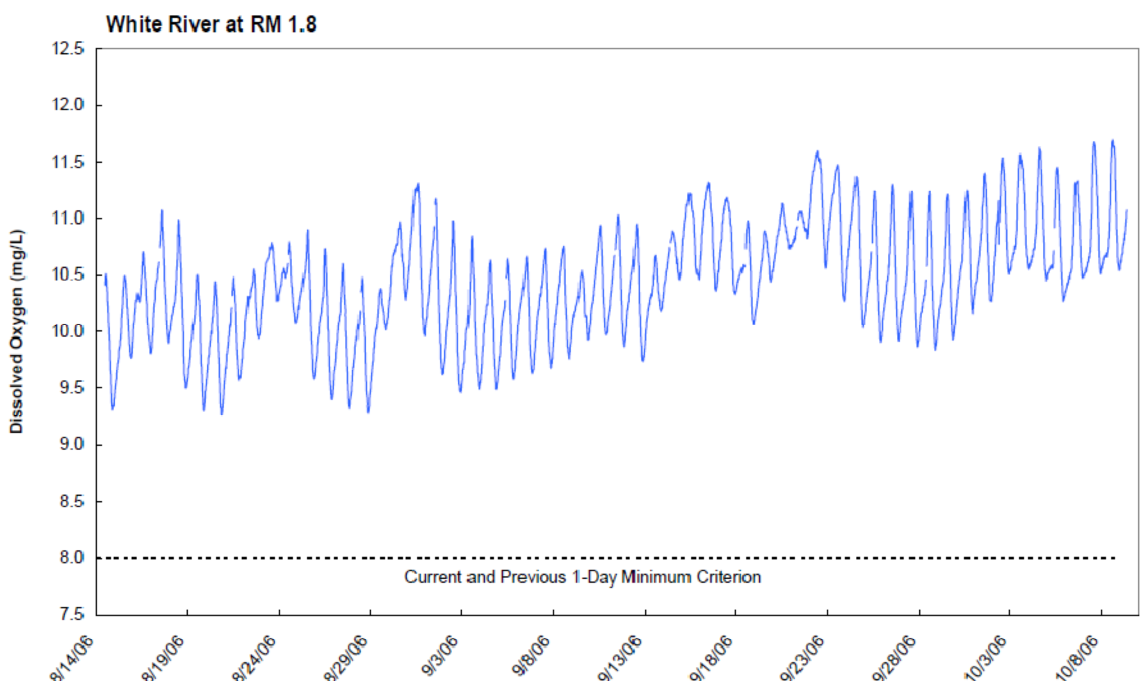


Figure 6-8. Continuous Dissolved Oxygen at White River RM 1.8 in 2006

Source: Ecology 2008c

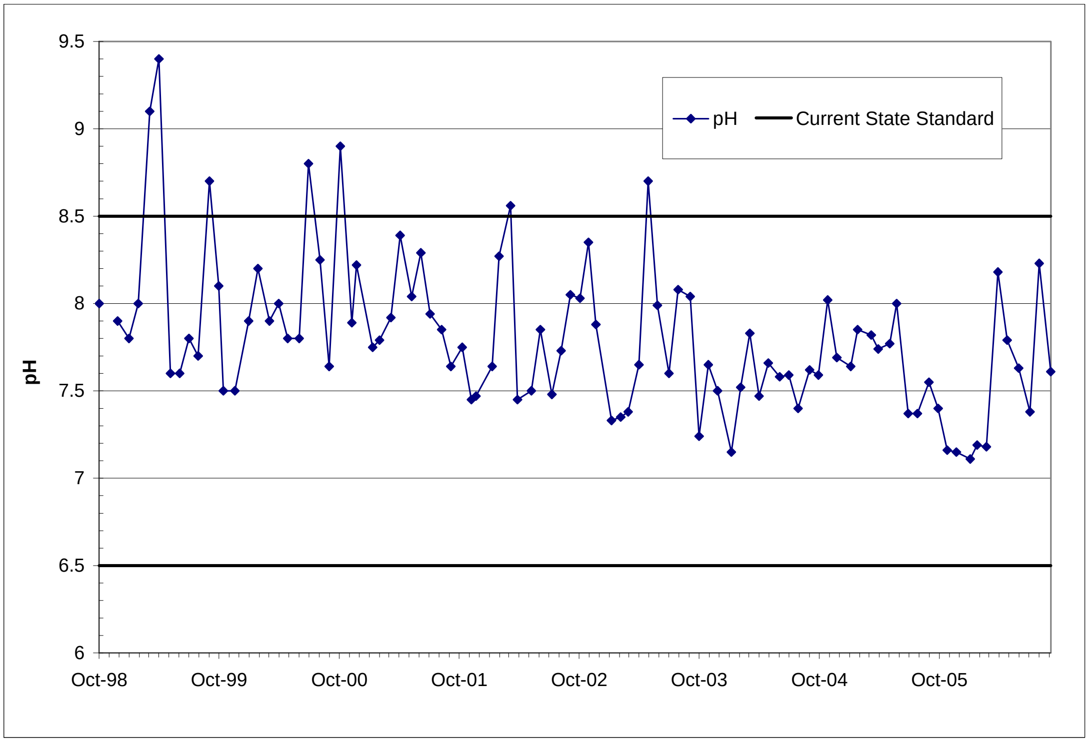


Figure 6-9. Periodic pH Measurements at White River RM 1.8 in 2006

Source: Ecology 2008c

Water Quality Status

In Ecology's Water Quality Assessment Report for 2002–2004, the White River downstream of the diversion dam was listed as impaired for instream flow, temperature, pH, and fecal coliform (bacteria that are considered indicators of fecal contamination).

6.1.2 Puyallup River

Puyallup River Water Quality Standards

As indicated in Table 6-1, under state standards, the Lower Puyallup River is designated as rearing/migration habitat from its mouth (RM 0.0) to RM 1.0. The applicable temperature criterion is 17.5°C and the DO criterion is 6.5 mg/L. The reach from RM 1.0 to the confluence with the White River (WR RM 10.4) is designated as core summer habitat. The applicable temperature criterion is 16°C and the DO criterion is 9.5 mg/L. The Puyallup Tribe also has federally accepted standards for the Puyallup River that vary somewhat from state standards, but that have jurisdiction with respect to the Clean Water Act (see Table 6-1).

Physical Environment

The Puyallup River and its hydrology are described in Chapter 5. The lower portion of the Puyallup River is a saltwater estuary and is tidally influenced. The less-dense fresh water from the river generally flows over the deeper and denser salt water found in Commencement Bay. The salt water wedge extends upstream about 2.5 to 3 miles, depending on tides and river flow rates. For the purposes of this study water quality impacts on the Puyallup River Estuary are assumed to be identical to impacts described for the Lower Puyallup River.

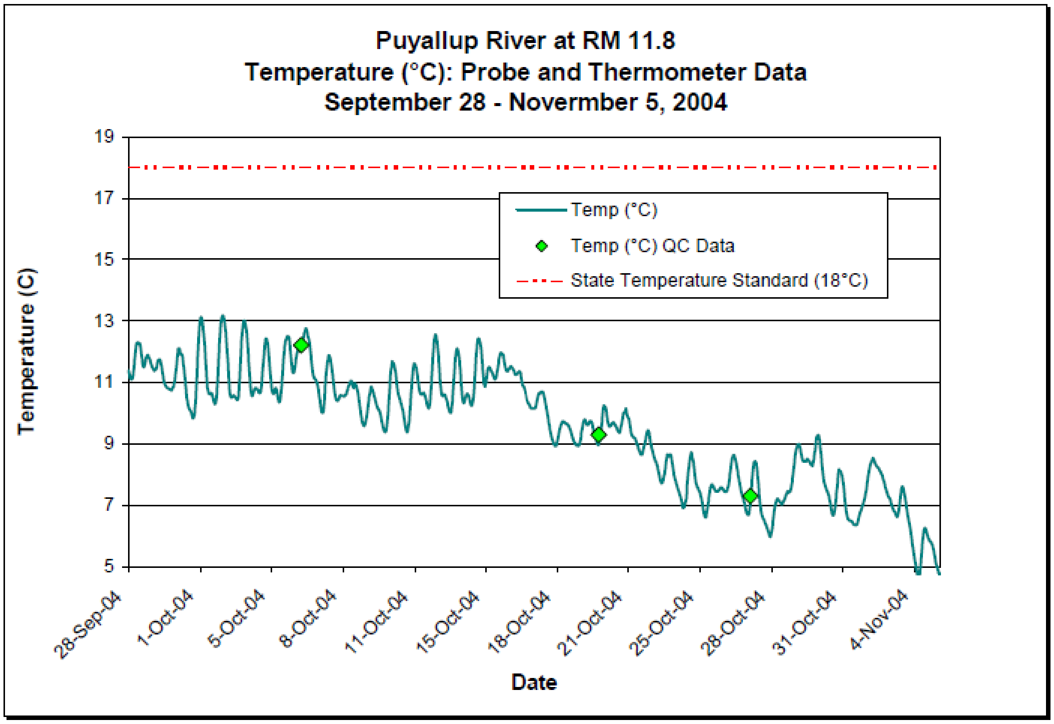
Similar to the White River, the Puyallup River flow peaks twice: once in the winter from precipitation storms and again in summer from snow/glacial meltwater. The average-monthly flow downstream of the White River is 4,400 cfs in December and 2,900 cfs in July. The Puyallup River, like the White River, is turbid during the glacial meltwater period in the spring and summer because of fine sediment from melting Mount Rainier glacial water (Ebbert 2002).

Previous Studies

Ecology has conducted water quality monitoring for temperature, pH, dissolved oxygen, and nutrients in the Puyallup River.

Temperature

Limited temperature data are available for the Lower Puyallup River. Temperature monitoring was conducted during the fall in the Puyallup River at RM 11.8, located about 1.4 miles upstream of the confluence with the Lower White River at RM 10.4. The Puyallup River 7-DADAvg temperature at RM 11.8 ranged up to about 13^{o}C in 2004, as shown in Figure 6-10. In 2006, 7-DADAvg temperature at RM 11.8 ranged from 15^{o}C to 16^{o}C, and was below the state water quality criterion of 16^{o}C and the Puyallup Tribe standard of 18 ^{o}C (see Table 6-1), as shown in Figure 6-11. Figure 6-12 shows that the 7-DADAvg temperature at RM 2.9 in 2006 was below 15^{o}C. The 2004 and 2006 monitoring data indicate that the 7-DADAvg temperature was below the state water quality criterion of 16^{o}C and the Puyallup Tribe standard of 18 ^{o}C (see Table 6-1). Ecology water quality publications also indicate that the Puyallup River temperature is below the state water quality criterion (Ecology 2005, 2008c).



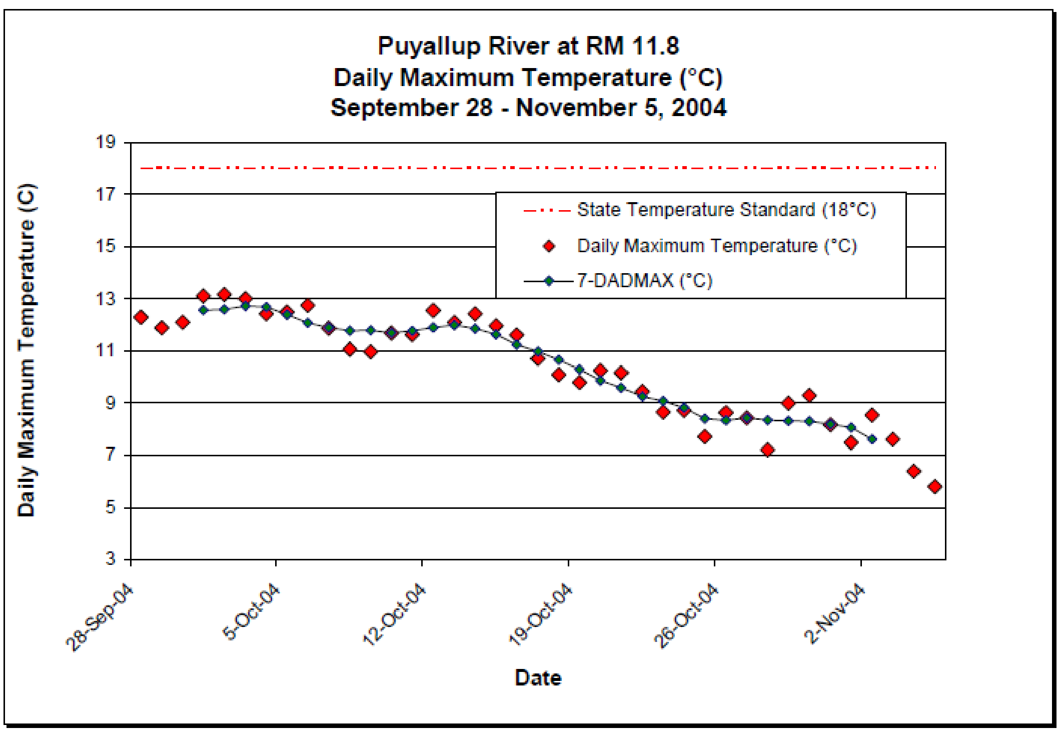


Figure 6-10. Puyallup River Temperature (Daily and Maximum Daily) at RM 11.8 in 2004

Source: Ecology 2005

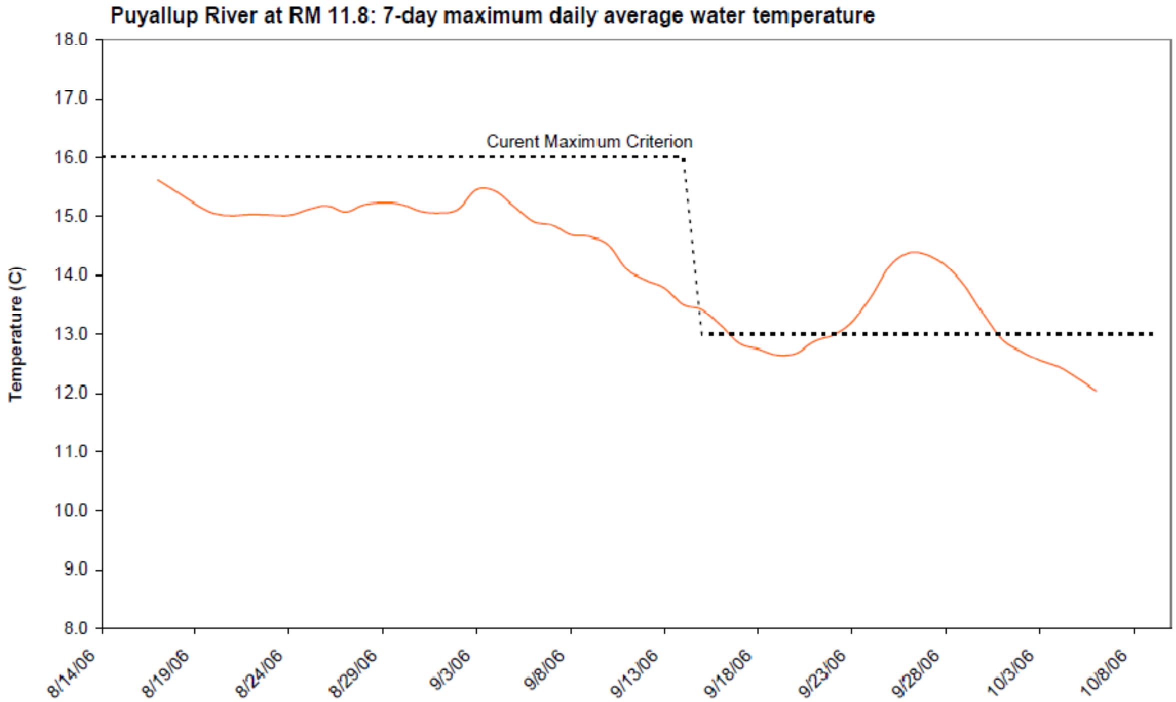


Figure 6-11. Puyallup River 7-Day Maximum Daily Average Water Temperature at RM 11.8 in 2006

Source: Ecology 2008

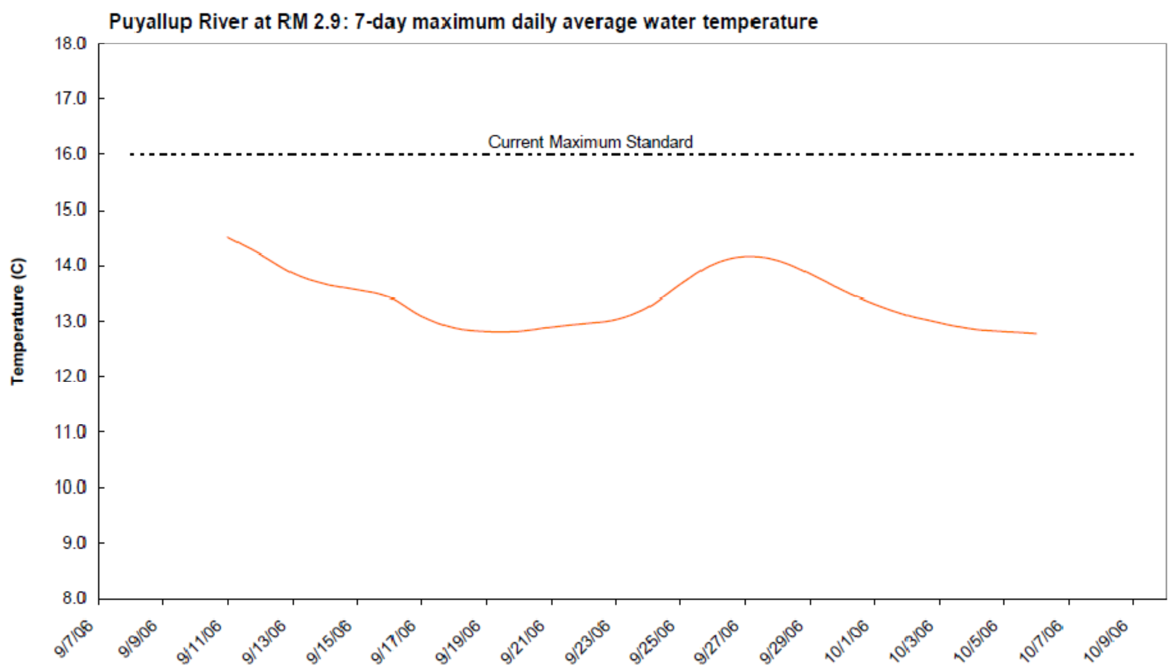


Figure 6-12. Puyallup River 7-Day Maximum Daily Average Water Temperature at RM 2.9 in 2006

Source: Ecology 2008c

Dissolved Oxygen

Monitoring data in the Puyallup River indicated that DO was generally above the state water quality criterion (minimum of 9.5 mg/L; see Table 6-1) at RM 2.0 and RM 11.8 in 2006, as shown in Figures 6-13 and 6-14, although there were days when DO levels failed to meet state or Puyallup Tribe standards. Other Ecology guidance documents indicate the same conclusion for other water years (Ecology 2005).

pH

Monitoring data indicate that pH is within the state and Puyallup Tribe water quality criterion (see Table 6-1) in the Lower Puyallup River (Ecology 2005, 2008c).

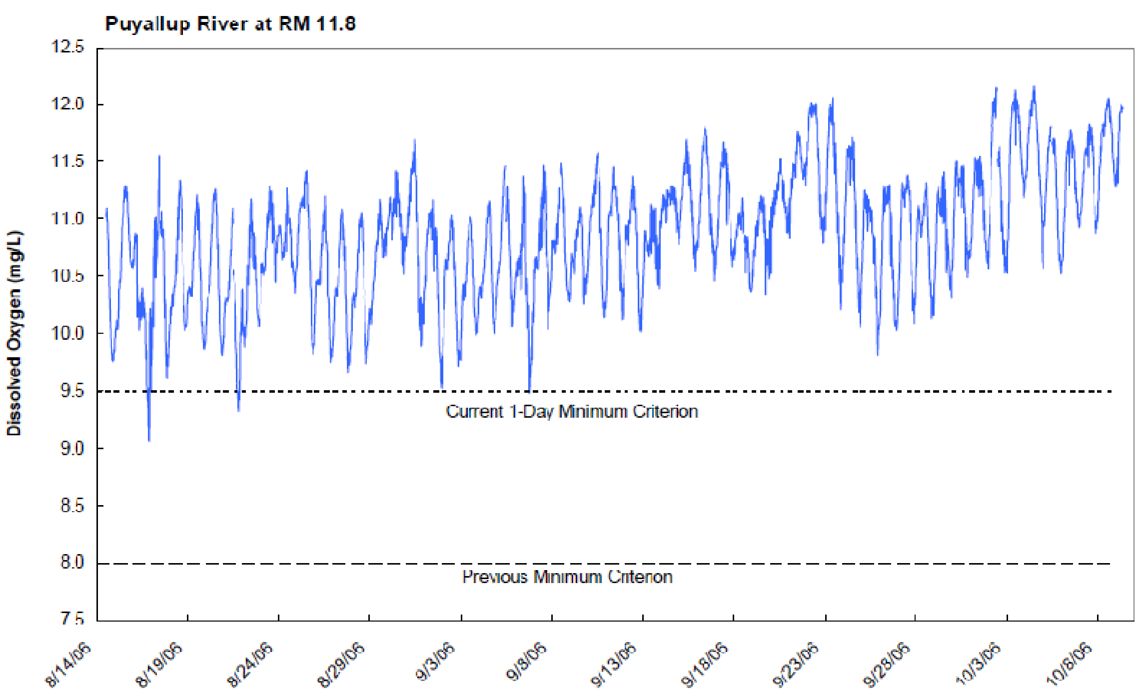


Figure 6-13. Puyallup River Continuous Dissolved Oxygen at RM 11.8 in 2006

Source: Ecology 2008c

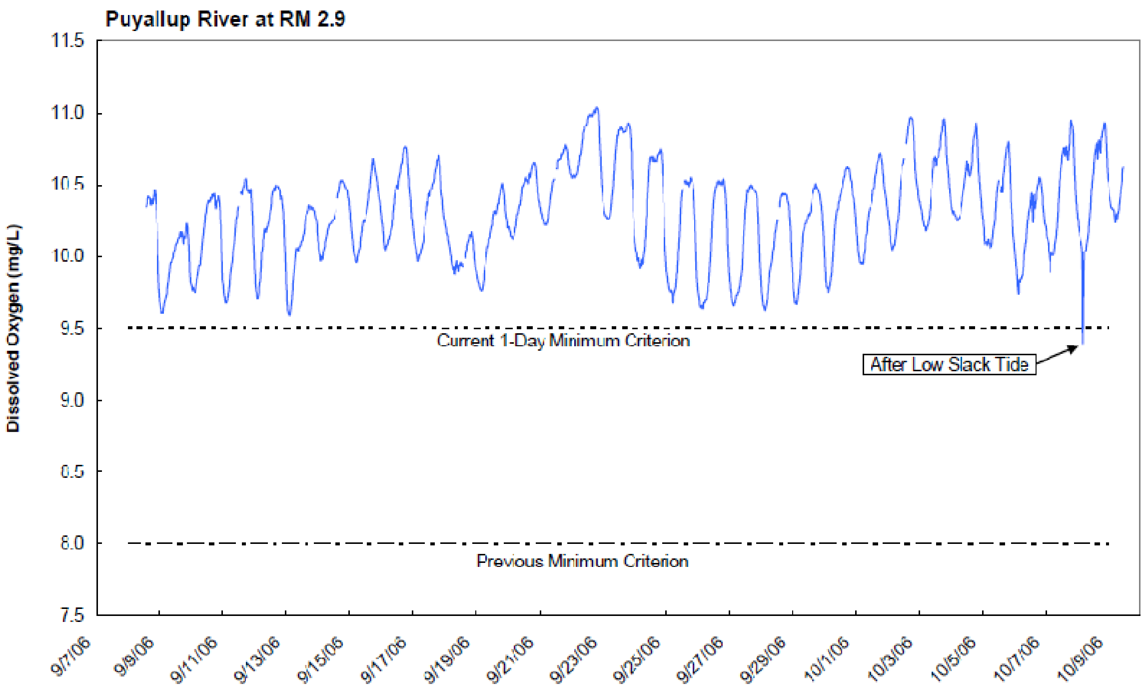


Figure 6-14. Puyallup River Continuous Dissolved Oxygen at RM 2.9 in 2006

Source: Ecology 2008c

Water Quality Status

In Ecology's Water Quality Assessment Report for 2002–2004, the Puyallup River was listed as impaired for instream flow and mercury.

6.1.3 Lake Tapps Reservoir

Lake Tapps Reservoir Water Quality Standards

Lake Tapps Reservoir is classified as a lake under the state standards. The applicable temperature criterion is no increase in the 7-DADMax temperature more than 0.3°C above natural conditions when temperature is above the state water quality standard[4]. The applicable DO criterion is no decrease in DO concentrations 0.2 mg/L below natural conditions (see Table 6-1).

[4] The natural condition of Lake Tapps Reservoir is the condition prior to construction of the levees associated with the Hydro Project. However, for the purposes of this Draft EIS, the No Action Alternative is the baseline condition against which impacts are measured.

Physical Environment

Lake Tapps Reservoir is a 2,700-acre freshwater reservoir created by a series of dikes that impound water diverted from the White River. The reservoir depth ranges up to 80 feet and it has a mean depth of about 25 feet. Lake Tapps Reservoir has relatively low phosphorus concentrations, low chlorophyll-a concentrations, and high visibility. R2 (2005) classified the reservoir as an oligotrophic to mesotrophic lake. Welch (2005, 2006) classified the reservoir as oligotrophic.

Oligotrophic waters are relatively low in nutrients and cannot support much plant life.

Mesotrophic waters have moderate levels of nutrients and can support moderate levels of plant life.

Lake Tapps Reservoir stratifies like most reservoirs in North America (Ecology 2006a). The stratification begins in early summer. A warmer layer of water develops on the top of the reservoir and a colder layer of water develops on the bottom of the reservoir, with a transition layer between the two, as shown in the water quality profile data from 2004 in Figure 6-15.

Algal growth and photosynthesis occurs in the upper layer of the reservoir, with higher DO concentrations during the day and lower DO concentrations at night when photosynthesis rates are reduced. The DO in the bottom layer of the lake is lower because algae grow in the upper layer and eventually die and sink to the bottom of the reservoir where they are consumed by biological processes, causing oxygen in the bottom of the reservoir to decrease. Light and nutrients and residence time govern the rate of growth in the upper layer of the reservoir and affect the rate of biological matter that falls to the bottom of the reservoir and is processed. The primary factors governing the growth of algae and the water quality in the reservoir are nutrients (phosphorus), the turnover rate in the reservoir (residence time), suspended solids (affecting turbidity), and water temperature. These factors are influenced by the water quality and the rate of diversion from the White River.

The White River is the primary source of phosphorus to the reservoir (Ecology 2006c). Figure 6-16 shows that the phosphorus concentration in the White River is much higher than the concentration of phosphorus in the reservoir or at the outlet. The White River is also the source of suspended sediment in the reservoir. Cold water flowing in from the river affects the temperature in the reservoir and the residence time. Because the White River has relatively high turbidity and a high concentration of suspended sediment, higher diversions into the reservoir decrease the residence time, increase the phosphorus concentration, and decrease the visibility in the reservoir. Lower diversions into the reservoir increase the residence time, decrease the phosphorus concentration, and increase the visibility and ability of light to penetrate the water column.

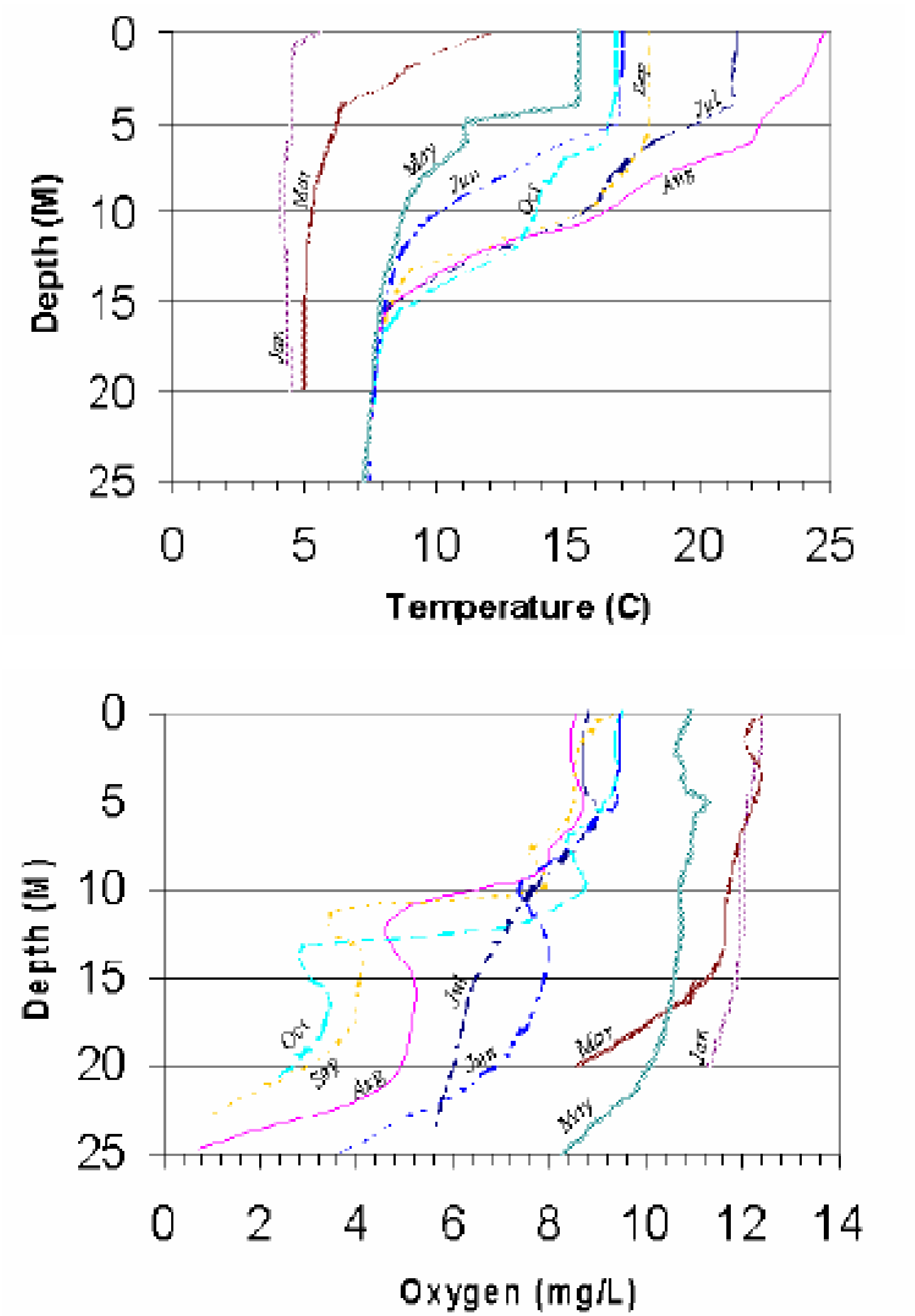


Figure 6-15. Lake Tapps Reservoir Dissolved Oxygen and Temperature Water Quality Profiles from 2004

Sampling location: center west portion of Lake Tapps Reservoir

Source: Ecology 2006c

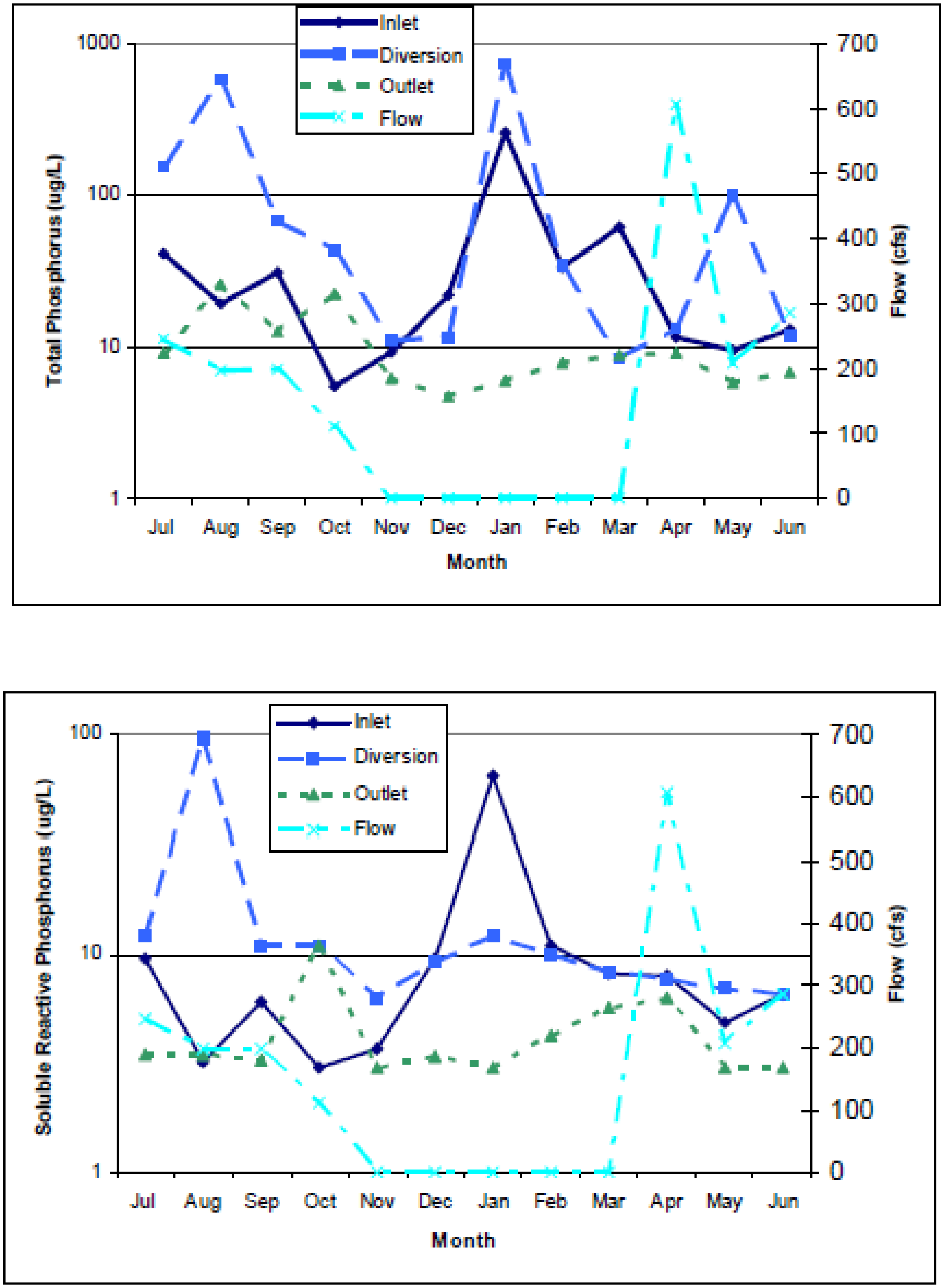


Figure 6-16. Total Phosphorus (top) and Soluble Reactive Phosphorus (bottom) at Lake Tapps Reservoir Inlet and Outlet Stations and Flow at the Diversion Dam

Source: Ecology 2006c

Previous Studies

The mean residence time of water in the reservoir was about 50 days during hydropower operations prior to 1994. After hydropower operations ceased in 2004, the residence time increased to about 140 days (R2 2005). Figure 6-17 shows that with the reduced diversions after 2004, the reservoir temperature increased several degrees in the summer. Ecology (2006c) also reported increased visibility, lower chlorophyll-a concentrations, and lower total phosphorus concentrations in the reservoir based on 2004–2005 monitoring data, compared with previous years when diversions from the White River to Lake Tapps Reservoir were higher. The decreased phosphorus and sediment input from reduced diversions to the reservoir has increased visibility, increased water temperature, reduced phosphorus concentrations, decreased algal growth, and improved water quality in the reservoir (Welch 2005).

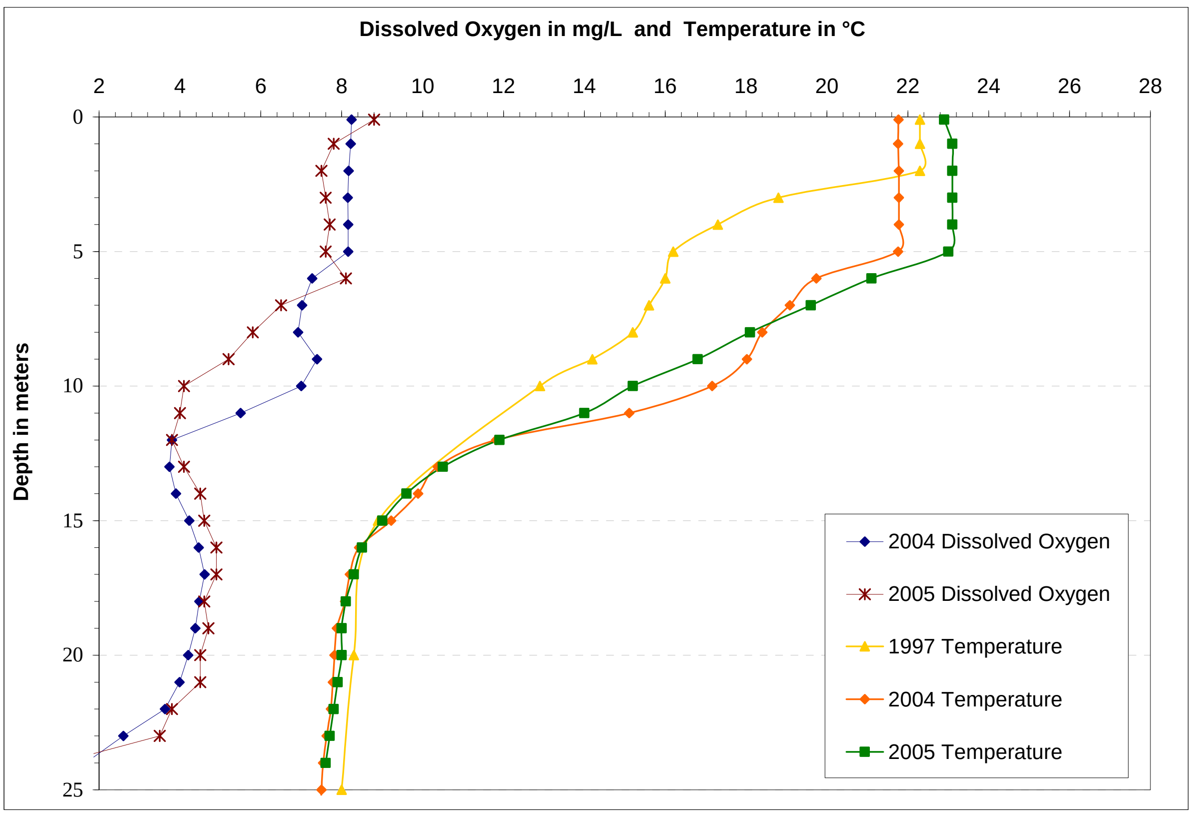


Figure 6-17. Lake Tapps Reservoir Temperature and Dissolved Oxygen Profiles for August 1997, 2004, and 2005 Monitoring

Water Quality Status

On Ecology's 2004 303(d)[5] list, Lake Tapps Reservoir is listed under Category 4C as being impaired by a non-pollutant (Eurasian milfoil; Listing #4693). Category 4C is for impairment by causes that cannot be addressed through a TMDL study (Ecology 2006c).

6.2 Environmental Impacts

6.2.1 Direct Impacts

The Proposed Action could result in a slight, non-significant increase in temperature in the Reservation Reach of the White River, as described in this section.

The analysis utilized water quality monitoring data, output from the STELLA™ computer model (see Chapter 5), analytical tools (where possible), and scientific judgment where insufficient data existed, or analytical tools were not available. DO and White River temperature analyses were performed by Aspect Consulting (Aspect unpublished). The computer model was used to compare the daily flow rate and reservoir level for the Proposed Action and the No Action Alternative. The model simulates the flow in the White River and Puyallup River and the Lake Tapps Reservoir inflow, outflow, level, and volume. Broadly, water quality effects of the Proposed Action would be caused by slight changes in the volume and timing of diversions from the White River to Lake Tapps Reservoir and releases from Lake Tapps Reservoir into the Lower White River. Because average flow changes due to the Proposed Action would be small (varying from 2% to 5%, as described in Chapter 5), the water quality impacts described below would tend to be relatively small as well.

6.2.1.1 White River

White River Reservation Reach

Analysis Method – Temperature

Water temperature was estimated at RM 4.9 and RM 15.5 for the 1988 to 2002 simulation period using a regression equation that predicts temperature that occurs at a specified flow rate. The regression equation was developed by Keta Waters (2006) using monitoring data. The equations developed relate daily maximum Reservation Reach water temperature to air temperature as measured at SeaTac and flow rates measured at the Buckley and Auburn gages as follows:

Reservation Reach at RM 15.5:

$$Tw = 5.8 - 0.36Ta^{mean} + 0.29Ta^{min} + 0.34Ta^{max} - 3.0\log(Q_{Buckley}) + 0.14\log(Q_{Auburn})$$

[5] Section 303 (d) of the federal Clean Water Act, Title 33 U.S.C 26.

Lower White River at RM 4.9:

$$Tw = 5.1 - 0.28Ta^{mean} + 0.33Ta^{min} + 0.33Ta^{max} + 1.2\log(Q_{Buckley}) - 5.4\log(Q_{Aubur})$$

Where:

Tw is the estimated daily maximum water temperature (°C).
Ta^{mean} is the daily mean air temperature at SeaTac(°F).
Ta^{min} is the daily minimum temperature at SeaTac (°F).
Ta^{max} is the maximum air temperature at SeaTac (°F).
$Q_{Buckley}$ is the flow at the White River near Buckley gage (cfs).
Q_{Auburn} is the flow at the White River near Auburn gage (cfs).

The regression equation was applied to determine the temperature resulting from various White River Reservation Reach flow rate values output from the STELLA model. The regression equations were used to predict water temperature on each day from July 1 to October 31. The 7-DADMax temperatures were calculated for each day by averaging that day's daily maximum temperature with the daily maximum temperatures of the 3 days prior and the 3 days after that date.

Results – Temperature

Figures 6-18 and 6-19 show the predicted relationship between flow rate and temperature and the estimated change in temperature from the Proposed Action compared with the No Action Alternative. The results indicate that there would be very little change in water temperature in the Reservation Reach as a result of implementing the Proposed Action. The water temperature change as a result of implementing the Proposed Action compared with the No Action Alternative would almost always be less than 0.1^{o}C. Temperature differences are shown in Figure 6-19. The difference in the water temperature exceedance above 0.1 C would be minimal. For example, as shown in Table 6-2, the difference in water temperature reaches 0.3^{o}C in only 15 days over the 15-year period simulated (1988 to 2002). From a practical standpoint, these results would likely be unmeasurable. As summarized in Table 6-3, these data show that there would be very little if any impact from a change in temperature in the Reservation Reach as a result of implementing the Proposed Action.

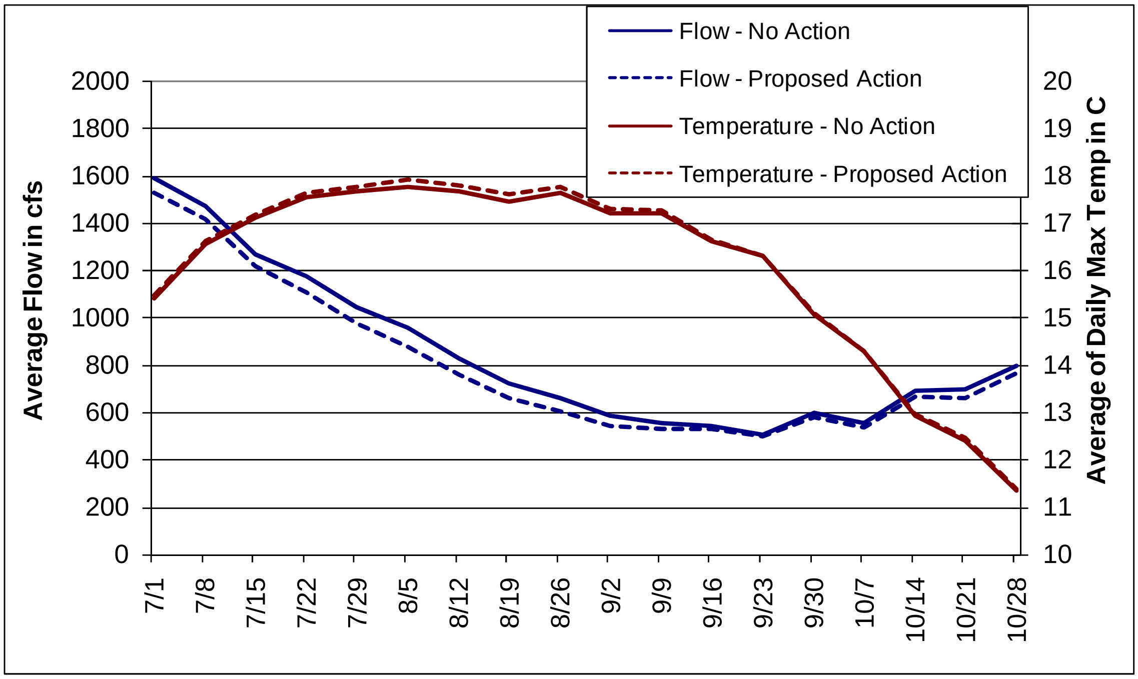
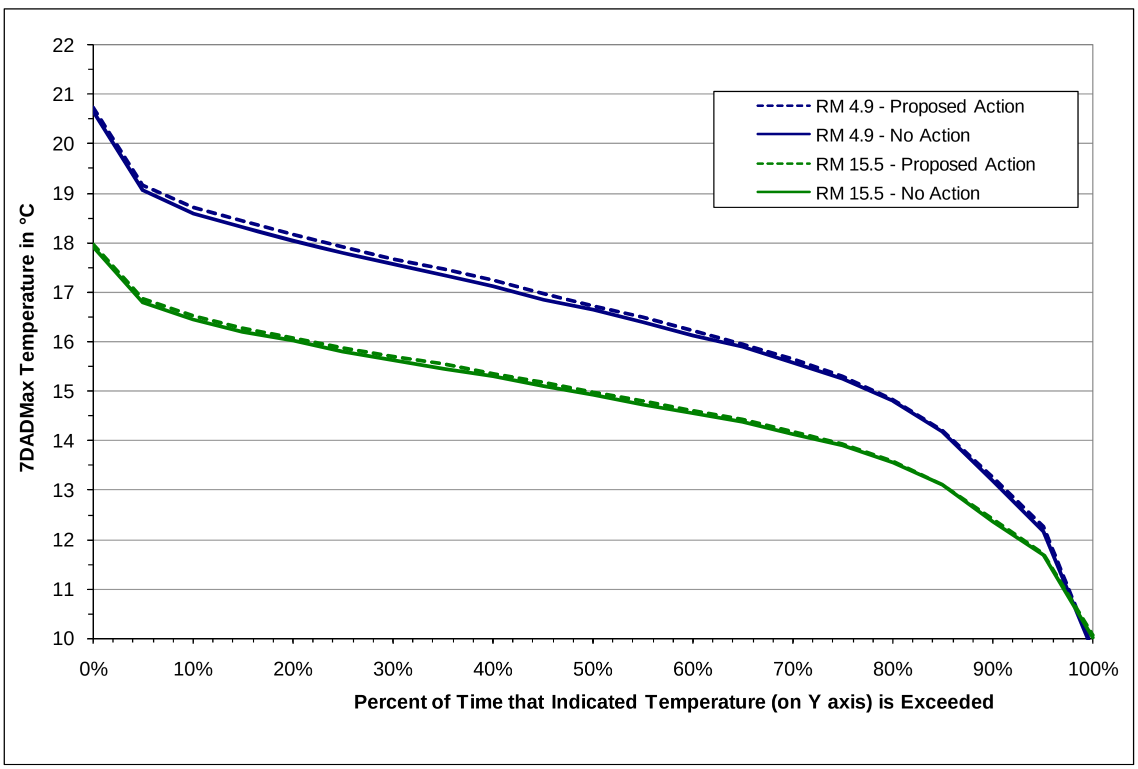


Figure 6-18. Change in Flow and 7-DADMax Temperature in the Reservation Reach from the Proposed Action and the No Action Alternative



Data based on the period from July 1 to October 31.

Figure 6-19. Change in 7-DADMax Temperature in the Reservation Reach from the Proposed Action and the No Action Alternative

Table 6-2. Number of Additional Reservation Reach Water Temperature Exceedances Resulting from the Proposed Action Compared with the No Action Alternative

Water Year	Number of Additional 16 °C Temp Exceedances July 1 to Sept 14		Number of Additional 13 °C Temp Exceedances Sept 15 to Oct 31		Total Number of Temperature Exceedances	
	River Mile 4.9	River Mile 15.5	RM 4.9	RM 15.5	RM 4.9	RM 15.5
1988	0	0	2	0	2	0
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	8	3	0	0	8	3
1993	0	0	0	0	0	0
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	5	0	0	0	5	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
Total	**13**	**3**	**2**	**0**	**15**	**3**

Note:
1) An additional temperature exceedance is considered to occur when the 7-DADMax temperature exceeds the State standard and the Proposed Action causes a temperature increase of more than 0.3° C.

Table 6-3. Reservation Reach Temperature

Water Body	Approximate RM Designation	State Standard (°C)	No Action Alternative Maximum 7-DADMAX Value (°C)	In or Out of Compliance	Proposed Action Maximum 7-DADMAX Value (°C)	In or Out of Compliance	∆ No Action Alternative to Proposed Action (°C)
Reservation Reach	24.0 to 4.0	16 (7-DADMax)	17.8	Out	17.9	Out	<0.1 higher typically
	24.0 to 4.0	13 (7-DADMax from Sept. 15 to July 1)	15.8	Out	15.9	Out	<0.1 higher typically

Analysis Method – Dissolved Oxygen

A limited amount of DO data measured under non-hydropower operating conditions is available for the Reservation Reach, Lower White River, and Lower Puyallup River. Because of this, it is not possible to develop a reliable correlation between flow rate and DO, as was done by Keta Waters for temperature of the Reservation Reach. The Proposed Action would not directly affect DO in the White River. The potential impacts of the Proposed

Action on DO levels in the White River are related to the change in water temperature in the reach.

To investigate the potential effects of the Proposed Action on DO concentrations in the Reservation Reach, the temperature results at RM 4.9 and RM 15.5 were used to calculate the saturated DO concentration. The saturated DO concentration is not a perfect indicator of DO in the reach, but the differences between saturated DO under Proposed Action and No Action Alternative conditions should be a strong indicator of the impacts of the flow changes on DO in the reach, since the only impacts would be due to the small temperature changes that would be, in turn, caused by the small changes in flow. The following formula (Committee on Sanitary Engineering Research 1960) was used:

$$DO_{sat} = 14.652 - 0.041022 * T_w + 0.007991 * T_w^2 - 7.7774 \times 10^{-5} * T_w^3$$

Where:

DO_{sat} is the saturated DO concentration in mg/L.
T_w is water temperature in ^oC.

Results – Dissolved Oxygen

The predicted change in DO as a result of the change in flow rate and temperature for the Proposed Action was estimated using the model described above. The results are shown in Figure 6-20 and are summarized in Table 6-4. The decrease in DO would almost always be less than 0.1 mg/L. The average decrease in DO would be less than 0.02 mg/L, and the maximum decrease would be about 0.2 mg/L. On some days, DO would increase under the Proposed Action. This shows that there would be very little if any impact from a change in DO in the Reservation Reach as a result of implementing the Proposed Action. However, because the Reservation Reach is currently listed as not fully meeting state standards for water quality, any exacerbation of impaired conditions must be evaluated very closely.

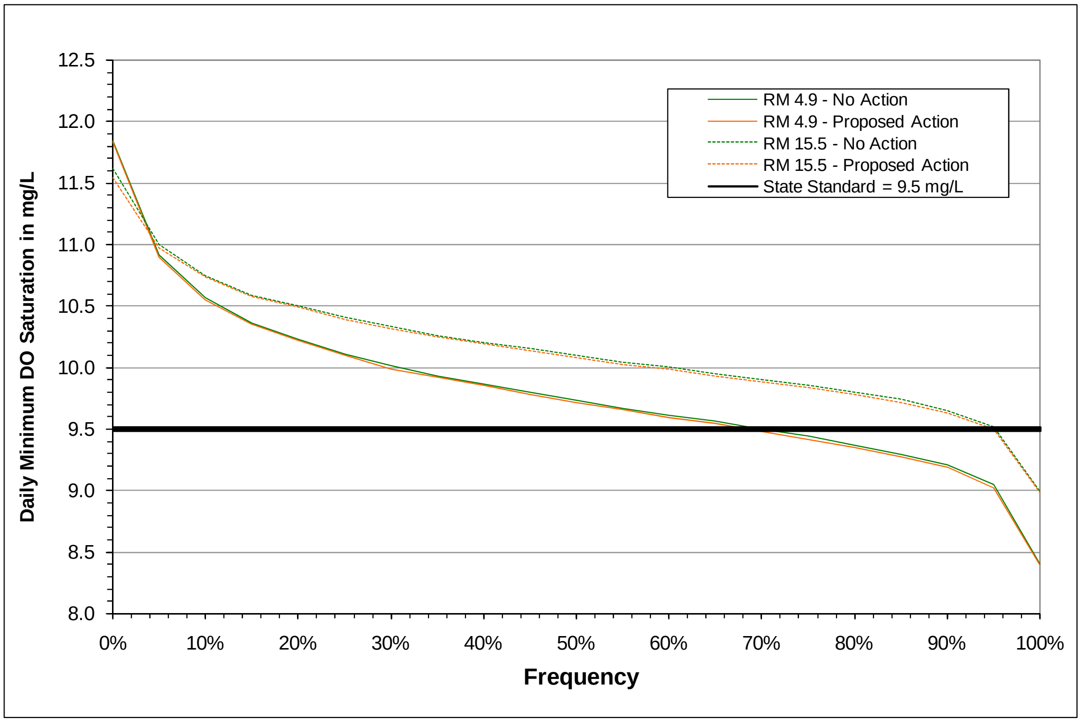


Figure 6-20. Predicted Daily Minimum Dissolved Oxygen Saturation in the Reservation Reach from the Proposed Action and No Action Alternative

Table 6-4. Predicted Change in Dissolved Oxygen Concentrations in the Reservation Reach under the Proposed Action

RM 4.9			RM 15.5		
Max Decrease	Average Change	Max Increase	Max Decrease	Average Change	Max Increase
-0.22	-0.02	0.04	-0.17	-0.01	0.03

All units in milligrams per liter (mg/L).

Analysis Method – pH

As shown on Figure 6-9, under historical conditions the pH level in the Lower White River (RM 1.8) has occasionally exceeded the upper end of state water quality criterion of 6.5 to 8.5. Figure 6-9 also shows an apparent trend towards lower pH levels over time. Since the Hydro Project ceased operating in early 2004, no White River pH levels exceeding state standards have been measured. According to Ecology, the primary cause of these high historic pH levels is the concentration of phosphorous in the river. Monthly measurements of pH at RM 8.0 (within the Reservation Reach) conducted in 2001 and 2004 show pH levels between 7.1 and 8.4. This is similar to long-term monitoring results for Lower White River pH.

As summarized in Chapter 5, the Proposed Action would, in an average year, reduce flow in the White River Reservation Reach by about 3%. These flow changes would not be expected to result in changes in phosphorous concentration in the reach. The Proposed Action would not be expected to impact pH in the Reservation Reach of the White River because (1) pH levels would be lower; (2) flow changes would be relatively small; and (3) phosphorous concentration in the White River would not be expected to change, or would be expected to decrease as upstream wastewater treatment plants implement treatment process improvements.

Results – pH

The Proposed Action would not be expected to adversely impact pH in the Reservation Reach of the White River.

Lower White River

Water quality in the Lower White River could be affected by changes in the flow and quality of water entering from the Reservation Reach and the tailrace canal. As described in Section 6.2.1.3, Lake Tapps Reservoir water quality conditions under the Proposed Action are incompletely known, but would not be expected to be significantly different than under current or No Action conditions. Because flow from the tailrace canal tends to be much smaller than flow from the Reservation Reach, changes in water quality of Lake Tapps Reservoir water released through the tailrace canal would not be expected to significantly affect water quality in the Lower White River. The following sections summarize the analysis of Proposed Action effects on Lower White River water quality for temperature, DO, and pH.

Analysis Method – Temperature

Water temperature in the Lower White River could be affected by changes in flow rates and water temperature in the Reservation Reach and by changes in flow rates and water temperature in the tailrace canal release from Lake Tapps Reservoir. As shown in Section 5.2.1, the Proposed Action would decrease releases and leakance from the tailrace canal, which tends to be warmer than the Reservation Reach. This should tend to reduce temperatures in the Lower White River and counteract the slight increase in temperature of the water entering the reach from the Reservation Reach.

The daily maximum water temperature in the White River just downstream of tailrace canal was calculated using the following mixing equation:

$$T_{\text{Lower White}} = (Q_{\text{Reservation Reach}} \times T_{\text{Reservation Reach}} + Q_{\text{Tailrace}} \times T_{\text{Tailrace}}) / (Q_{\text{Reservation Reach}} + Q_{\text{Tailrace}})$$

Where:
T = daily maximum water temperature in °C.
Q = daily average flow in cfs.

Between July 1 and October 31, Reservation Reach temperatures were predicted using the regression based on flow and air temperature developed by Keta Waters (2006). Daily model results were used for the Reservation Reach and for tailrace canal flows. Outside this period, monthly average temperatures from monitoring data were used for both the Reservation Reach and tailrace canal release as shown in Table 6-5.

Table 6-5. Water Temperature Assumptions used to Predict Temperature in the Lower White River

Month	Daily Maximum Water Temperature in °C	
	Reservation Reach	Tailrace Canal
January	4.8	5.2
February	5.7	6
March	6.7	7.5
April	9.0	8.7
May	10.5	10.9
June	13.1	13.3
July	Regression equation	16.5
August		17.3
September		17.9
October		14.2
November	6.5	11.2
December	5.0	8.3

These temperature assumptions were developed from limited available data. The Reservation Reach temperatures are from periodic spot measurements from various studies at RM 4.9 between 1998 and 2006 that provided eight to nine data points per month. Tailrace canal temperatures were based on continuous monitoring in August to October 2001 (HDR 2002) and on single measurements in each month in 2004 (Ecology 2006c). The same average monthly temperatures were used for tailrace canal releases under No Action and Proposed Action conditions, even though reconstruction of the Lake Tapps Reservoir outlet structure would be anticipated, and this change would be expected to pull water from deeper in the reservoir and to result in the release of somewhat cooler water under the Proposed Action. Reconstruction of the outlet structure would be expected to withdraw water that was cooler from Lake Tapps Reservoir. It is also likely that the water would have a lower DO concentration if withdrawn from below the hypolimnion[6]. It would be expected that water released from Lake Tapps Reservoir would have an opportunity to re-aerate prior to reaching the Lower White River. The historical tailrace canal temperatures used as a basis for analysis of Lower White River temperature impacts are primarily from a period when the

[6] The hypolimnion is the dense, bottom layer of water in a thermally-stratified lake.

Hydro Project was operating, and, therefore, these temperatures may be lower than under existing (or No Action) conditions. Recent, continuously-monitored temperature data collected by the Puyallup Tribe indicate that summer tailrace temperatures in 2004 through 2009 were between 2 and 5 ^{o}C lower than the average data shown in Table 6-5, and also lower than simultaneously-monitored Reservation Reach temperatures. The assumption that hydropower period tailrace temperature data represent tailrace temperatures under the No Action Alternative and the Proposed Action may overestimate the temperature of releases from Lake Tapps Reservoir. These assumptions tend to be conservative with respect to their potential to overestimate the adverse impacts of the Proposed Action on Lower White River temperatures.

It should be noted that these data do not form a solid, consistent data set. Given the limited availability of data, it was necessary to mix daily average and daily maximum temperatures, continuous monitoring results and spot temperature measurements, and data from different time periods and hydropower operating regimes. These assumptions make the predictive method less reliable than a data set with a long-term, continuous time series.

Results – Temperature

The predicted change in temperature for the Lower White River below the tailrace canal is shown in Figures 6-20 and 6-21 and summarized in Table 6-6. Figure 6-20 shows that more than 67% of the time, the Proposed Action would reduce or not affect Lower White River temperatures. Figure 6-21 shows that the increase in temperature as a result of the Proposed Action, compared with the No Action Alternative, would almost always be less than 0.3^{o}C except for about 2% to 3% of daily values. Almost all increases in temperature would be below 0.5^{o}C and no daily increase in temperature would be above 0.7^{o}C. On a monthly-average basis, all increases in temperature predicted for the Proposed Action were below 0.3^{o}C. Approximately one-half of the days when the analysis predicts an increase in Lower White River temperatures due to the Proposed Action are days when the analysis assumes that the tailrace releases are cooler than the flow in the Reservation Reach. When leakance from the outlet works under the No Action Alternative was halted under the Proposed Action, the analysis shows a slight increase in Lower White River temperature. This condition (that the tailrace is cooler than the Reservation Reach) seems uncertain, although it is confirmed by recent Puyallup Tribe monitoring data. As stated above, it is likely the assumptions concerning tailrace canal temperatures may overestimate the temperature of tailrace releases and the increases in Lower White River temperatures shown under Proposed Action conditions.

There are also many days with predicted decreases in Lower White River temperature. The average effect of the Proposed Action would be to decrease Lower White River temperature very slightly (by 0.02 ^{o}C). This shows that the change in Lower White River temperature as a result of the Proposed Action would be minimal, with an even balance between positive (i.e., toward cooler temperatures) and negative changes (toward higher temperatures). This would be a combined result of the effects of decreasing tailrace canal releases of warmer water (which cools the river) and slightly increasing diversions from the White River (which would slightly raise the temperature of the river). The net effect would be essentially no change in Lower White River temperature.

Analysis Method – DO

As shown in Figures 6-6 through 6-8, dissolved oxygen levels in the Lower White River have historically been lower than state standards. As shown on Figures 6-7 and 6-8, since hydropower operations ceased in 2004, and during periods when large diversions were not occurring, DO levels in the Lower White River have increased. Under the Proposed Action, DO levels could potentially be impacted by changes in the flow or in the dissolved oxygen concentration of the two sources of water entering the reach – from the White River Reservation Reach and from the tailrace canal. The Proposed Action would reduce average flow in the Reservation Reach by about 3%. However, as described in Section 6.2.1.1, the Proposed Action would not be expected to adversely impact DO in the Reservation Reach. As described in Section 5.2.1, flow from Lake Tapps Reservoir into the tailrace canal would be much lower under the Proposed Action. However, DO levels in Lake Tapps Reservoir are typically lower than DO levels in the White River Reservation Reach, and reconstruction of the outlet works under the Proposed Action would be expected to result in significant re-aeration of released Lake Tapps Reservoir water prior to it reaching the Lower White River. Therefore, the tailrace canal releases under the Proposed Action should result in somewhat higher DO levels in the Lower White River.

Results – DO

The Proposed Action would not be expected to result in adverse impacts to DO in the Lower White River (see Table 6-7).

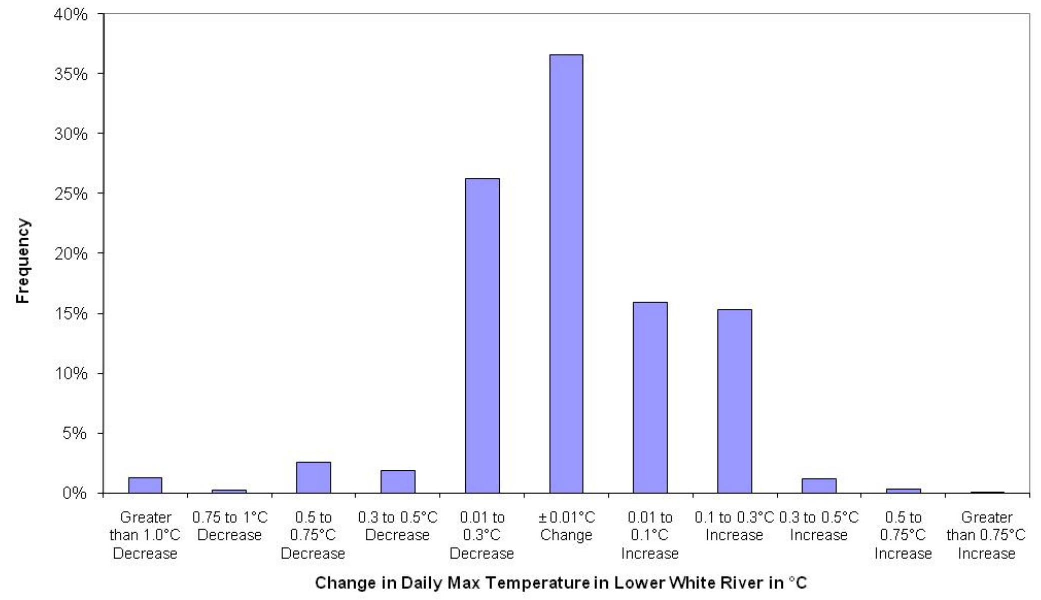


Figure 6-21. Predicted Change in Daily Maximum Temperature in the Lower White River (below tailrace canal) for the Proposed Action

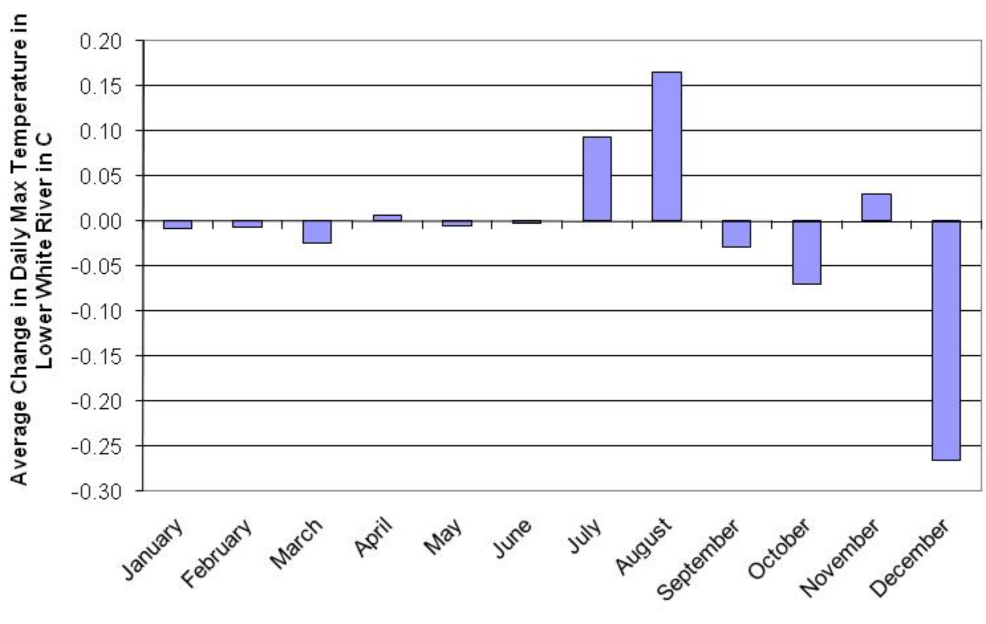


Figure 6-22. Monthly Distribution of Predicted Change in Daily Maximum Temperature in the Lower White River (below tailrace canal) for the Proposed Action

Table 6-6. Summary of Estimated Lower White River Temperature Impacts (7-DADMax)

Water Body	Approximate RM Designation	State Standard (°C)	No Action Value (°C)	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance	Δ Baseline to Proposed Action (°C)
Lower White River	4.0 to 0.0	17.5	17.7	Out	17.9	Out	<0.3 higher or lower typically

Table 6-7. Summary of Estimated Lower White River Dissolved Oxygen Impacts

Water Body	Approximate RM Designation	Minimum Dissolved Oxygen Criteria (mg/L) (2)	No Action Value (°C)	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance
Lower White River	4.0 to 0.0	8.0	8.0	In	Small Improvement	In

Analysis Method – pH

As shown on Figure 6-9, under historical conditions, the pH level in the Lower White River has occasionally exceeded the upper end of the state water quality criterion of 6.5 to 8.5. According to Ecology, the primary cause of these high historic pH levels is the high concentration of phosphorous in the river. Figure 6-9 also shows an apparent trend toward lower pH levels over time. Since the Hydro Project ceased operating in early 2004, Figure 6-9 indicates that no White River pH levels exceeding state standards have been measured. Note that pH levels can change over a 24-hour period depending on sunlight, algae photosynthesis, and other physical factors. No continuous pH data have been published since 2002; thus, it is not possible to evaluate peak pH values, to report a representative range of pH levels, or to assess pH trends since the Hydro Project ceased operation. Published data since 2002 are limited and consist only of grab samples or "spot check" measurements, and may not capture peak pH values that occur during afternoon daylight hours in the river. Additional pH data from Ecology's TMDL study are expected to be available in late February 2010.

As summarized in Chapter 5, the Proposed Action would reduce the average flow in the Lower White River by 5%. These flow changes would not be expected to result in changes in phosphorous concentrations or pH in the reach. Monitored pH levels appear to be falling over time, indicating that future violations of state standards may be less likely. Because flow changes are expected to be relatively small and because phosphorous concentrations and pH levels in the two reaches providing inflow to this reach (the White River Reservation Reach and Lake Tapps Reservoir tailrace canal) would not be expected to change, the Proposed Action would not be expected to adversely affect pH in the Lower White River.

Results – pH

The Proposed Action would not be expected to adversely affect pH in the Lower White River (see Table 6-8).

Table 6-8. Summary of Lower White River pH Impacts

Water Body	Approximate RM Designation	State Standard	Baseline Value	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance
Lower White River	4.0 to 0.0	6.5 to 8.5	7.0 to 8.3	In	No Change	In

6.2.1.2 Puyallup River

Lower Puyallup River streamflow conditions under the Proposed Action are based on STELLA model results, as documented in Chapter 5. No relevant analytical water quality tools are available to simulate or otherwise predict the effects of the Proposed Action on Lower Puyallup River water quality. Water quality impacts were, therefore, qualitatively estimated based on the expected change in flow in the reach and on changes in water quality of the water entering the reach from the Lower White River, as summarized in Section 6.2.1.1.

Puyallup Tribe Standards

The Puyallup Tribe of Indians has established surface water quality standards for sections of the Lower Puyallup River (RM 0.0 to 1.0 and 1.0 to 7.3) (Puyallup Tribe 1994). These standards are identical to state standards for pH, but differ for DO and temperature. Puyallup Tribe water quality standards are summarized in Table 6-1.

Analysis Method – Temperature

Historical monitoring summarized in Figure 6-12 indicates that the Lower Puyallup River meets state and Puyallup Tribe standards for temperature. The potential impact to temperature in the Lower Puyallup River due to the Proposed Action could only be caused by changes in flow or temperature in the water entering the reach from the Lower White River.

Results – Temperature

Because the Proposed Action would not adversely impact temperature in the Lower White River (see Section 6.2.1.1), and because the Proposed Action would reduce the flow in the Lower Puyallup River by only 2%, the Proposed Action would not be expected to have any adverse impacts on temperature in the Lower Puyallup River (see Table 6-9).

Table 6-9. Summary of Lower Puyallup River Temperature Impacts

Water Body	Approximate RM Designation	Puyallup Tribe Standard °C (7-DADMax)	Baseline Value °C	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance
Lower Puyallup River	10.4 to 1.0	16	< 15	In	No Change	In

Analysis Method – Dissolved Oxygen

Monitoring data (Figure 6-14) on the Lower Puyallup River indicates that DO levels are above the state water quality criterion of 9.5 mg/L and the Puyallup Tribe standard of 8.0 mg/L. The potential impact to DO in the Lower Puyallup River due to the Proposed Action could only be caused by changes in flow or in water quality in the water entering the reach from the Lower White River.

Results – Dissolved Oxygen

Because the Proposed Action would not adversely impact DO in the Lower White River (see Section 6.2.1.1), and because the Proposed Action would reduce the flow in the Lower Puyallup River by only 2%, the Proposed Action would not be expected to have any adverse impacts on DO in the Lower Puyallup River (see Table 6-10).

Table 6-10. Summary of Lower Puyallup River Dissolved Oxygen Impacts

Water Body	Approximate RM Designation	State Standard / Puyallup Tribe Standard	Baseline Value	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance
Lower Puyallup River	10.4 to 1.0	9.5 / 8.0	9.7	In	No Change	In

Analysis Method – pH

Monitoring data indicates that pH is within the state and Puyallup Tribe water quality criterion (see Table 6-1) in the Lower Puyallup River (Ecology 2005, 2008c). Monthly measurements of pH at RM 8.3 conducted in 2001 and 2004 show levels between 7.2 and 7.8. The analysis described in Chapter 5 shows that the Proposed Action would be expected to reduce average flow in the Lower Puyallup River by 2%.

Results – pH

As described in Section 6.2.1.1, the Proposed Action would not be expected to adversely impact pH in the water entering the Lower Puyallup from the Lower White River. Because influent water quality would not be expected to change, Lower Puyallup River flow changes would be small; and because historic monitoring data do not indicate that pH standards have been violated, the Proposed Action would not be expected to adversely impact pH in the Lower Puyallup River (see Table 6-11).

Table 6-11. Summary of Lower Puyallup River pH Impacts

Water Body	Approximate RM Designation	Puyallup Tribe Standard	Baseline Value	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance
Lower Puyallup River	10.1 to 1.0	6.5 to 8.5	7.2 to 7.8	In	No Change	In

6.2.1.3 Lake Tapps Reservoir

Analysis Method – Temperature

The STELLA model was used to predict the change in residence time and flushing rate that would occur for the Proposed Action as compared with the No Action Alternative. No quantitative analytical tools were available to estimate temperature in Lake Tapps Reservoir under No Action Alternative or Proposed Action conditions. Impacts were qualitatively estimated based on recent monitoring data and changes in residence time.

Results – Temperature

The Lake Tapps Reservoir daily flushing rate would be about 2.1% for the Proposed Action and about 1.4% for the No Action Alternative (Table 6-13). Flushing would increase by 47% under the Proposed Action. The flushing rate associated with both alternatives would be similarly small and would have a minor effect on algal growth; generally, a daily flushing rate of at least 5% to 10% is needed to decrease algae concentrations in lakes and reservoirs by flushing (Cooke et al. 1993; Horne and Goldman 1994). Algal concentrations in Lake Tapps Reservoir are low because phosphorus levels in the reservoir are low. Increased inflow to Lake Tapps Reservoir would not produce a dilution effect for phosphorus because the total phosphorus concentration of the inflow water is higher than total phosphorus in the reservoir (Welch 2006).

The Proposed Action would increase diversions into the reservoir and releases from the reservoir compared with the No Action Alternative. Lake Tapps Reservoir water levels under the Proposed Action would be similar to those under No Action Alternative conditions. The diversions and total phosphorus load to the reservoir under both No Action Alternative and Proposed Action conditions would be similar to what has occurred since 2004, when the reservoir water quality was improved compared with pre-2004 operations.

Although reservoir circulation would increase somewhat under the Proposed Action (compared with the No Action Alternative), inflows would still be very small compared with conditions during hydropower operations. Lake Tapps Reservoir temperature under Proposed Action conditions would be expected to be similar, or slightly lower than under No Action (see Table 6-12).

Table 6-12. Summary of Lake Tapps Reservoir Temperature Impacts

Water Body	State Standard (°C)	Baseline Value (°C)	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance
Lake Tapps Reservoir	May not increase the 7-day average daily max temperature more than 0.3 °C above natural conditions.	23	NA[7]	No Change	In

[7] Not applicable because compliance is measured as a change in conditions.

Table 6-13. Flushing Rate Predicted by the STELLA™ Model for the Proposed Action and the No Action Alternative

Monthly Lake Flushing Rate in 1/year
No Action

MONTH	WATER YEAR															Average	Range	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	%	Max	Min
10	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05
11	0.48	0.64	0.52	0.60	0.53	0.57	0.50	0.57	0.68	0.62	0.60	0.58	0.64	0.60	0.63	0.58	0.68	0.48
12	0.54	0.44	0.53	0.46	0.46	0.47	0.50	0.44	0.50	0.52	0.47	0.51	0.49	0.47	0.50	0.49	0.54	0.44
1	0.14	0.13	0.21	0.13	0.14	0.15	0.12	0.12	0.12	0.14	0.12	0.13	0.12	0.12	0.12	0.13	0.21	0.12
2	0.11	0.12	0.19	0.17	0.11	0.11	0.14	0.15	0.14	0.11	0.11	0.11	0.12	0.11	0.11	0.13	0.19	0.11
3	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.09	0.08
4	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.09	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.09	0.05
5	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05
6	0.05	0.04	0.05	0.04	0.05	0.05	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.05	0.04	0.05	0.05	0.04
7	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.04	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.04
Annual	1.36	1.46	1.48	1.45	1.38	1.42	1.36	1.41	1.60	1.48	1.43	1.43	1.47	1.42	1.47	**1.44**	1.60	1.36

Monthly Lake Flushing Rate in 1/year
Proposed Action

MONTH	WATER YEAR															Average	Range	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	%	Max	Min
10	0.08	0.08	0.08	0.09	0.09	0.07	0.09	0.08	0.10	0.08	0.09	0.09	0.08	0.09	0.07	0.08	0.10	0.07
11	0.72	0.93	0.66	0.90	0.71	0.78	0.68	0.81	0.99	0.92	0.90	0.78	0.93	0.90	0.93	0.84	0.99	0.66
12	0.31	0.23	0.31	0.22	0.24	0.25	0.26	0.25	0.26	0.32	0.26	0.30	0.27	0.22	0.28	0.27	0.32	0.22
1	0.20	0.20	0.34	0.21	0.22	0.19	0.19	0.19	0.20	0.26	0.26	0.27	0.24	0.18	0.25	0.23	0.34	0.18
2	0.18	0.19	0.25	0.17	0.17	0.20	0.19	0.15	0.18	0.17	0.19	0.20	0.21	0.29	0.19	0.20	0.29	0.15
3	0.12	0.12	0.09	0.09	0.08	0.13	0.09	0.11	0.08	0.10	0.10	0.09	0.09	0.30	0.09	0.11	0.30	0.08
4	0.11	0.10	0.09	0.13	0.08	0.14	0.08	0.08	0.15	0.09	0.08	0.08	0.09	0.11	0.09	0.10	0.15	0.08
5	0.11	0.08	0.10	0.10	0.08	0.11	0.08	0.08	0.10	0.09	0.09	0.09	0.10	0.08	0.09	0.09	0.11	0.08
6	0.12	0.09	0.12	0.11	0.10	0.13	0.09	0.10	0.10	0.12	0.11	0.12	0.12	0.10	0.12	0.11	0.13	0.09
7	0.14	0.10	0.14	0.14	0.10	0.14	0.10	0.11	0.10	0.14	0.14	0.14	0.14	0.10	0.14	0.12	0.14	0.10
8	0.15	0.11	0.15	0.15	0.11	0.15	0.11	0.13	0.13	0.15	0.15	0.15	0.15	0.11	0.15	0.14	0.15	0.11
9	0.12	0.09	0.11	0.11	0.07	0.10	0.08	0.10	0.10	0.12	0.11	0.11	0.11	0.09	0.12	0.10	0.12	0.07
Annual	2.09	2.05	2.05	2.14	1.76	2.14	1.74	1.91	2.18	2.01	2.17	2.07	2.19	2.21	2.19	**2.07**	2.21	1.74

Analysis Method – DO

The effects of the Proposed Action on DO in Lake Tapps Reservoir may also be estimated based on changes in residence time and flushing rate. In general, and particularly during the most critical period of the late summer (when the reservoir is stratified), the water diverted into Lake Tapps Reservoir has a higher DO level than the water in the reservoir itself because of the effects of algal growth. Under these conditions, increasing diversions into the reservoir and increasing overall releases from the reservoir (as occurs under Proposed Action conditions) may tend to raise the DO of the reservoir water somewhat.

Results – DO

Because the Proposed Action would result in an increase in Lake Tapps Reservoir flushing and a decrease in residence time, the Proposed Action would not be expected to have an adverse effect on DO in the reservoir (see Table 6-14).

Table 6-14. Summary of Lake Tapps Reservoir Dissolved Oxygen Impacts

Water Body	State Standard (mg/L)	Baseline Value (mg/L)	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance
Lake Tapps Reservoir	May not decrease DO conc. more than 0.2 mg/L below natural conditions.	2 to 9 (varies by depth)	NA[8]	No Change	In

Analysis Method – pH

The effects of the Proposed Action on pH in Lake Tapps Reservoir may be qualitatively estimated based on changes in residence time and flushing rate.

Results – pH

The changes in Lake Tapps Reservoir inflows and outflows under the Proposed Action would not be expected to have an adverse effect on pH in the reservoir (see Table 6-15).

[8] Not applicable because compliance is measured as a change in conditions.

Table 6-15. Summary of Lake Tapps Reservoir pH Impacts

Water Body	State Standard	Baseline Value	In or Out of Compliance	Proposed Action Effect	In or Out of Compliance
Lake Tapps Reservoir	6.5 to 8.5	NA	NA	No Change	NA

6.2.1.4 Summary of Direct Impacts and Compliance with Standards

This section summarizes the impacts of the Proposed Action on temperature, DO, and pH in each reach, as described in Sections 6.2.1.1 through 6.2.1.3 (see Tables 6-16, 6-17, and 6-18).

Table 6-16. Summary of Proposed Action Impacts and Compliance - Temperature

Water Body	Approximate RM Designation	State Standard (°C)	No Action Baseline Value (°C)	In or Out of Compliance	Proposed Action Value or Effect (°C)	In or Out of Compliance	Δ Baseline to Proposed Action (°C)
Reservation Reach	24.0 to 4.0	16 (7-DADMax)	17.8	Out	17.9	Out	<0.1 higher typically
	24.0 to 4.0	13 (7-DADMax from Sept. 15 to July 1)	15.8	Out	15.9	Out	<0.1 higher typically
Lower White River	4.0 to 0.0	17.5 (7-DADMax)	17.7	Out	17.9	Out	≤0.3 higher typically
Lower Puyallup River	10.1 to 1.0	16 (7-DADMax)	<15	In	No Change	In	No Change
Lake Tapps Reservoir	---	May not increase the 7-day average daily max temperature more than 0.3 °C above natural conditions.	23	NA	No Change	In	No Change

Table 6-17. Summary of Proposed Action Impacts and Compliance – Dissolved Oxygen

Water Body	Approximate RM Designation	State Standard/ Puyallup Tribe Standard (mg/L)	Baseline Minimum Value (mg/L) or Frequency	In or Out of Compliance	Proposed Action Value (mg/L) or Effect	In or Out of Compliance	Δ Baseline to Proposed Action (mg/L)
Reservation Reach	15.5	9.5	69% of values meet standard	Out	Small Change	Out	-0.01 lower typically
	4.9	9.5	96% of values meet standard	Out	Small Change	Out	-0.02 lower typically
Lower White River	4.0 to 0.0	8.0	8.0	In	No Change	In	No Change
Lower Puyallup River	10.1 to 1.0	9.5/ 8.0	9.7	In	No Change	In	No Change
Lake Tapps Reservoir	---	May not decrease DO conc. more than 0.2 mg/L below natural conditions.	2 to 9 (varies by depth)	NA	No Change	In	No Change

Table 6-18. Summary of Proposed Action Impacts and Compliance - pH

Water Body	Approximate RM Designation	State Standard	Baseline Value	In or Out of Compliance	Proposed Action Value or Effect	In or Out of Compliance	Δ Baseline to Proposed Action
Reservation Reach	24.0 to 4.0	6.5 to 8.5	7.1 to 8.4	In	No Change	In	No Change
Lower White River	4.0 to 0.0	6.5 to 8.5	7.0 to 8.3	In	No Change	In	No Change
Lower Puyallup River	10.1 to 1.0	6.5 to 8.5	7.2 to 7.8	In	No Change	In	No Change
Lake Tapps Reservoir	---	NA	NA	NA	No Change	In	No Change

6.2.2 Indirect and Cumulative Impacts

As shown in Tables 6-16, 6-17, and 6-18, only minor or no direct impacts to surface water quality are predicted for either the Proposed Action or the No Action Alternative. Therefore, no indirect or cumulative impacts resulting from the direct impacts to surface water quality would be anticipated under the Proposed Action or the No Action Alternative.

6.3 Mitigation Measures

While the Project would not result in significant direct, indirect, or cumulative adverse impacts to surface water quality, Cascade would provide the mitigation measures listed in Table S-1 (Summary) and Section 1.4 of this Draft EIS.

6.4 Significant and Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to surface water quality would be anticipated under the Proposed Action or the No Action Alternative.

Chapter 7: Groundwater

This chapter describes how groundwater (that is, the water below the ground surface that is free flowing within pore spaces and fractures) could be affected by the Proposed Action and the No Action Alternative. Groundwater is important because it flows into and, therefore, affects other water bodies, and because it is withdrawn through extraction wells for municipal, agricultural, and industrial use.

Groundwater Terms

Aquifer: An underground geologic layer of saturated soil or rock that that can yield significant quantities of water on a long-term basis.

Confining unit: A layer of lower-permeability material that overlies an aquifer. Sometimes called an aquitard.

Groundwater discharge: Removal of groundwater from an aquifer (for example, by pumping at a well).

Groundwater recharge: The process where natural sources (infiltrating rain, snowmelt, or surface water) or pumped water enters and replenishes the groundwater supply.

Group A wells: Groundwater wells that serve 15 or more households.

Group B wells: Groundwater wells that serve 2 to 14 households.

Hydrogeology: The distribution and flow of groundwater.

7.1 Affected Environment

7.1.1 Study Area

The study area for groundwater resources, shown in Figure 7-1, includes the upland areas around Lake Tapps Reservoir and portions of the White and Puyallup River valleys. The surface topography of the study area ranges from about elevation 600 feet on the plateau where Lake Tapps Reservoir is located to about elevation 50 feet in the Puyallup River valley west of the reservoir. The study area includes the regional groundwater recharge areas, aquifers, and discharge zones that could be affected by the Proposed Action.

7.1.2 Regional Geology

Bedrock

Sedimentary and volcanic bedrock underlies glacial deposits in the study area. Bedrock is present from an elevation of about -600 feet on the west side of Lake Tapps Reservoir to about -1,200 feet in the area where the White River flows into the Puyallup River (Jones 1999).

Glacial and Interglacial Deposits

The lower reaches of the White River and Puyallup River flow through the Auburn–Kent valley, which was created by glacial advances and meltwater erosion during the Pleistocene glaciation (Booth and Goldstein 1994). The Pleistocene glaciation formed most of the observable geologic features in the region.

Six glacial episodes, which involved the advance and retreat of glaciers, occurred during the Pleistocene glaciation. Each episode was separated by interglacial periods (Woodward et al. 1995). Strata of variable thickness were deposited during each glacial and interglacial period, and some of these deposits were eroded or reworked during subsequent glaciations. The total thickness of glacially-deposited sediments above bedrock is estimated to be up to 1,500 feet.

The most recent glacial episode that occurred in the region was the Vashon Stade of the Fraser Glaciation (Booth and Goldstein 1994). The major Vashon Stade glacial deposits are described below, and their distribution in the study area is shown in Figure 7-2.

- **Vashon Recessional Outwash (Qvr)** – Vashon Recessional Outwash is a poorly sorted mixture of fluvially-deposited sand and gravel. Recessional outwash is less dense than other Vashon Stade glacial deposits because it was deposited during the last glacial retreat and was not compacted by the advancing glacier. Recessional outwash deposits are generally not present on the plateau where Lake Tapps Reservoir is located.
- **Vashon Glacial Till (Qvt)** – Vashon Glacial Till is a very dense mixture of silt, sand, and angular to sub-angular gravel that was compacted by advancing glaciers. Thick deposits of glacial till mantle the plateau occupied by Lake Tapps Reservoir, and impede the downward migration of water.

Geologic Terms

Advance outwash: A very dense, stratified deposit of sand and gravel deposited at the front of advancing glaciers.

Alluvium: Sediment deposited by water.

Glaciation: The process of ice growth and retreat within a glacier.

Meltwater: Water that comes from melting snow and ice.

Pleistocene: A geologic epoch about 2.6 million to 10,000 years ago, characterized by repeated glaciations.

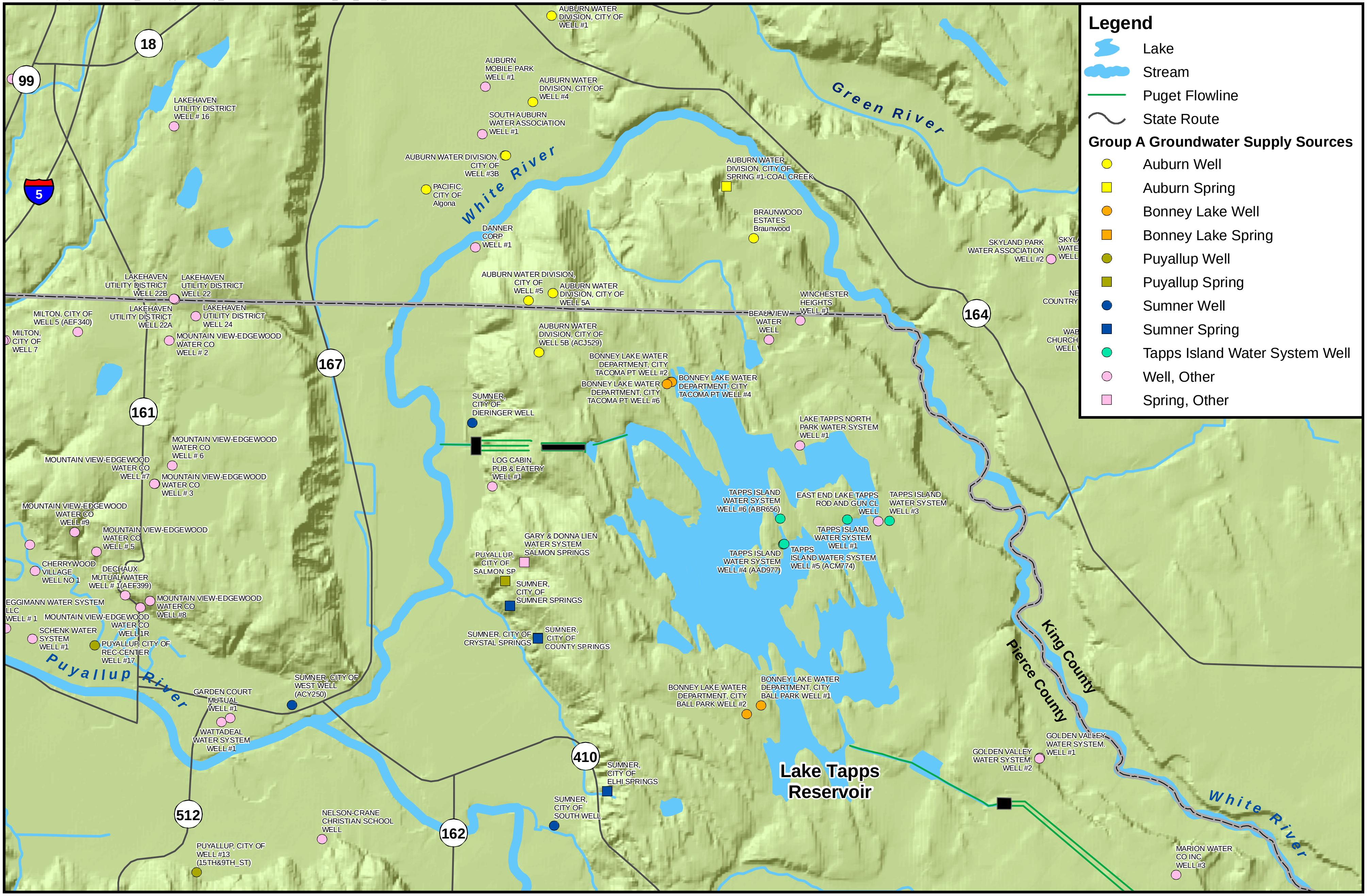
Recessional outwash: Stratified sand and gravel deposited at the front of retreating glaciers.

Stade: A period within a glacial retreat marked by glacial re-advance.

Strata: Beds or layers of sedimentary rock that are visually distinguishable from other layers.

Till: A dense, non-sorted, non-stratified deposit of silt, sand, gravel, and occasional boulders deposited by a glacier.

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Groundwater\7-1_GW_Study_Area.mxd - 8/20/2009 @ 10:32:56 AM



Source: DOH, 2008

0 0.5 1 2
Miles

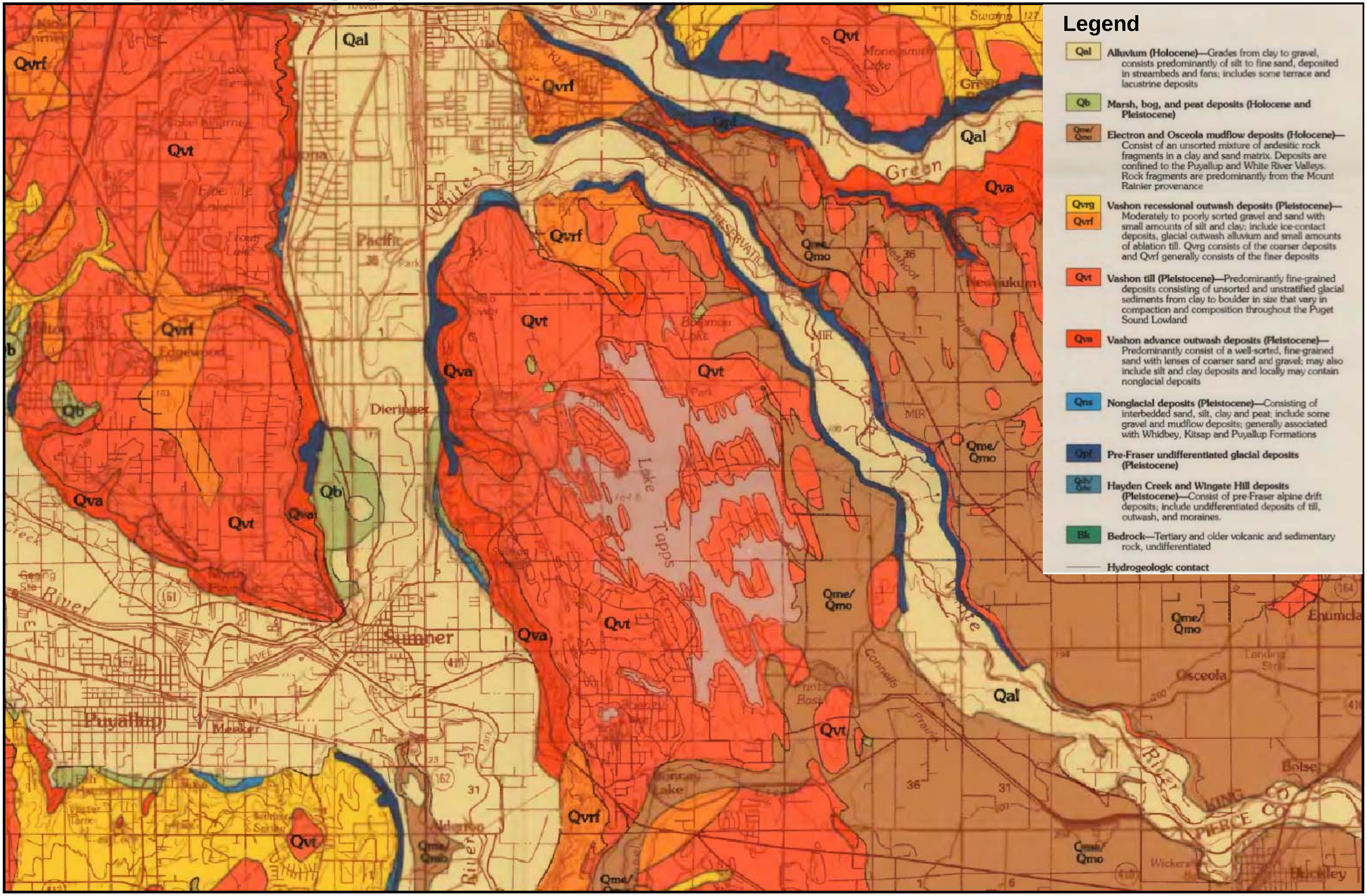
CASCADE WATER ALLIANCE

Figure 7-1

Groundwater Study Area

Lake Tapps Reservoir Water Rights and Supply Project

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Groundwater\7-2_Surficial_geology.mxd - 8/20/2009 @ 10:40:55 AM



Source: Jones, 1999

Figure 7-2

Surficial Geology of the Study Area

Lake Tapps Reservoir Water Rights and Supply Project

- **Vashon Advance Outwash (Qva)** – Vashon Advance Outwash is a poorly sorted mixture of sand and gravel that was deposited by meltwater streams originating from the front and margins of advancing glaciers. Advance outwash is denser than recessional outwash because it was compacted by the weight of the advancing glacier. Advance outwash deposits generally form the uppermost aquifer on the plateau where Lake Tapps Reservoir is located.

A sequence of older pre-Vashon glacial and interglacial sediments is present underlying the Vashon Advance Outwash. These units are typically grouped together according to sediment composition, rather than glacial origin (Woodward et al., 1995), as listed below.

- Upper Fine-Grained Unit (Q(A)f)
- Upper Coarse-Grained Unit (Q(A)c)
- Lower Fine-Grained Unit (Q(B)f)
- Lower Coarse-Grained Unit (Q(B)c)

Post-Glacial Deposits

Following glaciation, the valley was inundated with marine water and filled with older sediment approximately 13,000 to 5,000 years before present (ybp). As the sea level lowered and the land surface rose due to recession of the glacier, much of the valley became exposed (Dragovich et al. 1994). Younger (post-glacial) alluvial and deltaic deposits were deposited by the Puyallup River near Pacific and Auburn and by the Green River near Auburn. Mount Rainer volcanism deposited the Osceola Mudflow about 6,000 ybp, which is present below the ground surface in the valley and at the surface in the eastern portion of the study area. Recent alluvium is present throughout the river valleys in the near-surface deposits.

7.1.3 Hydrogeology

This section describes the major aquifers and confining units in the study area. The aquifers and confining units are described in order from oldest to youngest. Figures 7-3 and 7-4 show the Group A and Group B wells that draw from the aquifers in the area, as well as the locations of the hydrogeologic cross-sections (the cross-sections are shown in Figures 7-5, 7-6, and 7-7).

Lake Tapps Reservoir Uplands Area

Major aquifers and confining units in the Lake Tapps Reservoir uplands area are as follows:

- **Unconsolidated/Undifferentiated Deposits (Q(C)u)** – This unit of pre-Vashon interglacial origin contains a series of deep confining units and confined aquifers. This aquifer supplies water for some deep municipal supply wells in the study area, including those owned by Pacific.

- **Lower Coarse-Grained Unit (Q(B)c)** – This deep confined aquifer of pre-Vashon glacial origin is composed of sand and gravel with a thickness ranging from 100 to 300 feet. This aquifer is used for water supply by several wells in the study area, including Auburn's Well 5, Well 5A, and Well 5B in the area north of Lake Tapps Reservoir. The wells range in depth from 330.5 feet to 738 feet.

- **Lower Fine-Grained Unit (Q(B)f)** – This is a lower confining unit composed of fine-grained sediments; the unit is present throughout most of the study area.

- **Upper Coarse-Grained Unit (Q(A)c)** – This confined aquifer is of pre-Vashon glacial origin and is used extensively for domestic and municipal water supplies in the vicinity of the study area. The aquifer typically ranges from less than 100 feet to over 200 feet thick. Well yields typically range from about 350 to over 1,000 gallons per minute (gpm). Wells owned by Bonney Lake, Tapps Island Water System, and other water supply systems are completed in this aquifer. Portions of this aquifer extend from the Lake Tapps Reservoir Uplands to the area beneath, north, and west of the White River and Puyallup River valleys.

- **Upper Fine-Grained Unit (Q(A)f)** – The Upper Fine-Grained Unit is a regional confining unit composed of silt, sand, and clay with a thickness ranging from less than 50 feet to over 100 feet. This confining unit is present throughout most of the Lake Tapps Reservoir Uplands. Wells are not typically completed in this unit, although discontinuous sand and gravel lenses can yield small quantities of water.

- **Vashon Advance Outwash (Qva)** – Vashon Advance Outwash is a confined or semi-confined aquifer underlying the Qvt with a thickness ranging from less than 50 feet to over 100 feet in the study area. Portions of the Qva are directly underlain by the Q(A)c, forming a single aquifer (the Qva/Q(A)c). Within the study area, the Qva/Q(A)c aquifer is present in the southwest and northeast portions of the Lake Tapps Reservoir Uplands. Coal Creek Springs discharges up to 6.5 million gallons per day (mgd) from the Qva/Q(A)c aquifer (PGG 1999).

- **Vashon Till (Qvt)** – Vashon Till is present at or near the surface in most of the Lake Tapps Reservoir Uplands. It ranges from approximately 50 feet to more than 100 feet thick and acts as a regional confining unit. Vashon Till is extremely dense and impedes water infiltrating from the surface. The regional hydrogeologic study for the City of Auburn (PGG 2000) estimated a horizontal hydraulic conductivity of about 3.0 x 10^{-4} to 3.0 x 10^{-1} feet/day and a vertical hydraulic conductivity of 3.0 x 10^{-6} to 3.0 x 10^{-3} feet/day for Vashon Till. Small units of discontinuous coarse-grained materials are irregularly interbedded in this unit, which yield small quantities of water extracted in areas of the Lake Tapps Reservoir Uplands for domestic well supply (PGG 1999).

White and Puyallup River Valley Area

Alluvial aquifers are present in the White River and Puyallup River valleys. The younger and older alluvium has filled the ancestral glacial valleys, creating buried river valley aquifers. There is an overlying coarse-grained facies and a lower finer-grained facies. These aquifers may be unconfined in some places, although the deeper and older aquifer deposits may be semi-confined or confined by low-permeability sedimentary deposits. The Osceola Mudflow is a low-permeability unit that acts as a confining unit.

Terms

Cavitation: The formation of bubbles in a liquid and their sudden collapse, which can cause damage in a pump.

Facies: A distinct rock unit for an area or environment; the rock unit's characteristics (for example, grain size) are based on its depositional environment.

Gaining reach: A section of a stream that is gaining flow from groundwater.

Hydraulic conductivity: The ease with which water can move through pore spaces and fractures.

Hydraulic gradient: The slope of the water table or potentiometric level, or the change in hydraulic head over the distance between the two monitoring wells.

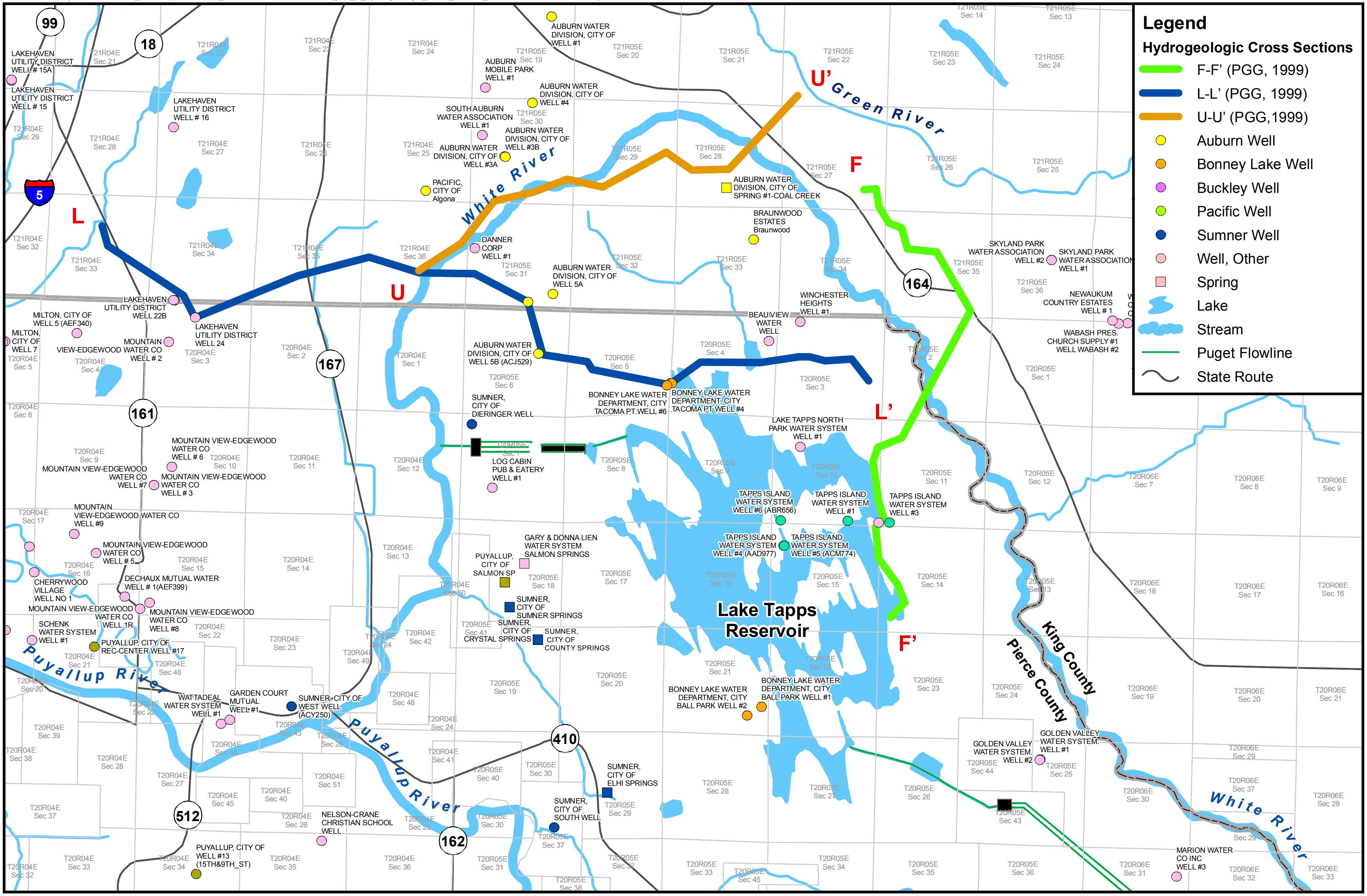
Hydraulic head: A measurement of water pressure above a datum. This measurement can be used to determine a hydraulic gradient between two or more points.

Losing reach: A section of a stream where water moves from the stream into the bed and banks to groundwater.

Potentiometric level: The top of the saturated zone when the aquifer is overlain by a confining unit.

This page intentionally left blank.

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Groundwater\7-3_Gp_A_hydrogeologic_cross_section_locations.mxd - 8/20/2009 @ 10:43:28 AM



Source: DOH, 2008

0 0.5 1 2
Miles

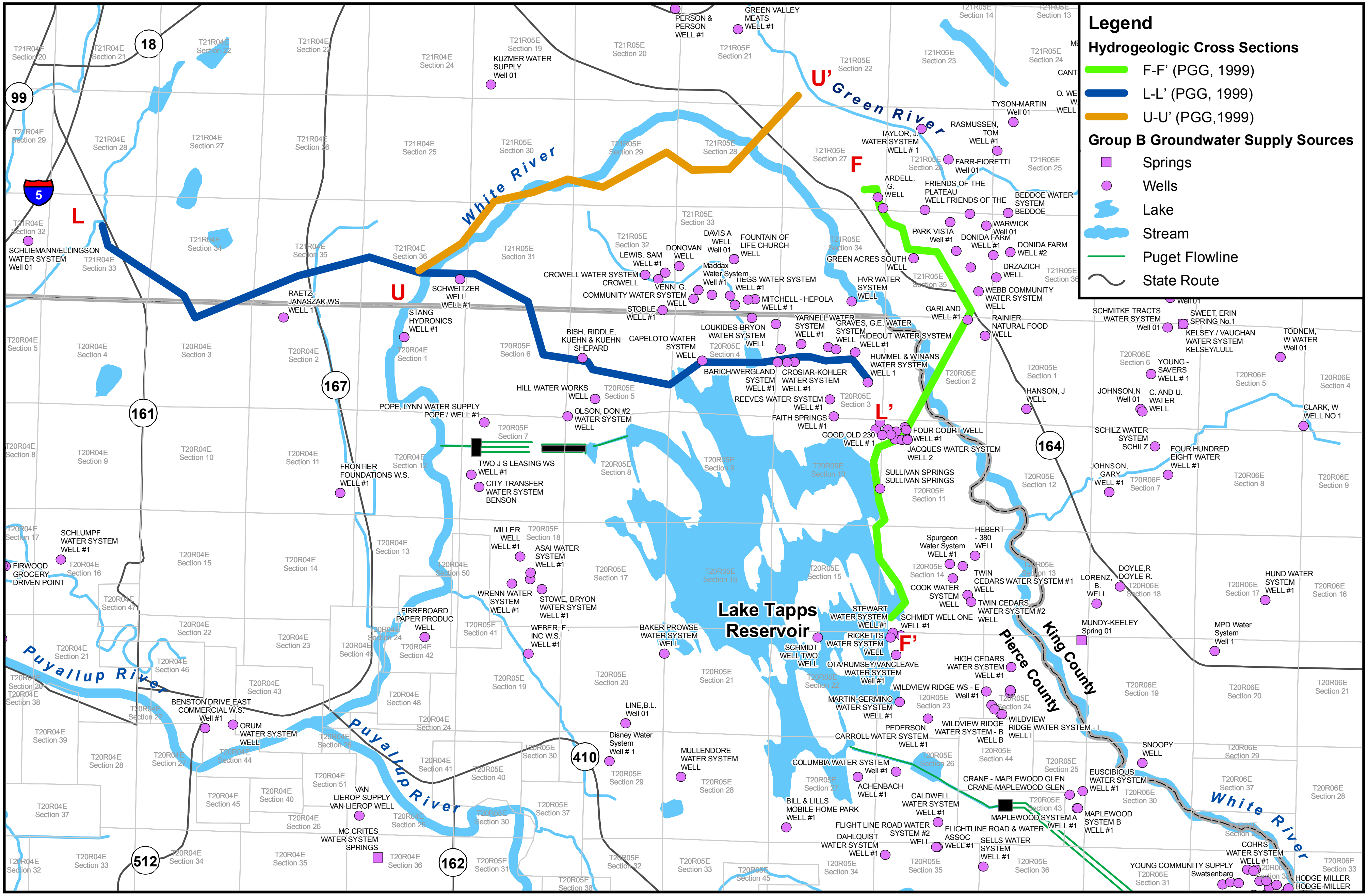
CASCADE WATER ALLIANCE

Figure 7-3

Group A Groundwater Source Locations and Hydrogeologic Cross-Sections

Lake Tapps Reservoir Water Rights and Supply Project

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Groundwater\7-4_Gp_B_hydrogeologic_cross_section_locations.mxd - 8/20/2009 @ 10:47:42 AM



Source: DOH, 2008

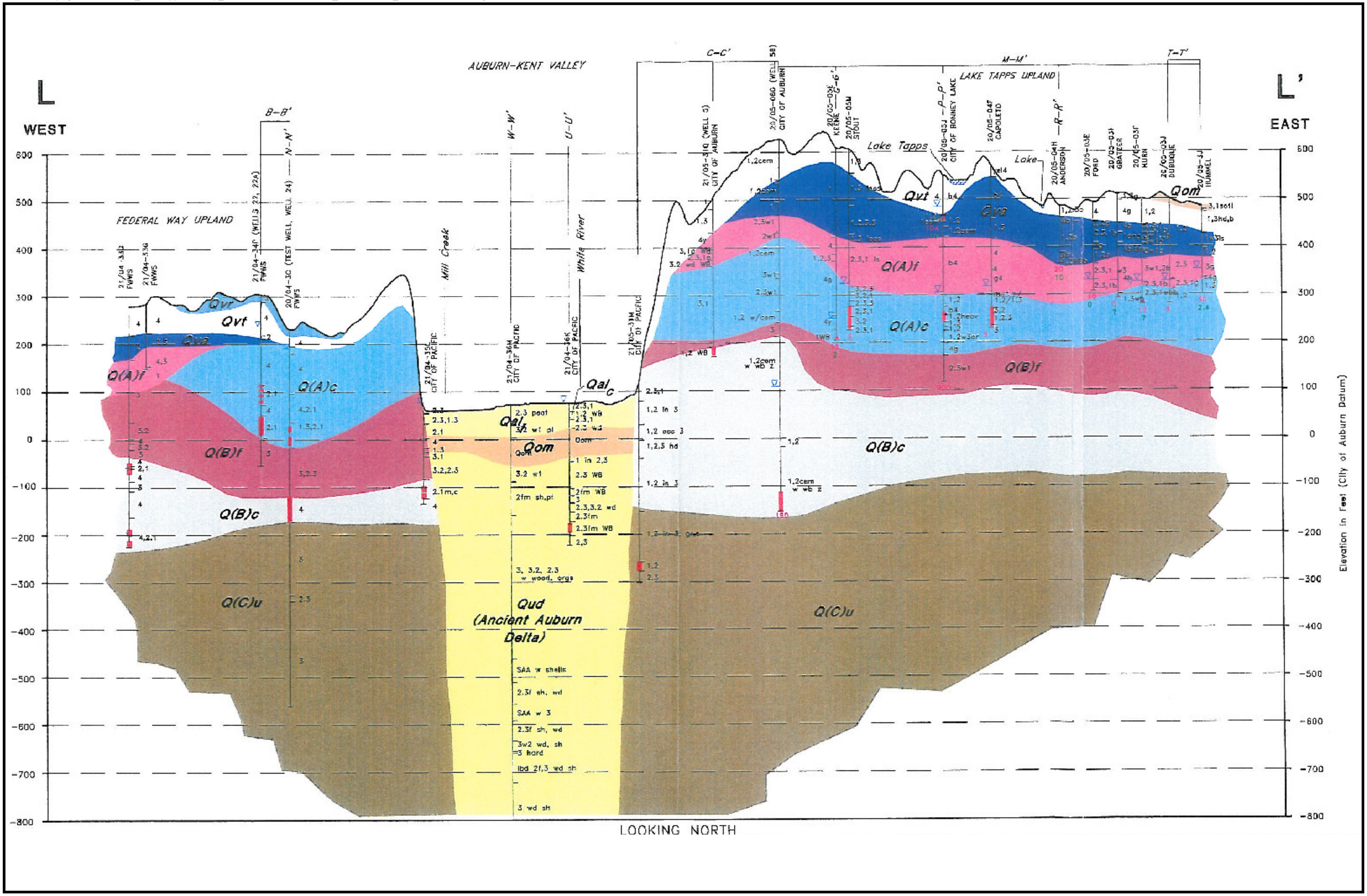
0 0.5 1 2
Miles

CASCADE WATER ALLIANCE

Figure 7-4

Group B Groundwater Source Locations and Hydrogeologic Cross-Sections

Lake Tapps Reservoir Water Rights and Supply Project



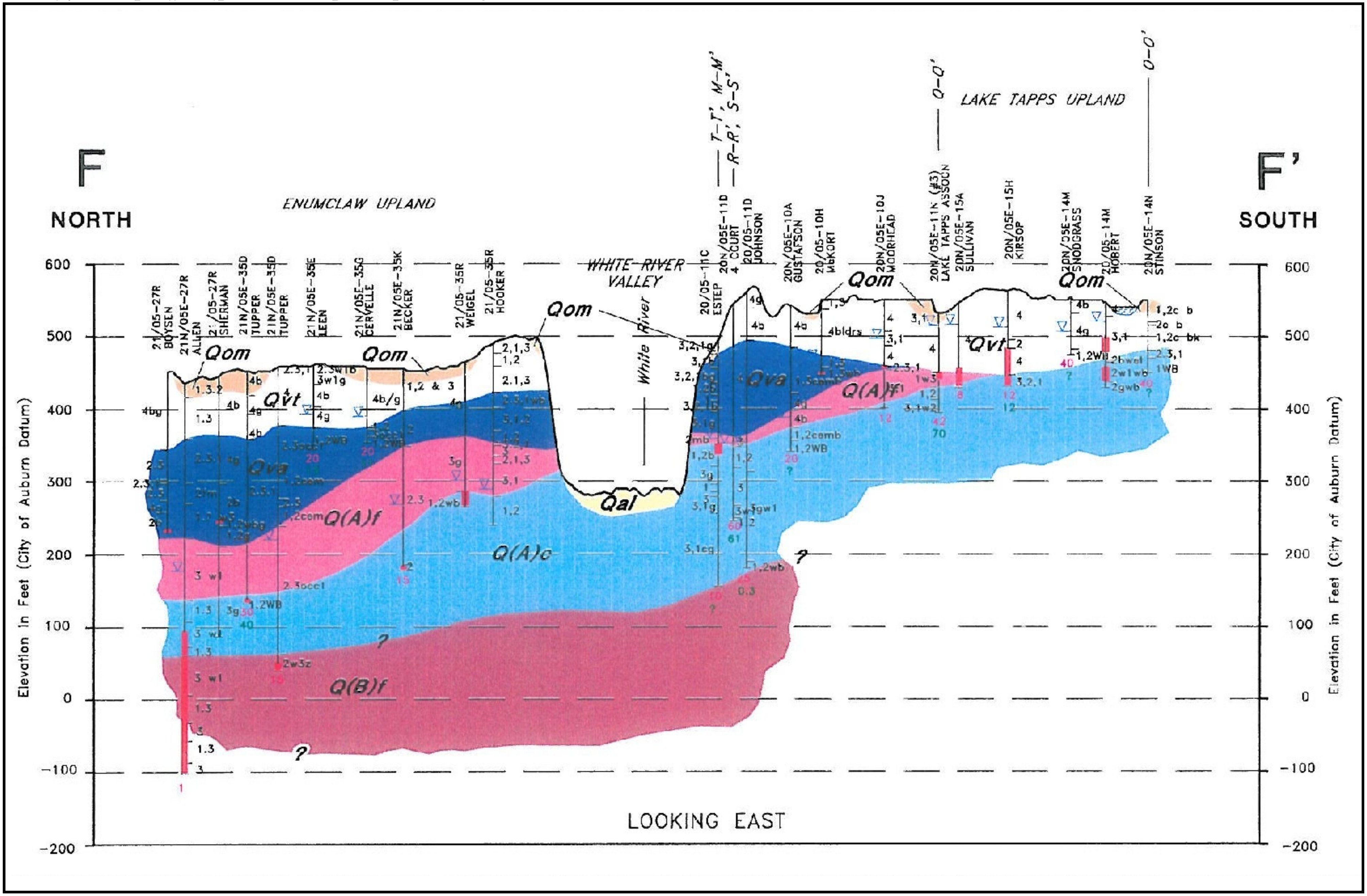
Source: PGG, 1999

Figure 7-5

Hydrogeologic Cross-Section L-L'

Lake Tapps Reservoir Water Rights and Supply Project

CASCADE WATER ALLIANCE

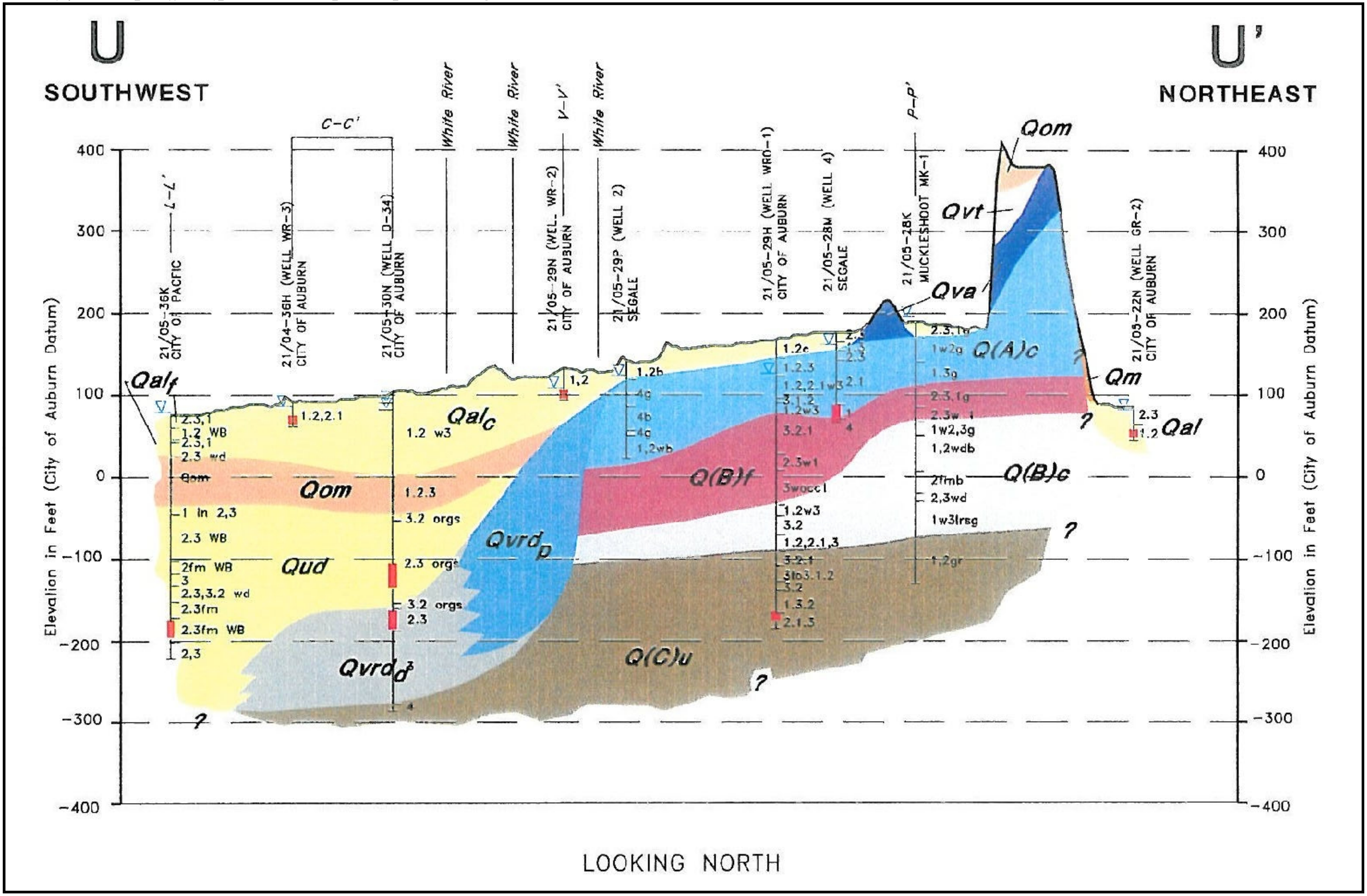


Source: PGG, 1999

Figure 7-6

Hydrogeologic Cross-Section F-F'

Lake Tapps Reservoir Water Rights and Supply Project



Source: PGG, 1999

Figure 7-7

Hydrogeologic Cross-Section U-U'

Lake Tapps Reservoir Water Rights and Supply Project

CASCADE WATER ALLIANCE

7.1.4 Groundwater Recharge, Flow Paths, and Discharge

Recharge

The aquifers underlying the Lake Tapps Reservoir Uplands receive recharge from seepage from Lake Tapps Reservoir and from precipitation. The components of recharge in the Lake Tapps Reservoir Upland are quantified below:

- Total mean annual groundwater recharge in the Lake Tapps Reservoir Uplands is estimated at approximately 42 mgd, or 65 cubic feet per second (cfs) (PGG 1999). This estimate was developed using a methodology based on soil types, land use, land cover, and precipitation data specific to southwest King County (Woodward et al., 1995).

- Annual seepage from Lake Tapps Reservoir to groundwater sources is estimated to be between 2.4 and 14.5 mgd (PGG 1999). Seepage from the reservoir contributes an estimated 6% to 35%, or an average of 19%, of the total groundwater recharge from the Lake Tapps Reservoir Uplands (PGG 1999).

- Seasonal changes in reservoir water levels can cause slight fluctuations in seepage from the reservoir. Analysis of average water level data recorded between 1996 and 2000 shows a seasonal variation of seepage rates from the reservoir of approximately +/- 3% (HDR and Golder 2002). This relatively small seasonal fluctuation in seepage rates is due to low hydraulic conductivity of the underlying Vashon Till and the relatively minor difference in hydraulic head associated with changes in reservoir level compared with the large vertical gradient between the groundwater table and the aquifer.

Groundwater in the Lake Tapps Reservoir Uplands has a strong downward vertical gradient, with leakance through the Vashon Till recharging the underlying aquifer. A component of recharge from aquifers to the southeast of Lake Tapps Reservoir may also be present.

The aquifers in the White River and Puyallup River valleys receive recharge from precipitation and seepage from the Lake Tapps Reservoir Uplands (Woodward et al. 1995). The alluvial aquifer also receives recharge from the losing reaches of the White River and Puyallup River (PGG 1999).

Groundwater Flow Paths and Discharge

Groundwater generally flows radially outward from Lake Tapps Reservoir in the Qva and Q(A)c aquifers toward the White River and Puyallup River, as shown in Figures 7-8 and 7-9. Figure 7-10 is a conceptual drawing of interactions between surface water and groundwater in the study area. Groundwater discharges to the White River and Puyallup River, and also discharges to several springs in the study area, as discussed below (HDR and Golder 2002).

- **Coal Creek Springs** – This spring, located at the northern edge of the Lake Tapps Reservoir Uplands, is used for water supply by Auburn. Coal Creek Springs discharges at a rate of approximately 4,200 gpm (Luzier 1969; PGG 1999).

- **West Hill Spring** – This spring is used by Auburn for water supply. Based on Auburn's water right, West Hill Spring discharges at a rate of about 1,000 gpm (Ecology 2008e).

- **Salmon Springs** – Salmon Springs A, located at the southwest edge of the Lake Tapps Reservoir Uplands, discharges at a rate of approximately 1,200 gpm (Walters and Kimmel 1968; PGG 1999). Salmon Springs B discharges at a rate of approximately 3,600 gpm (Walters and Kimmel 1968).

- **Sumner Springs, Crystal/County Springs, and Elhi Springs** – Sumner uses three spring fields: Sumner Springs, Crystal/County Springs, and Elhi Springs (City of Sumner 2008). These springs discharge along the valley wall downslope of the plateau where Lake Tapps Reservoir is located.

- **Grainger Springs and Victor Falls Springs** – Bonney Lake uses two springs – Grainger Springs and Victor Falls Springs – with a reported yield of 4,050 gpm (Central Puget Sound Water Suppliers' Forum 2001; City of Bonney Lake 2008c).

Although smaller springs in the area discharge some of the groundwater collected from the Lake Tapps Reservoir Uplands, the springs listed above account for a majority of the spring discharge from the Lake Tapps Reservoir Uplands, with an estimated total of approximately 14,000 gpm. Flows from these springs are generally constant and constitute approximately 47% of the estimated total groundwater recharged from the Lake Tapps Reservoir Uplands (HDR and Golder 2002).

Gaining and Losing River Reaches

White River

The White River receives some groundwater originating from the Lake Tapps Reservoir Upland. PGG (1999) estimated that groundwater discharge was about 0.24 mgd per mile from the east edge of the Lake Tapps Reservoir Upland, and about 0.15 mgd from the west edge of the Lake Tapps Reservoir Upland.

Groundwater may discharge to the White River when the hydraulic groundwater potentiometric level is higher than the stream level (this is a gaining stream), whereas surface water may recharge aquifers when the groundwater potentiometric level is lower than the stream stage (this is a losing stream). The magnitude of groundwater recharge or discharge is controlled by the hydraulic gradient, the conductance of the streambed, and the hydraulic conductivity and degree of hydraulic connection between an aquifer and a river.

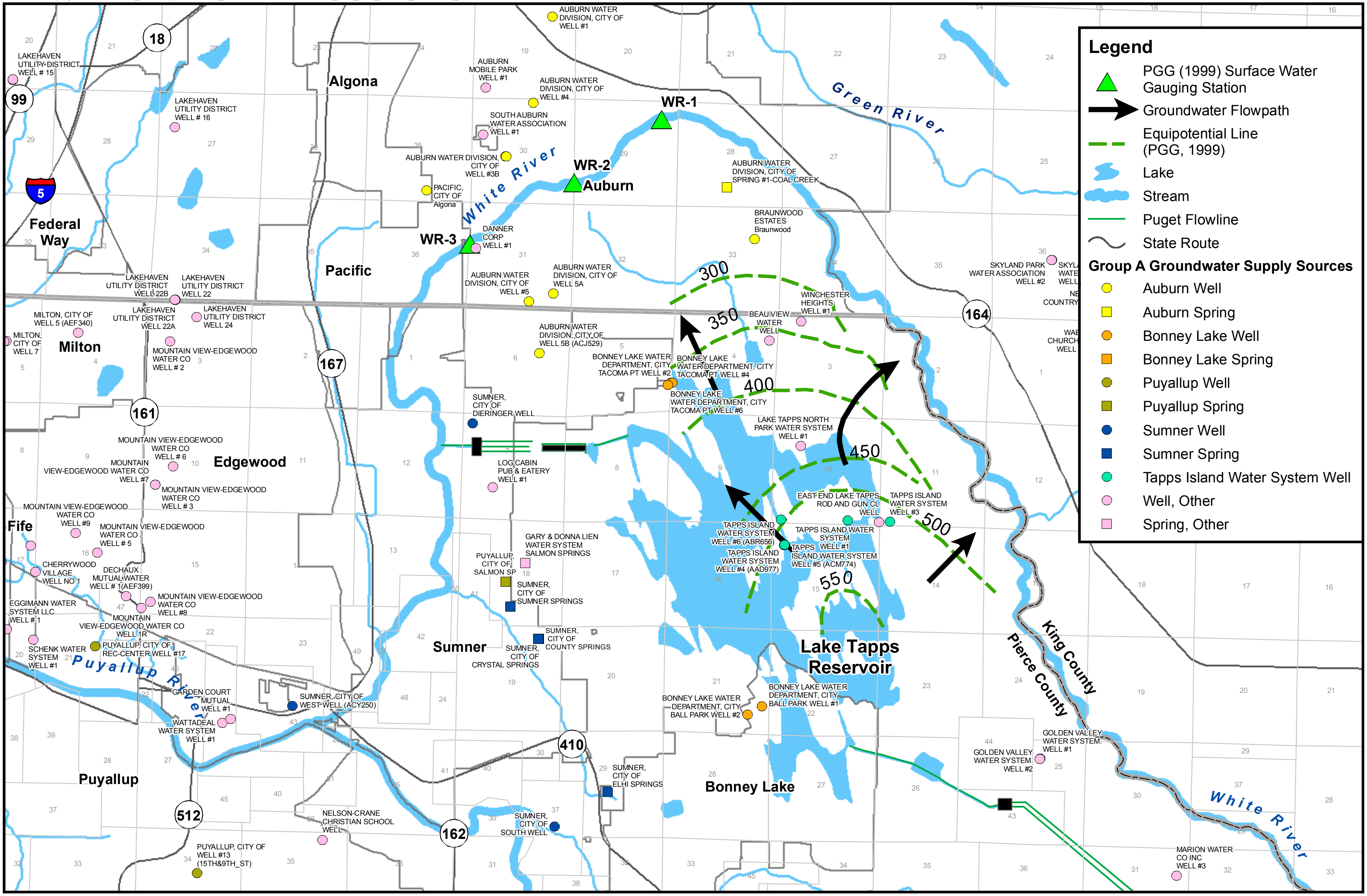
PGG (1999) monitored stream and groundwater elevations at three locations along the Reservation Reach of the White River. These monitoring locations are shown in Figures 7-8 and 7-9 and the findings are summarized below.

- **WR-1** – This monitoring station is located just upstream of Auburn's Game Farm Park. Measurements indicate that groundwater discharges to the White River at this location during the winter and is recharged by the river in the summer.
- **WR-2** – This station is located just upstream of Auburn's Roegner Park. Measurements indicate that groundwater is recharged by the White River during both summer and winter conditions. The proximity of this site to Auburn's wells suggests that pumping during the summer may depress groundwater levels below the level of the river, causing induced recharge of the groundwater system from the White River.
- **WR-3** – This station is located just downstream of the A Street SE bridge. Measurements indicate that groundwater discharges to the White River at this location throughout the year.

The available data indicate a complex hydrologic connection between the White River and the shallow aquifer, including gaining and losing reaches; however, detailed information is not available.

This page intentionally left blank.

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Groundwater\7-8_GW_flow_vashon_advanced_outwash.mxd - 8/20/2009 @ 10:56:03 AM



Source: DOH, 2008; HDR, Inc. and Golder Associates, 2002

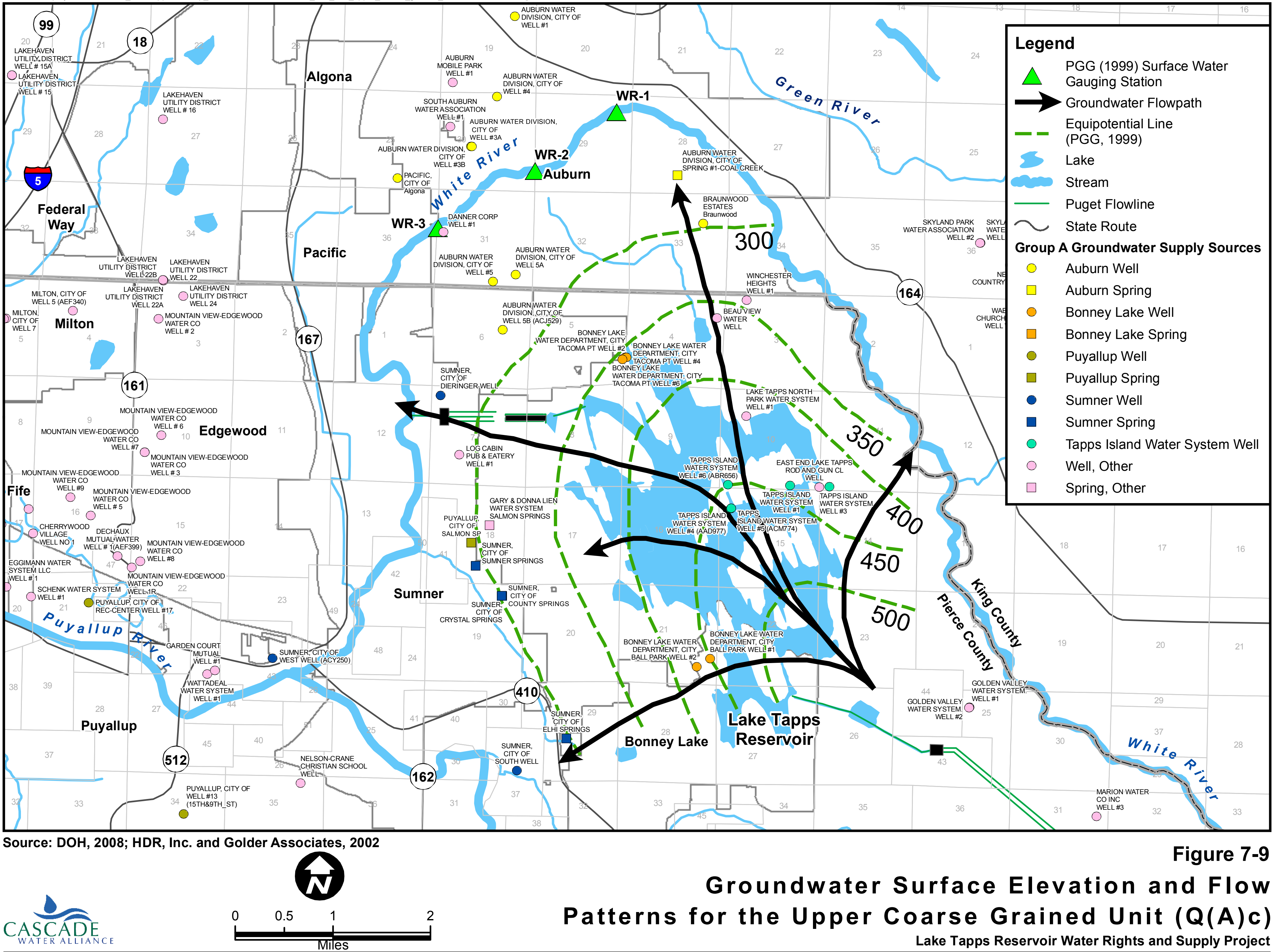
0 0.5 1 2 Miles

Figure 7-8

Groundwater Surface Elevation and Flow Patterns for the Vashon Advanced Outwash (Qva)

Lake Tapps Reservoir Water Rights and Supply Project

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\Groundwater\7-9_GW_flow_upper_coarse_grained_unit.mxd - 8/20/2009 @ 12:37:21 PM



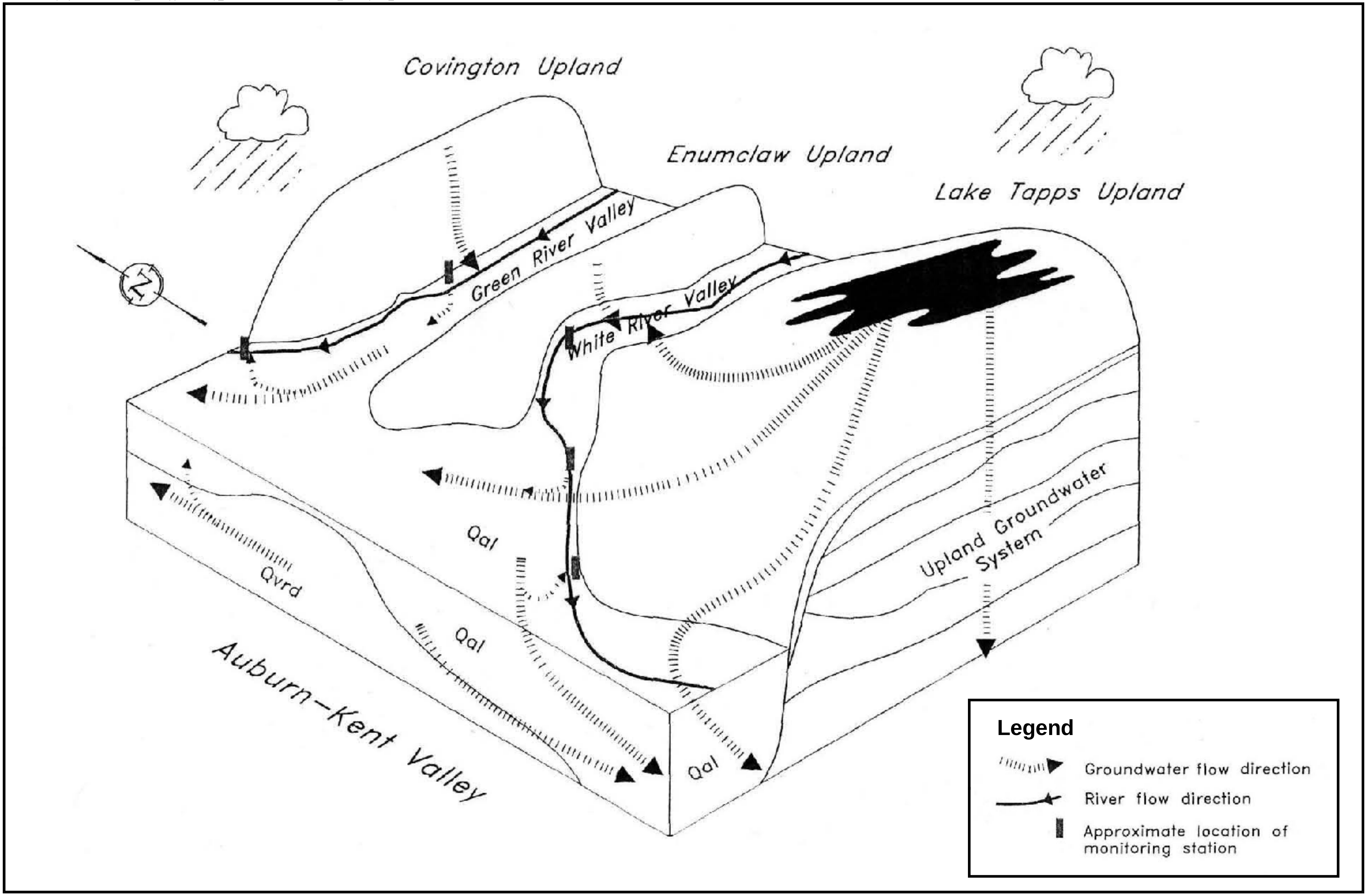
Source: DOH, 2008; HDR, Inc. and Golder Associates, 2002

CASCADE WATER ALLIANCE

Figure 7-9

Groundwater Surface Elevation and Flow Patterns for the Upper Coarse Grained Unit (Q(A)c)

Lake Tapps Reservoir Water Rights and Supply Project



Source: PGG, 1999

Figure 7-10

Conceptual Groundwater and Surface Water Flow in the Auburn-Kent Valley

Lake Tapps Reservoir Water Rights and Supply Project

7.1.5 Groundwater Quality

Groundwater quality in the study area is generally high. PGG (1999) reported the quality of water in the Qalc and Qvrd aquifers as excellent. Purveyors of groundwater within the study area report clean and safe drinking water from their wells and springs. Annual reports show post-treatment water quality of drinking water pumped from study area aquifers meets or surpasses all standards regulated by the U.S. Environmental Protection Agency and the Washington State Department of Health (City of Auburn 2007; City of Sumner 2008; City of Bonney Lake 2008c).

7.1.6 Groundwater Use and Water Rights

Groundwater from the Lake Tapps Reservoir Uplands and White River and Puyallup River valley aquifers provides a water supply for municipalities, water companies, various private wells, and other domestic users. Major purveyors of groundwater in the study area include Auburn, Sumner, Bonney Lake, Puyallup, and the Tapps Island Water System. Additional groundwater appropriations in the area are constrained by the Instream Resources Protection Program (WAC 173-510), which requires a determination to be made as to whether the proposed withdrawal will directly affect stream flows in streams for which closures and instream flows have been adopted, including streams within the study area (WAC 173-510-040).

Major Public Water Systems

Auburn

A majority of Auburn's water supply is extracted from the aquifers underlying the Auburn-Kent Valley and Coal Creek Springs. Water rights associated with these supply sources are summarized in Table 7-1. See Figure 7-1 for Auburn's well and spring locations. Table 7-2 lists Auburn's well construction details and provides information about its springs. The depth of Auburn's wells range from 330.5 feet to 738 feet below top of casing.

Table 7-1. City of Auburn Groundwater Rights

Production Well / Spring	Water Right Certificate or Permit Number	Quantity Annual – Qa (gpm)
Well 1	GW Cert. 3560	1,120
Well 2	G1-00277 C	3,840
Well 3A	G1-23629 C	3,600[a]
Well 3B		
Well 4	G1-20391 C	3,600
Well 5	G1-23633 C	720
Well 5A	G1-25518 P	187 (supplemental right)
Well 5B		
Well 6[b]		
Well 7[b]		
Braunwood (Satellite Well)	G1-25173 C	7
Algona (Satellite Well)	G1-22769 P	109
CCS (Coal Creek Springs)	SW Cert 857	9,410
WHS (West Hill Spring)	Claim	1,010

[a] Wells 3A and 3B permitted jointly.
[b] Supplemental to Wells 1, 2, 3A, 3B, and 4.
Source: PGG 1999

Table 7-2. City of Auburn Well and Spring Details

Production Well / Spring	Hydrogeologic Unit	Well Depth	Top of Screen	Bottom of Screen	Static Groundwater Depth	Pumping Groundwater Depth	Pump Intake Depth
		Feet below Top of Casing					
Well 5	Q(B)c	330.5	311.5	328.5	249.8	276.7	300
Well 5A	Q(B)c	570	510	570	401.7	475.6	530
Well 5B	Q(B)c	738	708	738	476.2	662.2	692.5
Braunwood (Satellite Well)	Q(A)c	NAv[1]	NAv	NAv	NAv	NAv	NAv
Algona (Satellite Well)	Qal	NAv	NAv	NAv	NAv	NAv	NAv
CCS (Coal Creek Springs)	Qva/Q(A)c/Qal						
WHS (West Hill Spring)	Qva						

[1]NAv = not available

Sumner

Sumner's primary water supply comes from three spring fields (Sumner Springs, Crystal Springs/County Springs, and Elhi Springs) located east of the White River. During peak demand periods, groundwater is extracted from three wells: South Well; Dieringer Well; and West Well (City of Sumner 2008). See Figure 7-1 for the well and spring locations. Table 7-3 summarizes the water rights associated with these sources. Table 7-3 lists Sumner's well construction details and provides information on Sumner's springs.

Table 7-3. City of Sumner Groundwater Rights

Production Well / Spring	Water Right Certificate or Permit Number	Quantity Annual – Qa (gpm)
Salmon Springs	S2-15000	1,008
Salmon Springs	S2-21979 C	900
Elhi Springs	Claim	100
Crystal Springs/ County Springs	Claim	675
Dieringer Well	G2-03584 C	6.25
South Well	G2-23281 C	800
West Well[a]	G2-21980 C	100

[a] This well primarily provides irrigation water, although it may be used as an emergency drinking water supply.

Source: Ecology 2008e

Table 7-4. City of Sumner Well and Spring Details

Production Well / Spring	Hydrogeologic Unit	Well Depth	Top of Screen	Bottom of Screen	Static Groundwater Depth	Pump Intake Depth
		Feet below Top of Casing				
Dieringer Well	Qal	320	207	310		160
South Well	Qal	304	278	304	6.33	100
West Well[a]	Qal	280	270	280		35
Salmon Springs	Q(A)c					
Elhi Springs	Q(A)c					
Crystal Springs/ County Springs	Q(A)c					

[a] This well primarily provides irrigation water, although it may be used as an emergency drinking water supply.
Source: Ecology 2008e

Bonney Lake

Groundwater pumped from springs at Victor Falls and Grainger Springs and from wells at the Tacoma Point and Ball Park sites supply Bonney Lake. See Figure 7-1 for Bonney Lake's spring and well locations. The minimum flow at Victor Falls and Grainger Springs was recorded in 1985. The average low flow in the summer months for 1998 through 2002 was 970 gpm at Victor Falls and 870 gpm at Grainger Springs.

Although not used in recent years, Bonney Lake also maintains water rights associated with the McDonald Wells. In 2006, Bonney Lake's wells and springs produced approximately 1,290,647,000 gallons of water (City of Bonney Lake 2008c). Table 7-5 summarizes the water rights associated with these sources. Table 7-6 lists well construction details and provides information about Bonney Lake's springs. In addition to its groundwater supplies, the Bonney Lake entered an agreement in 2005 to purchase up to 2 mgd peak flow from Tacoma Water, as needed (City of Bonney Lake 2006a).

Table 7-5. City of Bonney Lake Groundwater Rights

Production Well / Spring	Water Right Certificate or Permit Number	Quantity Annual – Qa (gpm)
Tacoma Point Old Well	C 2809-A	45
Tacoma Point Well No. 2[a]	C G2-26854	800
Tacoma Point Well No. 4[a]	P G2-27693	1,600
Tacoma Point Well No. 6[a,b]	Wellfield	
Ball Park Well No. 1	C G2-26853	800
Ball Park Well No. 2	C 6671-A	185
Grainger Springs	C 9328	22.4
Grainger Springs	C S2-20715	55 (plus 1,945 supplemental right)
Victor Falls No. 1	C 6459	360
Victor Falls No. 2	C 9652	504
Victor Falls No. 3	C 11485	504
Victor Falls No. 4	C S2-00840	403
McDonald Well	C 2679-A	48
McDonald Well	C G2-22219	24 (supplemental right)

[a] Tacoma Point Wells 2, 4, and 6 are operated as a wellfield.

[b] This well is a backup to Well 2, which is bent and is used by Bonney Lake to ensure the reliability of full beneficial use under the Tacoma Point water rights Well 4 permit.

Source: City of Bonney Lake 2006b

Table 7-6. City of Bonney Lake Well and Spring Details

Production Well / Spring	Hydrogeologic Unit	Well Depth	Top of Screen	Bottom of Screen	Static Groundwater Depth	Pump Intake Depth
		Feet below Top of Casing				
Tacoma Point Well No. 2[b]	Q(A)c	312	289	307	246	
Tacoma Point Well No. 4[b]	Q(A)c	320	287	310	248	
Tacoma Point Well No. 6[a,b]	Q(A)c	301	273	296	248	
Ball Park Well No. 1	Q(A)c	241	199	231	102	185.1
Ball Park Well No. 2	Q(A)c	244	214	234	135	203.2
Grainger Springs	QVa					
Victor Falls No. 1	QVa					
Victor Falls No. 2	QVa					
Victor Falls No. 3	QVa					
Victor Falls No. 4	QVa					

[a] This well is a backup to Well 2, which is bent and is used by Bonney Lake to ensure the reliability of full beneficial use under the Tacoma Point water rights Well 4 Permit.

[b] Tacoma Point Wells 2, 4, and 6 are operated as a wellfield.

Other Group A/B Public Water Systems

Groundwater in the study area is extracted by smaller public water purveyors, including the Tapps Island Water System, the City of Pacific, and the City of Puyallup. Figure 7-1 shows some of the larger wells and springs. Groundwater is extracted by these users from shallow and deeper aquifers in both the uplands and river valley portions of the study area. Information (well logs, construction diagrams, etc.) on the other Group A/B well systems was obtained from the files of the Washington Department of Health, Tacoma–Pierce County Health Department, and the Washington State Department of Ecology.

Drinking water used by the Tapps Island Water System is supplied by six wells on the plateau where Lake Tapps Reservoir is located. Table 7-7 summarizes the Tapps Island Water System groundwater rights. Well construction details for the Tapps Island Water System are included in Table 7-8. The depths of the six wells range from 86 feet to 140 feet below the top of casing. No springs have been developed as a water source by the Tapps Island Water System.

Table 7-7. Tapps Island Water System Groundwater Rights

Production Well	Water Right Certificate or Permit Number	Quantity Annual – Qa (gpm)
Well #3	G2-23908	145
Well #4	G2-25522	202
Well #5	G2-23718	202
Well #6	G2-27196	4 (plus 200 supplemental right)

Puyallup uses water from five wells and two springs. Only one of these sources, Salmon Springs, is located in the study area (see Figure 7-1). The total water right for Puyallup is 11.2 mgd (Central Puget Sound Water Suppliers' Forum 2001), and an estimated 3,600 gpm (5.2 mgd) is withdrawn from Salmon Springs (HDR and Golder 2002).

The remaining Group A/B public water systems in the study area include approximately 65 wells and a spring (see Figure 7-1). The shallowest well is 47 feet below the top of casing, while the deepest well is 460 feet below top of casing. Most of the wells withdraw water from the Qva or Q(A)c aquifer. Table 7-8 lists the well construction details. As mentioned earlier, the majority of information in this table was obtained from well logs, which usually do not include the depth to pump intake.

Table 7-8. Other Group A/B Public Water Supply Well Details

Public Water System Name	Production Well/Spring	Source Number	Well Depth	Top of Screen	Bottom of Screen	Static Ground Water Depth	Pumping Ground Water Depth	Pump Intake Depth
			Feet Below Top of Casing					
17th St. Ct. Water System	Well #1	01	120			99	100	115
205th Ave. Ct. E. Water System	Well #1	01	217			176	181	212
Achman Water System	Well #1	01	267			220	232	145
Anderson, G.	Well #1	01	157					
Asai Water System	Well #1	01	200	200	203	151	171	
Baker Prowse Water System	Well	01	131					
Barich/Wergland System	Well #1	01	220					
Bassham Water System	Well	01	200			175	180	200
Beau View Water	Well	01	260	240	260	167	221	
Benson, Vance Water	Well #1	01	139			115		
Bish, Riddle, Kuehn & Kuehn	Shepard	01	320					
Capeloto Water System	Well	01	300			254		
Carpenter-Carson Water System	Carptenter-Carson Well	01	198			162		
Celli-Greenlish H2O Water System	Well #1	01	243			143	160	240
Cook Water System	Well	01	158			114	126	147
Cover-Allard Water System	Well	01	274			224		
Crosiar-Kohler Water System	Well #1	01	140			125	140	135
Crowell Water System	CROWell	01	180					
Cutler-Carter Water System	Well 1	01	250					
Davis A Well	Well 01	01	225					
Deep Water	Deep Water	01	383	380	383	236	286	235
Donovan	Well	01	197			103		
East End Lake Tapps Rod and Gun Club	Well AEF319	01	63	60	63	25	55	
Faith Springs	Well #1	01	263			203		
Fountain of Life Church	Well	01						
Four Court Well	Well #1	01	298			195	256	273
Gary and Donna Lien Water System	Salmon Springs	01						
Good Old 230	Well # 1	01	230			196	207	221
Grave, G.E. Water System	Well	01	220			183		
Hebert-380	Well	01	170			135.4		
Hill Water Works	Well	01	234			185		
Hummel & Winans Water System	Well 1	01	185			153.5	179	179
HVR Water System	Well	01	314					
Jacques Water System	Well 1	01	460			221.5	287	
Jacques Water System	Well 2	02	407			203.6	321	357
Lake Tapps North Park Water System	Well #1	01	147			132		
Lane Water System	Well #1	01	320					
Lee, Jeong Water System	Well #1	01	380			208		
Lewis, Sam	Well #1	01	160					
Loukides-Bryon Water System	Well	01	254			206		
Maddax Water System	Well #1	01	224					
Miller Well	Well #1	01	105			70	85	
Mitchell-Hepola	Well # 1	01	200					
Nichols Water System	Well # 1	01	140	135	140	122		
Olson, Don #2 Water System	Well	01	403			262	274	258
OTA/Rumsey/VanCleave Water System	Well #1	01	84			35		
Prehm Public Well	Well	01	260	120	127	107	109	210
Rainer View Water System	Well #1	01	174	170	174	135.4	138	137.3
Reeves Water System	Well #1	01	147			119	136	
Retcless Water System	Well #1	01	270			173		
Ricketts Water System	Well	01	98			44		
Rideout Water System	Well #1	01	220			169.66	182	218
Schmidt Well One	Well #1	01	74			50		
Schmidt Well Two	Well	01	60			45		
Sprugeon Water System	Well #1	01	143	133	143	128		
Stewart Water System	Well #1	01	148			113		
Stoble	Well #1	01	280					
Stowe, Bryon Water System	Well #1	01	47					
Sullivan Springs	Sullivan Springs	01	117	90	115	32		
Tapps Island Water System	Well #1	01	110					
Tapps Island Water System	Well #3	03	100					
Tapps Island Water System	Well #4 (AAD977)	04	87	39	86	46.33	58	
Tapps Island Water System	Well #5 (ACM774)	05	86	61	81	43	46	
Tapps Island Water System	Well #6 (ABR656)	06	140	68	125	101	112	120
Tiegs Water System	Well #1	01						
Twin Cedars System #1	Well	01	90					
Twin Cedars System #2	Well	01	71			24.25	40	63
Venn, G. Community Water System	Well	01						
Weber Water System	Well	01	85	85	90	60		
Winchester Heights	Well #1 AFK803	01	103	100	103	75	82	
Wrenn Water System	Well #1	01	316.5			243.3		
Yarnell Water System	Well #1	01	201			140	180	

7.2 Environmental Impacts

7.2.1 Direct Impacts

No Action Alternative

The No Action Alternative would have no impact on groundwater.

Proposed Action

This section describes the potential impacts of the Proposed Action on aquifer recharge, spring flow, and the supply of groundwater to public and domestic wells. No direct impacts to groundwater would be anticipated under the Proposed Action.

Lake Tapps Reservoir Operations

Lake Tapps Reservoir provides a source of aquifer recharge. The reservoir's water surface level provides the driving head to cause water to seep from the reservoir into the aquifer. The rate of recharge from the reservoir is influenced by the reservoir's surface level, and a change in surface level has the potential to influence aquifer recharge. The following sections describe Cascade's estimate of the associated changes in aquifer recharge and the effects on the groundwater supply.

Historic Reservoir Operations

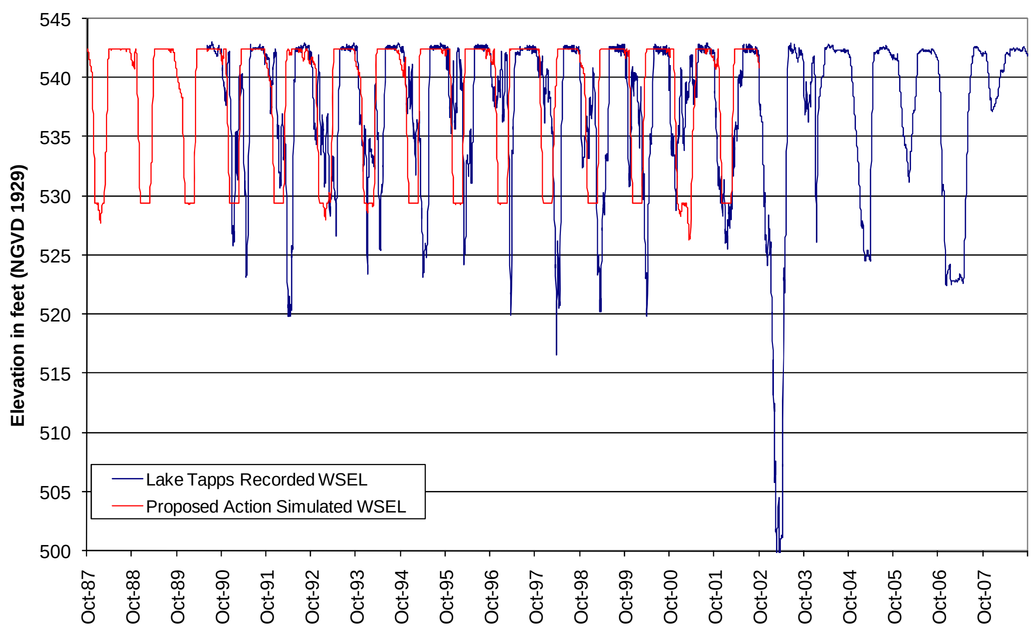
During the hydropower period (prior to 2004), water was diverted into the reservoir for the purpose of storing and releasing it to generate power. The White River diversion rate, turbine releases, and residence time of water in the reservoir were relatively high during the hydropower period compared with the post–hydropower period. The reservoir was maintained at Full Pool or nearly Full Pool levels (elevation 542 feet) during the hydropower period depending on the available water supply. Under hydropower operations, the reservoir was drawn down starting in October and the water surface level and storage was reduced during the winter to elevation 516 to 526 feet to control milfoil growth (see Chapter 1). The reservoir was usually refilled in May. Figure 7-11 shows the daily historic Lake Tapps Reservoir water surface levels from 1987 to 2008.

During the post-hydropower period (since 2004), the minimum winter drawdown reservoir level has usually been between 523 and 536 feet. Spring Refill occurs earlier in the season (March to May), and consequently the reservoir remains at nearly Full Pool elevation for a longer period in the summer. The average reservoir level from 2004 to 2008 was 537.3 feet. The reservoir level during the hydropower period averaged 536.1 feet (based on data from 1990 to 2003).

The reservoir level was drawn down below elevation 500 feet in 2003 to allow for repair of the dikes around the reservoir. This was an unusual event and is not part of the Proposed Action. The reservoir would not be drawn down so severely or emptied in the future unless during an emergency event or to facilitate dike maintenance or other infrastructure repair.

Proposed Action Compared with Historic Reservoir Operations

The reservoir level associated with the Proposed Action was computed using the STELLA™ reservoir operations model developed for analysis. Figure 7-11 shows the daily predicted reservoir level from 1988 to 2008 compared with the historic reservoir level. The predicted Proposed Action reservoir level does not decrease below elevation 530 feet except in one year (2001), while the historic reservoir level regularly decreased below elevation 525 feet. Figures 7-12 and 7-13 show the Proposed Action and historic daily reservoir level during 1992[1] (a dry year) and 1998 (an average year). These graphs show that under the Proposed Action, Spring Refill occurs in April and May and starts several months earlier, and the reservoir level is at a higher elevation for a longer period in the summer. Figure 7-14 shows that the average reservoir level predicted for the Proposed Action is about 0.77 foot higher than the historic reservoir level during this period.



WSEL = water surface elevation

Figure 7-11. Daily Lake Tapps Reservoir Historic and Simulated Proposed Action Water Surface Elevation for 1988 to 2008

[1] This year (1992) is the dry year selected for graphical comparison because historical operations in 2001 did not follow the typical pattern of drawdown.

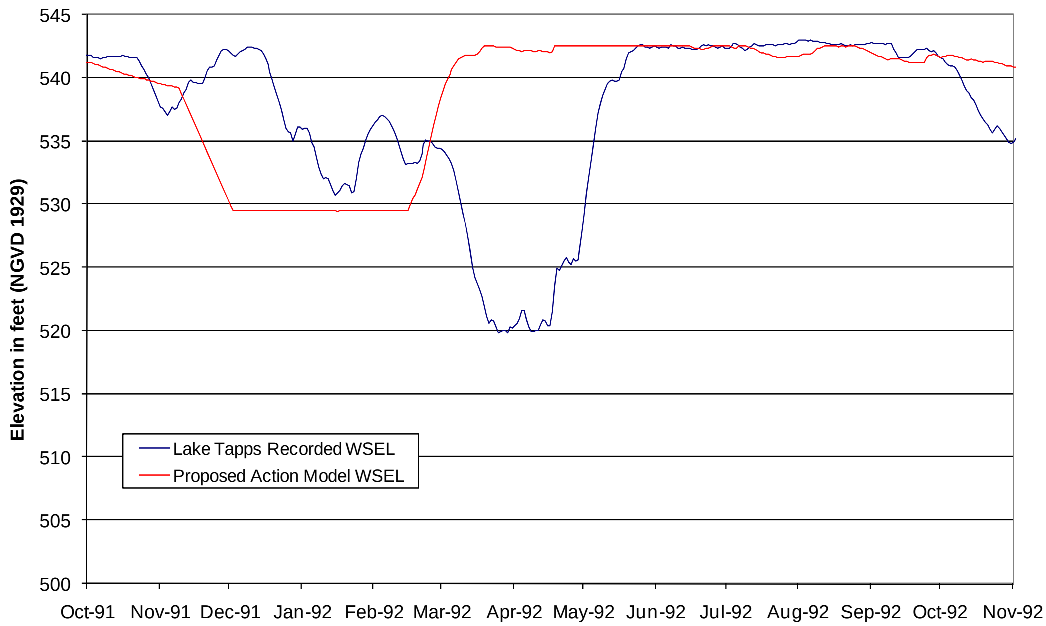


Figure 7-12. Daily Lake Tapps Reservoir Historic and Simulated Proposed Action Water Surface Elevation for 1992 (Dry Year)

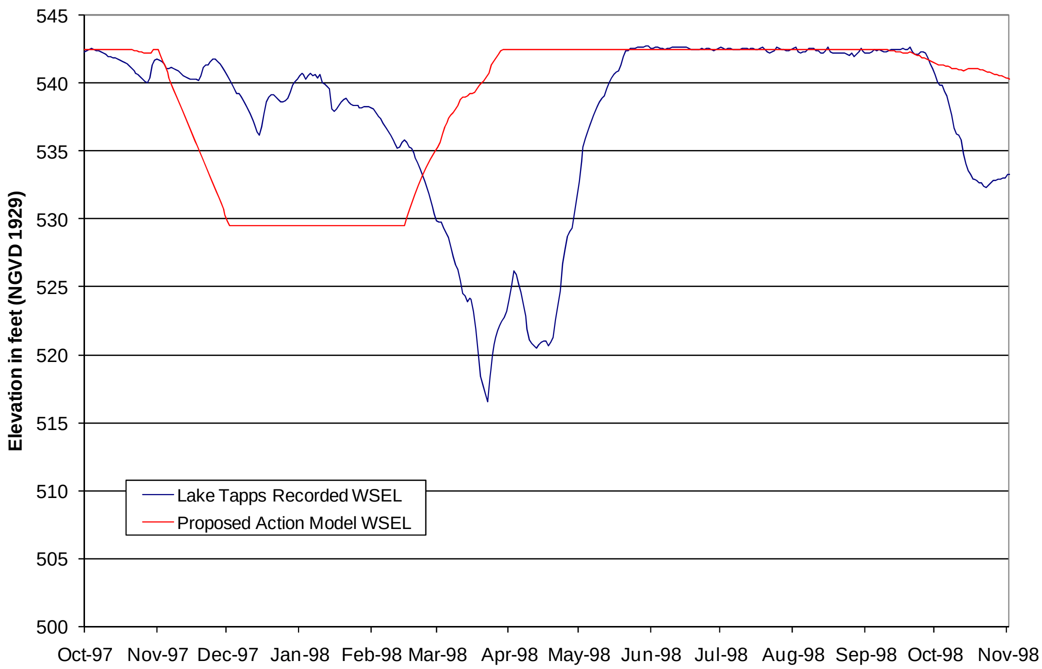


Figure 7-13. Daily Lake Tapps Reservoir Historic and Simulated Proposed Action Water Surface Elevation for 1998 (Average Year)

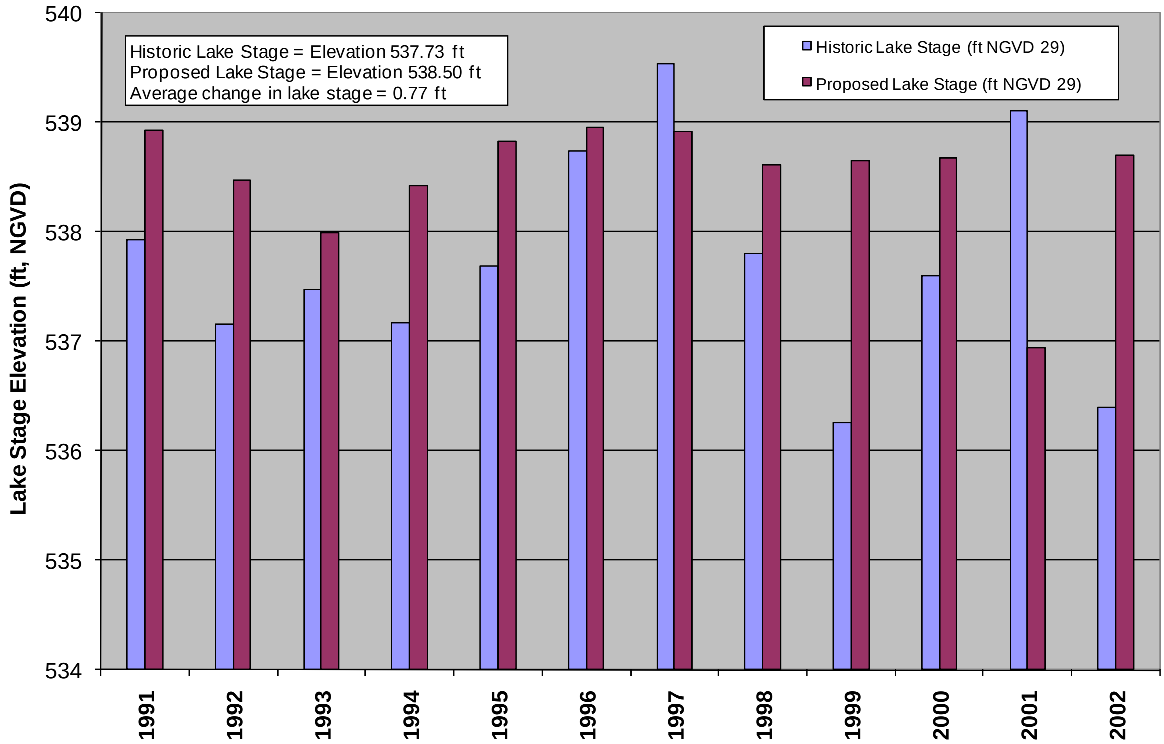


Figure 7-14. Annual Average Lake Tapps Reservoir Historic and Simulated Proposed Action Water Surface Elevation for 1991 to 2002

Proposed Action Compared with No Action Alternative

Figure 7-15 shows the monthly average and overall average reservoir level predicted by the model for the Proposed Action and No Action Alternative for the period 1988 to 2002. Under the Proposed Action, the reservoir level will be slightly higher in March and slightly lower in October and November than under the No Action Alternative. The average reservoir level for the Proposed Action will be 538.50 feet, and slightly higher than the No Action Alternative (539.32 feet).

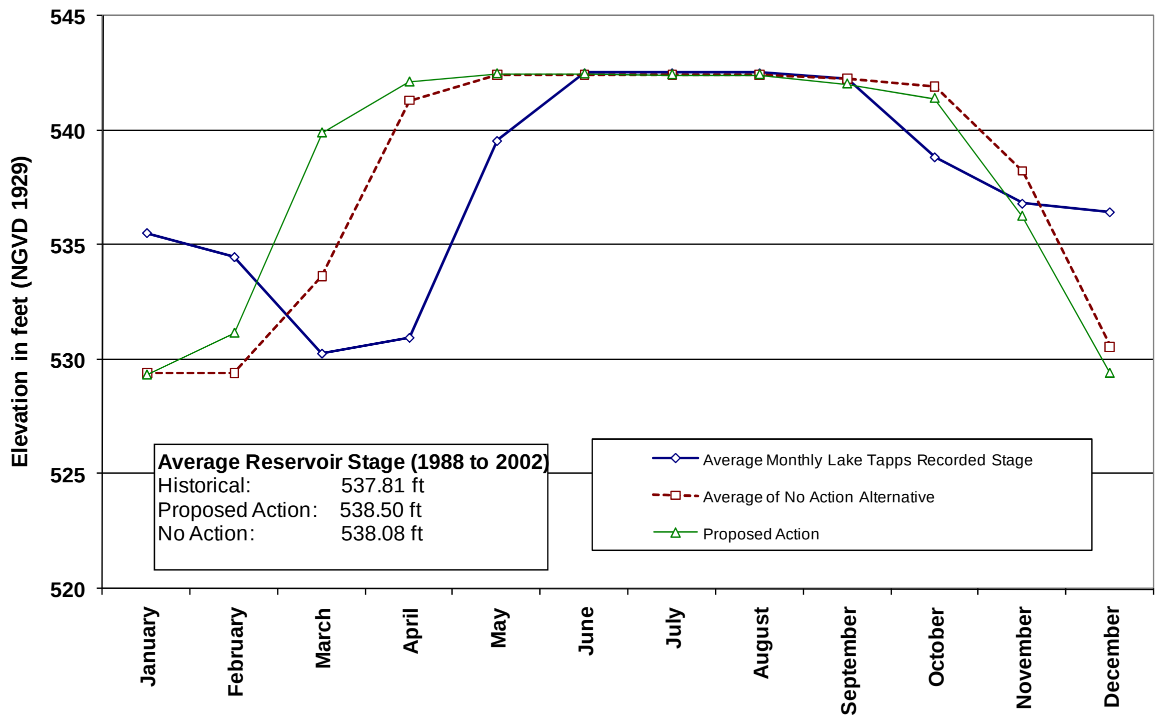


Figure 7-15. Monthly Average Lake Tapps Reservoir Historic and Simulated Proposed Action and No Action Alternative Water Surface Elevation (1988 to 2002)

Changes in Recharge

Method to Calculate Change in Recharge

The system is operated by diverting water from the White River and into Lake Tapps Reservoir. The water surface elevation in the reservoir is at least several hundred feet higher than the groundwater surface elevation in the uppermost Qva aquifer. The higher head in the reservoir causes water to seep downward from the reservoir into the underlying aquifers, as shown in Figure 7-10. Seepage of surface water from the reservoir to groundwater recharges the uppermost aquifer. Changes in Lake Tapps Reservoir levels have the potential to influence the rate of water seeping from the reservoir to the aquifer.

The potential change in aquifer recharge from changes in reservoir level was computed using the Darcy seepage equation.

$$Q = k * A * i$$

where:

Q = seepage (ft/day)
k = vertical hydraulic conductivity (ft/day)
A = reservoir surface area (square ft)
i = vertical hydraulic gradient (ft/ft)

The water surface area of the reservoir is about 2,500 acres or 1.1×10^{8} ft^2 at an average water level of 538.5 feet. The hydraulic conductivity was estimated at 1.0×10^{-6} cm/sec or 0.003 ft/day, based on prior research by PGG (1999). PGG (1999) field-measured the concentration of tritium[2] in the reservoir and at about 20 wells around the reservoir. The difference in tritium concentrations between the reservoir and wells was used to estimate the rate of seepage from the reservoir and to then back-calculate the vertical hydraulic conductivity.

The hydraulic conductivity and surface area are assumed constant and the vertical hydraulic gradient is treated as the only independent variable in the equation. Hydraulic gradient is calculated as the difference between the reservoir water surface elevation and the groundwater elevation in the uppermost aquifer, divided by the vertical distance between the bottom of the reservoir and the middle of the uppermost aquifer. The average 1988 to 2002 reservoir water surface elevation was used in the equation to identify the effect of the Proposed Action on long-term aquifer recharge. Since the reservoir is always at least partially full, it always provides recharge and it is appropriate to average out the short-term changes in reservoir levels to calculate the long-term recharge associated with the Proposed Action. To simplify the analysis and to provide a conservative estimate of aquifer recharge, a constant value of the lowest measured groundwater surface elevation in the uppermost aquifer and a constant value of 100 feet between the bottom of the reservoir and the middle of the uppermost aquifer were assumed. These assumptions are appropriate, given the geologic cross-section and given that the objective of the calculation is to estimate the change in seepage associated with the change in water levels.

[2] Tritium is a radioactive isotope of hydrogen with a 12.3-year half-life. Prior to 1944, essentially all tritium was produced naturally through the interaction of cosmic radiation and atmospheric nitrogen. Since that time, testing of thermonuclear devices has significantly increased the global levels of tritium. Most tritium deposited over continents results from precipitation. Tritium can travel through the local surface and groundwater systems; the concentration of tritium is dependent on local dilution factors (Stimac 1983).

Change in Recharge from Proposed Action Compared with Historic Operations

Table 7-9 shows that the Proposed Action's average reservoir level for 1988 to 2002 is 538.50 feet and it is higher than the historic reservoir stage of 537.81 feet during this period. This means that the hydraulic gradient and the aquifer recharge associated with the Proposed Action would be slightly higher than occurred previously during hydropower operations. A change in reservoir level of about 1 foot causes less than 1% change in hydraulic gradient and aquifer recharge, and is insignificant.

Table 7-9. Historic and Simulated Proposed Action and No Action Alternative – Lake Tapps Reservoir Computed Seepage for Average 1988 to 2002, 1992, and 2001

	Historic	No Action Alternative	Proposed Action
Average 1988 – 2002			
Reservoir Level (ft, NGVD)	537.81	538.08	538.50
Vertical Hydraulic Gradient	1.88	1.88	1.88
Calculated Seepage (cfs)	7.10	7.11	7.13
Dry Year 1992			
Reservoir Level (ft, NGVD)	537.20	537.97	538.46
Vertical Hydraulic Gradient	1.87	1.88	1.88
Calculated Seepage (cfs)	7.08	7.11	7.13
Dry Year 2001			
Reservoir Level (ft, NGVD)	537.98	538.09	536.94
Vertical Hydraulic Gradient	1.88	1.88	1.87
Calculated Seepage (cfs)	7.11	7.11	7.07

Parameters used in Calculation			
Upper Qva Aquifer lowest Groundwater Elevation (ft)	Est. Hydraulic Conduct (ft/day)	Reservoir Area (sq ft)	Vert. Flow Path Length (ft)
350	3.0E-03	1.09E+08	100

Comparison to PGG (1999) Seepage Estimate		
gpd	cu ft/day	cfs
2.40E+06	3.21E+05	3.7
1.50E+07	2.01E+06	23.2

NGVD = National Geodetic Vertical Datum
cfs = cubic feet per second

Change in Recharge from Proposed Action Compared with No Action Alternative

The difference in computed hydraulic gradient and aquifer recharge from the Proposed Action and No Action Alternative is shown on Table 7-9. The calculations are presented for the average from 1988 to 2002 and for two dry years (1992 and 2001). The average reservoir level from the Proposed Action is about 538.50 feet and is higher than the No Action Alternative at 538.08 feet. The difference in reservoir level between these two alternatives is about 0.42 foot and has an insignificant effect on hydraulic gradient and aquifer recharge.

Effects on Water Supply Wells

Public Supply Wells

The aquifers in the vicinity of the plateau where Lake Tapps Reservoir is located are used for municipal water supply by Auburn and Bonney Lake. Sumner and Puyallup use groundwater from the White River and Puyallup River valley alluvial aquifer for municipal supply. Other Group A/B public water system wells are located in the project vicinity.

Figure 7-16 shows a typical municipal public supply well. A typical municipal supply well is constructed with an air rotary or cable tool drilling rig. The drilling rig advances the borehole and steel casing is driven or advanced into the borehole. Upon reaching the target aquifer and if there is adequate groundwater head above the bottom of the well, the well is tested using air surging, pumping, or bailing. If initial testing indicates the potential to produce the desired yield, a well screen is installed or the casing is perforated and an 8- to 24-hour aquifer pumping test is completed on the well. A line-shaft turbine or a submersible pump is installed in the well. The depth of the well screen and pump intake is designed so that the pump intake is set above the top of the screen to (1) ensure uniform water flow, (2) avoid aerating the screen, and (3) ensure that the groundwater level in the well remains well above the pump intake to avoid cavitation of the pump bowls. Maintenance of water levels above the top of the pump intake and well screen during pumping is an important criterion for proper operation of a municipal water supply well.

Well logs and well construction diagrams and specifications were obtained for the municipal supply wells near Lake Tapps Reservoir and in the White and Puyallup River valleys. The well specifications are presented in Tables 7-1 through 7-7. Figure 7-17 compares the elevation of Lake Tapps Reservoir with the elevation of the well screen interval, groundwater level during pumping, and pump intake. This shows that the groundwater level in almost all the municipal water supply production wells was above the well screen and pump intake. Since the production wells operated properly in the past with water levels above the well screen and pump intake and the Proposed Action is predicted to result in a reservoir water surface elevation higher than the reservoir water surface elevation during historic operations, it was concluded that the Proposed Action would not affect the municipal water supply wells.

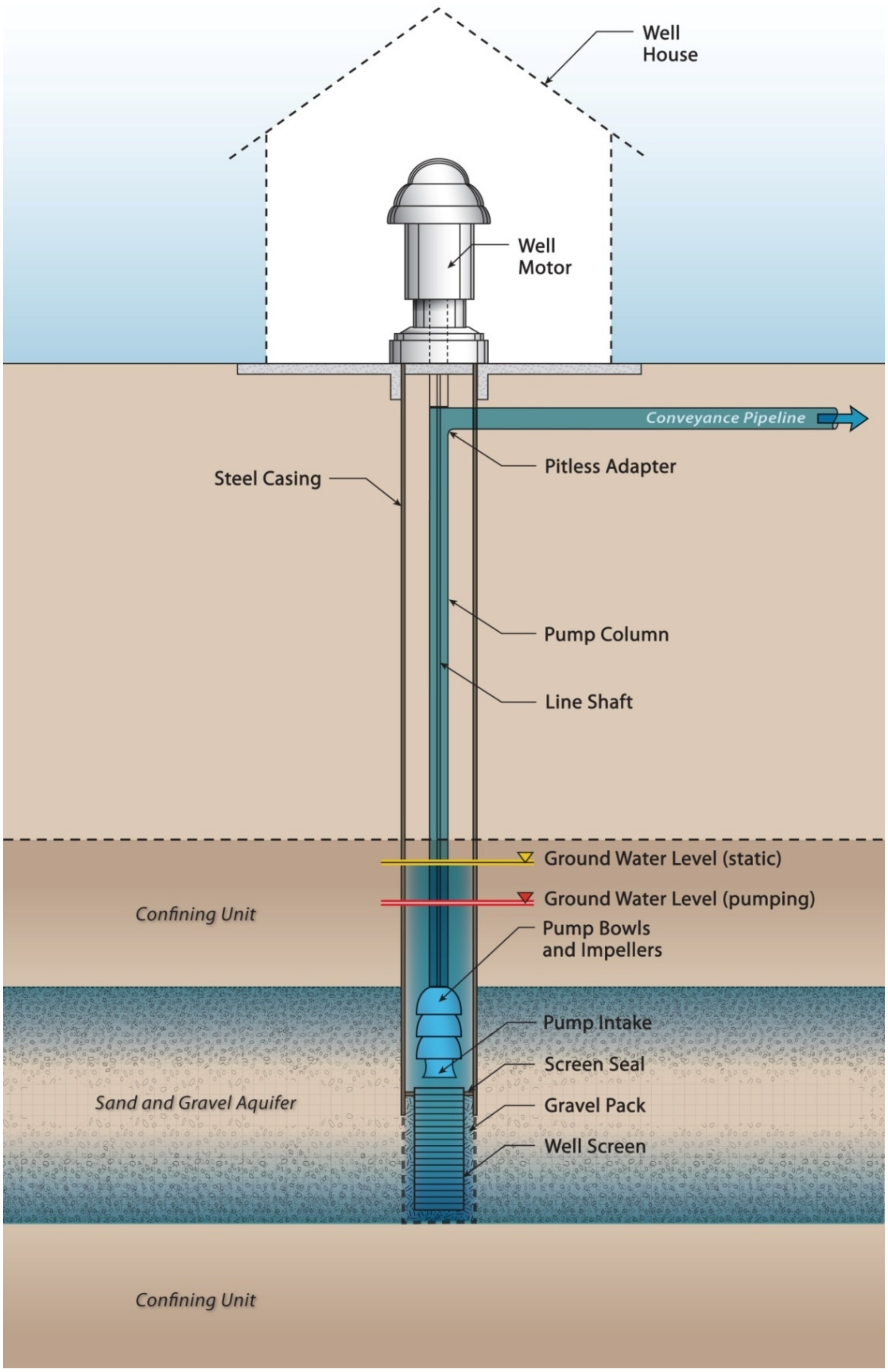


Figure 7-16. Details of Municipal Water Supply Well

Domestic Wells

Most domestic wells in the vicinity of the reservoir are several hundred feet deep and are completed in the uppermost Qva aquifer. It is not anticipated that domestic wells would be affected by the Proposed Action because the reservoir level would not change significantly and would be slightly higher than during the historic reservoir operations.

Springs

Springs located on the edges of the plateau where Lake Tapps Reservoir is located provide a source of public water supply to various municipalities including Auburn, Sumner, and Bonney Lake. Spring water flows out of the upper Qva and Q(A)c aquifer to these springs. The elevation of Lake Tapps Reservoir is above the elevations of these springs, as shown on Figure 7-18, and a portion of the recharge to these aquifers comes from Lake Tapps Reservoir seepage. The operation of the Proposed Action would not affect spring flow because the Lake Tapps Reservoir level would be higher compared with historic reservoir operations and the change in aquifer recharge from operation of the reservoir compared with the Proposed Action is insignificant.

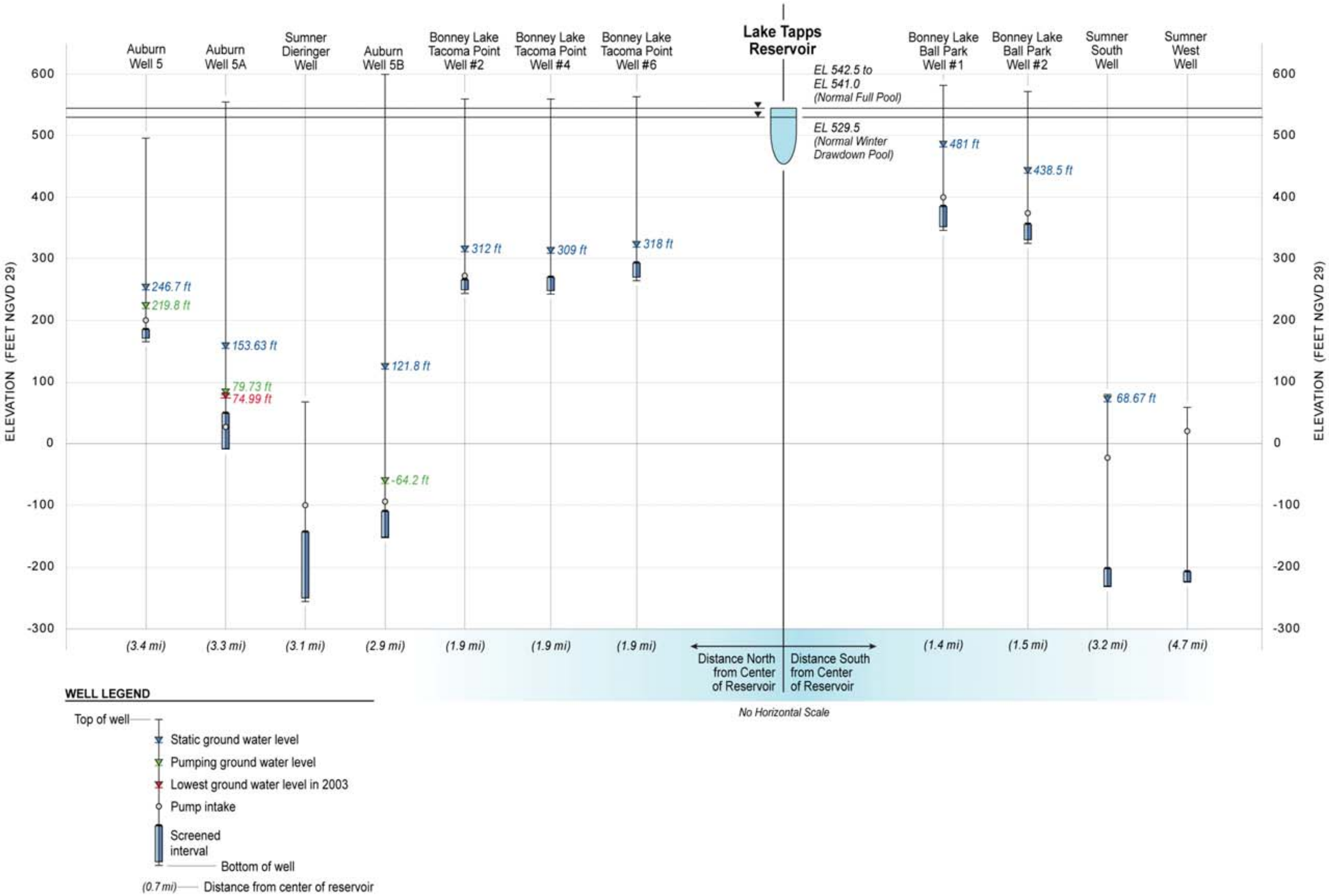


Figure 7-17. Profile of Large Municipal Wells Located near Lake Tapps Reservoir

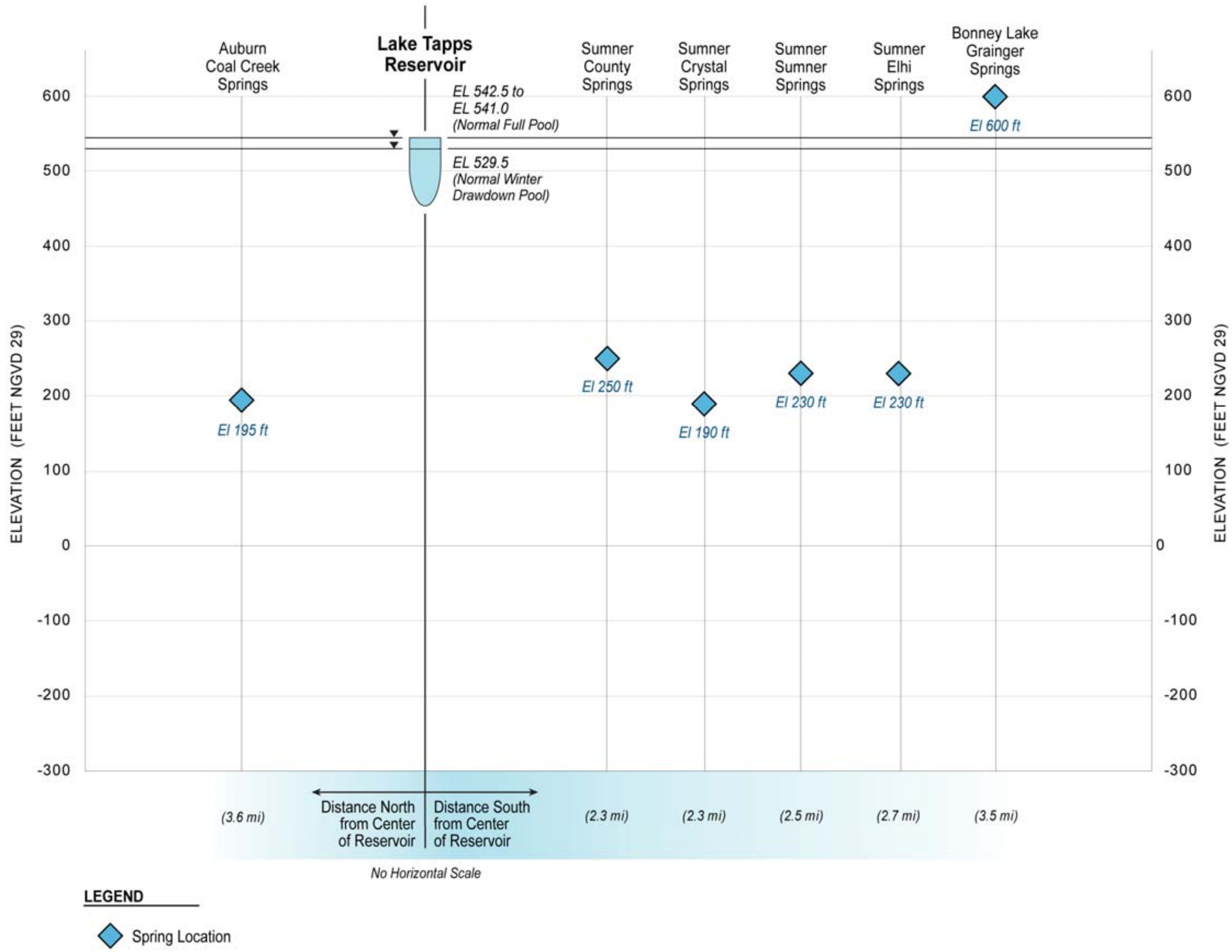


Figure 7-18. Profile of Municipal Springs Located near Lake Tapps Reservoir

7.2.2 Indirect and Cumulative Impacts

No significant direct impacts to groundwater are predicted for either the Proposed Action or the No Action Alternative. Therefore, no indirect or cumulative impacts resulting from the direct impacts to groundwater would be anticipated.

7.3 Mitigation Measures

While the project would not result in significant direct, indirect, or cumulative impacts to groundwater, Cascade would provide the mitigation measures listed in Table S-1 (Summary) and Section 1.4 of this Draft EIS.

7.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to groundwater would be anticipated under the Proposed Action or the No Action Alternative.

Chapter 8: Plants and Wildlife

Many species of plants and wildlife occupy the White River Reservation Reach, Lower White River, Lower Puyallup River, and Lake Tapps Reservoir. Vegetation types in the vicinity range from native plant communities to golf course turf, and the area provides habitat for waterfowl and other birds, invertebrates, amphibians, and mammals such as deer, bear, coyotes, opossums, and raccoons. This chapter describes how plants and wildlife and their habitats could be affected by the Proposed Action and No Action Alternative.

8.1 Affected Environment

8.1.1 Plants

The Project is located in the larger *Tsuga heterophylla* Zone (Western Hemlock Zone), a vegetative zone that includes most of the Puget Sound lowlands of western Washington. Pre-development native vegetation in this zone consisted predominantly of forests dominated by western hemlock (*Tsuga heterophylla*), Douglas fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*), with an understory of swordfern (*Polystichum munitum*), vine maple (*Acer circinatum*), and salmonberry (*Rubus spectabilis*) (Franklin and Dyrness 1988).

Vegetation in the study area has been altered by development and urbanization over the past 150 years, and now includes a mixture of vegetation types. Almost all of the land within the study area has been logged; forested environments now consist of second- and third-growth forests that were last logged in the 1960s and 1970s. The third-growth forests contain more deciduous species than the second-growth forests (FERC 1992). Modifications to the landscape, including the artificial creation of Lake Tapps Reservoir, urban development, and the introduction of non-native species, have further disturbed the pre-development vegetation composition.

Vegetation dominated by western hemlock
Lake Tapps Reservoir with view of Mount Rainier
August 2008

Vegetation that could be influenced by the water included in the water rights under the Proposed Action generally includes the following: (a) the riparian corridor of the White River from the diversion dam near Buckley downstream to its confluence with the Lower Puyallup River; (b) the vegetated part of Lake Tapps Reservoir (the area extending lakeward from the shoreline to the limit of rooted plants); and (c) the shoreline and riparian zone of the reservoir. Vegetation in the vicinity of the Lower Puyallup River was not evaluated because much of the Lower Puyallup River downstream of the confluence with the White River is contained within levees and the adjacent land is highly developed. Vegetation along the Lower Puyallup River is not expected to be affected.

Existing studies and databases were reviewed, recent aerial photographs were evaluated, and reconnaissance-level field reviews of the study area were conducted for this analysis. Documents reviewed included the following:

- Aerial photography (USDA 2006)
- The United States Fish and Wildlife Service (USFWS) Wetlands Online Mapper (USFWS 2008)
- The King County Sensitive Areas Ordinance (King County 2008a)
- The Pierce County Wetlands Inventory (Pierce County 2008b)
- *Soil Survey of Pierce County Area, Washington* (Zulauf 1979)
- Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) database (WDFW 2008)
- Washington Department of Natural Resources (WDNR) Natural Heritage Program database (WDNR 2007)
- Environmental Assessment for Hydropower License, White River Hydroelectric Project (FERC 1992)

White River Riparian Areas

The White River riparian corridor is wide and densely vegetated with forest vegetation from the diversion dam (River Mile [RM] 24.3) downstream to RM 10. Most of the land adjacent to both river banks through this reach is owned by Puget or is within the Muckleshoot Indian Reservation, and remains undeveloped (Kerwin 1999). Dominant trees within the riparian zone in this area include black cottonwood, Douglas fir, western red cedar, red alder, and bigleaf maple. The shrub understory is dominated by salmonberry, Indian plum (*Oemleria cerasiformis*), and red-osier dogwood (*Cornus sericea*).

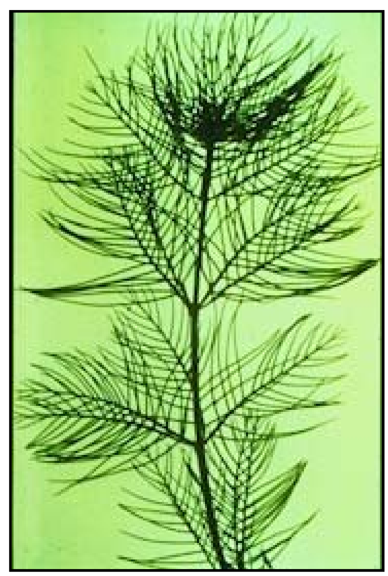
Downstream of RM 10, the river flows through a more urbanized reach dominated by industrial, residential, and commercial land uses. The forested riparian corridor becomes narrower and some areas are completely devoid of trees. Vegetation associated with riverfront parks and residences present in this reach include grasses, ornamental herbs and shrubs, and some remnant native trees and shrubs. Sumner Meadows Golf Links, an 18-hole golf course adjacent to the river in this area, has also replaced historic native riparian vegetation with maintained golf course turf.

Riverine wetlands associated with the White River are restricted to areas upstream of RM 10 within the study area. The National Wetland Inventory (NWI) identifies several wetlands dominated by forested, scrub-shrub, and emergent vegetation communities throughout this area. Figure 8-1 shows the locations of wetlands mapped as part of the King County Sensitive Areas Ordinance and by the Pierce County Wetlands Inventory (King County 2008a; Pierce County 2008b).

In the urbanized reach downstream of RM 10, riverine wetlands are much less common because development and dikes have constrained surface water to the river channel. WDFW PHS data identify 43 wetlands associated with the White River. Several of the wetlands are coincident with the wetlands mapped by the NWI and the county inventories (see Figure 8-1). Some of these wetlands are located on agricultural land and others are in a more natural setting (WDFW 2008). The WDNR Natural Heritage Program does not identify the presence of any high-quality native wetland plant communities or occurrences of state or federally-listed plant species within the study area.

Lake Tapps Reservoir

Very little native emergent or floating-leaved aquatic vegetation is associated with Lake Tapps Reservoir. Occurring only in shallow water areas, these vegetation types have been limited by the artificial nature of water management activities at the reservoir, and because of the highly developed nature of the shoreline properties. Since 1912, the Lake Tapps Reservoir levels have been managed to facilitate power generation and more recently to promote recreation. Water levels are typically lowered in the winter when recreational boating is not expected, in part to discourage weedy aquatic vegetation from dominating many parts of the reservoir.



Eurasian watermilfoil
Photo source: Ecology n.d.(c)

Aquatic vegetation in Lake Tapps Reservoir is dominated by Eurasian watermilfoil (*Myriophyllum spicatum*) (milfoil), an introduced non-native species. Because milfoil can reproduce vegetatively from plant fragments, it spreads easily and has become a nuisance. It is native to Europe and Asia, and was originally introduced to the eastern United States. The earliest specimen of milfoil found in Washington was discovered in Lake Meridian near Kent, Washington in 1965 (Ecology 2008e). The Washington State Noxious Weed Control Board and Pierce County list milfoil as a Class B Weed (Washington State Noxious Weed Control Board 2008; Pierce County 2008a). The annual controlled drawdowns of reservoir levels have been moderately successful in controlling milfoil populations. Pondweed (*Potamogeton* spp.) has also been observed in Lake Tapps Reservoir.

Some of the shallow parts of the reservoir and areas affected by reservoir hydrology possess the necessary soils, hydrology, and vegetation to be designated wetlands. Wetland hydrology in these areas is provided by the reservoir water levels or associated groundwater table. The NWI identifies wetlands dominated by forested, scrub-shrub, and emergent communities along the lacustrine fringe of Lake Tapps Reservoir and at nearby palustrine areas that drain to the reservoir (USFWS 2008). Figure 8-1 shows wetlands mapped as part of the King County Sensitive Areas Ordinance and by the Pierce County Wetlands Inventory in the vicinity of the reservoir (King County 2008a; Pierce County 2008b). The WDFW PHS database identifies 38 wetlands near the Lake Tapps Reservoir shoreline, some of which coincide with the wetlands shown in Figure 8-1, with surface or subsurface hydrologic connections to the reservoir (WDFW 2008). In addition, FERC (1992) identified 74 acres of wetlands in the study area created by the dikes and flowline built as part of the hydropower facilities.

Terms

Deciduous: Refers to trees that shed their leaves annually.

Emergent vegetation: Wetland vegetation consisting of erect, rooted, herbaceous plants adapted to living in saturated soils.

Forbs: Broad-leafed, herbaceous flowering plants.

Lacustrine: Refers to the area in or along the shoreline of lakes.

Listed species: Any species of plant or wildlife that has been determined to be endangered or threatened.

Palustrine wetlands: Wetlands that are non-tidal and that are dominated by trees, shrubs, emergent vegetation, mosses, or lichens.

Passerine: Relating to an order of birds that includes perching birds and songbirds such as finches and sparrows.

Riparian: A term used to describe areas along a watercourse or water body; it may be used to describe vegetation or habitat.

Scrub-shrub vegetation: Consists of woody plants less than 60 feet tall, including shrubs, tree saplings, or stunted trees or shrubs.

Understory: Vegetation that grows underneath the shade of taller trees.

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\8_1_County_Wetlands_Inventory.mxd - 8/20/2009 @ 1:17:11 PM

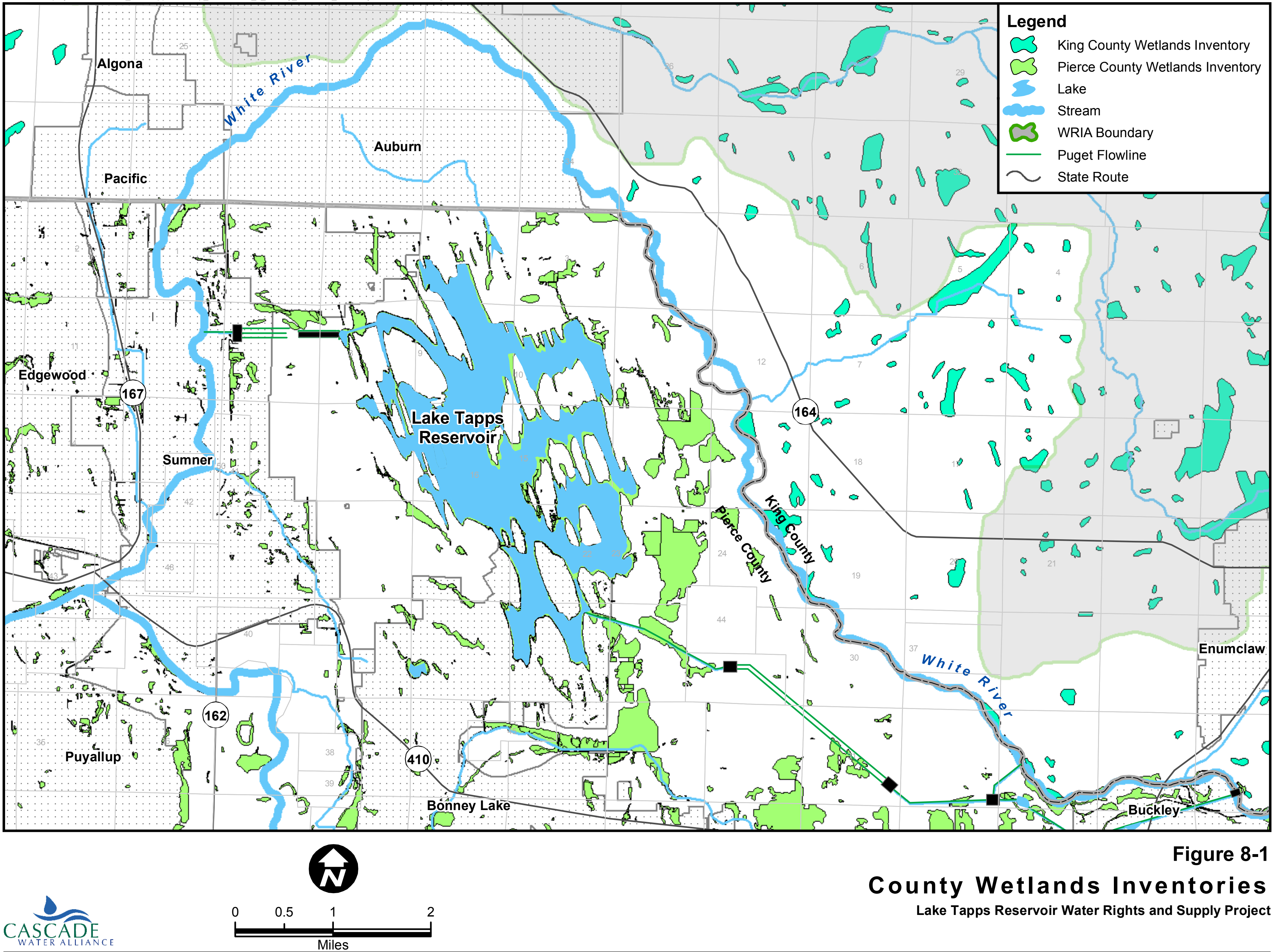


Figure 8-1

County Wetlands Inventories

Lake Tapps Reservoir Water Rights and Supply Project

CASCADE WATER ALLIANCE

Lake Tapps Reservoir Shoreline Riparian Communities

The majority of the Lake Tapps Reservoir shoreline has been developed for residential use. Vegetation in these areas consists of maintained lawns, disturbance-tolerant forbs, and planted ornamentals. The high degree of residential development limits the establishment of native plants. Tapps Island Golf Course is located on Tapps Island in the northeast section of the reservoir, and is vegetated with well-maintained golf course turf.

Scattered remnant native plants, including some trees, remain on a few developed properties, and pockets of native vegetation are present. Small tracts of native shoreline vegetation are present in the following locations:

- On Snag Island on the east side of the reservoir, which is forested in the areas between large-lot waterfront residences.
- On a small undeveloped island in the northwest portion of the reservoir.
- At the southern end of a small island on the west side of the reservoir.
- South of 45th Street E.
- Near the intersection of Sumner Tapps Highway E and N Tapps Highway E on the west side of the reservoir.
- On five small peninsulas on the north side of the reservoir.
- At the western end of Tapps Island.
- At the east side of Snag Island along the eastern shoreline.
- Near the reservoir inlet.

These areas are generally vegetated with black cottonwood, willows (*Salix* spp.), Sitka spruce (*Picea sitchensis*), red alder, Douglas fir, western red cedar, and bigleaf maple (*Acer macrophyllum*), with understories of beaked hazelnut (*Corylus cornuta*), Himalayan blackberry (*Rubus armeniacus*), salal (*Gaultheria shallon*), and various grasses.

The shoreline of the penstock forebay (see Chapter 2) in the northwest portion of the reservoir is vegetated with relatively undisturbed forest, shrub, and herbaceous plants. Forested vegetation in this area includes Douglas fir, red alder, and black cottonwood, and shrub communities include Douglas spirea (*Spiraea douglasii*), Himalayan blackberry, oceanspray (*Holodiscus discolor*), salal, and willows. Small herbaceous communities are vegetated primarily with reed canarygrass (*Phalaris arundinacea*).

8.1.2 Wildlife

The Proposed Action could influence wildlife in the White River from the diversion dam to its confluence with the Lower Puyallup River, in Lake Tapps Reservoir, and in the adjacent habitat that helps support wildlife species dependent on these water features. The Lower Puyallup River was not evaluated with regard to wildlife because the levee system and highly developed nature of the lower portion of the river precludes any likely impacts under the conditions of the Proposed Action.

White River

Within the study area, the White River and its associated riparian zone provides a well-functioning wildlife corridor and habitat area for multiple species. The riparian corridor of the White River upstream of RM 10 in the study area is more than a mile wide in places, undeveloped, and relatively undisturbed. These conditions provide a large area of textured habitat dominated by forest and shrub species within a landscape dominated by agricultural and residential land uses. The vegetated riparian corridor becomes increasingly narrow downstream of RM 10. Although industrial, commercial, and residential land uses border the river within the city limits of Sumner, this area provides a habitat reserve and migratory corridor for wildlife living in the urban environment.

The forested riparian corridor surrounding much of the White River within the study area supports a variety of passerines, waterfowl, raptors, amphibians, and mammals. A Red-tailed hawk (*Buteo jamaicensis*) was observed perched in a tree along the banks of the Reservation Reach of the White River during an October 2008 site visit. A Sharp-shinned hawk (*Accipiter striatus*) was also observed near the river during this site visit. Wetlands adjacent to the White River within the study area provide habitat for a variety of local wildlife species. Wetlands mapped as part of the King County Sensitive Areas Ordinance and by the Pierce County Wetlands Inventory in the vicinity of the reservoir are shown in Figure 8-1 (King County 2008a; Pierce County 2008b).

The PHS database identifies an occurrence of Western toad (*Bufo boreas*) near the White River, north of Lake Tapps Reservoir (WDFW 2008). Western toads typically inhabit marshes, springs, creeks, and small lakes, and meadows and forests in proximity to a water body. The Western toad is state-listed as endangered and a federal species of concern.

A Northern spotted owl (*Strix occidentalis caurina*) territory is centered on a site along the Green River, north of Lake Tapps Reservoir, and extends south into the study area (WDFW 2008). The Northern spotted owl is a threatened species under the federal Endangered Species Act (ESA), and is state-listed as endangered. Northern spotted owls typically nest and roost in mature and old-growth forests. Because they do not build their own nests, they are dependent on the presence of existing nesting structures such as broken-top trees, cavities, mistletoe brooms, and abandoned raptor nests, which are often present in older forests. Dispersal habitat includes sufficient canopy closure to shelter owls from avian predators and provide adequate foraging opportunities. Such habitat is necessary for maintaining connections between populations separated by tracts of inadequate nesting and roosting habitat (USFWS 1992). Critical habitat has been designated for the Northern spotted owl (73 FR 47325), although none is present in the study area.

A Bald eagle nest is mapped by the PHS database near the diversion dam (WDFW 2008). Eight Bald eagles were observed in the vicinity of the White River in the Reservation Reach during an October 2008 site visit. The Bald eagle is protected by the federal Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d, 54 Stat. 250), which protects nest trees and restricts harassment, and the state Bald Eagle Protection Act (RCW 77.12.655), which requires the establishment of buffer zones around nests and roost sites. The State of Washington established the Bald Eagle Protection Rules (WAC 232-12-292) to protect habitat via habitat management plans. Bald eagles are listed as a federal species of concern by USFWS and as a state sensitive species.

Bald eagle perched in a tree along the White River Reservation Reach
October 2008

The PHS identifies two Vaux's swift (*Chaetura vauxi*) nests near the Boise Creek confluence with the White River (WDFW 2008). The swifts typically forage in open areas above woodlands, lakes, and rivers, where flying insects are abundant. Vaux's swift is a state-listed species of concern.

Two Great blue heron colonies are located near the White River, east of Lake Tapps Reservoir (WDFW 2008). Foraging opportunities in the vicinity of these colonies include the White River and surrounding agricultural land.

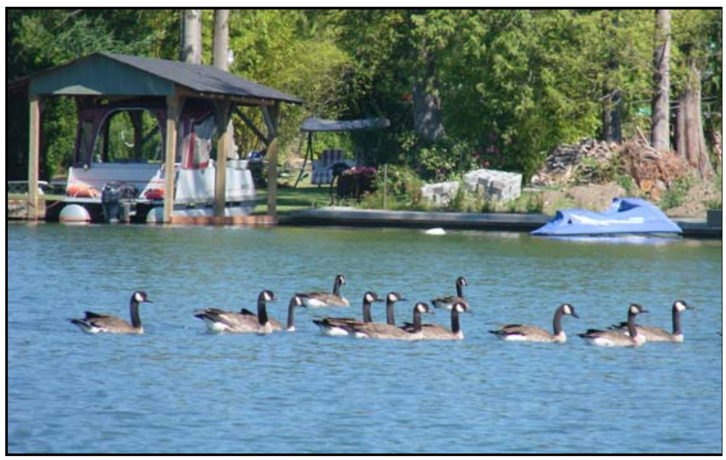
Several small waterfowl concentration areas are located in the vicinity of the White River (seven located on agricultural lands and two located on non-agricultural lands) (WDFW 2008). These areas provide habitat for ducks and other waterfowl throughout different times of the year. Wood ducks (*Aix sponsa*) have been observed in wetlands adjacent to the White River near the confluence with Boise Creek. Nest boxes are present in this area (WDFW 2008).

Lake Tapps Reservoir

A majority of the Lake Tapps Reservoir shoreline has been developed for residential use. Despite a high percentage of residential development along the shoreline, Lake Tapps Reservoir provides wildlife habitat in the shallow water areas along the shoreline and for various terrestrial species and birds that rely on bodies of water.

Birds observed during an August 2008 site visit include Barn swallow (*Hirundo rustica*), Violet-green swallow (*Tachycineta thalassina*), Tree swallow (*Tachycineta bicolor*), Osprey (*Pandion haliaetus*), Mallard (*Anas platyrhynchos*), Great blue heron (*Ardea herodias*), Cedar waxwing (*Bombycilla cedrorum*), various Sparrows (*Passer* spp.), Common crow (*Corvus brachyrhynchos*), Belted kingfisher (*Megaceryle alcyon*), Canada goose (*Branta canadensis*), various gulls (*Larus* spp.), and Killdeer (*Charadrius vociferus*). An Osprey nest was also observed on a piling-supported platform located in the reservoir near the eastern shoreline.

The WDFW PHS database identifies Lake Tapps Reservoir as an area of regular waterfowl concentration, providing resting and foraging habitat for hundreds of waterfowl. Several other small waterfowl concentration areas were also identified in terrestrial and wetland areas near the shoreline of the reservoir (two located on agricultural lands and nine located on non-agricultural lands) (WDFW 2008). Lake Tapps Reservoir and the nearby wetlands provide habitat for various waterfowl throughout the year, although the greatest concentrations are present during the fall migration period (FERC 1992).



Waterfowl on Lake Tapps Reservoir
August 2008

The PHS database also identifies a Pileated woodpecker (*Dryocopus pileatus*) nest, located north of the reservoir near Lake Tapps North Park. This nest was last observed in January 1990 (WDFW 2008). If the nest is still present, the breeding territory may extend south toward the reservoir. Pileated woodpecker home ranges average 1,480 acres surrounding a nest, and typically include areas dominated by coniferous forests (WDFW 2005). The Pileated woodpecker is listed by WDFW as a state candidate species.

A Great blue heron (*Ardea herodias*) nesting colony is also recorded in the PHS database, located near the reservoir on the south side of Bonney Lake (WDFW 2008). Herons nesting in this colony may use the shoreline of Lake Tapps Reservoir to forage for small fish and amphibians.

Three Bald eagle (*Haliaeetus leucocephalus*) nests are mapped near the southern shoreline of Lake Tapps Reservoir. Two are mapped in close proximity to each other, approximately 0.5 mile southeast of the reservoir in a forested area. The third nest is mapped near the shoreline on the south side of the reservoir in an area developed with residential uses (WDFW 2008). Lake Tapps Reservoir provides foraging habitat for Bald eagles in the area, and the White River corridor may also provide a seasonal food source for Bald eagles. As previously mentioned, Bald eagles are protected by the federal Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d, 54 Stat. 250), which protects nest trees and restricts harassment, and by the state Bald Eagle Protection Act (RCW 77.12.655), which requires the establishment of buffer zones around nests and roost sites. Furthermore, the State of Washington established the Bald Eagle Protection Rules (WAC 232-12-292) to protect habitat via habitat management plans. Bald eagles are listed as a federal species of concern by the USFWS and as a state sensitive species.

Areas classified as Urban Natural Open Space (which includes public parks and undeveloped land with natural vegetation that provides wildlife habitat) are present in a generally forested area near the north shore of Lake Tapps Reservoir within Lake Tapps North Park (WDFW 2008). These natural habitat areas can play an important role in supporting migratory and resident birds and urban wildlife such as Black-tailed deer (*Odocoileus hemionus*), coyotes (*Canis latrans*), opossums (*Didelphis virginianus*), raccoons (*Procyon lotor*), and small mammals.

Black-tailed deer are present in the study area (FERC 1992), and Black bear (*Ursus americanus*) and Cougar (*Puma concolor*) have been observed in the shoreline areas of the diversion flume (City of Buckley 2008).

Wetlands along the shoreline of Lake Tapps Reservoir provide habitat for a variety of local wildlife species. Ecological properties of wetland habitats can support a variety of invertebrate, bird, amphibian, fish, and mammal species. Because of the limitations for development of wetlands, they often provide refuge for wildlife in urban settings. Figure 8-1 shows wetlands mapped as part of the King County Sensitive Areas Ordinance and by the Pierce County Wetlands Inventory in the vicinity of the reservoir (King County 2008a; Pierce County 2008b).

No wildlife species listed as threatened or endangered under the ESA are known to occur in the vicinity of Lake Tapps Reservoir (WDFW 2008). No designated or proposed wildlife critical habitat is present.

8.2 Environmental Impacts

8.2.1 Direct Impacts

No significant direct impacts to plants or wildlife would be anticipated under the Proposed Action or the No Action Alternative.

No Action Alternative

Plants

The hydrologic conditions of the study area under the No Action Alternative would be similar to conditions since the conclusion of hydropower operations in early 2004. Flow rates in the White River and water levels in Lake Tapps Reservoir would be comparable to current conditions. Because the No Action Alternative would not alter hydrology in the study area, vegetation communities would not be affected.

Wildlife

Study area hydrology under the No Action Alternative would be similar to current conditions in the study area; therefore, the No Action Alternative would not affect wildlife habitat or wildlife use within the study area.

Proposed Action

Plants

White River Riparian Areas

Under the Proposed Action, plants growing in the White River riparian corridor would not be substantially affected by changes in water flows because these areas currently experience flows ranging from floods to low water events, and reflect some level of ongoing disturbance. Vegetation, especially vegetation located within a riverine or riparian environment, is generally tolerant of water level changes. Plants in these settings are particularly resilient to changes in water levels if they occur during the winter, when the plant metabolism has slowed due to colder temperatures. If water levels recede to normal levels during the growing season, March through October, existing vegetation would not likely be affected. For example, black cottonwood trees are very tolerant of winter time flooding, but if these flood levels persist well into the growing season, the trees would become stressed and might die. Trees less tolerant of high water levels, such as Douglas fir and bigleaf maple, generally occur in uplands.

Most of the riparian areas lie outside the ordinary high water line of the White River; however, some areas, such as riverine wetlands, are dependent on overbank flooding from a stream or river on a frequency of at least once every 2 years (Hruby 2004). The hydrology in these wetlands is usually not entirely supplied by river flows, but is also influenced by precipitation or groundwater discharge. Overbank flooding is variable in frequency and intensity and typically occurs during high flow events; occurrence of flooding usually corresponds with the time of year with highest precipitation or the first melt of snow in the basin. In the White River basin, these events typically occur prior to the start of the growing season, and inundation remains for a portion of the growing season. Inundation during the growing season tends to influence plant growth. Since the Proposed Action would maintain wet season peak flow rates similar to those for the No Action Alternative, impacts to riverine wetland plant communities would not be anticipated.

Monthly average flow rates under the Proposed Action would generally be higher in the early growing season (March and April) than currently in the White River Reservation Reach. This change would be expected to maintain the existing riverine wetland systems. The increased flow rates would cause only a small fluctuation in river levels, and would not exceed the peak flow rates in the preceding wetter months. Areas that do not normally flood would not be inundated. Monthly average flow rates in the White River for the remainder of the growing season would be slightly lower than existing conditions. These reduced flow rates would result in only minimal changes in river levels, and a substantial decrease in moisture conditions would not be anticipated.

Since peak flow rates under the Proposed Action would be similar to existing conditions and monthly average flow rates would increase slightly only in the early growing season, change in overall wetland acreage would be unlikely. Low flow rates associated with a dry year scenario would be unlikely to affect the long-term ecology of existing riverine wetlands because these conditions would be infrequent.

The White River downstream of the tailrace is mostly channelized and subject to large fluctuations in water depth. Because no riparian wetlands or floodplain areas are present within this reach, alterations to the current flow rates would be expected to have a negligible impact on plants and wildlife habitat. Any impacts on plants and wildlife would be more likely to occur in the meandering portion of the channel in the upper reaches of the study area, where the floodplain is more intact.

Lake Tapps Reservoir

The Proposed Action would alter current reservoir procedures by filling the reservoir approximately 1 month earlier in an average water year. Since the Proposed Action would not flood additional land, vegetation communities rooted along the shoreline of Lake Tapps Reservoir would not be expected to change. Since the change in flood timing would occur during the early growing season before most plants have emerged from winter dormancy, effects to individual plants would not be expected to result from the Proposed Action. Hydrology within Lake Tapps Reservoir for the remainder of the growing season would be comparable to the current conditions, and impacts to vegetation would be unlikely.

Annual drawdown of the reservoir water levels currently occurs in the winter, and would continue if the Proposed Action were selected. Drawdown during the winter would continue to limit and control the dominance and abundance of Eurasian watermilfoil. Milfoil habitat would be made available 1 month earlier during a normal water year, which could allow for more growth; however, since the additional habitat would be created early in the growing season when milfoil is not actively growing, substantial increases in milfoil production resulting from the Proposed Action would not be expected.

During a dry year scenario, early growing season water levels would be lower than current conditions due to a delayed Spring Refill. This scenario is not predicted to occur during most years, and prolonged ecological impacts would not be anticipated.

Lake Tapps Reservoir Shoreline Riparian Communities

The riparian areas surrounding Lake Tapps Reservoir would not likely be affected by the change in timing of Spring Refill, or the decreased water levels during a dry year scenario. Most riparian plant communities are rooted in soils situated above the current limits of the water table fluctuation within the reservoir. Upland areas, such as land dominated by Douglas fir or bigleaf maple, are particularly separate from the reservoir water regime, and would not be affected by water level fluctuations. Riparian plant communities vegetated with plants that are tolerant of or dependent upon wetland hydrology, such as red alder, black cottonwood, or willows, may depend on the current annual reservoir water level fluctuations. Filling the reservoir earlier in the spring would not likely affect these areas for the reasons discussed earlier. However, delayed Spring Refill could occur during dry years, which could dry out some of these areas. Since these changes would only be predicted to occur within the early part of the growing season, and not when temperatures are very warm, only minimal effects to individual plants would be expected.

Wildlife

White River

Changes in flow rates associated with the Proposed Action would be unlikely to cause a substantial change in vegetation that affected habitat structure. Furthermore, peak flow rates would be relatively unaltered, which would help maintain current flooding conditions and disturbance regimes in adjacent riverine wetlands. Lower flow rates in the summer and fall would alter river stage only slightly, and impacts to adjacent wetland habitat would not be expected.

Waterfowl concentrations in the White River floodplain are typically associated with large open water areas. These areas can receive hydrology from a variety of sources, including tributary streams, groundwater discharge, and floodwaters from the White River. Waterfowl habitat currently influenced by the White River would be sustained since peak flow conditions would not change. The only potential change would result from increased flow rates in the early growing season, which would help maintain riverine wetland conditions. Reduced flow rates toward the end of the water year could affect the duration of flooding in these areas, although these impacts would likely be minor and occur when natural systems typically experience less surface water inundation.

Species present in the vicinity of the study area that are not dependent on habitats associated with river hydrology, such as the Northern spotted owl, would not be affected.

Lake Tapps Reservoir

The Proposed Action would not affect vegetation that may currently provide cover, forage, or other habitat functions to wildlife along the lacustrine fringe or in the shoreline riparian areas of Lake Tapps Reservoir. The slight change in timing of Spring Refill would not be expected to change the configuration, area, or plant species composition of wetlands along the fringe of Lake Tapps Reservoir. Habitat functions provided by these wetlands would not be expected to change.

Refilling Lake Tapps Reservoir earlier each year and maintaining a static water surface elevation for an increased duration might improve habitat conditions for amphibian species nesting along the reservoir shoreline. Many amphibian species, particularly the western chorus frog (*Pseudacris regilla*), rely on thin-stemmed emergent plant stems and static water levels for nesting habitat. Nesting generally occurs in the spring and emerged tadpoles continue to rely on shoreline habitats until they metamorphose in the summer. These organisms provide an important food source for wetland-dependent birds such as the Great blue heron, or furbearing mammals such as River otter or Mink. During a dry year, a temporary decrease in the duration of available shallow water habitat for amphibians could occur due to the delayed Spring Refill. These events would likely be infrequent and not substantially affect wildlife since habitats would still be available, just slightly later in the year.

Winter exposure of sediments in the reservoir attracts waterfowl and shorebirds. Under the Proposed Action, these habitats would be available for approximately 1 month less than under the No Action Alternative during most years. In March, when the mud areas would no longer be exposed, waterfowl that congregate in the area would either feed farther landward, or find forage in other areas. Farmland in the Puyallup or Green River valleys provides habitat for these staging flocks. Waterfowl also use the reservoir surface to loaf and find refuge from land-based predators such as domestic animals or weasels. With earlier Spring Refill, the reservoir would increase the available resting habitat for resident or migratory birds.

8.2.2 Indirect and Cumulative Impacts

No Action Alternative

Plants

Because conditions under the No Action Alternative would be similar to existing conditions, no indirect or cumulative impacts would be anticipated.

Wildlife

Because conditions under the No Action Alternative would be similar to existing conditions, no indirect or cumulative impacts would be anticipated.

Proposed Action

Plants

Adult Pacific salmon die after they return to natal waters to spawn, leaving carcasses in channels and along banks. The carcasses provide an important seasonal supply of organic matter to riverine ecosystems. As the carcasses decompose, nutrients are released into the environment, assisting with the productivity of riparian vegetation. Under the Proposed Action, conditions for salmon in the study area would be maintained, as would their contribution to the riparian ecosystem. The Proposed Action would not be expected to affect vegetation or contribute to indirect or cumulative impacts.

Wildlife

Salmon eggs and juveniles are known to provide a source of food for many wildlife species, including waterfowl such as Common mergansers (*Mergus merganser*) and Harlequin ducks (*Histrionicus histrionicus*), various gulls, ravens and crows (*Corvus* spp.), Ospreys, Northern river otters (*Lontra canadensis*), raccoons, snakes, and salamanders. Furthermore, returning adult salmon and their carcasses left behind in river systems after spawning can provide a source of food for wildlife. Carcasses are linked to the largest group of wildlife consumers of any salmon life stage, including Bald eagles, Turkey vultures (*Cathartes aura*), gulls, opossums, shrews (*Sorex* spp.), coyotes, raccoons, and waterfowl (Cederholm et al. 2000). It is anticipated that under the Proposed Action, conditions suitable to salmon would be maintained, in turn maintaining forage for wildlife dependent on salmon in the study area. Since impacts to wildlife would be negligible, cumulative impacts would not occur.

8.3 Mitigation Measures

While the project would not result in significant direct, indirect, or cumulative impacts to plants or wildlife, Cascade would provide the mitigation measures listed in Table S-1 (Summary) and Section 1.4 of this Draft EIS.

8.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts would be anticipated under the Proposed Action or the No Action Alternative.

This page intentionally left blank.

Chapter 9: Fisheries

The Puyallup River Basin (which includes the White River, Lake Tapps Reservoir, and the Lower Puyallup River) contains productive riverine habitat for fish species, particularly for salmon spawning, rearing, and migration. This chapter addresses how fisheries resources could be affected by changes in the way that the White River–Lake Tapps Reservoir system is managed.

9.1 Affected Environment

The affected environment for fisheries resources is defined as the water bodies downstream of the diversion dam that may receive more or less water (or water at a different time) as a result of the Proposed Action or No Action Alternative. This area includes the Reservation Reach of the White River, Lake Tapps Reservoir, the Lower White River, the Lower Puyallup River, and the Puyallup River estuary, as well as the lands around them (see Figure 9-1). The stocked fishery in Lake Tapps Reservoir is considered part of the affected environment and is discussed in this chapter; however, the primary focus of the fisheries resources analysis is on the fish species native to the White River and Puyallup River.

9.1.1 Physical Habitat

Dams

Two dams in the Project vicinity affect fisheries resources: the diversion dam and Mud Mountain Dam (MMD).

Diversion dam. Puget constructed the diversion dam on the White River in 1910 at RM 24.3.

The **Reservation Reach** of the White River is located between River Mile (RM) 24.3 and RM 3.6 (see Figure 9-1). Water from the White River that is not diverted into Lake Tapps Reservoir flows along the Reservation Reach for approximately 21 miles.

The Reservation Reach is divided into three sections:

- The **Upper Section** (RM 24.3 to RM 20.9) about 3.4 miles long
- The **Middle Section** (RM 20.9 to RM 9.1) about 11.8 miles long
- The **Lower Section** (RM 9.1 to RM 3.6) about 5.5 miles long.

The **Lower White River** (RM 3.6 to RM 0.0), approximately 3.6 miles long, is located below the confluence with the tailrace to the White River's confluence with the Lower Puyallup River.

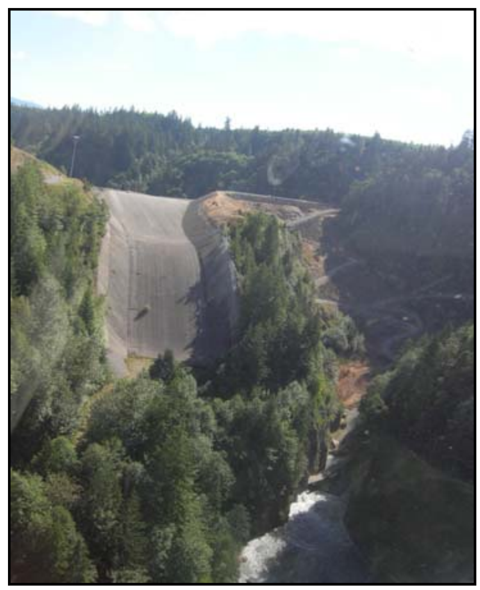
The **Lower Puyallup River** (RM 10.4 to RM 1.0), approximately 9.4 miles long, is located below the confluence of the Lower White River and the Puyallup River.

The **Puyallup River estuary** (RM 1.0 to RM 0.0) is the reach of the Puyallup River from approximately 1 mile above the outlet to Commencement Bay.

The diversion dam is scheduled for replacement by the U.S. Army Corps of Engineers (USACE). Construction is slated to begin in 2012. The diversion dam's condition and design hinder the function of the fish ladder at the dam. The diversion dam is a barrier to upstream fish passage except during high water events. Because of the diversion dam's condition, migrating salmon can swim upstream during high water events without encountering the fish ladder, with no other way past MMD to upstream habitat (NOAA Fisheries 2003) (see below for additional discussion of the fisheries operations at the diversion dam). The diversion dam also has no features to ensure or aid transport of large woody debris (LWD)[1] into the Reservation Reach (NOAA Fisheries 2003).

The diversion dam on the White River at RM 24.3. The fish ladder and trap and the intake to Lake Tapps Reservoir are at right. The fish hatchery operated by the Muckleshoot Indian Tribe is at upper left.
Photo courtesy of R.C. Ladley, Puyallup Tribe Fisheries Division

Mud Mountain Dam. In 1948, USACE completed construction of MMD on RM 29.5 of the White River. MMD is a flood control reservoir that impounds about 4 miles of the White River, from RM 35 to RM 31 just above the confluence with the Clearwater River. MMD provides flood protection for land along the White River and along the Lower Puyallup River downstream of its confluence with the White River. The reservoir is empty most of the time; however, during periods of high precipitation, the reservoir is temporarily filled to reduce the river flow. MMD is an impassible barrier to upstream fish passage. In 1995, USACE made a series of fish passage improvements at MMD for downstream passage of fish (NOAA Fisheries 2003).



Mud Mountain Dam
Photo courtesy of R.C. Ladley, Puyallup Tribe Fisheries Division

[1] For a definition of this term and other terms used in this chapter, see page 9-9.

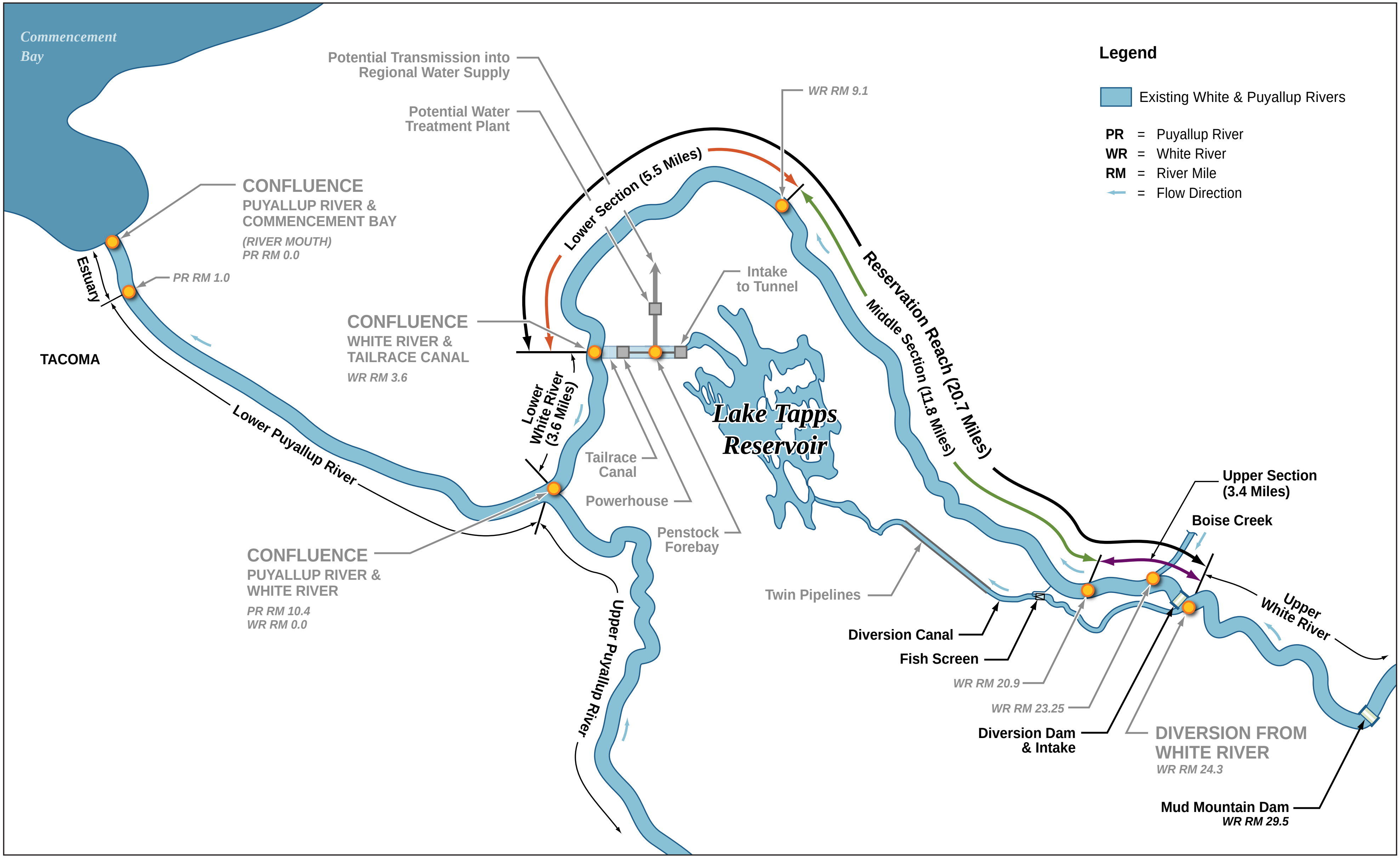
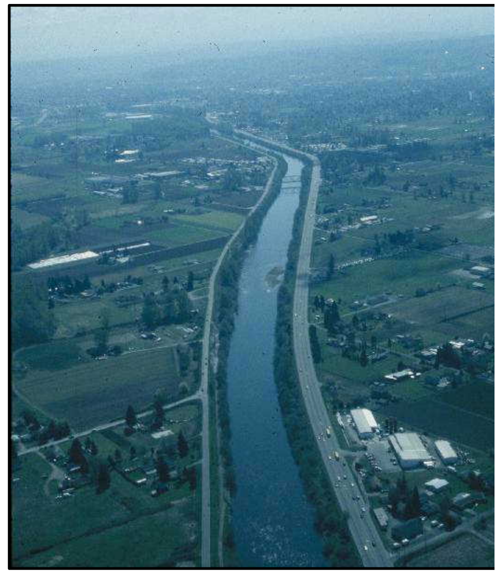


Figure 9-1. Stream Reaches in the Project Vicinity

Lake Tapps Water Rights and Supply Project

Levees

To provide flood protection and control channel migration and bank erosion, construction was initiated in 1908 on a system of levees and/or revetments along a portion of the White River and along the Lower Puyallup River (Kerwin 1999). On the White River, levees were constructed from RM 9.1 to RM 0.0. In the late 1950s, the levee on the left bank of the White River was extended to RM 11.3; however, flooding in the early 1970s breached the levee at RM 10.3 and destroyed the upper section (Kerwin 1999). Along the Puyallup River, flood control levees are located from RM 28.6, well above the confluence with the White River at RM 10.4, to Commencement Bay. The Puyallup River levees are generally located on the river banks. The resulting active channel width is approximately 130 feet (Kerwin 1999).



A channelized stream
Photo courtesy of R.C. Ladley, Puyallup Tribe Fisheries Division

Prior to levee construction, the White River was braided and prone to frequent and rapid channel migration due primarily to the large sediment bed load (King County 1988). The channels and floodplains of the White River and Puyallup River were hydrologically and functionally connected prior to flood control actions. Levee construction and channel modifications for flood control have resulted in straighter rivers with decreased river lengths and widths and, in places, have isolated the river channels from the floodplains (Kerwin 1999; Marks et al. 2008). In a natural system, a river's side channels and riparian zones are inundated during higher flow periods. These areas of slower-moving water provide cover and rearing habitat for juvenile fish. Construction of flood control and bank erosion prevention structures and associated channel modifications has removed some of the natural sinuosity of the rivers and restricted the spawning and rearing habitats once present in riverine ponds and side channels (Kerwin 1999).

A natural, braided stream
Photo courtesy of R.C. Ladley, Puyallup Tribe Fisheries Division

Fish Ladder, Trap, and Transport

Downstream migration. Until 1939, the intake of the White River into Lake Tapps Reservoir was not screened to prevent entrainment of downstream-migrating fish into the flow line to the reservoir. In 1939, a rotating drum fish screen was installed at the intake. Though it was an improvement over no screens, the rotating drum fish screen had a high potential for injuring fish returning to the White River (NOAA Fisheries 2003). In 1996, the rotating drum fish screen was replaced with a vee screen (NOAA Fisheries 2003). In this structure, most of the water flows through the legs of the vee into the diversion canal leading to Lake Tapps Reservoir; at the same time, fish are channeled to the bottom of the vee and into a bypass that returns the fish to the White River (see Figure 9-2).

Fish screen (vee shape) for downstream-migrating fish
Photo courtesy of R.C. Ladley, Puyallup Tribe Fisheries Division

Upstream migration. In 1948, the same year that MMD was completed, USACE constructed a fish ladder and trap at the diversion dam for upstream-migrating fish (the Buckley Fish Trap). When anadromous salmonids return upstream to the Upper White River to spawn, they are captured in the fish trap at the top of the fish ladder in the diversion dam, and are then transported via a tanker truck and released in the Upper White River upstream of MMD at RM 33.6 (see Figure 9-2). Since 1948, USACE has captured, enumerated, and identified each salmonid trapped at the diversion dam and hauled upstream (Marks et al. 2008). During the salmonid spawning run (late May to early October), USACE operates the trap 1 to 5 days per week or as necessary. The trap is checked for fish presence, then the trap is hoisted onto a tanker truck and the fish are released from the trap to the truck. According to the Puyallup Tribe Fisheries Division, the number of returning fish has exceeded the capacity of trap and haul operation since 2000.

Fish ladder at the Buckley Fish Trap
Photo courtesy of R.C. Ladley, Puyallup Tribe Fisheries Division

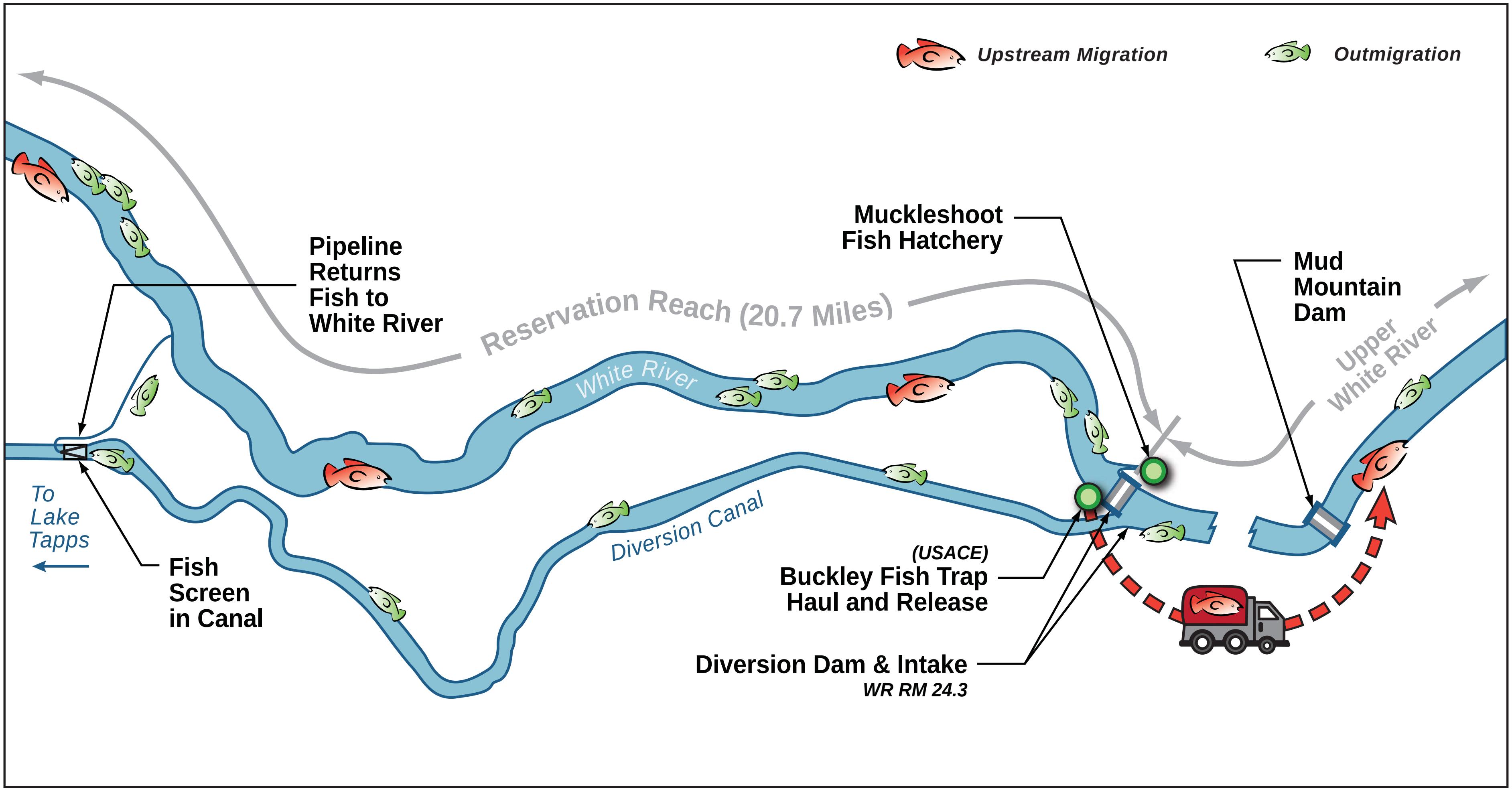


Figure 9-2. Fish Upstream and Downstream Migration near the Diversion Dam

Lake Tapps Water Rights and Supply Project

Terms used in this chapter:

Anadromous fish: Fish that hatch in fresh water, migrate to the ocean to grow and mature, then return to fresh water to spawn.

Bed load: The quantity of silt, sand, and gravel or other debris rolled along the bed of a stream.

Dissolved oxygen (DO): The oxygen gas dissolved in water. Fish absorb oxygen directly into their bloodstream through their gills (comparable to land animals breathing oxygen into their lungs). A higher DO content is favorable for fish.

Escapement: Fish that have survived natural and fishing mortality to constitute the spawning population.

Fry: Young salmonids that have emerged from their redds and absorbed their yolk sacs, up to the time they are about 2 inches long.

Large woody debris (LWD): Logs, limbs, or root wads that are waterward of the ordinary high water line. These areas can create habitat features important to fish life.

Natal stream: The stream where a fish was hatched and reared.

Outmigration: The downstream movement of juvenile/fry from their freshwater rearing area to the ocean.

Pool: Aquatic habitat in a stream that is deeper and sometimes wider than habitats immediately above or below.

Reach: A portion of a stream's length.

Redd: An excavation dug in gravel or small substrate material by salmonids and where eggs are deposited.

Refugia: An area of a stream that provides shelter or safety for aquatic species.

Riffle: A shallow stream reach with a broken water surface caused by ripples or waves formed over obstacles or substrate in the streambed.

Riparian: Of or relating to the banks of a watercourse.

Riprap: Man-made armoring (frequently large rocks) placed along a stream bank to prevent erosion.

Salmonids: Members of the fish family *Salmonidae*, including salmon, trout, and char.

Smolt: A subadult salmonid that is migrating from fresh water to sea water.

Substrate: Materials (silt, sand, gravel, and rocks) that form the bottom of streams.

Turbidity. Refers to the suspended sediments or floating material that clouds the water and makes it appear dark and muddy. Turbidity may prevent penetration of sunlight and affect production of food in a water body.

9.1.2 Characteristics of Aquatic Reaches

White River

Upper White River above the Diversion Dam (above RM 24.3)

The headwaters of the White River originate from the glaciers on Mount Rainier. The glaciers supply cold water with a large sediment load. Total suspended sediment production in the White River is estimated to range from 440,000 to 1,400,000 tons annually (Kerwin 1999). The high sediment loads are responsible for the braided nature of the river from RM 71 to RM 56 (Marks et al. 2008). The river flow exhibits two peak flow periods: (1) during December to January when rainfall is highest, and (2) during snowmelt in May through June.

The Upper White River flows from Mount Rainier into the White River valley. Most of the broad valley is undeveloped. There is a well-developed riparian zone consisting of second growth forest except at the headwaters in Mount Rainier National Park, where old growth dominates (Marks et al. 2008). Downstream of RM 61, the White River and many of its tributaries flow through timber production lands.

From the glacial headwaters, the river initially flows east and then assumes a northerly direction for about 18 miles to Ranger Creek, and then flows northwest for about 8 miles to the confluence with the West Fork White River (RM 49.2) and another 4 miles to the confluence with the Greenwater River (RM 45.8). Significant tributaries of the White River include the West Fork White River, Huckleberry Creek, Clearwater River, and the Greenwater River. The White River and West Fork White River are glacial streams characterized as unconfined, braided complex channels (Marks et al. 2008).

Woody debris is abundant in the Upper White River, but woody debris of significant size is rare since most of the upper watershed is second growth forest except for the portion in Mount Rainier National Park (Marks et al. 2008), as noted above. Abundant spawning gravels are found in downstream portions of pools and in low-velocity areas along the lower reaches of the Upper White River and West Fork White River (Marks et al. 2008).

Non-glacial tributaries include Huckleberry Creek, the Clearwater River, and the Greenwater River. Huckleberry Creek is a low- to moderate-gradient stream with a complex channel structure and abundant spawning gravel for the first 1.5 miles. LWD is abundant in the upper reaches of Huckleberry Creek. The Clearwater River flows through a steep canyon in its upper reaches, but the lower 5.5 miles flow through a broad valley. A natural anadromous fish barrier is present at RM 7.3, and substrates consist of small cobbles with gravel present in the lower-gradient riffles and pools. Limited amounts of LWD are present in the lower reach of the Clearwater River (Marks et al. 2008). The Greenwater River is a medium-sized, low-gradient pool-riffle stream with large deposits of spawning gravel (Marks et al. 2008).

Limited amounts of LWD are present in the Greenwater River due to the small size of the trees present along the river (Marks et al. 2008).

White River Reservation Reach (RM 24.3 to RM 3.6)

The White River Reservation Reach acts as a fish migration corridor and also provides spawning and rearing habitat for seven species of salmonids including spring and fall Chinook, coho, chum, and pink salmon (Williams et al. 1975), and steelhead, cutthroat, (Kerwin 1999), and bull trout (WDFW 2009a).

Braided channel with large woody debris (LWD) in the Middle Section of the Reservation Reach (RM 20.9 to RM 9.1)

The Reservation Reach below the diversion dam is a meandering river with many gravel bars and side channels (Embrey 1991) in some areas. The Upper Section of the Reservation Reach (RM 24.3 to RM 20.9) is characterized by a moderate to steep gradient and streambed substrate consisting of gravel and cobbles with boulder-sized riprap or deposits of sand along the edges. The riparian corridor is well developed in the Upper Section, and overhanging vegetation in this area provides adequate protection for fish from predation. The Middle Section (RM 20.9 to RM 9.1) is not as steep as the Upper Section and consists of a broad, complex, braided channel with many significant side channels and a substrate composed of gravel/cobbles with abundant spawning gravel. LWD is present in this section and forms large logjams. The Lower Section (RM 9.1 to RM 3.6), through Auburn, is gravel/cobble-dominated, contains sparse LWD, is confined by levees, and is a low-gradient system with a decrease in spawning gravel and spawning activity compared with the Upper Section (Kerwin 1999; Marks et al. 2008).

Levee on the left bank in the Lower Section (RM 9.1 to RM 3.6) of the Reservation Reach, just upstream from Auburn

Lower White River (RM 3.6 to RM 0.0)

The Lower White River below the confluence with the tailrace at RM 3.6 to its confluence with the Lower Puyallup River is channelized and straightened with levees on both banks (Embrey 1991). The substrate in this section consists largely of embedded cobble and gravel substrates, with sand deposits where low-velocity conditions are present along the river edges (Embrey 1991; Hilgert and Madsen 1998). The river gradient in this straightened section is much lower than in the Upper Section. Overhanging vegetation is sparse, but vegetation grows along both levees on either side of the river in this area (Embrey 1991).

Lower Puyallup River

The main stem Lower Puyallup River below the confluence with the White River is extensively channelized and mostly contained within a series of flood protection dikes, revetments, and levees along both banks (Embrey 1991; Kerwin 1999). Most LWD has been removed as part of ongoing channel maintenance activities (LPWMC 1992). These flood control measures have eliminated connections with side- and off-channel aquatic habitats and decreased riparian vegetation (Embrey 1991).

The Lower Puyallup River is tidally influenced near the estuary, has a low channel gradient, and has deposits of sand covering much of the river bottom (Embrey 1991). The Lower Puyallup River is isolated from local sources of gravel by levees. Channelization of the river causes high water velocity during peak flow events. These factors result in a river reach with a limited amount of stable spawning gravel. As a result, survival is believed to be low for any spawning that occurs. Channelization and levees have also reduced riverine processes that form pools, side channels, and other habitat features and refugia needed by salmonids, thereby decreasing the suitability of this area for all salmonids (Kerwin 1999). Since the amounts of rearing, holding, and spawning habitats are limited, salmon primarily use the Lower Puyallup River as a transportation corridor (Kerwin 1999; Williams et al. 1975). Pink and chum salmon are the only two species regularly observed to spawn below the confluence of the White River. According to the Puyallup Tribe Fisheries Division, three restoration projects have been constructed to provide critical off-channel rearing, refuge, and transition habitat within the tidally-influenced reach of the Lower Puyallup River. The three sites are Gog-le-hi-te, Clear Creek, and the newest site, Sha Dadx, completed in 2008.

Lake Tapps Reservoir

Lake Tapps Reservoir stratifies in the summer with a warm layer on top and a cold layer on the bottom (Mueller 1997). The bottom cold layer has a higher dissolved oxygen (DO) content than the upper warm layer. Productivity (i.e., the ability to produce food in the water body) is low due to the turbidity caused by the glacial origins of diverted White River water. Aquatic plants are limited by this turbidity as well as by annual lake drawdowns (Mueller 1997).

Lake Tapps Reservoir is managed as a warm water fishery by the Washington State Department of Fish and Wildlife (WDFW), and has been historically stocked by this agency. The reservoir is heavily used for recreational purposes, including fishing, when the water surface elevation is at Normal Full Pool (see Chapter 10). A resident fisheries enhancement plan developed by WDFW and Puget in 1990 included a salmonid stocking program, warm water fish habitat improvements, and a monitoring and evaluation program to assess the success of the two enhancement programs (Mueller 1997). However, these enhancement programs have not been implemented (Caromile 2009). WDFW is, however, stocking tiger muskellunge (see Section 9.1.4) in Lake Tapps Reservoir (Mueller 1997; Caromile 2009).

9.1.3 Fish Species in the White River and Puyallup River

This section primarily focuses on salmonid fish species in the White River and Puyallup River. While non-salmonid fish species occur in the White River and Puyallup River, none of the non-salmonid species are listed as threatened or endangered under the Endangered Species Act (ESA). Where applicable, the ESA listings of the salmonid species are discussed below.

Non-salmonids

Non-salmonid species in the Puyallup River Basin include Pacific lamprey and river lamprey. Pacific lamprey larvae inhabit fine silt and mud substrates in backwaters of cold water streams. After 4 to 7 years, the larvae metamorphose to miniature adults and migrate to the Pacific Ocean. In the marine environment only, Pacific lamprey are parasitic on other fish. Adult lamprey migrate to fresh water between March and October, overwinter in deep pools, and spawn the following spring (Wydoski and Whitney 2003). Little information is available regarding the status of Pacific lamprey populations in the Puyallup River Basin.

River lamprey, similar to Pacific lamprey in their life history patterns, occur from northern California to southeastern Alaska, including most major rivers in Washington. Like Pacific lamprey, river lamprey are parasitic on other fish. Unlike Pacific lamprey, river lamprey may spend their entire life cycle in fresh water, becoming parasitic upon maturing to the adult life stage (Wydoski and Whitney 2003). Little information is available regarding the status of river lamprey populations in the Puyallup River Basin.

Other native freshwater species that may be present in the Puyallup River Basin include mountain whitefish, dace, peamouth, three-spine stickleback, largescale sucker, and up to seven species of freshwater sculpin (Wydoski and Whitney 2003).

CASCADE WATER ALLIANCE

Salmonids

The mix of salmonid species and life stages present in the White River and Puyallup River varies spatially and temporally. Table 9-1 shows the life history and habitat utilization periods for salmonid species in the Puyallup River Basin.

Table 9-1. Salmonid Life History and Habitat Utilization in the White River and Puyallup River

Species	Freshwater Life Phase	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Winter steelhead	Upstream migration	■	■	■	■	■	■	■	■	■	■											■	■	■	■
	Spawning					■	■	■	■	■	■	■													
	Incubation					■	■	■	■	■	■	■	■	■	■	■									
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Smolt outmigration							■	■	■	■	■	■	■	■										
Sea-run cutthroat	Upstream migration	■	■															■	■	■	■	■	■	■	■
	Spawning				■	■	■	■	■	■															
	Incubation				■	■	■	■	■	■	■	■	■	■											
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Smolt outmigration							■	■	■	■	■	■	■	■										
Coho	Upstream migration															■	■	■	■	■	■	■			
	Spawning	■	■																■	■	■	■	■	■	■
	Incubation	■	■	■	■	■	■	■	■												■	■	■	■	■
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Smolt outmigration					■	■	■	■	■	■	■	■	■	■										
Spring Chinook	Upstream migration									■	■	■	■	■	■	■	■	■	■	■					
	Spawning																■	■	■	■					
	Incubation	■	■	■	■	■	■											■	■	■	■	■	■	■	■
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Fry outmigration									■	■	■	■	■	■	■	■	■							
	Juvenile outmigration			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
Fall Chinook	Upstream migration												■	■	■	■	■	■	■	■	■				
	Spawning																	■	■	■	■	■			
	Incubation	■	■	■															■	■	■	■	■	■	■
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■										
	Juvenile outmigration				■	■	■	■	■	■	■	■	■	■	■	■	■								

Species	Freshwater Life Phase	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Pink	Upstream migration																■	■	■	■					
Pink	Spawning																	■	■	■	■	■			
Pink	Incubation	■	■	■	■	■	■												■	■	■	■	■	■	■
Pink	Juvenile rearing				■	■	■	■	■	■	■														
Pink	Juvenile outmigration			■	■	■	■	■	■	■	■	■	■												
Chum	Upstream migration																						■	■	■
Chum	Spawning	■	■																				■	■	■
Chum	Incubation	■	■	■	■	■	■	■	■														■	■	■
Chum	Juvenile rearing				■	■	■	■	■	■	■	■	■	■											
Chum	Juvenile outmigration				■	■	■	■	■	■	■	■	■	■											
Bull trout	Upstream migration									■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Bull trout	Spawning																	■	■	■	■	■			
Bull trout	Incubation	■	■	■	■														■	■	■	■	■	■	■

Sources: HDR 2002. Data adapted from WDFW et al.1993, Williams et al. 1975, Embrey 1991, and FERC 1992.

Since 1991, the Puyallup Tribe of Indians Fisheries Division has conducted foot surveys on the Upper White River to determine fish distribution and spawning success for salmon, steelhead, and bull trout (Marks et al. 2008). In addition, the Puyallup Tribe has conducted spawning ground escapement surveys for salmonids in the Puyallup River system, and WDFW regularly conducts surveys on the Clearwater River and on Wilkeson Creek for steelhead and South Prairie Creek for Chinook and steelhead.

Chinook Salmon (*Oncorhynchus tshawytscha*)

According to the Salmonid Stock Inventory (SaSI), three Chinook stocks are present in the Puyallup River Basin (WDFW 2009a):

- White River spring Chinook
- White River fall Chinook
- Puyallup River fall Chinook

White River spring and fall Chinook. Two genetically and behaviorally distinct runs of Chinook salmon, both spring and fall, use the White River system.

The White River is the only river in the Puget Sound area to support a run of spring Chinook. Fish arriving at the White River Buckley Fish Trap prior to August 15 are typically considered spring Chinook; those arriving after August 15 are typically considered fall Chinook (WDFW et al. 1996). This life history type seems to be segregated by location within the system. For example, about 60% of the Chinook smolts sampled above the diversion dam (RM 24.3) were spring fish, and about 40% were fall fish. Smolts sampled below the dam were nearly the reverse of the upstream proportions (42% spring and 58% summer/fall fish) (Ford et al. 2004). Large numbers of Puyallup River fall Chinook have been observed to stray into the White River to spawn. Salmon spawning surveys conducted by the Puyallup Tribe from 2003 to 2006 on Boise Creek (a tributary of the White River Reservation Reach) showed that 47% to 64% of Chinook sampled were hatchery fall Chinook from the Puyallup River (Marks et al. 2008).

Adult White River spring Chinook enter the freshwater system as early as May, and will stay in the river until spawning begins in mid-August. Adults generally return as 3- to 4-year-old fish. Some spawning occurs in the main stem White River Reservation Reach and side channels, but the majority of spawning occurs in the Upper White River and in larger Upper White River tributaries such as the Greenwater River and Clearwater River (Ladley et al. 1996).

Chinook fry emerge from eggs approximately 90 to 110 days after spawning, and the majority of juvenile spring and fall Chinook smolts outmigrate to salt water as subyearlings (Dunston 1955). Juvenile outmigration trapping estimates from the 1950s indicated that 80% of spring Chinook exhibit this migratory pattern (Dunston 1955). Spring Chinook fry outmigration occurs from May through August. Juvenile spring Chinook typically exhibit stream-type rearing behavior; that is, they spend a year in their natal stream, outmigrating during the second year of freshwater life from February through August, with peak migration during May (Marks et al. 2008; Wydoski and Whitney 2003).

Puyallup River fall Chinook. Puyallup River fall Chinook are found throughout the Puyallup River, Lower White River, and many of the associated tributaries. Fall Chinook salmon enter the Puyallup River system as early as June and continue through November with the majority of spawning occurring during September through late October, although some tributaries support spawning into early November (Marks et al. 2008). The majority of spawning fall Chinook are 4-year-old fish with a large proportion of 3-year-old fish (Marks et al. 2007).

The majority of fall Chinook fry generally exhibit ocean-type rearing behavior; that is, they reside in their natal stream for approximately 3 months before beginning downstream migration to the estuary from late February through the end of August, with the peak occurring near the end of May (Marks et al. 2008).

ESA listing for Chinook. The White River spring Chinook salmon hatchery stock is listed as a threatened species under the ESA. This stock is considered essential to recovery of the natural stocks in the Puyallup River Basin (NOAA Fisheries 2009). White River spring and White River fall and Puyallup River fall run Chinook salmon in the Puyallup River Basin are also listed as threatened under the ESA (NOAA Fisheries 2009). Puget Sound Chinook are listed as a State Candidate Species by WDFW (WDFW 2009b).

Steelhead Trout (*Oncorhynchus mykiss*)

Both rainbow trout and steelhead (the anadromous form of rainbow trout) are present throughout the Puyallup River Basin. Offspring from both steelhead and rainbow trout can either become anadromous or remain in fresh water (Marks et al. 2008; Wydoski and Whitney 2003). Both winter and summer runs of steelhead trout use the Puyallup River system, but the majority of the steelhead in the Puyallup River Basin are winter-run.

Three winter steelhead stocks – the main stem Puyallup River, White River, and Carbon River stocks – have been identified in the Puyallup River system. These wild native stocks are treated separately due to geographical spawning isolation. Although summer-run fish are captured at the Buckley Fish Trap every year, it is suspected that summer steelhead in the White River are fish straying from the Green River or Skagit River systems. However, because both winter and summer steelhead are known to use the White River system, it is presumed that there are steelhead in the system throughout the year (Marks et al. 2008).

The majority of steelhead returning to the White River are 4-year-old fish (56%) with a smaller proportion of 5-year-olds (34%). Approximately 5% of those fish are repeat spawners (Marks et al. 2008). Summer steelhead are generally observed at the Buckley Fish Trap during August and September. Winter-run steelhead enter the White River system beginning in November, peak in mid-December, and usually reach the Buckley Fish Trap by late December (Marks et al. 2008). Steelhead reside in the White River system through June and start upstream migration in March, with peak spawning occurring in late April to early May. Steelhead usually spawn in upper tributaries, although they commonly use the main stem of the Upper White River as well (Marks et al. 2008). In the White River system, fry emerge within 4 to 8 weeks following spawning. Juvenile steelhead rear in fresh water for 1 to 4 years, with the majority outmigrating as 2-year-old fish to nearshore waters in the spring (Marks et al. 2008; Wydoski and Whitney 2003).

ESA listing for steelheads. Naturally spawned anadromous winter-run and summer-run steelhead populations in the Puyallup River Basin are listed as threatened species under the ESA (NOAA Fisheries 2009).

Bull Trout (*Salvelinus confluentus*)

Bull trout are present in the Puyallup River Basin and have both non-migratory freshwater and anadromous forms in the White River; however, very little is known about their use of the White River system. Anadromous forms migrate upstream beginning in early June to spawn in tributaries and some main stem areas during the first 3 weeks in September through the first week of October. According to the Puyallup Tribe Fisheries Division, radio telemetry of adult migratory bull trout indicates that a small population of these fish exists within the White River and co-mingles with a population of smaller resident bull trout that resides upstream of Mud Mountain Dam.

Like steelhead, bull trout have the ability to spawn more than once in their life cycle, making it difficult to recover pre- or post-spawn mortalities for study (Marks et al. 2008). Bull trout spawning occurs within higher elevation tributary streams about 2,800 feet and predominantly within Mount Rainier NationBull trout fry develop between 165 and 235 days following spawning, and emerge in late winter and spring (Pratt 1992). Post-spawning outmigration occurs fairly rapidly at rates that have been observed at up to 8 miles/day. Anadromous bull trout in the White River are believed to be primarily 5 years of age (Ladley et al. 2007).

ESA listing for bull trout. Bull trout in the Puyallup River Basin are listed as a threatened species under the ESA (NOAA Fisheries 2009; USFWS 2009). Puget Sound bull trout are listed as a State Candidate Species by WDFW (WDFW 2009b).

Coho Salmon (*Oncorhynchus kisutch*)

Two coho stocks are present in the Puyallup River Basin based on distinctly separate spawning distributions. The two stocks, as defined by WDFW, are the Puyallup River and White River stocks.

Coho salmon are found throughout the Puyallup and White River system and are primarily tributary spawners, with key spawning areas located in tributaries including South Prairie Creek (a tributary of the Puyallup River), Boise Creek, the Clearwater River, the Greenwater River, and Huckleberry Creek. However, main stem spawning does occur along channel margins and lower-velocity side channels. The majority of spawning occurs from mid-September through late December, peaking around the end of October and beginning of November. The South Prairie Creek run usually spawns later, well into February and early March (Marks et al. 2008).

Most coho juveniles exhibit stream-type behavior and will spend over a year in fresh water, out-migrating to nearshore waters between March and the beginning of July, with peak migration occurring around mid-May. Complex woody debris structures, sloughs, beaver ponds, and side channels are important rearing habitat elements for juvenile coho salmon.

Since several year classes of coho juveniles may utilize overlapping freshwater habitat in the White River between spring emergence and the end of smolt migration, the most accessible stream reaches in the main stem White River and side channels could contain juvenile coho salmon year-round.

Pink Salmon (*Oncorhynchus gorbushcha*)

Puyallup River pink salmon use the White River, Carbon River, and Puyallup River for spawning, incubation, and migration in odd-numbered years. Pink salmon enter the Puyallup/ White River system in mid-July and spawn from late August through mid-November, with peak spawning occurring from late September through early October (Marks et al. 2008). Pink salmon are mass spawners that primarily spawn in slower side channel habitats as well as in tributaries and along the shallower outer channel margins of the White River. Pink fry outmigration occurs from February through June, peaking at the end of March (Marks et al. 2008). Pink salmon have short freshwater residence times as juveniles, migrating rapidly downstream upon emergence from the gravel to rear in estuaries and the nearshore marine environment (Quinn 2005).

Pink salmon in southern Puget Sound have been known historically to spawn in relatively low numbers in the Puyallup River primarily above RM 16, in South Prairie Creek, and in other tributaries as well as the main stem (NOAA Fisheries 2003). Nearly all known historical pink salmon spawning in the Puyallup River system has occurred in a few clear water tributaries such as South Prairie Creek, Kapowsin Creek, Fennel Creek (Williams et al. 1975; WDFW et al. 1993), and Boise Creek (Marks et al. 2008). Pink salmon spawning has been observed in the main stem Puyallup River, Lower Carbon River, and White River (Williams et al. 1975).

The spawning and abundance pattern of pink salmon drastically changed in 2003 when an unprecedented number of adult pink salmon returned to the Puyallup/White River watershed. WDFW escapement data from 1959 to 2001 shows the number of adult pinks returning to the Puyallup system ranged from 2,700 to 49,000, with an annual average seasonal return of 19,400. In 2003, the run increased to almost 185,000 pink salmon returned to the Puyallup River Basin; 466,000 returned in 2005; and more than 600,000 returned in 2007 (Marks et al. 2009). During recent years with large pink salmon escapement, the number of fish transported above MMD has increased, and increased spawning activity has been documented in the upper main stem and west fork of the White River (Marks et al. 2008).

Biologists for the Puyallup Tribe of Indians have indicated that the Puyallup River system has not seen this utilization explosion and noted that most of these returning fish have been spawning in the White River system (Marks et al. 2008). Pink salmon escapement has been high in the main stem Puyallup River below RM 27.5, as well as in other Puyallup River major tributaries, but not to the extent as in the White River system (Marks et al. 2008).

Chum Salmon (*Oncorhynchus keta*)

Chum salmon are present throughout the Puyallup Basin, with spawners observed as far upstream as RM 23.5 (Boise Creek) on the White River and near RM 29.5 (Fox Creek) on the Puyallup River (Marks et al. 2008). Adult chum enter the Lower Puyallup River around mid-October, and active spawning occurs in most rivers and tributaries from mid-November through the end of January, peaking in mid-December. Chum salmon are mass spawners that primarily spawn in slower side channel habitats as well in tributaries and along the shallower outer channel margins of the White River. Spawning occurs from mid-November through January, with peak spawning occurring in mid-December (Marks et al. 2008). Chum salmon fry have short freshwater residence times and usually emerge between late winter and early spring. Juvenile chum rapidly move downstream to rear in Commencement Bay and the nearshore marine environment (Marks et al. 2008; Quinn 2005).

The Puyallup Tribe has been rearing chum salmon in the Diru Creek Hatchery facility since 1979, and the Tribe currently rears and releases between 1.5 and 2.7 million chum (Marks et al. 2008). The Diru Creek Hatchery is located on a tributary to Clarks Creek on the Puyallup River (Marks et al. 2008). The Puyallup Tribal Fisheries Department has been operating a juvenile fish trap on the Puyallup River (at RM 10.6) since 2001. At this trap, outmigrating juvenile chum are detected from early March, with peak outmigration occurring in the first week of May (Berger and Williamson 2005).

Sockeye Salmon (*Oncorhynchus nerka*)

Sockeye salmon are found in the White River system in relatively small numbers. Escapement above MMD ranged between 5 and 378 adult migrants (averaging only 43 individuals) between 1983 and 2007. The relatively small numbers are typical of populations of sockeye found in river systems that do not have lakes. Juvenile sockeye in these systems can rear in side channels and along channel margins for up to 2 years prior to migrating to marine areas. Sockeye salmon transported above MMD have been observed in several White River tributaries such as the Greenwater River, Clearwater River, Huckleberry Creek, and Silver Springs (Marks et al. 2008). Sockeye spawning in the White River occurs from September through October and spatially overlaps with Chinook, coho, and pink salmon (Marks et al. 2008).

Cutthroat Trout (*Oncorhynchus clarki*)

A coastal cutthroat trout population is present in the Puyallup River system. However, little is known about its population status (Grette and Salo 1986). Juvenile coastal cutthroat rearing habits are similar to those of coho and steelhead, that is, residing in fresh water for at least a year. However, coastal cutthroat may spend their entire marine life cycle within estuarine habitats (Leider 1997).

9.1.4 Fish Species in Lake Tapps Reservoir

WDFW completed a fisheries survey of Lake Tapps Reservoir during fall 1997 (Mueller 1997). A total of 12 fish species were captured, including, in order of numerical dominance, largescale sucker (*Catostomus macrocheilus*), kokanee (*O.nerka*), yellow perch (*Perca flavescens*), redside shiner (*Richardsonius balteatus*), rock bass (*Ambloplites rupestris*), black crappie (*Pomoxis nigromaculatus*), common carp (*Cyprinus carpio*), mountain whitefish, sculpin (Cottus sp.), smallmouth bass (*Micropterus dolomieu*), bluegill (*Lepomis macrochirus*), and cutthroat trout (*O.clarki*) (Mueller 1997). When based on biomass (total fish mass weight per unit volume), largescale suckers and common carp were the two dominant species.

Lake Tapps Reservoir is also well known in the area for its tiger muskellunge (*Esox masquinongy x E. lucius or E. lucius x E. masquinongy*) and largemouth bass fishery. Tiger muskellunge, a hybrid of the musky and the northern pike, have been stocked in Lake Tapps Reservoir following the suggestion made in the 1997 survey in an attempt to improve the density and growth of warm water fish species through predation of the largescale suckers and common carp. Mueller (1997) also suggested that Lake Tapps Reservoir is better suited for pelagic (i.e., living free in open water), cold water species (e.g., kokanee) than warm water species because of the cool water temperatures, low primary productivity, and general lack of aquatic vegetation.

9.2 Environmental Impacts

This section summarizes the impacts of the Proposed Action and the No Action Alternative using the flow changes and the fisheries monitoring data recorded for the White River.

9.2.1 Flow Rates in the Reservation Reach

The flow rate in the Reservation Reach has generally increased due to the decrease in White River diversions since 2004. The average annual flow rate at the upstream end of the Reservation Reach (measured at the Buckley gage) was 554 cubic feet per second (cfs) during the hydropower period[2]. During the hydropower period, flow exceeded 1,000 cfs only about 15% of the time. Since hydropower power generation ceased in early 2004 (the post-hydropower period), the average annual flow at the same location was 1,313 cfs. As shown in Figure 9-3, average monthly flow has also increased in every month of the year. Figure 9-4 shows the frequency of exceedance for mean daily flow rates; for example, at a flow rate of 1,000 cfs, the frequency of exceedance is approximately 43% for the post-hydropower period.

[2] For the purposes of this analysis, the hydropower period is defined as 1990 through 2003. The post-hydropower period is defined as February 2004 through September 2008.

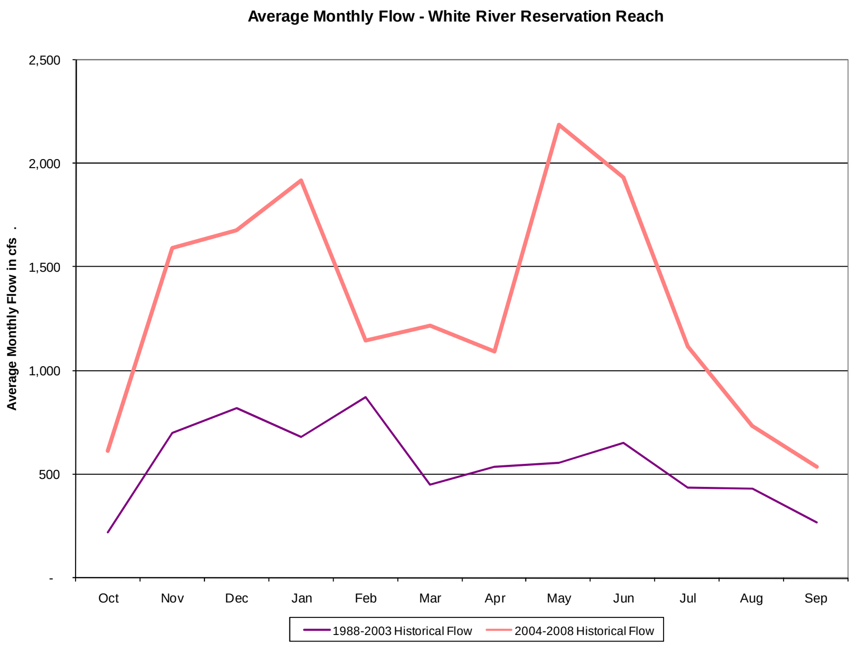


Figure 9-3. Average Monthly Flow in the Reservation Reach during Hydropower and Post-Hydropower Operations

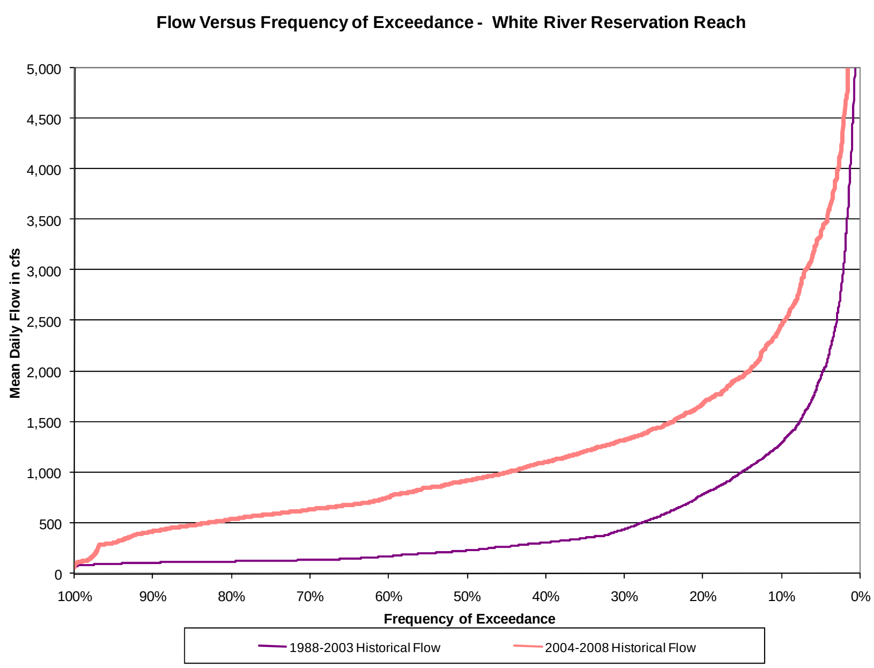


Figure 9-4. Flow Rate versus Exceedance Frequency in the Reservation Reach during Hydropower and Post-Hydropower Operations

9.2.2 Fisheries Monitoring Data

Marks et al. (2008) documented that the section of the Reservation Reach from the diversion dam downstream to approximately RM 11 is used by Chinook, coho, steelhead, and pink salmon. Chum salmon have been observed, but the majority of chum salmon usually spawn below RM 15. Spawning survey information from the Puyallup Tribe (Ladley 2008) indicates that a greater number of Chinook salmon spawn in the upper half of the Reservation Reach than the lower half. The reason for this spawning preference might be that in the Reservation Reach, there are significant side channels, LWD, and logjams that provide complex habitat conducive to salmonid rearing and spawning. A 1-mile-long side channel at RM 14.5 supports Chinook, coho, and pink salmon as well the highest concentration of chum salmon spawners in the White River (Marks et al. 2008). Aerial surveys by the Puyallup Tribe have documented Chinook and steelhead spawning in another side channel located on the left bank near RM 12. Preliminary observations by Puyallup Tribe fisheries biologists indicate that the Reservation Reach and associated side channels are used by different life stages of Chinook, coho, steelhead, chum, and pink salmon (Ladley 2008). More detailed fisheries monitoring data by species is presented below.

Chinook Salmon

Annual Chinook salmon escapement (1970 to 2008) above the Buckley Fish Trap ranged from fewer than 100 to more than 5,000 (Figure 9-5). Spring Chinook escapements were down to 66 fish in 1977 and 6 fish in 1986 (Marks et al. 2008). The decline in Chinook escapement initiated the development of a recovery plan involving artificial propagation. There are two spring Chinook stocking programs in operation: (1) the Muckleshoot Indian Tribe's White River Hatchery, and (2) WDFW's Minter Creek program (Marks et al. 2008). The adult Chinook returns at the Buckley Fish Trap in 2007 and 2008 were significant and nearly three times the 2004 returns, the year in which hydropower operation ceased (Marks et al. 2008).

The Puyallup Tribe conducted a telemetry study that documented Chinook spawning in the main stem White River and in Boise, Greenwater, Clearwater, West Fork, and Huckleberry Creeks (Marks et al. 2008).

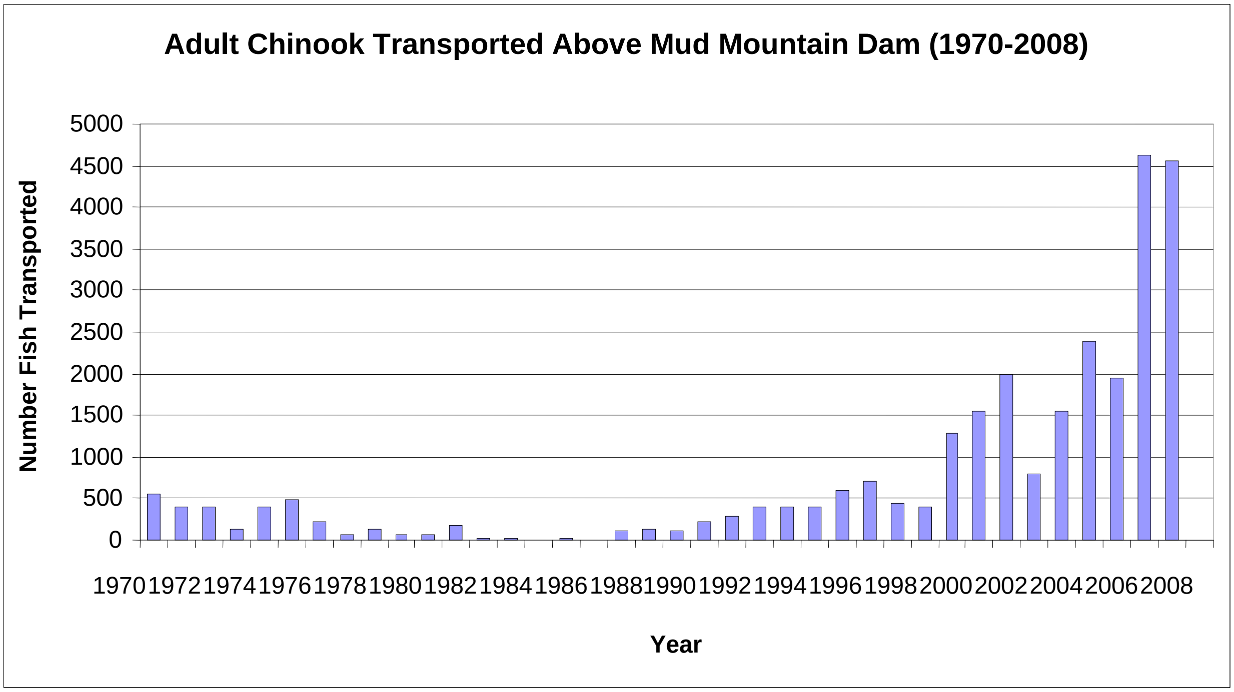


Figure 9-5. Adult Chinook Transported above Mud Mountain Dam (1970 – 2008)

(Source: Marks et al. 2008)

As noted in Section 9.1.3, there are two populations of Chinook in the White River. White River fall Chinook may make more use of larger main stem White River than spring Chinook. Many of the Chinook observed spawning in the main stem White River from RM 3.5 up to the diversion dam at RM 24.3 and in Boise Creek may be fall Chinook (Marks et al. 2008).

Winter Steelhead

Winter steelhead abundance in the White River has been declining (Figure 9-6) since 1988. Increased flow in the Reservation Reach since 2004 has not resulted in an increase in steelhead escapement. Thus, the decline is probably related to environmental factors other than flows in the White River because many other Puget Sound winter steelhead stocks have been in decline since 1990 as well (Marks et al. 2008). Limiting factors and causes for this decline are still uncertain at this time. Winter steelhead enter the Puyallup River system in the winter and spring during high water and are mature enough to spawn within a few months of entering fresh water (Marks et al. 2008). Steelhead tend to use the Upper White River and tributaries above MMD for spawning and rearing, and would be less influenced by increases in Reservation Reach flows. Also, under certain conditions, steelhead can gain access to the portion of the White River between the diversion dam and MMD. When USACE reconstructs the diversion dam in 2012, this will no longer be the case. In response to this decline, the Puyallup Tribe, the Muckleshoot Tribe, and WDFW began a supplementation program on the White River. The program utilizes wild broodstock to generate approximately 35,000 yearling smolts (Marks et al. 2008).

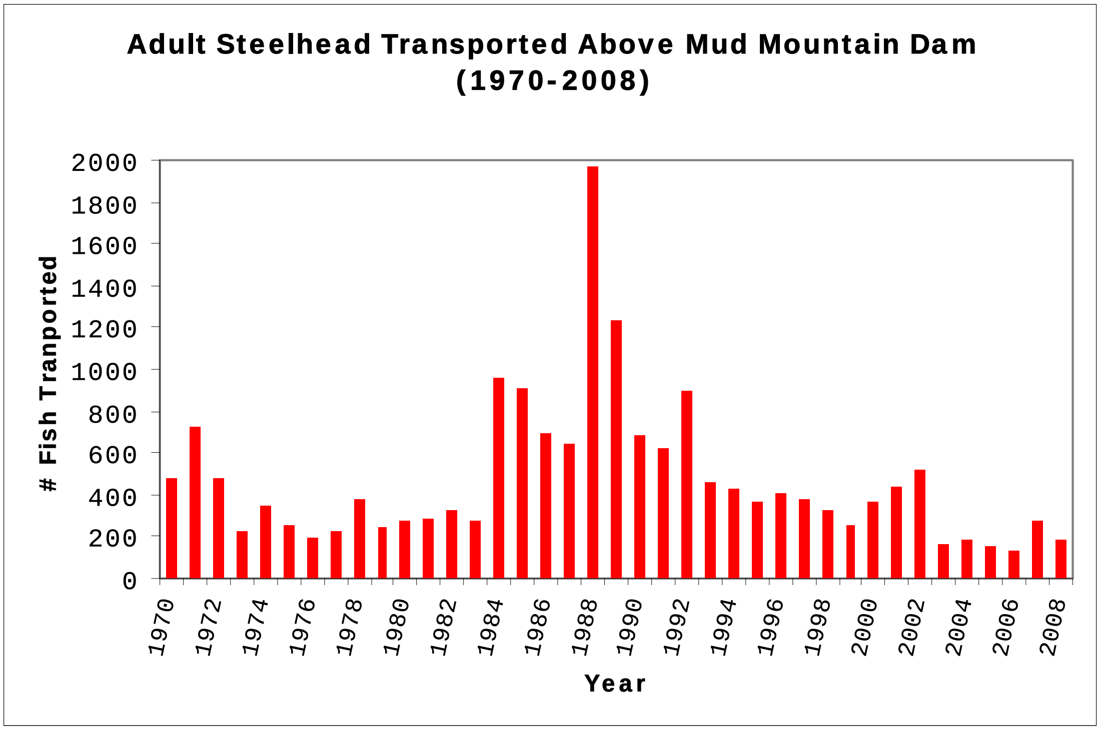


Figure 9-6. Adult Steelhead Transported above Mud Mountain Dam (1970 – 2008)

(Source: Marks et al. 2008)

Bull Trout

Bull trout escapement has not changed appreciably in the last decade. Fish passed around MMD via the trap and haul operation averaged between 29 and 49 individuals (Figure 9-7) since 1999 (Marks et al. 2008). Anadromous bull trout probably use the Reservation Reach as a migratory corridor and possibly as a foraging area, but spawn in the cold upper reaches of the White River drainage.

Coho Salmon

Coho salmon escapement has generally shown larger numbers since 2000 in the White River (Figure 9-8). The majority of coho are tributary spawners, but some main stem and side channel spawning occurs in the Reservation Reach (Marks et al. 2008). Side channels are important rearing habitat elements for juvenile coho, and increased flow in the river may be providing increased habitat.

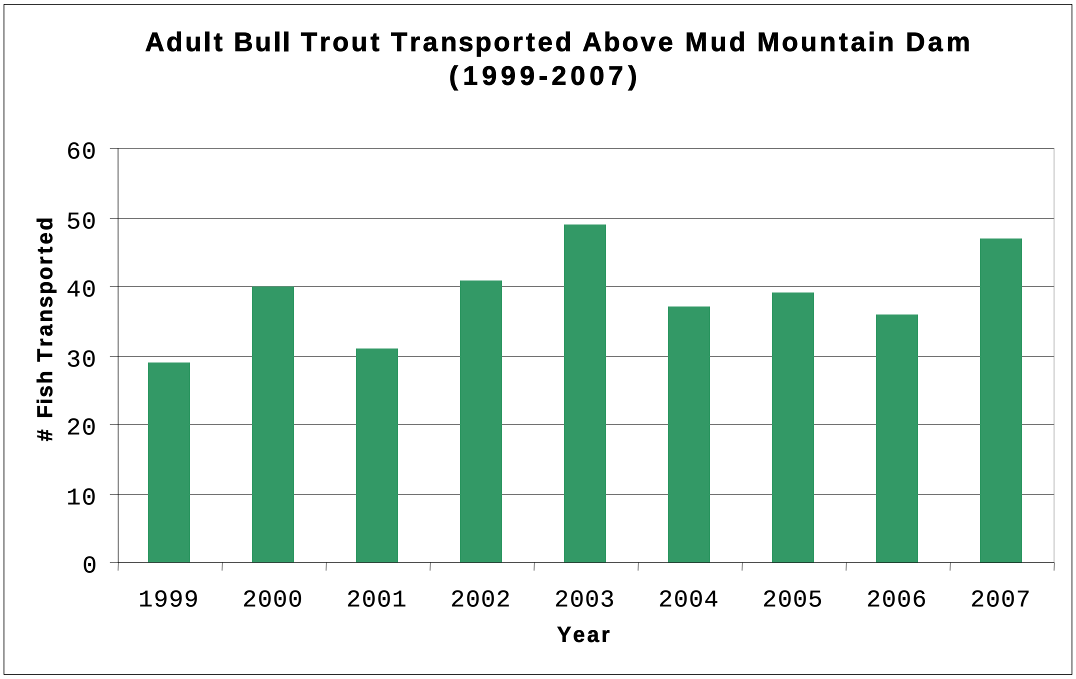


Figure 9-7. Adult Bull Trout Transported above Mud Mountain Dam (1999 – 2007)

(Source: Marks et al. 2008)

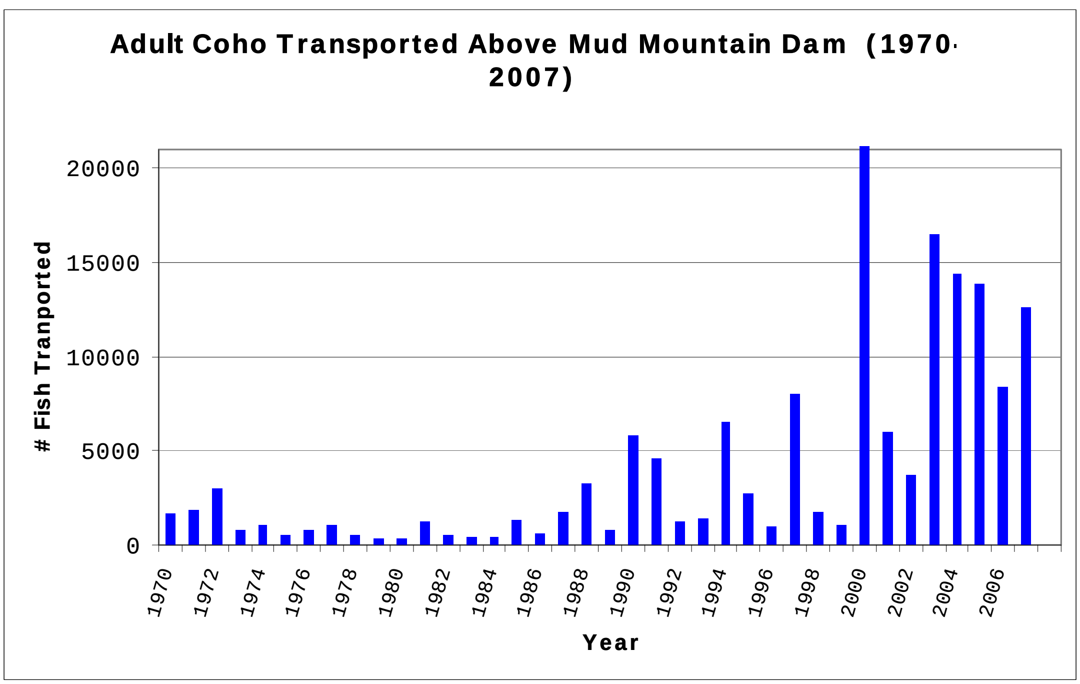


Figure 9-8. Adult Coho Transported above Mud Mountain Dam (1970 – 2007)

(Source: Marks et al. 2008)

Pink Salmon

Pink salmon escapement has dramatically increased in the White River system since 2003 (Figure 9-9). This has been a trend observed throughout the Puget Sound area. Colonization by pink salmon in the Puyallup River system has been greater in the White River drainage than in the Puyallup River drainage (Marks et al. 2008). Because pink salmon typically use the lower reaches of river systems for spawning (Wydoski and Whitney 2003), the increase in flow and instream habitat in the main stem Reservation Reach, as well as the increase in side channel habitat, has probably contributed to the increase in pink salmon escapement in the White River drainage.

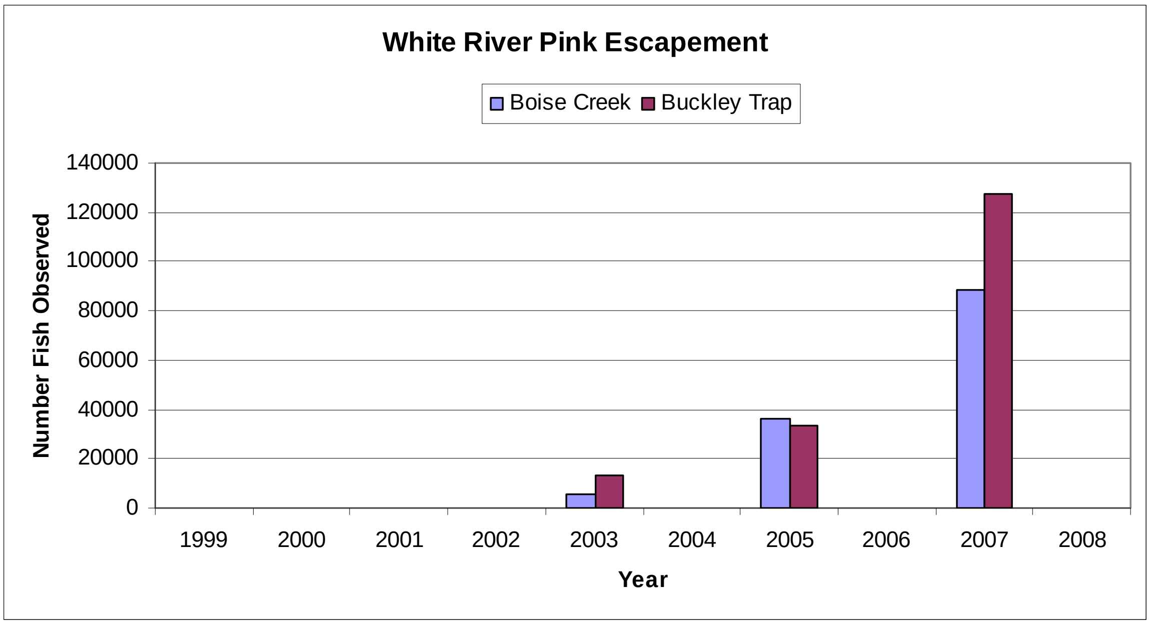


Figure 9-9. Pink Salmon Escapement in the White River (1999 – 2007)

(Source: Marks et al. 2008)

9.2.3 Instream Flow Studies Conducted on the White River and Puyallup River

IFIM Flow Studies

Puget conducted instream flow incremental methodology (IFIM) studies[3] at five study sites on the White River from 1985 to 1986. In a settlement agreement with the Muckleshoot Indian Tribe (Ecology 2006a), Puget committed to maintaining a flow rate of 130 cfs immediately below the diversion dam. In 1989, as part of the Federal Energy Regulatory Commission (FERC) relicensing effort, NOAA Fisheries and the other resource agencies re-evaluated the instream flow study and proposed higher flows (ranging from 350 to 500 cfs) based on assumptions about juvenile salmonid rearing habitat (R2 1995).

In 1991, the U.S. Geological Survey (USGS) conducted an IFIM study at three sites on the Puyallup River (RMs 7, 14, and 20) and at two sites on the White River (RMs 3 and 5) (Embrey 1991). The White River RM 3 study area was downstream of the tailrace, and the Puyallup River RM 7 study area was located downstream of the White River confluence with the Puyallup River at RM 10.4. The 1991 USGS study concluded that fish habitat peaks at flows in the White River at RM 3 from 300 to 900 cfs for adult steelhead and salmon spawning, and from 180 to 300 cfs for juvenile salmon and steelhead rearing. The USGS study indicated that the IFIM optimum flows for the Puyallup River at RM 7 (3.4 miles downstream of the White River confluence) are 1,500 cfs for pink and chum spawning, and 390 to 600 cfs for juvenile salmon and steelhead rearing.

The results of the 1991 IFIM studies were used in conjunction with water quality data and updated fish preference curves developed by Ecology and WDFW to suggest minimum flows in the White River that were protective of the fishery (Ecology 2006a). Ecology used the data available in the 1991 USGS report and updated default preference curves to run the IFIM model for the Puyallup River at RM 7. The Weighted Useable Area (WUA) results for the Puyallup River for salmonid juveniles showed peak fish habitat values at stream flows very similar to the 1991 USGS results (Ecology 2006a). This recent IFIM modeling found that juvenile coho and Chinook WUA values peaked at 400 cfs, while steelhead juvenile WUA values peaked at 700 cfs. The USGS study indicated similar results, with coho and Chinook juvenile WUA values peaking at 390 cfs and steelhead juvenile WUA values peaking at 600 cfs.

Puget conducted IFIM studies again from 1993 to 1994 to develop site-specific habitat suitability preference curves for application in the Reservation Reach. These studies were

[3] The Instream Flow Incremental Methodology (IFIM) was developed as a reconnaissance-level approach for estimating the effect of water flow reductions on fish. The methodology is based on two assumptions: (1) fish populations are constrained by their environments, and under the conditions of flow reduction, limiting factors are related; (2) it is possible to integrate the relationships between biomass and physical factors to derive a single synthetic factor that summarizes the effects of all the individual factors. The need for summarization led to the concept of weighted usable area (WUA) (Maughan and Barrett 1991).

conducted in early March and late April of each year and involved on-site collection of habitat data and fish observations for juvenile Chinook, juvenile steelhead, and juvenile coho salmon in the White River (R2 1995). The monthly minimum instream flow recommendations ranged from 30 cfs to 500 cfs.

As part of the FERC relicensing effort, NOAA Fisheries (2003) re-examined the IFIM studies conducted by Puget from 1985 to 1994, and generally found that the WUA was maximized for species and life stages at 130 cfs to 500 cfs using curves based on data from other river systems. These previous interpretations of the output weighted the five 1991 study reaches according to the length of the reach they were believed to represent. Based on new information that was unavailable at the time the IFIM study was performed, NOAA Fisheries modified the weighting for juvenile Chinook salmon to include only the upper two study reaches. The new information stated that juvenile Chinook prefer natural stream bank habitat with LWD 3.5 times more than they prefer modified bank habitat (NOAA Fisheries 2003). The upper two White River study reaches were characterized by largely natural stream banks, and the lower three reaches were predominately modified by levees and riprap. The maximum WUA juvenile salmonid spawning and rearing flows estimated from the IFIM study were modified from the earlier analyses and are listed in Table 9-2. In its 2003 Draft Biological Opinion (NOAA Fisheries 2003), NOAA Fisheries noted that maintaining habitat connectivity across the range of flows that the fish population actually experiences in the White River is more important than maximizing WUA from a selected instream flow. As river flows increase, the main channel velocities increase, forcing juvenile salmonids to seek refuge in protected side channels. Connectivity between the main channel and side channels is critical so juvenile salmonids are not stranded in side channels as stream flows recede. Chum, Chinook, coho, and steelhead spawning is known to occur in side channels as well as in main channel areas. While some juveniles use side channels as flood refuge, or are flushed in, other juveniles move into side channels volitionally, or are incubated and rear in side channels until smolt migration, where habitat quality and survival can be superior to that of main channels.

IFIM attribute indices are usually termed habitat suitability indices (HIS) and are developed using direct observations of the habitat attributes used most often by a specific salmonid life stage, by expert opinion about what the life requisites are, or by a combination of both. Various approaches are taken to factor assorted biases out of this suitability data, but they remain indices that are used as weights of suitability. The hydraulic estimates of depth and velocity at different flow levels are combined with the suitability values for those attributes to weight the area of each cell at the simulated flows. The weighted values for all cells are summed, thus the term weighted usable area (WUA). The WUA versus discharge function shown in Table 9-2 is usually combined with water availability to develop an idea of what salmonid life stages are affected by a loss or gain of available habitat at certain times of the year.

Table 9-2. Maximum WUA versus Discharge by Species and Life Stage, Based on Re-weighting Study Reaches According to Juvenile Salmonid Utilization

Salmonid Species	Spawning Flow (Adult) (cfs)	Rearing Flow (Juvenile) (cfs)
Chinook	415	150
Steelhead	500	260
Coho	315	150
Pink	550	
Chum	330	

(Note: NOAA Fisheries found that WUA was maximized for salmonid species and life stages at a range of flows.)

Hydraulic Analyses Conducted on the Reservation Reach

Herrera Environmental Consultants conducted hydraulic analyses of the Reservation Reach in 2005 and in 2007 for the Puyallup Tribe of Indians (Herrera 2006, 2007). The 2005 study involved developing a hydraulic model of the Reservation Reach. The 2007 study's purpose was to evaluate the relationship between river flow and main stem and side channel inundation. Herrera (2007) concluded that a minimum instream flow between 400 and 800 cfs is necessary to inundate side channels with flows capable of maintaining suitable habitat quality in these side channels (i.e., wetted area, depth, and water volume).

The Herrera 2005 hydraulic modeling results indicated that the combined wetted (inundated) area of all side channels increases steadily over the range of simulated flows on the main stem. Field observation and modeling results indicated that side channels are continually activated for flows ranging from 200 to at least 1,000 cfs, thereby providing a steady increase in side channel length, wetted area, water depth, and water volume available for various life history stages of salmonids. Within the 1.5-mile study reach, a 100-cfs increase in base flow added approximately 3.2 acres of wetted side channel and approximately 0.75 acre-feet of water volume in side channels. In side channels, the optimal channel depth for spawning Chinook (approximately 1 foot) corresponded to a flow of 800 cfs in the main stem.

Results of this study, in combination with the 2005 model and an understanding of the geomorphic evolution of the Lower White River, indicate that local variability in side channel response to changes in flow can be extrapolated over the approximately 13.3-mile extent of the unconfined Reservation Reach (roughly RM 11 to RM 24.3).

9.2.4 Direct Impacts

No significant direct impacts to fisheries resources are predicted for either the Proposed Action or the No Action Alternative.

No Action Alternative

The No Action Alternative was developed to represent how Lake Tapps Reservoir would likely be operated in the future if the municipal water supply project was not developed. As described in the No Action Alternative (see Chapter 3), from a water operations perspective, this would be a continuation of the way that the White River–Lake Tapps Reservoir system has been operated since the cessation of hydropower operations in early 2004. Under the No Action Alternative, the Interim Agency Flows (see Chapter 3) would continue and fishery mitigation and enhancement activities would not be funded through the tribal settlement agreements. The state of the fisheries would remain as described above.

Proposed Action

White River Flows

Compared with the No Action Alternative, diversions from the White River would increase by an average of 37 cfs under the Proposed Action (see Chapter 5). This extra 37 cfs represents 3% of the available water in the White River above the diversion. The highest volume of diversion would occur in late winter/early spring when Lake Tapps Reservoir was refilled. Diversions would be curtailed when flow in the White River decreased to below the minimum flow threshold. At certain times of the year, flow rates in the Reservation Reach under Proposed Action conditions could exceed flow rates under No Action Alternative conditions during periods when the available flow in the White River allowed diversions to Lake Tapps Reservoir under No Action Alternative conditions, but not under the Proposed Action.

Figure 9-10 shows the simulated average daily flow rates from the STELLA™ model for the upstream end of the Reservation Reach for the Proposed Action and No Action Alternative. Average monthly flows would be very similar under the Proposed Action and No Action Alternative. Figure 9-11 and Figure 9-12 show the STELLA-model simulated flows for the Proposed Action and No Action Alternative for an average year (1998) and a dry year (2001). Figure 9-11 shows that for an average year, except for the Spring Refill period when the reservoir was being filled, the flow in the White River under either alternative would be very similar. During a dry year, the variation in flow would also occur primarily in the Spring Refill period (see Figure 9-12), but for a longer time than during an average year. Under the Proposed Action's operational rules, diversion would not occur to Lake Tapps Reservoir unless the Recommended Flows in the White River were met.

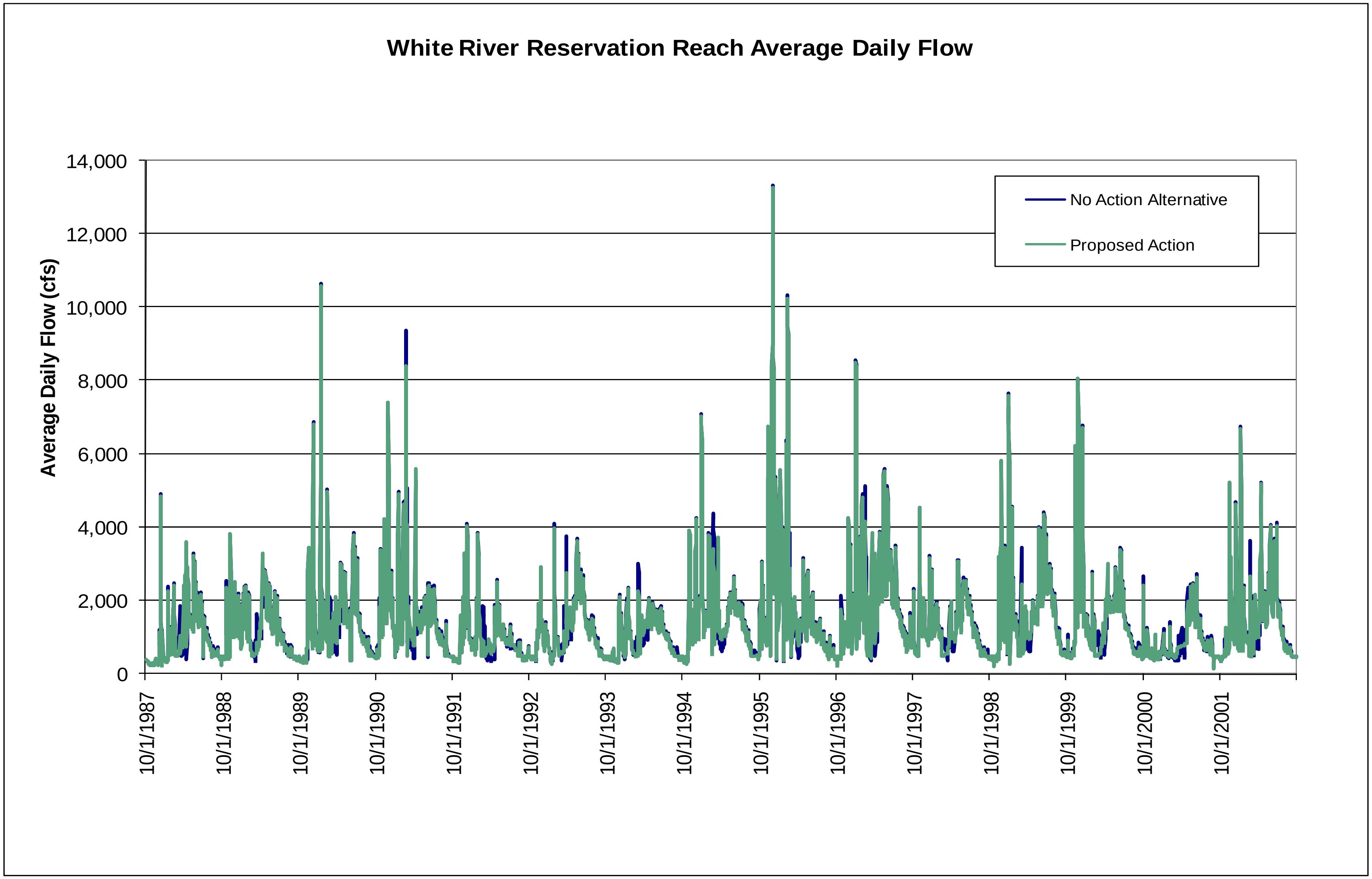


Figure 9-10. Average Daily Flow at the Upstream End of the Reservation Reach – Proposed Action and No Action Alternative

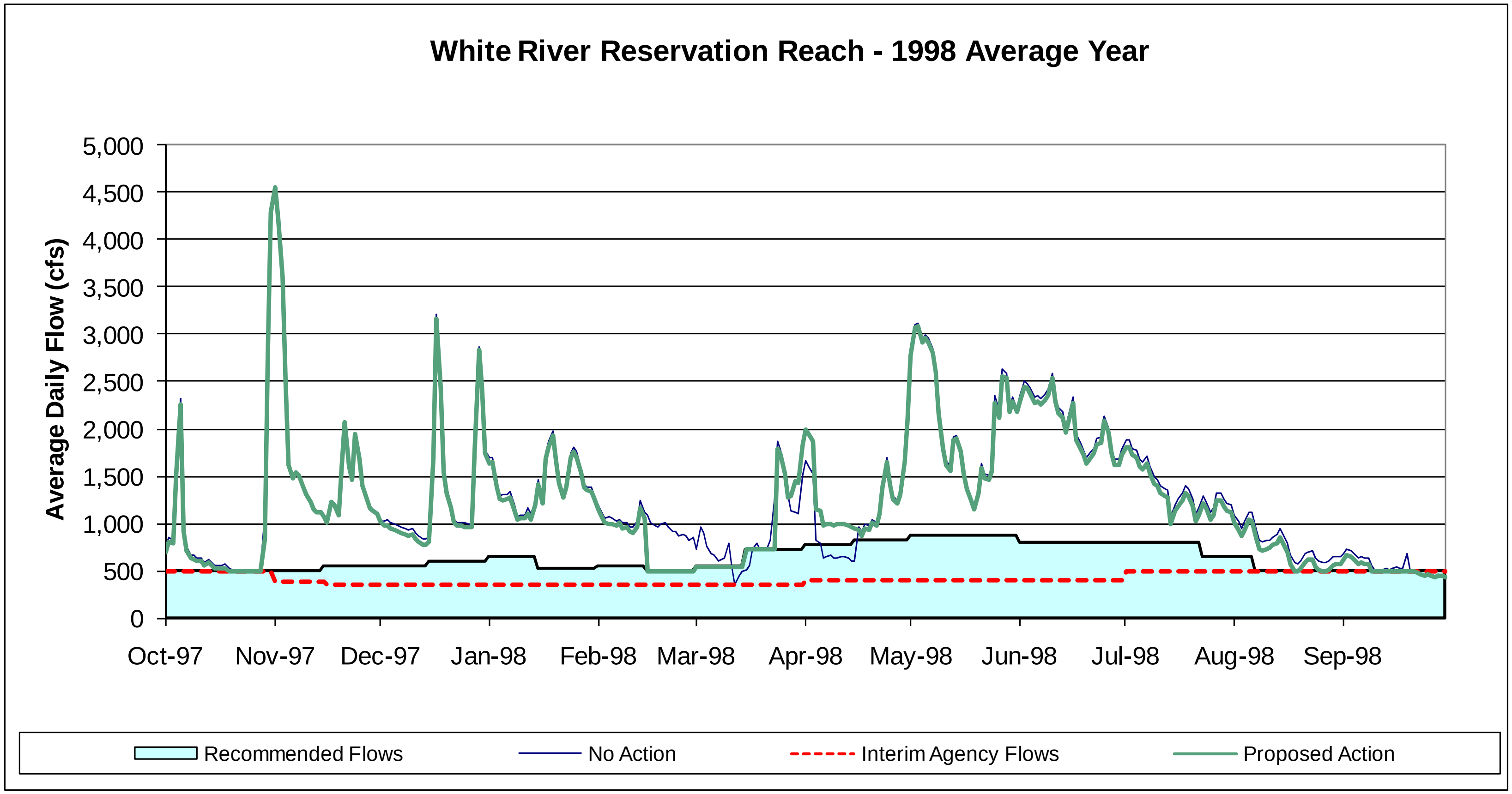


Figure 9-11. Proposed Action and No Action Alternative Flow Rates in the Reservation Reach in an Average Year (1988) Compared with Cascade's Recommended Flow Regime and the Interim Agency Flows

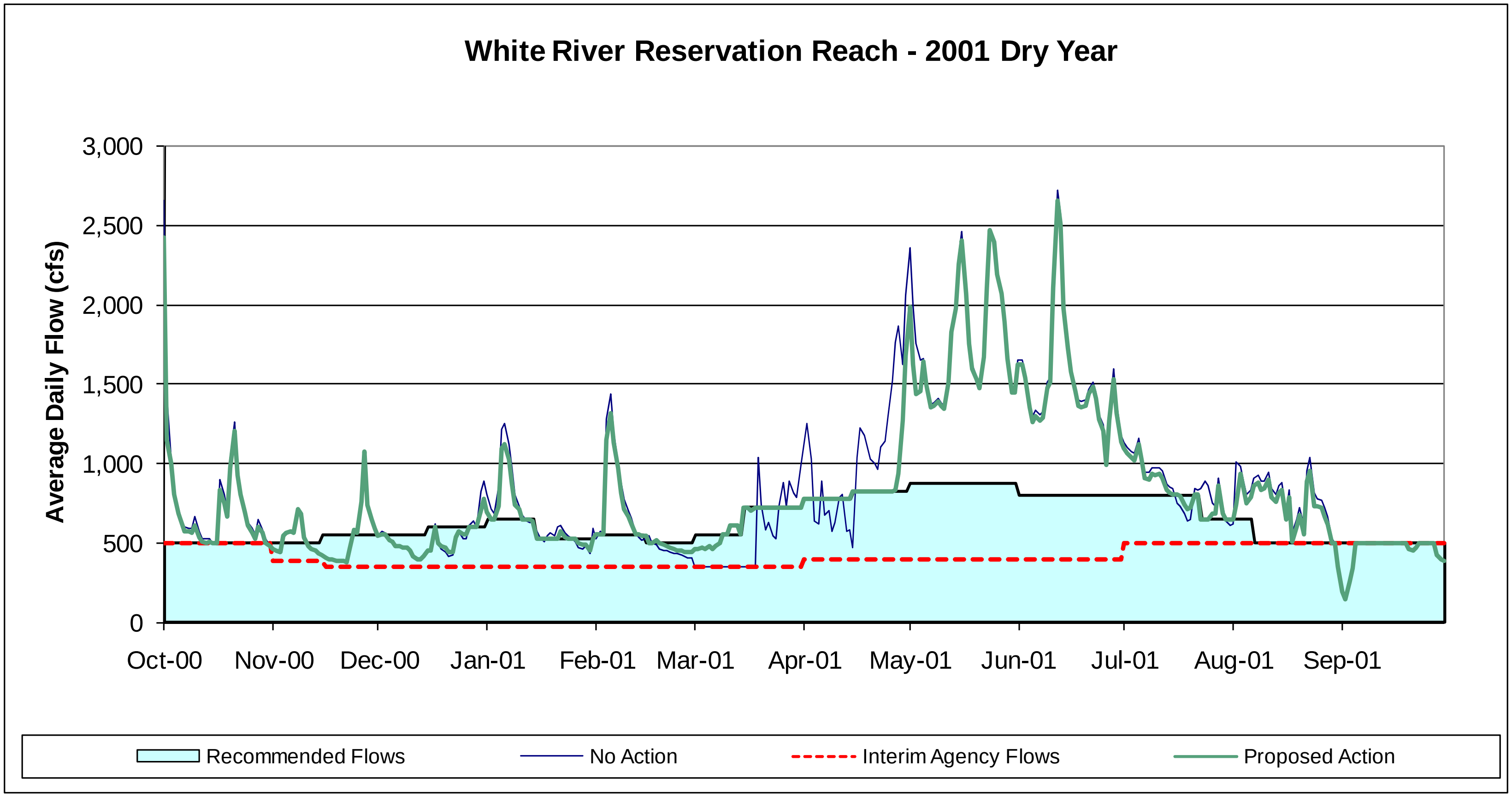


Figure 9-12. Proposed Action and No Action Alternative Flow Rates in the Reservation Reach in a Dry Year (2001) Compared with Cascade's Recommended Flow Regime and the Interim Agency Flows

Cascade evaluated the effect of the Proposed Action on wetted area in the Reservation Reach, Lower White River, and Lower Puyallup River by calculating total wetted area in those reaches with and without the Proposed Action. Wetted areas were calculated using model-simulated flows from the STELLA model for each reach and relationships between flow and wetted area developed by Herrera Environmental Consultants for the Reservation Reach (Herrera 2006, 2007) and by R2 Resource Consultants for the Lower Puyallup River and Lower White River (Ramey 2004). Daily average flow results from the model of each of the five segments were used to calculate the wetted area in that reach for each day of each model run.

The STELLA model subdivides the Reservation Reach into four distinct segments: the Upper, Middle, and Lower Sections, as well as an additional Focused Study Area located in the Middle Section. Herrera evaluated the Middle Section in detail to address side channel composition and activation. The Focused Study Area lies entirely within the Middle Section; therefore, it was not included in the total wetted area calculations for the Reservation Reach. With the exception of the Upper Section, the Proposed Action and No Action Alternative follow the same pattern until approximately 90% exceedance, when higher flows would occur under the Proposed Action (Figure 9-13). The difference between flow rates would be more noticeable in the Middle Section because the Middle Section flows through a broader valley segment that contains more side channels than the other sections.

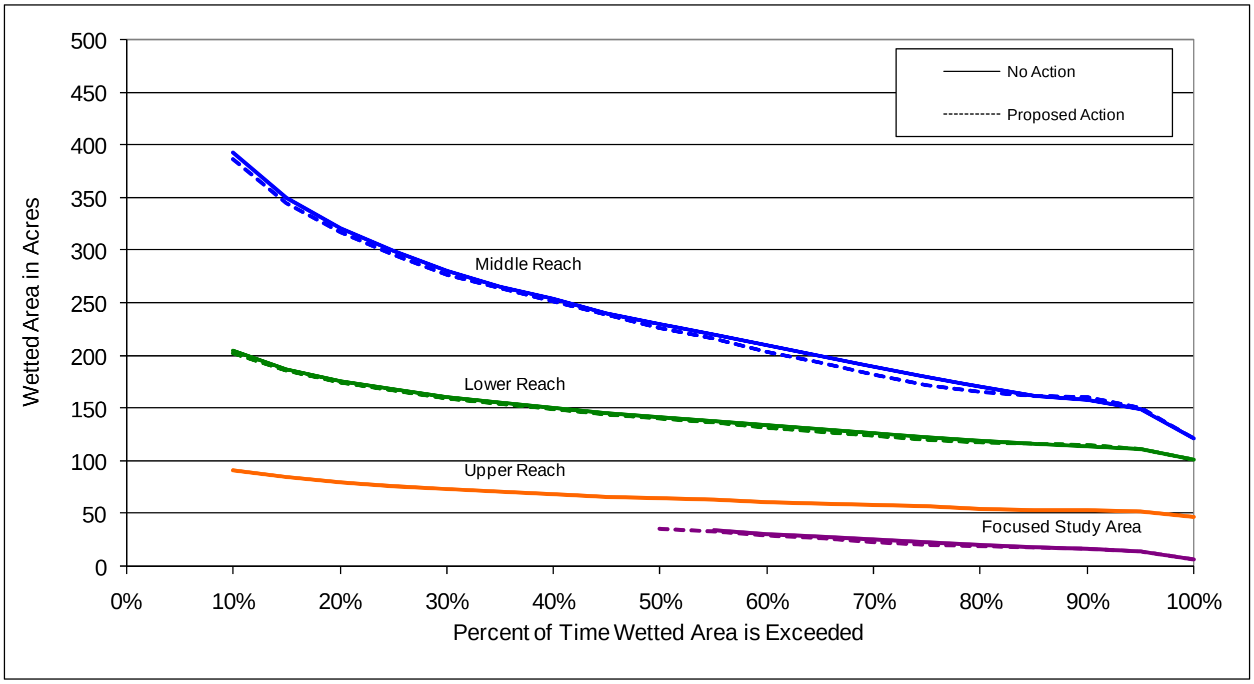


Figure 9-13. Change in Wetted Area in the Reservation Reach for the Proposed Action and No Action Alternative

Lake Tapps Reservoir

Compared with the No Action Alternative, the Proposed Action would result in decreased reservoir levels during the winter, spring, and fall during dry years and little difference in reservoir levels during an average water year. It is estimated that the average Lake Tapps Reservoir water surface elevation would be 0.4 feet higher under the Proposed Action than under the No Action Alternative. The average residence time of water would be more than 2 months shorter under the Proposed Action than under the No Action Alternative (176 days versus 253 days). These changes would not be expected to affect fish in the reservoir.

Effects of the Proposed Action on Aquatic Habitat and Fish

The potential effects of the Proposed Action on aquatic habitat and fish resources are summarized below for the White River, Lower Puyallup River, and Lake Tapps Reservoir.

White River

As outlined in Section 1.4 of this Draft EIS, Cascade would implement fishery mitigation and enhancement activities under the settlement agreements with the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe (see Chapter 2). The agreements include the following:

- $19.8 million for fishery mitigation and watershed enhancement, which may include hatchery capital expenses, operations and maintenance, habitat acquisition or restoration, or other fishery enhancement or mitigation activities.
- Enhanced streamflow monitoring.
- Enhanced water quality monitoring.
- Enhanced funding for replacement, maintenance, and operation of gaging equipment.
- Enhanced project maintenance including fish screen maintenance in the diversion canal, outlet screening, and sediment trapping.
- A Tailrace Study and Tailrace Plan to address fish attraction at the tailrace and water quality and fishery concerns, and to determine the nature and scope of the improvements at the tailrace to address the identified concerns.
- An outlet screening study to assess the risk of introducing predatory or exotic species from Lake Tapps Reservoir into the White River.

Juvenile salmonid (Chinook, coho and steelhead) rearing occurs on a year-round basis in the Puyallup River Basin (see Table 9-1). The most critical period for juvenile salmonid rearing is during the low flow period between August and October; thus, low flows during that period would have the greatest likelihood of affecting juvenile salmonids. Spring Chinook salmon spawning also occurs during the September to October low flow period. Pink salmon spawn in late summer/early fall. Coho and chum spawn in late fall/early winter. Adult salmonid species need adequate flows during spawning so they do not spawn in the thalweg (high velocity area) of the river. If spawning does occur in the thalweg, salmon redds are vulnerable to scour during high water events in the winter.

Water temperature during the low flow period is relatively high and dissolved oxygen is relatively low. The low flow conditions, combined with the decreased water quality, reduce the available physical habitat for juvenile rearing and adult spawning. In addition, predatory fish may become more active during warmer periods and become more concentrated in available juvenile habitats due to lower flows, thereby increasing predation on juvenile salmonids. Temperature effects on migrating adult Chinook salmon during warm flow conditions may also affect reproductive success, including egg viability and pre-spawn mortality rates. The White River is listed as impaired for temperature on the 2008 State 303(d) list of impaired water bodies. In 2005, 2006, and 2007, data collected by the Muckleshoot Indian Tribe Fisheries Division found the 7-day average of the daily maximum water temperatures exceeded the state water quality standard of 16^{o}C during periods in summer and the standard of 13^{o}C during early fall.

The greatest volume of White River diversion would occur in the late winter and early spring when Lake Tapps Reservoir was refilled. The primary concern during this period would be to ensure that smolt outmigration was not affected. In the White River and Puyallup River, salmonid smolt outmigration occurs primarily over a period extending from February through August when chum smolts begin outmigrating in February, winter steelhead smolts and bull trout in April, and Chinook smolts in May (see Table 9-1). The early part of this period encompasses the time of spring runoff when flows are typically high. Increases in river discharge stimulates the movement of salmon and steelhead smolts and adult bull trout, and higher typical flows during May and June would probably benefit juvenile salmonid and adult bull trout outmigration. From a functional perspective, the predicted reduction in flow during the spring and early summer would not affect smolt outmigration.

Table 9-3 lists the estimated difference that the Proposed Action and the No Action Alternative flow regimes would have on fish habitat available in side channels in the Focused Study Reach (RM 12.9 to RM 14.4) by evaluating differences in wetted area. There would be little difference in the number of acres wetted for the two flow scenarios. The average side channel area difference between the Proposed Action and the No Action Alternative is 2.1 acres (51.6 minus 49.5) (Table 9-3).

Table 9-3. Estimated Side Channel Area in Focused Study Reach [1]

Month	No Action Average Flow[2] (cfs)	Proposed Action Average Flow[2] (cfs)	No Action Side Channel Area[3] (acres)	Proposed Action Side Channel Area[3] (acres)
October	707	682	25.3	24.5
November	1,810	1,816	60.6	60.8
December	1,990	1,954	66.4	65.2
January	1,871	1,839	62.6	61.6
February	1,893	1,597	63.3	53.8
March	1,217	1,268	41.6	43.3
April	1,717	1,843	57.7	61.7
May	2,107	2,070	70.1	68.9
June	2,117	2,066	70.5	68.8
July	1,420	1,362	48.1	46.3
August	893	825	31.3	29.1
September	605	582	22.1	21.3
Average	1,529	1,492	51.6	50.4
Maximum	2,117	2,070	70.5	68.9
Minimum	605	582	22.1	21.3

1 Study area is RM 12.9 to 14.4; entire reach is RM 11 to 24.3

2 Flow is estimated above tailrace, near Auburn.

3 Area based on 15.5 acres at 400 cfs, plus 0.032 acre more per cfs.

Source: Herrera 2006, 2007

The amount of refugia available to fish in the side channels would vary slightly for the Proposed Action flows compared with the No Action Alternative flows, but the amount of area is not biologically significant since the flow patterns are very similar and the changes in the amount of refugia available are seasonally dynamic under a more natural hydrograph (i.e., stream flow over time). It is the natural yearly and seasonal variability in flows that shapes channel morphology, transports sediments, distributes LWD, and establishes connectivity with floodplain and side channel areas (HDR 2002).

Lower Puyallup River

The maximum decrease in flow would occur during higher flow periods when the minimum instream flow in the river would be fully met and when ample rearing habitat was available for salmonids. Ramey (2004) stated that this amount of flow reduction at these flow levels causes a very minor reduction in wetted width and useable habitat. Williams et al. (1975) indicated that spawning and rearing habitat is very limited or unfavorable in this section of the river and this lower section of the Puyallup River is mainly used as a transportation corridor for migrating salmonids.

The Proposed Action flows would conform to a more natural flow regime that would maintain habitat connectivity across a range of flows between side channels and the main stem of the Reservation Reach. These connections should enhance fry colonization and juvenile rearing for Chinook, steelhead, and coho salmon. The situation is different in the Lower White River and Lower Puyallup River where side channel habitat is very limited. The White River is channelized between levees along both banks from the confluence with the Puyallup River upstream to RM 8.5, and the Puyallup River is channelized between levees along both banks from the confluence with the White River downstream to Commencement Bay.

Lake Tapps Reservoir

Annual drawdown of the reservoir water levels currently occurs in the fall and winter, and would continue if the Proposed Action were selected. The Proposed Action would alter current reservoir procedures by filling the reservoir approximately 1 month earlier in an average water year. Because the change in flood timing would occur during the early spring before most warm water fish have started spawning, effects on warm water fish would not be expected to result from the Proposed Action. For a dry year scenario, early season water levels would be lower than current conditions due to a delayed Spring Refill. This scenario is not predicted to occur during most years, and prolonged ecological impacts would not be anticipated. Due to the minimal change in reservoir surface elevation and residence time, there would be no effect on the resident fish species occupying the reservoir.

9.2.5 Indirect and Cumulative Impacts

The Proposed Action and No Action Alternative flows would have negligible impacts on the fisheries in the Lower White River and Lower Puyallup River. Both of these alternatives would result in similar flow rates during the critical low flow period, and would restore river flows that mimic the natural hydrograph in the Reservation Reach, the Lower White River, and Lower Puyallup River. This would result in more flow during the critical low flow period and higher peak flows in the spring.

The data indicate that the increase in flow rate since hydropower operations ceased has been beneficial to the recovery of certain fish species in the White River system. Flows would be well above the IFIM values established by NOAA Fisheries and would be very favorable to salmonid outmigration, rearing, spawning, and migration in the Reservation Reach. It is unlikely that minor changes in water surface elevations would affect fish in Lake Tapps Reservoir because the changes would be within the limits of existing seasonal variation.

Thus, both the Proposed Action and the No Action Alternative should provide positive indirect and cumulative impacts that include improved returns for many salmonid species and associated improved fish harvesting conditions, increased food sources for wildlife, enhanced recreational and cultural benefits, and improved general ecosystem health. The differences in indirect and cumulative impacts between the Proposed Action and the No Action Alternative may not be measurable due to annual, seasonal, and biological variations.

9.3 Mitigation Measures

While the project would not result in significant adverse direct, indirect, or cumulative impacts to fisheries resources, Cascade would provide the mitigation measures listed in Table S-1 (Summary) and Section 1.4 of this Draft EIS.

9.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to fisheries resources would be anticipated under the Proposed Action or the No Action Alternative.

Chapter 10: Recreation and Aesthetics

Communities with abundant recreational and aesthetic resources view these resources as cherished treasures, tout the value of their proximity, and regard them as vital to the community's quality of life and economy. Access to parks, public spaces, and water lends a neighborhood a sense of place, and is essential to the social and economic fabric that makes a community a great place to live, work, and play. This chapter focuses on potential impacts to recreational opportunities along sections of the White River downstream of the diversion dam, on Lake Tapps Reservoir, and along the Lower Puyallup River. It also describes how the area's aesthetics – that is, the perception of the area's visual beauty – could be affected.

10.1 Affected Environment

White River and Lower Puyallup River

The White River and the Lower Puyallup River have been subject to a century of human-induced modifications, which have affected their natural flows and the habitat they provide for fish. As a result, recreational facilities for water-related activities are limited and fishery runs have diminished over the years.

Lake Tapps Reservoir

Boat docks and entertainment along Lake Tapps' shoreline. August 2008

Lake Tapps Reservoir is heavily used by motorized and non-motorized watercraft, and facilities along its shoreline (such as parks, docks, water slides, and entertainment gathering areas) provide various forms of water-related outdoor enjoyment. Lake Tapps Reservoir's appeal for waterfront homeowners and recreationalists is enhanced during the summer months (recreation season) when the spectacular landscape of Mount Rainier is in full view and the warmer weather encourages outdoor relaxation and enjoyment of the scenery. Consistent with Puget's agreement with the Lake Tapps Community (see Chapter 2), the recreation season since 2004 has extended from April 15 through October 31.

During the late fall and winter months (off-season), Puget has lowered the water surface elevation to help control milfoil (see Chapter 8), and views of the reservoir may include tree stumps and snags depending on the location and the water surface elevation in the reservoir.

The reservoir encompasses approximately 2,700 surface acres at Normal Full Pool stage (Pierce County 2005). The reservoir's shape is extremely irregular and there are numerous islands, creating approximately 57.5 miles of shoreline. The reservoir bottom is riddled with tree stumps and snags. The east side of the reservoir contains a higher concentration of shallow areas and visible boating hazards. The eastern shoreline is less intensely developed due to the presence of dikes and public roads adjacent to the reservoir edge.

Boating hazards on the east side of Lake Tapps Reservoir
August 2008

10.1.1 Recreation

White River Recreational Facilities

During a massive flood in 1906, the White River, which formerly flowed north through Kent, jumped its banks into the Stuck River channel and began flowing south to the Puyallup River (see Chapter 2). Evidence of past flooding (large woody debris piles strewn about the wide floodplain) and flood protection (rock or concrete armoring along the riverbank) can be seen in the area. No designated public boat access points exist along the reach of the White River between Buckley and Puyallup. Table 10-1 lists public park facilities near Auburn, Pacific, and Sumner with direct water and/or shoreline access to the White River.

Opportunities for recreational fishing are not available along the Reservation Reach of the White River (see Figure 1-2) due to the lack of access from the diversion dam to the former channel of the Stuck River. Fishing for pink salmon is popular from Auburn downstream to the confluence with the Lower Puyallup River in odd numbered years when these salmon return to spawn (see Chapter 9).

Table 10-1. Public Park Facilities with Direct Water and/or Shoreline Access on the White River

Facility Name	Location	Owner	Primary Facilities
Auburn Game Farm	3030 R Street SE	City of Auburn	• 86 acres – 53 in active uses • Soccer, softball fields • Picnic facilities • Amphitheater • Walking trails • Playground • Basketball, pickleball court
Auburn Game Farm and Wilderness Park and Campground	2401 Stuck River Road	City of Auburn	• 18 tent and recreational vehicle sites; camping with hookups • Picnic facilities • 18-hole disc golf course • Fishing access • Equestrian trail
Ballard Park	37th Way and R Street SE	City of Auburn	• Neighborhood park • Playground • Picnic facilities • Walking trails • Park sits high above river; no direct river access
Roegner Park	601 Orvetz Road	City of Auburn	• 21-acre community park • Playground • Picnic facilities • Walking trail and equestrian trail • Restrooms
White River Trail	Between Roegner Park and the Auburn Game Farm Wilderness Park	City of Auburn	• 2.5 miles along the river • Wide asphalt path • Soft surface trail for horses
Pacific City Park	3rd Avenue SE	City of Pacific	• 12-acre park; formerly a King County landfill • Restrooms • Large grassy lawn and shade trees • 1,700 linear feet of river frontage • Trail on old dike leads to river
Sumner Meadows Golf Links	14802 Stewart Road – Sumner	Sumner Municipal Course – privately managed	• Scottish links style layout – unique to Pacific NW • Driving range

Lake Tapps Reservoir Recreational Facilities

Recreational opportunities such as boating, water skiing, fishing, and swimming make Lake Tapps Reservoir a regional draw for greater Seattle–Tacoma area residents. There are several points of access for the general public. Boat launch facilities located on the north end at the Lake Tapps North Park and on the south end at Allan Yorke Park are available to all users for a fee. The City of Bonney Lake, which operates Allan Yorke Park, recently increased the non-resident boat launch fee; the City estimates that approximately 80% of the boaters using the boat ramp are not residents of Bonney Lake (The News Tribune 2008).

Picnic area at Lake Tapps Reservoir
August 2008

Users of Lake Tapps Reservoir naturally include the waterfront homeowners, homeowners' association members, and their families and friends. According the *Lake Tapps Boat Management Plan* (Pierce County 2005), by 1998 over 95% of the platted properties around the reservoir contained a residence.

An informal survey conducted in 2003 for preparation of the *Lake Tapps Boat Management Plan* identified 1,620 docks, 180 boat ramps, 2 planes, and a total of 2,604 boats including power boats, non-motorized boats, and personal watercraft (jet skis, wet bikes). The *Lake Tapps Boat Management Plan* indicates that the majority of boat activity originates from the waterfront homes or homeowners' association boat ramps. Boat traffic in the early morning hours and weekdays is typically attributed to lakefront and homeowners' association members, whereas the weekend and evening boaters are thought to be from nearby communities.

As indicated above, water skis, jet skis, wet bikes, and other personal watercraft are extremely popular on the reservoir. Overcrowding is a common problem and complaint. Typical recreational planning standards recommend upward of 40 acres per boat for suitable water skiing conditions and 1 to 20 acres for other boaters. Lake Tapps Reservoir is nearing or over capacity for the number of watercraft on the reservoir during peak summer months.

Fishing is a top recreational draw to Lake Tapps Reservoir due to the presence of warm water fish species that are not as common elsewhere in Washington's lakes (for more detail on fisheries, see Chapter 9). Largemouth and smallmouth bass and yellow perch, carp, and rainbow trout are regularly caught on Lake Tapps Reservoir. The tiger muskies fishery is also very popular, with fish 40 to 50 inches long not uncommon. Tiger muskies are a non-reproducing hybrid of northern pike and are known for improving lake fishing by thinning non-native species such as perch, rock bass, and bluegill. Not all fishing is done by boat (power and non-motorized) because the shallow waters of Lake Tapps Reservoir offer good fishing from the shore or from waterfront docks.

Swimming area at Lake Tapps Reservoir
August 2008

Swimming and other forms of water play are enjoyed by people of all ages at Lake Tapps Reservoir. The designated swimming areas at the public parks are popular all summer. Private swim slides, diving boards, and swimming accessories are common backyard features of the waterfront properties.

Lake Tapps Reservoir features two types of private parks: the Puget-owned and -operated employees' park and the homeowners' association parks maintained by each of the Lake Tapps Reservoir residential communities. Pierce County and the City of Bonney Lake own the public parks, and the Tapps Island Homeowners' Association owns a public golf course. Table 10-2 lists the public and private park facilities with direct water and/or shoreline access on Lake Tapps Reservoir.

Table 10-2. Public and Private Park Facilities with Direct Water and/or Shoreline Access on Lake Tapps Reservoir

Facility Name	Location	Owner	Primary Facilities
Lake Tapps North Park – Public	2022 198th Ave E. in Bonney Lake	Pierce County	• 4-lane boat launch • Boat fueling • Boat wash • Swimming • Beach area • Picnic facilities • Hiking trail • Concessions • Restrooms

Facility Name	Location	Owner	Primary Facilities
Allan Yorke Park – Public	7203 W. Tapps Highway in Bonney Lake	City of Bonney Lake	• Ball fields • 2-lane boat launch • Fishing dock • Playground • Skateboard facility • Swimming area • Tennis courts • Concessions • Restrooms
Puget employee park – Private	Adjacent to Lake Tapps North Park	Puget	• 38 tent and recreational vehicle camping sites • 17 fully-equipped cabins • Restrooms • Picnic shelters • Boat launch • Swimming area • Playground, volleyball, and basketball • Pierce County Sheriff's Department Marine Services boat and equipment
Tapps Island Golf Course – Public	Tapps Island	Tapps Island Homeowners' Association	• 9-hole public golf course • Clubhouse, pro-shop, restaurant, and restrooms
Tapps Island Park – Private	Tapps Island	Tapps Island Homeowners' Association	• Boat launch • Tennis court, pickleball, basketball, volleyball • Swimming pool • Paved bike and walking path
Jenks Park – Private	Banker's Island	Banker's Island Homeowners' Association	• Boat launch • Swimming area • Basketball court • Play area • Picnic facilities
Lakeridge Walk-in Park – Private	Banker's Island	Banker's Island Homeowners' Association	• Swimming area • Picnic facilities • Play area • Walking trails
Driftwood Point – Private	Driftwood Point Island (west side of reservoir)	Driftwood Point Homeowners' Association	• Boat launch • Swimming area • Tennis courts, basketball, volleyball, baseball • Playground • Walking trail

Facility Name	Location	Owner	Primary Facilities
Tacoma Point/Evergreen Point Parks (2) – Private	Peninsula communities on the NW side of Lake Tapps Reservoir	Tacoma Point and Evergreen Point Homeowners' Associations	• Boat launch and docks • Tennis and basketball court • Picnic facilities
Inlet Island Maple Point Park – Private	SE side of Lake Tapps Reservoir near Prince Basin inlet	Inlet Island Homeowners' Association	• Boat launch • Picnic facilities • Playground • Clubhouse
Church Lake – Private	South end of Lake	Church Lake Homeowners' Association	• Boat launch • Playground • Swimming area • Picnic area

Lower Puyallup River Recreational Facilities

The White River joins the Lower Puyallup River in the vicinity of State Route (SR) 167 and Highway 410. The Lower Puyallup River is contained by levees on both shorelines, creating a relatively straight channel as it flows toward Commencement Bay. The City of Puyallup is actively pursuing grants to implement phases of the Riverwalk Trail; however, existing recreational opportunities or points of public access are lacking. Table 10-3 lists public and private park facilities near Puyallup and Fife with direct water and/or shoreline access to the Lower Puyallup River.

Sport fishing in the Puyallup basin includes target species such as Chinook, coho, pink, chum, and steelhead. Fishing seasons and limits are annually determined for each target species to prevent over-fishing and to protect threatened or depressed stocks such as bull trout, spring Chinook, and wild winter steelhead (Marks et al. 2008). Recreational fishing for pink salmon takes place in the fall of odd numbered years when these salmon return to spawn. The Lower Puyallup River is also a popular location for coho salmon fishing in the fall of each year.

Table 10-3. Public and Private Park Facilities with Water and/or Shoreline Access on the Lower Puyallup River

Facility Name	Location	Owner	Primary Facilities
Skate Park – Public	1299 4th Street NW	City of Puyallup	• 10,000-square-foot skate park • Spectator seating • Restroom • Parking • Lighting
Puyallup Riverwalk Trail – Public	South side of river underneath SR 16; future extension plans to connect to Pierce County's Foothills Trail	City of Puyallup	• Built portions include a 10-foot-wide asphalt surface plus soft surface shoulder • Trail is enclosed by chainlink fence; river access permitted in places via gates • Wider portions of trail include benches, lawn, and picnic tables
Palmer Property – Public	Recent City of Puyallup acquisition adjacent to the Milwaukee-5th Street Bridge	City of Puyallup	• 1.25 acres of riverfront property • Future park development potential • Low bank river access
Puyallup River Levee Trail – Public	North side of river in Fife	City of Fife	• Future trail • Would connect to Riverwalk Trail • Planned for north side of river, crossing over to south side at the Melroy Bridge
Linden Firs Golf and Country Club – Private	2519 E. Main, Puyallup	Privately owned	• Opened in 1926 • 9-hole links style

10.1.2 Aesthetics

White River

The appearance of the banks of the Reservation Reach of the White River remains relatively natural and undisturbed because of the lack of access and tribal ownership along this reach of the river. Overall, the White River is constantly changing and is highly dynamic. The sights and sounds of rushing white water are present along the White River. Large log jams and rocks pose challenges for boaters and provide habitat for river birds and wildlife.

Lake Tapps Reservoir

Waterfront property owners and recreational users see contrasting views across the reservoir depending on the time of year. During the recreation season when the reservoir is full, Lake Tapps Reservoir is known for its waterfront scenes and views of Mount Rainier. During the late fall and winter when the water surface elevation is drawn down, tree stumps and snags may be visible depending on the location and the water surface elevation.

Lower Puyallup River

The Lower Puyallup River's appearance is quite different than that of the White River. Its appearance is less natural, with tall, earthen levees on both sides of a straightened river channel. The Lower Puyallup River's channel is much wider than the channel of the White River, and the water is deeper and flows more slowly. Very little shoreline or beach can be seen along the Lower Puyallup River from the few public access points.

10.2 Environmental Impacts

10.2.1 Direct Impacts

No Action Alternative

White River and Lower Puyallup River

No direct impacts to recreation or aesthetics on the White River or the Lower Puyallup River would be anticipated under the No Action Alternative. Water flow rates in the White River and Lower Puyallup River would remain within the limits of existing seasonal variations. Under the No Action Alternative, water would be diverted from the White River at a rate that maintained Interim Agency Flows (see Table 3-1). In addition, the minimum instream flow requirements would not be addressed in the Lower Puyallup River by decreasing diversions from the White River (see Chapter 3).

Lake Tapps Reservoir

No direct impacts to recreation or aesthetics at Lake Tapps Reservoir would be anticipated under the No Action Alternative. Under the No Action Alternative, there would be no withdrawals for municipal water supply, only diversions for reservoir level maintenance consistent with the 2004 Lake Tapps Reservoir Management Agreement (see Chapter 2). According to surface water quantity modeling results for Lake Tapps Reservoir (see Chapter 5), Normal Full Pool water surface elevations would be maintained under the No Action Alternative as they have been since 2004. Seasonal Fall Drawdown and Spring Refill of the reservoir would continue, and no water would be withdrawn for municipal supply purposes.

Proposed Action

White River and Lower Puyallup River

No direct impacts to recreation or aesthetics on the White River or the Lower Puyallup River would be anticipated under the Proposed Action.

Cascade identified the potential impacts to the White River and Lower Puyallup River by estimating the average flow rate per month for the reaches of these rivers within the study area (see Chapter 5). Cascade used this information to determine the changes that could occur, and then assessed whether or not recreational opportunities and aesthetics along the White River or Lower Puyallup River would be affected.

Water flow rates in the White River and Lower Puyallup River would remain within the limits of existing seasonal variations. Water would be diverted from the White River at a rate that maintained the Recommended Flows (see Table 3-2). Under the Proposed Action, flow rates would neither exceed the maximum nor drop below the minimum levels identified for the No Action Alternative. Unlike the situation under the No Action Alternative, minimum instream flow requirements in the Lower Puyallup River would be addressed by reducing the flow rate of water diverted from the White River, as necessary, from February 15 through March 31 (see Chapter 5).

Lake Tapps Reservoir

Cascade identified the potential impacts on recreation and aesthetics at Lake Tapps Reservoir by evaluating monthly changes in the modeled water surface elevation (see Chapter 5), particularly during the recreation season. Water surface elevation changes in the reservoir could alter water-related activities and access as well as perceptions of the area's visual beauty.

Of the recreational facilities at Lake Tapps Reservoir, only the boat docks, boat ramps, and swimming areas/water slides would be directly affected by water surface elevations. It is assumed that all of the facilities around the reservoir function normally during the typical recreation season. Throughout its history, the reservoir's water surface elevation has fluctuated on a regular basis due to the seasonal drawdown and refill. Recreational facilities around the reservoir have been designed, constructed, and operated to accommodate these changes in water surface elevation.

For the purpose of evaluating potential project impacts, Cascade conducted topographic and aerial Light Detection and Ranging (LiDAR) surveys to reveal the elevation and topography of shorelines. The aerial survey data allowed visual inspection of the entire shoreline with detailed contour information at 1-foot intervals. Even at a pool surface elevation of 538 feet, a review of the docks and ramps around the shoreline found that none would be "high and dry" or without water beneath them. The annual range of Normal Full Pool water levels is predicted to remain the same under the Proposed Action as under the No Action Alternative.

No impacts to recreation and aesthetics in and around Lake Tapps Reservoir would be anticipated under the Proposed Action. The water surface elevation in Lake Tapps Reservoir is lowered and the reservoir is refilled every year, and under the Proposed Action, this process would continue. Per the 2009 Agreement Regarding Lake Tapps between Cascade Water Alliance and the Lake Tapps Community (see Chapter 2), Cascade would maintain the reservoir at Normal Full Pool from April 15 through September 30 each year (Cascade 2009a). During periods between April 15 and September 30 when divertible flow from the White River was not adequate to keep the reservoir at or above the minimum recreational level, water supply releases from the reservoir would be reduced or eliminated. Normal Full Pool would be maintained from September 16 through September 30 of each year more than 90% of the time, as measured by the number of days in a rolling 10-year period. Modeling results summarized in Chapter 5 show that water levels in late September would be below the minimum recreation level on 12 days over the 15-year simulation period. Cascade would make reasonable efforts to maintain Normal Full Pool through October 31 in all years. Under the Proposed Action, water levels in October of the water year following a dry year like 2001 could be up to 1.2 feet lower than under the No Action Alternative.

During the late fall and winter (off-season), anglers with low-draft boats and vehicles equipped to launch beyond the boat ramps occasionally use the reservoir. According to water quantity modeling results (see Chapter 5) the average water surface elevations for the Proposed Action could be approximately 0.5 foot lower in October, 2 feet lower in November, 1 foot lower in December, and virtually no change in January compared with the water surface elevations for the No Action Alternative. In contrast, modeling also predicted that in February and March, the water surface elevations for the Proposed Action could be approximately 1 foot to 6 feet higher than those for the No Action Alternative. The lower late fall and winter reservoir water surface elevations would be within the normal drawdown elevations.

10.2.2 Indirect and Cumulative Impacts

Because recreation and aesthetics would not be directly affected under the Proposed Action or the No Action Alternative, no indirect or cumulative impacts would be anticipated.

10.3 Mitigation Measures

While the project would not result in significant direct, indirect, or cumulative impacts to recreation and aesthetics, Cascade would provide the mitigation measures listed in Table S-1 (Summary) and Section 1.4 of this Draft EIS.

10.4 Significant Unavoidable Adverse Impacts

There would be no significant unavoidable adverse impacts to recreation or aesthetics under the Proposed Action or under the No Action Alternative.

Chapter 11: Land and Shoreline Use

Land and shoreline use planning helps create and maintain vital communities with close-knit neighborhoods, a sustainable economy, protected natural systems, and an efficient public infrastructure. Each jurisdiction in the study area – the cities of Auburn, Bonney Lake, Buckley, Pacific, and Sumner, and unincorporated King and Pierce counties – has adopted land and shoreline use planning policies, guidelines, and designations. This chapter describes each jurisdiction's land and shoreline use planning as it applies to the study area, as well as potential impacts of the Proposed Action and No Action Alternative on land and shoreline use.

11.1 Affected Environment

As described in Chapter 1, the objective of the Proposed Action is to manage the White River–Lake Tapps Reservoir system to enable withdrawal of water for municipal supply purposes while maintaining water quality, recreational reservoir levels, and adequate stream flows for fish and wildlife. Implementing the Proposed Action could change Lake Tapps Reservoir elevations and White River flow rates; thus, areas that could be affected include those immediately adjacent to the White River Reservation Reach, Lake Tapps Reservoir, and the Lower White River (downstream of the tailrace canal).

Because much of the Puyallup River downstream of the confluence with the Lower White River is contained within levees, and adjacent land is highly developed, the Proposed Action would not be expected to affect land and shoreline use and planning along the Lower Puyallup River. Therefore, this chapter does not address potential impacts to land and shoreline use for the Lower Puyallup River area.

11.1.1 Current Land and Shoreline Use

Land Use

Table 11-1 lists the current land use designations in the study area by jurisdiction.

Table 11-1. Current Land Use Designations in the Study Area

Study Area Location	Jurisdiction	Land Use Designation	Type of Use
White River Reservation Reach	City of Auburn	P1/LHP1	Public Use
		RMHP/LHRMP	Residential Manufactured Home Park
		RR	Residential District
		R1/LHR1, R2/LHR2	Single Family Residential District
		UNC	Unclassified Use
	City of Buckley	S	Sensitive Area
		P	Public Institutional
	City of Pacific	RO	Residential Open Space
		RS-6	Single Family Residential
	City of Sumner	M-1	Light Industrial
		M-2	Heavy Industrial
	King County	RA-10	Rural Area
		A-35	Agricultural
		Other	Other (Tribal Land)
	Pierce County	R10	Rural
		ARL	Agricultural Resource Land
Lower White River (downstream of the tailrace canal)	City of Sumner	M-1	Light Industrial
		M-2	Heavy Industrial
		LDR-6, LDR-8.5	Low Density Residential
		RP	Residential Protection
		GC	General Commercial
		MUD	Mixed Use Development
		AG	Agriculture

Study Area Location	Jurisdiction	Land Use Designation	Type of Use
Lake Tapps Reservoir	City of Bonney Lake	R-1	Low Density Residential
		R-2	Medium Density Residential
		R-3	High Density Residential
		PF	Public Facilities
	Pierce County	R10	Rural
		MSF	Moderate Density Single Family
		HRD	High Density Residential
		NC	Neighborhood Center

Sources: City of Auburn 2009b; City of Bonney Lake 2009; City of Buckley 2005a; Pierce County 2007

Shorelines

The State of Washington adopted its Shoreline Management Act (SMA) (Chapter 90.58 Revised Code of Washington [RCW])[1] in 1972 with a goal of preventing the "inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The SMA establishes a broad policy for shoreline development, giving preference to uses that protect the quality of water and the natural environment, depend on proximity to the shoreline, and preserve and enhance public access or increase recreational opportunities for the public along shorelines. Under the SMA, each city and county adopts a shoreline master program that is based on state guidelines, but is tailored to the specific needs of the community (Ecology 2003).

Shoreline use in the study area is governed by local shoreline management program regulations enforced by the cities of Auburn, Bonney Lake, Buckley, Pacific, and Sumner and by King and Pierce counties. Table 11-2 lists the current shoreline designations in the study area.

[1] Chapter 90.58 RCW: Shoreline Management Act of 1971. http://apps.leg.wa.gov/RCW/default.aspx?cite=90.58.

Table 11-2. Current Shoreline Designations in the Study Area

Study Area Location	Jurisdiction	Shoreline Jurisdiction
White River Reservation Reach	City of Auburn [1]	Natural
		Urban Conservancy
		Shoreline Residential
	City of Buckley	Conservancy
	City of Pacific	Rural
		Conservancy
	City of Sumner	Urban Conservancy 100 feet
		Urban Conservancy 200 feet
	King County	Natural
		Rural
	Pierce County	Conservancy
		Rural
Lower White River (downstream of the tailrace canal)	City of Sumner	Urban Conservancy 200 feet
		Urban 50 feet
Lake Tapps Reservoir	City of Bonney Lake	Urban
		Natural Environment
	Pierce County	Rural Residential
		Conservancy

[1] Washington State Department of Ecology (Ecology) approved Auburn's Shoreline Master Program update on May 20, 2009.

Sources: City of Buckley 2007; King County 2008a; Pierce County 2008b; City of Auburn 2008; City of Sumner 2005; City of Bonney Lake 1975; City of Pacific 1974.

11.1.2 Comprehensive Plans

In 1990, the Washington State Legislature passed the Growth Management Act (GMA) (Chapter 36.70A RCW)[2], which requires the fastest growing counties and their cities to undertake planning that addresses suburban sprawl, environmental protection, quality of life, and related issues. Many jurisdictions must develop a comprehensive plan per GMA guidelines. A comprehensive plan is the starting point for the planning process; it is the centerpiece of local planning and describes how neighborhoods should evolve. All regulations on development are required to comply with comprehensive plans.

[2] Chapter 36.70A RCW: Growth management – planning by selected counties and cities. http://apps.leg.wa.gov/RCW/default.aspx?cite=36.70A.

According to Chapter 36.70A.040 RCW[3], each county with a population of 50,000 or greater and the cities located within those counties are required to adopt a county-wide planning policy under RCW 36.70A.210[4]. The counties and cities are required to identify and protect critical areas, designate urban growth areas, and adopt a comprehensive plan. Both King County and Pierce County are subject to this code.

Mandatory elements of the comprehensive plan include (a) a land use element that will designate locations and population densities for different types of uses, and (b) a capital facilities element. The land use element should include a component that estimates the future population growth and provides for the protection of the quality and quantity of groundwater used for public water supplies. The capital facilities element shall include an inventory of existing facilities, a forecast for future needs of facilities, the proposed locations and capacities of future facilities, and a finance plan to accommodate facilities at least 6 years into the future.

Additionally, Washington Administrative Code (WAC) 246-290-100[5] requires that purveyors of community public water systems with 1,000 or more services submit a water system plan for review and approval every 6 years. The plan should demonstrate system capacity at least 20 years into the future.

The comprehensive plans of the jurisdictions in the study area are described below.

City of Auburn

Land Use

In its comprehensive plan, the City of Auburn designates areas adjacent to the White River Reservation Reach as open space, public and quasi-public (such as small churches and daycare centers), neighborhood commercial, single family residential, and light commercial (City of Auburn 2009a).

Shorelines

Within Auburn, the White River Reservation Reach is designated as a natural, urban conservancy, and shoreline residential environment:

- The natural environment is defined as an area relatively free of human influence that would become irreversibly impaired as a result of development. The purpose of

[3] 36.70A.040 RCW: Who must plan — Summary of requirements — Development regulations must implement comprehensive plans. http://apps.leg.wa.gov/RCW/default.aspx?cite=36.70A.040.
[4] RCW 36.70A.210: County-wide planning policies. http://apps.leg.wa.gov/RCW/default.aspx?cite=36.70A.210.
[5] WAC 246-290-100: Water system plan. http://apps.leg.wa.gov/WAC/default.aspx?cite=246-290-100.

designating an area as a natural environment is to preserve it by restricting development to very low-intensity uses.

- The urban conservancy environment designation is intended to protect and restore the ecological functions of open space, floodplains, and other sensitive areas that exist in urban and developed settings. Urban conservancy environments are generally not suitable for intensive water-dependent uses.
- The shoreline residential environment is an area that is intended to accommodate residential development, provide public access, and allow residential use of shorelines. The shoreline residential environment is characterized by single family or multifamily development, or areas planned for residential development (City of Auburn 2008).

Development along the White River must comply with Auburn's shoreline master program, and should promote public access to the river while protecting the shoreline and water quality (City of Auburn 1986).

Growth

Auburn encompasses areas in both Pierce County and King County, with the majority of its population located in King County. Auburn began annexing large tracts of land in 1998, and since that time its population growth has averaged nearly 3.6% per year. By 2020, Auburn anticipates that its population will be approximately 71,600. Auburn's comprehensive plan states that its first goal is to "manage growth in a manner which enhances, rather than detracts from community quality and values by actively coordinating land use type and intensity with City facility and service provision and development" (City of Auburn 1986).

Municipal Water Supply

Auburn's municipal water supply sources include the Coal Creek watershed and the West Hills Spring watershed, supplemented by a system of 10 groundwater wells. Additionally, based on its wholesale water agreement with the City of Algona, Auburn acquired the water right to the Algona Well 1. Auburn's Comprehensive Water Plan (City of Auburn 2009c) was created to ensure adequate water service to meet the needs of the existing community and to provide for planned future growth. The City's Comprehensive Water Plan incorporates the planned growth described in Auburn's comprehensive plan (see Section 7.1.6). The City's Comprehensive Water Plan states that Auburn has sufficient average annual reliable pumping capacity to serve its retail customers, Algona, and the Muckleshoot Indian Tribe through 2019. The Plan also states that Auburn does not currently have sufficient instantaneous reliable pumping capacity to serve retail customers, Algona, and the Muckleshoot Indian Tribe.

City of Bonney Lake

Land Use

The comprehensive plan designations for future land use in Bonney Lake adjacent to Lake Tapps Reservoir are as follows: single family residential, medium density residential, and conservation/open space (City of Bonney Lake 2008b). Designations are based largely on existing land use and zoning, former comprehensive plan designation, and physical constraints.

Shorelines

Bonney Lake implements the SMA through its Shoreline Management Master Plan, adopted in 1975. The goals and policies of the Shoreline Management Master Plan are considered elements of the comprehensive plan.

In Bonney Lake, Lake Tapps Reservoir has a shoreline designation of urban environment and natural environment. The urban environment is an area of high-intensity land use including residential, commercial, and industrial development. The intent of the urban environment designation is to optimize shoreline uses that are presently urbanized or projected to be urbanized. A natural environment is an area relatively free of human influence. A designation of natural environment discourages activities that might alter the natural characteristics of these shorelines (City of Bonney Lake 1975).

Growth

Since 2000, Bonney Lake has grown at an annual rate of 8%. However, 8% is not a sustainable growth rate because it would put a significant strain on Bonney Lake's available resources in the long-term. Bonney Lake's various utility plans have assumed from 3.5% to 3.9% annual growth. In balance, the City of Bonney Lake assumes that the population will grow at an annual rate of 4%. With 4% annual growth, Bonney Lake's 2022 population forecast is 27,284 (City of Bonney Lake 2008a).

Municipal Water Supply

The Bonney Lake municipal water system is supplied by five municipal groundwater wells and two springs. Bonney Lake's wells and springs are recharged by several underground aquifers; these aquifers are replenished by rainwater that falls on the plateau where Bonney Lake is located, and by Lake Tapps Reservoir (see Section 7.1.6).

At the beginning of 2005, Bonney Lake entered into a wholesale water agreement to purchase up to 2 million gallons per day (mgd) of peak day[6] water from Tacoma Water. Bonney Lake estimates that it has sufficient water supply from its groundwater wells, springs,

[6] The day of each year when the highest volume of water is drawn from the source.

and this wholesale water supply to meet the demand requirements of the system until approximately 2010 (City of Bonney Lake 2008c). This capacity can be extended through approximately 2017 with the use of a proposed 15-million-gallon peaking storage tank, intended to augment the city water supply at peak use times during the summer months. However, Bonney Lake plans to obtain additional water rights and/or wholesale water supply to meet the projected long-term demands, improve reliability and redundancy within the system, and ensure adequate water supply during hot, dry summers or if the sources of supply experience a decline in capacity (City of Bonney Lake 2008c). Overall water demand within Bonney Lake's system is expected to increase approximately 15% to 20% within the next 6 years and 45% to 60% within the next 20 years (City of Bonney Lake 2008c).

City of Buckley

Land Use

The comprehensive plan designations for future land use in Buckley adjacent to the White River Reservation Reach and diversion dam are as follows: sensitive area and public institutional. Buckley's land use designations are intended to protect community character by encouraging contextual design, promoting economic development of appropriate businesses, and safeguarding the environment (City of Buckley 2005a).

Shorelines

Within Buckley, the White River Reservation Reach has a shoreline designation of conservancy environment. Conservancy environments include those areas (a) containing natural resources important in maintaining the regional ecological balance, (b) having high recreational value, or (c) containing extensive or unique history or cultural resources. Conservancy environments lend themselves to management on a sustained yield basis, because intensive development would interfere with the natural processes. The intent of the conservancy environment designation is to protect and manage existing natural resources to achieve sustained resource utilization and provide recreational opportunities (City of Buckley 1999).

Growth

In the late 1990s, Buckley's wastewater treatment plant (WWTP) reached its capacity to treat sewage, and since then very few development applications have been approved within Buckley. The rate of future development in Buckley will largely depend on its ability to upgrade the WWTP and secure sites for additional water wells (City of Buckley 2005a). Once the WWTP is upgraded and the well sites are secured, Buckley will be prepared to continue growing.

The Pierce County Regional Council (PCRC) has assigned Buckley a 2022 population allocation of 5,200, an increase of 690 over Buckley's estimated population in 2005. This low allocation is due to two factors: (1) Pierce County's population growth rate as a whole is expected to slow down, and (2) Buckley's growth rate has been slow in recent years due to the moratorium on development. Once service upgrades are complete, Buckley will likely grow at a rate similar to that of neighboring jurisdictions, resulting in an estimated 2024 population between 7,800 and 9,400, likely settling at around 8,750 due to the capacity of the WWTP (City of Buckley 2005a).

Municipal Water Supply

The City of Buckley's water utility currently receives approximately 83% of its supply from South Prairie Creek, located south and east of the city limits. The remaining 17% of the supply comes from groundwater sources.

Based on the current supply rates and the anticipated population growth rate in Buckley, maximum day demand will exceed current source capacity in 2010. To meet future demands, additional water sources will be required. Future developments related to treatment, transmission and distribution, and storage will be required to maintain a level of service able to accommodate projected growth (City of Buckley 2005b) (see Section 7.1.6).

City of Pacific

Land Use

The comprehensive plan designations for future land use in Pacific adjacent to the White River Reservation Reach are public use and medium density residential. In establishing future land use designations, the City of Pacific considered location, intensity and density of development based on current trends, protection of water supply quality and quantity, provision of public facilities and services, and the overall costs and benefits of growth (City of Pacific 2004).

Shorelines

The City of Pacific adopted its Shoreline Ordinance in 1974, following the adoption of state shoreline regulations (RCW 90.58). Pacific's Shoreline Ordinance designated shorelines using guidelines similar to those outlined by King County in its Shoreline Management Master Program in 1978, and the designations have not been updated since that time (City of Pacific 2008a).

Within Pacific, the White River has shoreline designations of urban and rural (City of Pacific 1974). The urban environment is an area of high-intensity land use including residential, commercial, recreational, and industrial development. The urban environment designation is designed to promote increasing utilization and efficiency of urban areas and encourage multiple use of the shoreline if the major use is shoreline-dependent. The rural environment designation is intended for areas characterized by agricultural uses, low-density residential uses, and buffers between urban areas. The designation is intended to limit the density of development in the rural environment, provide permanent open space, and maintain adequate building setbacks from shorelines (King County 1978).

Growth

Pacific has experienced substantial population growth in the past 30 years and expects to continue this trend over the next 20 years. In 2022, population in Pacific is expected to reach 8,060. The majority of population growth is expected to occur within the King County portion of Pacific's boundaries. These estimates are based on the Washington State Office of Financial Management's projected population growth numbers (City of Pacific 2004). Pacific's comprehensive plan evaluates the capacity of existing infrastructure compared with the current demand and projected needs.

Municipal Water Supply

Pacific receives water sufficient to meet current demands from three active wells located in Algona. Pacific's fourth well has not been developed at this time due to high concentrations of manganese in the water from this well. Pacific's system currently has no need for additional sources of supply, but some improvements to the storage and distribution system may be necessary by 2024 (City of Pacific 2008b) (see Section 7.1.6).

City of Sumner

Land Use

Sumner's comprehensive plan designation for future land use in the study area is public–private utilities and facilities (City of Sumner 2005).

Shorelines

Sumner has adopted a shoreline master program in accordance with RCW 90.58. The major goals and objectives established in the shoreline master program are the basis for Sumner's policies and regulations.

Within Sumner, the White River has shoreline designations of urban and urban conservancy. An urban conservancy environment is an area of mixed land use that is generally located in a floodplain with the potential for ecological restoration. The designation is intended to protect and restore ecological functions while allowing a variety of water-oriented uses. The distance that new permanent structures should be set back from the floodway edge or ordinary high water mark[7] is either 100 or 200 feet, depending on the intensity of development in the area. An urban environment is an area of high-intensity land uses,

[7] The ordinary high water mark is a biological vegetation mark used by regulators to establish a typical water elevation.

intended to accommodate high-intensity commercial and residential uses while providing protection and restoration of ecological function. Preferred uses along shorelines are those that are consistent with the control of pollution and prevention of damage to the natural environment, or are unique to or dependent on the use of shorelines (City of Sumner 2002).

Growth

The PCRC has assigned Sumner a 2022 population estimate of 12,250, an increase of 3,225 over Sumner's estimated 2006 population of 9,025 (Pierce County 2007). This number was calculated using building permit, land use, and other development data provided to Pierce County for evaluation of Sumner's growth capacity, developing densities, and future housing capacities (City of Sumner 2005).

Municipal Water Supply

Sumner receives most of its water supply from three spring fields, and also uses three additional wells to meet peak demands in the summer (see Section 7.1.6). Sumner's draft Water System Plan (City of Sumner 2009) states that Sumner has the capacity to meet average day demands through at least 2029. The plan also states that Sumner will not be able to accommodate peak day demands beginning in 2012 if source improvements and water rights transfers are not completed.

King County

Land Use

The comprehensive plan designation for future land use in unincorporated King County adjacent to the White River is rural residential, with a density allocation of one dwelling unit per 2.5 to 10 acres (King County 2006).

Shorelines

Within unincorporated King County, the White River is designated as a natural environment. The natural environment consists of areas characterized by the presence of some unique natural features considered valuable in their undisturbed or original condition, and which are relatively intolerant of intensive use. The purpose of designating the natural environment is to preserve and restore those natural resource systems existing relatively free of human influence (King County 1978).

Growth

King County's growth target range represents the County's policy choices regarding the amount of growth it intends to accommodate. In 2002, unincorporated King County was assigned a growth target in the County's comprehensive plan based on land capacity and other factors. For the unincorporated areas of south King County, the total adopted target number of households for 2022 is 4,935, assuming an average household size of 2.49 people. This target number is intended to be used as a guide for future planning of land uses and decisions on services and infrastructure (King County 2008b).

Municipal Water Supply

King County is not a water utility that provides potable water to citizens in the region. Instead, King County supports coordination of regional water supply planning, sales of excess water supplies among municipalities in the region, water quality programs, water conservation, and reuse and reclaimed water programs. The King County Utilities Technical Review Committee reviews utility plans for those water utilities serving unincorporated King County, or that are otherwise subject to the King County planning requirements of King County Code 13.24[8].

Pierce County

Land Use

The Pierce County comprehensive plan (Pierce County 1994b) designations for future land use adjacent to Lake Tapps Reservoir are as follows: moderate density single family, rural 10, neighborhood centers, and high density residential. Comprehensive plan land use designations for future land use adjacent to the White River in Pierce County are as follows: high density residential, reserve 5, and rural 10 (Pierce County 1994a).

Shorelines

Within unincorporated Pierce County, Lake Tapps Reservoir has shoreline designations of rural–residential and conservancy, and the White River has shoreline designations of conservancy and rural:

- The rural–residential environment is an area of medium-intensity land use that does not imply large-scale alterations to the natural environment. The purpose of a rural–residential designation is to allow for a natural transitional area between urban and open space. Rural environments are those areas that are currently or potentially suitable for intensive agricultural and recreation purposes. The intention of the rural environment designation is to protect agricultural land from urban expansion and encourage the preservation of open space.
- The conservancy environment is an area designed to protect, conserve, and manage existing natural resources as well as historic and cultural areas. The conservancy

[8] Chapter 13.24 K.C.C.: Water and Sewer Comprehensive Plans. Rules and Regulations of the Department of Development and Environmental Services: http://www.metrokc.gov/ddes/pub_rule/acrobat/13-24utr.pdf.

designation is intended to preserve areas for continuous recreational benefits to the public and sustainable resource utilization (Pierce County 1974).

Growth

For unincorporated Pierce County, the 2022 population allocation is 230,380 for urban areas and 159,400 for rural areas (total of 389,780). The basis for the County's urban population projection is a county-wide projection range generated by the Washington State Office of Financial Management (Pierce County 2007). The estimated population of unincorporated Pierce County in 2007 was 377,660.

Municipal Water Supply

Pierce County does not provide water as a utility or purveyor. To integrate water resources, water supply, and land use planning, Pierce County implemented the Public Water Systems Coordination Act of 1977[9] (Chapter 70.116 RCW) by issuing the *Pierce County Coordinated Water System Plan and Regional Supplement 2001* (Pierce County 2001). This plan identifies current and future water supply demands, requirements, and necessary facilities for the major water purveyors within Pierce County.

11.2 Environmental Impacts

All the jurisdictions with the potential to be affected by the Project are subject to GMA requirements described in Section 11.1.2 of this document and currently have comprehensive and water supply plans in place. Because the water rights for the White River–Lake Tapps Reservoir system have historically been held by Puget for hydropower purposes, the opportunity to acquire water rights within this system to address future water supply demands has not been incorporated into any of those plans.

Under the Proposed Action, the change to the existing water right and issuance of the additional water rights would allow the diversion, storage, and withdrawal for municipal use of that water under the water rights historically held by Puget and unavailable to other potential users. Thus, the Proposed Action would not affect the surrounding communities' current plans for growth and methods for accommodating their municipal water supply needs in the future. For a discussion of potential impacts related to groundwater supplies, see Chapter 7 of this document.

Cascade issued the *2004 Transmission and Supply Plan* (TSP) in September 2005 (Cascade 2005). The TSP is fully consistent with local land use plans, as required by state law. Consistency with local land use plans has been documented in approvals of the TSP issued by King County in December 2006 and by the Washington State Department of

[9] Chapter 70.116 RCW: Public water system coordination act of 1977. http://apps.leg.wa.gov/RCW/default.aspx?cite=70.116.

Health (DOH) in January 2007. Before water can be withdrawn by Cascade from Lake Tapps Reservoir for use as a regional water supply, Cascade would need to satisfy DOH requirements for additional, updated water system plans, which would also need to be consistent with local land use plans.

11.2.1 Direct Impacts

No significant direct impacts to land and shoreline use are predicted for either the Proposed Action or the No Action Alternative.

No Action Alternative

White River

Under the No Action Alternative, water elevations and flow rates in the White River would be similar to existing conditions and would remain within the limits of existing seasonal variations. All of the average monthly flow rate changes would be small when compared with the natural range of variation in flow rates.

Because the No Action Alternative would minimally alter water elevations and flow rates in the White River, current and future land use would not be affected by implementing the No Action Alternative.

Lake Tapps Reservoir

Under the No Action Alternative, reservoir elevation would not exceed 545 feet. Because reservoir elevation fluctuations would be minimal and would remain within Cascade-owned land, no change in land or shoreline use in the area surrounding Lake Tapps Reservoir would be expected as a result of implementing the No Action Alternative.

Proposed Action

White River

Water elevations in the White River would remain within the limits of existing seasonal variations under the Proposed Action. All of the average monthly flow changes would be small when compared with the natural range of variation in flows. Because the Project would operate within the limits of the Recommended Flows (see Table 3-2), White River flows under the Proposed Action would neither exceed the maximum nor drop below the minimum flows described for the No Action Alternative.

Because the Proposed Action's effects on White River water elevations and flow rates would be minimal, current and future land and shoreline use would not be affected as a result of implementing this alternative.

Lake Tapps Reservoir

When Cascade acquired the real property rights of Lake Tapps Reservoir from Puget in 2009, the area included all land up to the 545.7-foot contour line (according to the 1929 elevation datum[10]). The area inside of this boundary is considered to be within the normal range of reservoir elevations, and can only be used consistent with the 1954 Deed between Puget and the Lake Tapps Development Company (see Section 2.1).

Reservoir elevation would not exceed 545 feet under the Proposed Action. Because reservoir elevation fluctuations would remain within Cascade-owned land, no change in land or shoreline use plans in the area surrounding Lake Tapps Reservoir would be anticipated.

11.2.2 Indirect and Cumulative Impacts

No Action Alternative

Because of the similarities between the No Action Alternative and existing conditions, no indirect impacts would be anticipated.

Because the No Action Alternative would not affect land and shoreline use, no cumulative impacts would be anticipated.

Proposed Action

Implementing the Proposed Action would provide a beneficial impact with respect to existing and planned land uses in King County and Pierce County. Land use plans for King County, Pierce County, and many municipalities within these two counties forecast significant growth in the coming decades. Without increases in available water supplies, many communities in the two counties could experience potable drinking water shortages in the future. The Proposed Action specifically addresses and responds to water supply needs by providing a regional supply that could offset shortages brought about by growth. In addition, the location and storage capacity associated with the Project would enhance regional water supply reliability, further supporting planned development described and analyzed in adopted land use plans.

[10] For more information on this datum, see Chapter 1.

11.3 Mitigation Measures

While the project would not result in significant direct, indirect, or cumulative impacts to land and shoreline use, Cascade would provide the mitigation measures listed in Table S-1 (Summary) and Section 1.4 of this Draft EIS.

11.4 Significant Unavoidable Adverse Impacts

There would be no significant unavoidable adverse impacts to land and shoreline use under the Proposed Action or under the No Action Alternative.

Chapter 12: Climate Change

Climate change[1] is addressed in this chapter because of its potential to affect water resources and the Lake Tapps Reservoir Water Rights and Supply Project ("Project"). According to the U.S. Environmental Protection Agency (USEPA), "it is increasingly clear that climate change may have impacts on water resources and affect the programs designed to protect the quality of these resources.... Some of the primary consequences of climate change for water resources include rising sea levels, warming water temperatures, and changes in the amounts and location of rain and snow" (USEPA 2008a).

Climate change may result from:

- Natural factors, such as changes in the Sun's intensity or slow changes in the Earth's orbit around the sun;
- Natural processes within the climate system (e.g., changes in ocean circulation); and
- Human activities that change the atmosphere's composition (e.g., through burning fossil fuels) and the land surface (e.g., deforestation, reforestation, urbanization, desertification).

Source: USEPA 2008a

Postulating potential future climatic conditions may be useful when planning for long-term municipal water supply needs and environmental conservation. Climate has changed in the past, and future changes (when they occur) could affect the quantity of regional water resources. This could, in turn, affect the availability of water for municipal consumption, for fish and wildlife habitat, and for recreation. In the project area, climate change could affect White River stream flow and operation of the White River–Lake Tapps Reservoir system. This chapter provides information on potential changes to climate and stream flow in the White River basin, and the possible effects of those changes on the Project and, conversely, the Project's potential to impact the global climate.

To provide general guidance on incorporating the potential for climate change into environmental review and decision-making under Washington's State Environmental Policy Act (SEPA), Jay Manning, the Director of the Washington State Department of Ecology (Ecology), sent a letter to SEPA Responsible Officials and Administrators (Manning 2008). The letter established a SEPA working group as part of the 2008 Climate Action Team (CAT). The 2008 CAT's final report was released in November 2008, and includes products and recommendations developed by the SEPA working group to provide guidance on incorporating the potential for climate change into the SEPA process (CAT 2008). This CAT

[1] The term *climate change* is often used interchangeably with the term *global warming*, but according to the National Academy of Sciences, "the phrase 'climate change' is growing in preferred use to 'global warming' because it helps convey that there are [other] changes in addition to rising temperatures" (USEPA 2008b). Other aspects of the climate that always have and are continuing to change are rainfall patterns, snow and ice cover, and sea level.

document offers guidance for analyzing and mitigating potential impacts of greenhouse gas (GHG) emissions caused by project and non-project actions on climate, but not on how to evaluate the potential effects of climate change on the action under consideration.

In 2009, the Washington State Legislature authorized Ecology to seek assistance from the scientific community to assist in determining the ability of the environment, natural systems, communities, and organizations to deal with potential or actual impacts of climate change and the vulnerability to which a natural or social system is susceptible to sustaining damage from climate change impacts[2]. Because the Proposed Action would not affect climate change or greenhouse gas emissions, the focus of the Draft EIS analysis is in a new area of science: the assessment of the strengths and vulnerabilities of these system to climate change.

The Lake Tapps Reservoir Water Rights Project under the Proposed Action would not change the operation of the Project to result in additional GHG emissions above the emissions that would occur under the No Action Alternative. Therefore, the Project would not affect the global climate or greenhouse gas emissions. However, certain potential climate changes could affect the White River, Lake Tapps Reservoir, and the Project's effectiveness as a source of municipal and industrial water supply.

12.1 Background on Climate Change

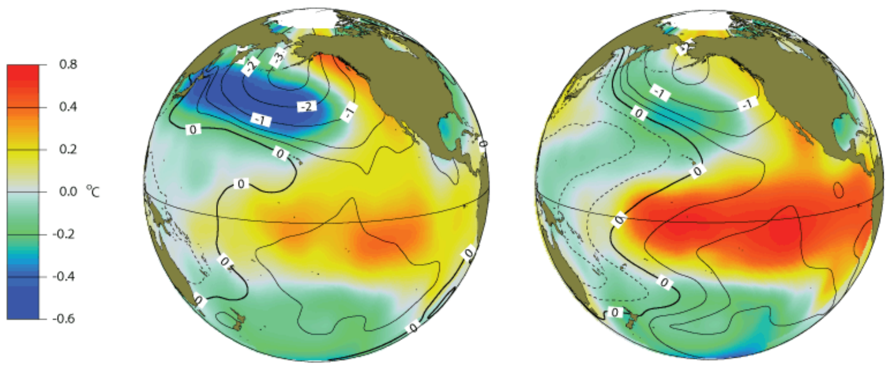
Climate change prediction and analysis are extremely complex and often controversial. Scientists must make many separate assumptions about future ocean and atmospheric conditions, and the interactions between oceanic and atmospheric systems. Massive computer models (called GCMs, or General Circulation Models) are developed to represent the physics, chemistry, and thermodynamics of large oceanic/atmospheric circulation patterns. Several different GCMs are typically used and many different possible sets of future scenarios are examined. These sets of GCM results do not represent the detailed topography of the region, let alone that of the individual river basin. Therefore, the results must be down-scaled to a particular region (like the Cascade Mountains of the Pacific Northwest), then even further down-scaled to an individual river drainage basin or meteorological monitoring station, where the predicted changes in meteorological characteristics are applied in historically calibrated hydrological models to develop climate-change-affected runoff estimates.

The downscaling process attempts to match the statistical characteristics from the large-scale GCM results while maintaining the natural variability of the historic meteorological data record (Polebitski et al. 2007a). This downscaling process introduces error and uncertainty into the resulting climate change meteorology. Likewise, the hydrologic modeling process

[2] Laws of 2009, Ch. 519, Sec. 12

introduces its own inaccuracies. The final results are typically viewed as possible or potential scenarios of what might happen, rather than as predictions of what will happen.

Variations in Pacific Northwest climate are strongly affected by the El Nino/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) – two large-scale patterns of climate variability. Prediction of the state of ENSO and PDO is important to accurate prediction of long-term weather in the Pacific Northwest. According to the Climate Impacts Group (CIG) "[e]ven with perfect predictions of ENSO and PDO, about 70% of the region's winter climate variability remains unexplained (by these two factors). Other climate patterns, combined with "noise" and the chaotic nature of climate system, also contribute" (CIG 2009).



Warm Phase PDO

Warm Phase ENSO

The **PDO** (like ENSO) reflects changes in sea surface temperature, sea level pressure, and wind patterns. The warm phase PDO is characterized by anomalously warm sea surface temperatures near the equator and along the coast of North America, and anomalously cool sea surface temperatures in the central North Pacific. The cool phase PDO has the opposite pattern.

An **El Niño** (the warm phase of **ENSO**) is characterized by stronger than average sea surface temperatures in the central and eastern equatorial Pacific Ocean, reduced strength of the easterly trade winds in the Tropical Pacific, and an eastward shift in the region of intense tropical rainfall. A **La Niña** has the opposite pattern.

Source: CIG n.d.

In spite of the difficulties and uncertainties, climate change modeling is being used by some scientists to simulate global-scale and continent-scale temperature and precipitation trends. Over the short period that these techniques have been available, they have been shown to have some applicability for projecting regional trends (Polebitski et al. 2007b). However, smaller-scale climate projections and predictions for short (daily or hourly) time intervals are less reliable. Similarly, projections of climate conditions many decades in the future include much more variability and are untested. For these reasons, this chapter primarily focuses on general, long-term trends and regional-scale projections of climate change. Where detailed, local-scale information on far-future hydrology is available, it is referenced here with caution, and serves more as an indication of one view of possible future conditions rather than a firm prediction.

Climate and Water Supply in the Pacific Northwest and the White River Basin

As mentioned above, the two principal large-scale meteorological factors affecting climate variability In the Pacific Northwest are ENSO and PDO. ENSO and PDO both involve cyclical warming and cooling of sea temperatures that affect weather patterns in the Pacific Northwest. ENSO episodes usually last 6 to 18 months and recur on a 2-year to 7-year cycle. The PDO effect is believed to occur in 20-year to 30-year cycles. These cyclical climate systems, in combination with complex local geographic features, complicate the ability to predict long-term changes due to climate change.

According to historic climate data, an increase in average temperature of the Puget Sound region of 2.3^{o}F occurred during the 20th Century (Mote et al. 2005). The variation in PDO and ENSO accounts for about 40% of the increase in average winter temperature, but the source of the additional observed warming is unclear. Average annual precipitation has also increased over the last 80 to 100 years, but not outside of the range of natural variability. Generally, according to the CIG, both temperature and precipitation in the Pacific Northwest are predicted to increase in the future, although some studies show certain future periods with precipitation decreases. Temperature is predicted to increase year-round. Precipitation is predicted to increase in winter and decrease in summer. However, prediction of future precipitation is more difficult because precipitation is more highly variable and occurs at a much smaller scale. GCMs do not represent the topographic detail of the land surface. For temperature, an elevation versus temperature lapse rate can be applied to the GCM results, but the topographic effects on precipitation are far more spatially complicated and more difficult to generalize. For these reasons, the available predictions for precipitation vary more widely than those for temperature. Thus, future precipitation trends and data are more difficult to define and less certain.

The reliability of many municipal water supplies[3] in the Pacific Northwest is largely determined by winter precipitation and annual runoff from the mountains. Due to the limited amounts of reservoir storage in the Pacific Northwest, the region relies heavily on winter snowpack to store much of the water that will be used throughout the drier and higher water demand period of summer. If warming temperatures reduce storage in winter snowpack, late summer water supplies could be adversely affected. Careful, flexible operation of available storage reservoirs is necessary to capture the available runoff and maximize the available water supply, while still providing necessary flood control protection, where appropriate.

[3] This applies only to water systems that rely upon surface water as a primary source of supply. Systems relying upon groundwater tend to be much less affected by annual and seasonal variations in precipitation and runoff.

The White River basin is dependent on rain, snow, and glacial melt for streamflow. A portion of the precipitation is stored in snowpack during the winter and is released in early spring and summer as runoff (Ball 2004). According to Ball, in the 1990s, the White River historic streamflow record showed a shift toward increasing winter peaks and less pronounced spring peaks. According to his climate projections, this trend is expected to continue. His estimates suggest that the winter streamflow peak will begin to exceed the spring peak in about 2020. Summer flow volumes are expected to decrease in subsequent years (Ball 2004).

One specific study of the impacts of potential climate change on the White River has been completed by Palmer and Polebitski (2009). According to Palmer's and Polebetski's study, the overall volume of flow is not projected to change very much, but the seasonal pattern of flow is projected to change. The winter peak will become larger and the spring-summer peak will become smaller. Also, the late summer flows will become smaller under the assumed effects of climate change. These changes, if they occur, would influence flow throughout the White and Puyallup Rivers and the operation of the White River–Lake Tapps Reservoir system, as well as water levels in Lake Tapps Reservoir.

12.2 Environmental Impacts

Although withdrawing water for municipal use from Lake Tapps Reservoir is not expected to affect climate in the region, climate change could affect operation of the White River–Lake Tapps Reservoir system. If a significant warming trend occurs in the future, this would likely reduce glaciers and snowpack in the mountains that feed the White River, and streamflow could change. Potential impacts of climate change on snowmelt-driven water systems like the White River basin could include increased winter flows, lower summer flows, earlier spring peak flows, and an increased length of time between snowmelt and the onset of fall rains (Hamlet et al. 2001).

As noted above, Palmer and Polebitski (2009) completed a study of the impacts of potential climate change on the White River for King County. This study estimated climate change impacts on the White River and on Lake Tapps Reservoir. Palmer's and Polebitski's study found that White River winter flow would increase by 36.3% (compared with the historic record), while summer flow would decrease by 28%. The study also found more variability in summer flow and lower late-summer water levels in Lake Tapps Reservoir during some years.

Several of the important operational assumptions used in this study are not reflective of planned operations under the Proposed Action. This is primarily because up-to-date information on the Project's proposed operation was not available to Palmer and Polebitski at the time their analysis was performed. If the study is re-opened in the future, operational assumptions could be changed to match actual, planned operations. Differences between the operational assumptions used by Palmer and Polebitski and currently planned operations are summarized in Table 12-1.

Table 12-1. Differences between Palmer and Polebitski Simulation of Lake Tapps Reservoir Water Supply Project and Proposed Action

Operational Assumption	Palmer and Polebitski	Proposed Action
Puyallup River Minimum Flow (MF)	MF is met by deferring diversions to, and by increasing releases from Lake Tapps Reservoir.	During the spring, the diversion to Lake Tapps Reservoir is reduced by up the full amount of the water supply with-drawal (65 cfs) when minimum flow is not being met.
Average Annual Lake Tapps Water Supply diversion	100 cfs	75 cfs, with reduced deliveries during drought years
Operational priority between White River minimum flows, recreational water levels in Lake Tapps Reservoir, and water supply deliveries	White River fish flows Water supply deliveries Summer recreational water levels	White River fish flows Summer recreational water levels Water supply deliveries
Maximum rate of diversion into Lake Tapps Reservoir	2,000 cfs	1,000 cfs February to summer, 400 cfs summer to fall, 150 cfs late fall to February
Diversion Dam Efficiency	Between 95% and 100%	100% after reconstruction by USACE
Lake Tapps Reservoir water levels	Hydropower Maximum Target level	Maintain Normal Full Pool (elevation 542.5 feet, NGVD) from Apr. 15 to Sept. 30

The Palmer and Polebitski study results and conclusions regarding flow downstream of the diversion dam and water levels in Lake Tapps Reservoir are not utilized directly in this Draft EIS analysis because of the significance of these differences.

Since the Palmer and Polebitski study results could not be used directly, the climate-impacted flow results from their study were closely evaluated to determine whether they could be utilized by incorporating the flow predictions upstream of the Project into the operational modeling performed by Aspect Consulting (described in Section 5.2.1). Aspect's review found a significant discontinuity in the predicted flow of the White River near Buckley, especially concentrated on the first days of July. Climate change simulated flow above the Lake Tapps diversion dam (which represents three GCM scenarios[4] but under current, i.e., year 2000 conditions) is shown to be different from and lower than historically measured flow. This occurs under present (year 2000) climate model predicted conditions when the flows should agree. Under future climate-impacted hydrology, there is also a very sharp drop

[4] The three scenarios (ECHAM5_A2, GISS_B1, and IPSL_A2) were derived from three GCMs representing a range of possible future greenhouse gas emissions.

(of 300 to 500 cfs) in predicted flow at this location instantaneously on the first day of July of almost every year. Similar up and down steps are observed at other month boundaries. These sharp, abrupt changes are believed to be artifacts of the modeling process, rather than predicted climate change effects.

After discussions with the study's authors, it is believed that these steps in the predicted climate-impacted flow results are due to the use of individual, monthly bias correction factors. On the first day of each month, a different adjustment factor is applied, resulting in un-naturally large changes in flow. A scientifically valid means to correct these anomalies has not yet been developed.

It was determined that Palmer's and Polebitskis's climate change impacted flows were not fully usable in Aspect's model to estimate the effects of the assumed climate changes on the Project for two reasons:

1. Project operations are critically affected by the size of daily flow in July.

2. It was not deemed possible to reliably correct the projected flow.

Nevertheless, these projections do provide one possible indication of both the direction and the possible worst-case[5] magnitude of climate change effects.

Potential climate change effects on No Action Alternative and Proposed Action project operations are, therefore, described qualitatively, generally using the valuable information from Palmer and Polebitski (2009), as well as similar results from Vano et al. (2009). The remaining sections qualitatively summarize the likely effects of climate change on surface water resources under both the No Action Alternative and the Proposed Action.

12.2.1 Direct Impacts

No Action Alternative

The No Action Alternative would not be expected to affect climate in the region. However, the No Action Alternative would experience somewhat different flow and water level conditions under the assumed effects of global climate change (which are qualitatively derived from Palmer's and Polebitski's study). The most significant change is likely to be that winter flow would be higher and late summer flow would be lower throughout the White and Puyallup River systems, as shown in the climate-impacted flows provided by Palmer and

[5] Estimating how conservative hydrological model-produced results are is challenging. The 15-year historical period evaluated in Chapter 5 appears to contain relatively more frequent dry years than would an "average" 15-year period. It includes 3 of the 10 driest years in the last 75 years. For this reason, historically-based hydrological results are likely conservative with respect to drought conditions.

Polebitski. It is possible that at times, even without diversion of water into Lake Tapps Reservoir, projected flow in the White River Reservation Reach could fall below the Recommended Flows, particularly in the late summer. This sometimes happens now, due to natural causes. If summer flows of the White River near Buckley are indeed lower under climate change impacted conditions, there would likely be less flow available to divert into Lake Tapps Reservoir. This could result in somewhat lower late summer water levels in Lake Tapps Reservoir and an increase in the amount of time that the reservoir is below the minimum recreational level of 541 feet.

Proposed Action

The Proposed Action would not be expected to affect climate in the region. However, the Proposed Action flow and water level results summarized in Chapter 5 could be affected by natural climate variability, and would be affected by the climate change-influenced flows estimated by Palmer and Polebitski. Water cannot be diverted to Lake Tapps Reservoir when flow arriving at the diversion dam is less than the required minimum flow. As a result, lower summer flow in the White River above the diversion dam could lead to less water being diverted into Lake Tapps Reservoir to maintain recreational water levels and to meet water supply withdrawals. During certain years, diversions into the reservoir might not be high enough to completely meet both needs. Under these conditions, Lake Tapps Reservoir water levels could fall below the minimum recreational level of 541 feet and withdrawals from the reservoir to meet Project water supply demands might need to be reduced. These conditions could continue until flow in the White River increased above the required minimum flow.

Within the scientific community there remains a wide range of divergent opinion regarding Global Climate Change (GCC), particularly in the realm of assessing strengths and vulnerabilities of natural and social system to deal with impacts. Subjects on which there is divergent opinion include the following: What is the cause(s) of GCC (is it naturally occurring, influenced by man, or a combination of the two)? What is the planet currently doing (is the planet in a long-term warming or cooling trend at this time)? This divergence of opinion can lead to a divergence of conclusions about the potential effects of GCC. If one assumes a “worst case” scenario, then the resulting impacts can be assumed to be significant and highly adverse. If one assumes a “best case” scenario, then the resulting impacts can likewise be assumed to be negligible, or even non-existent or positive.

The authors of this Draft EIS have taken neither a worst nor a best case scenario as to the potential effects GCC might have on the White River and on the Project. Rather, the authors have taken a scenario that is closer to, but lesser than, a best case scenario as the likely scenario for analysis purposes. The authors acknowledge that others could choose a differing scenario for analysis purposes. However, since there is neither a consensus of opinion nor undisputed scientific evidence that supports any singular choice of scenario, particularly within the realm of assessing strengths and vulnerabilities of natural and social system to deal with impacts, there is no clear or undisputed scenario that must be chosen.

For this Project, the most substantive potential adverse impacts of GCC would be impacts that affect the quantity and timing of flows in the White River. If GCC results in a reduction of water in the White River in the late spring, summer, and early fall time (that period of the year when flows in the river are normally at their lowest levels), then it would create competing interests between instream flows and the availability of flows for diversion from the White River into Lake Tapps Reservoir for the beneficial uses of recreational reservoir levels and withdrawal as municipal and industrial water supply.

The effects of the Proposed Action on the important surface water metrics under historical hydrologic conditions are qualitatively summarized in Table 12-2. This table also shows where the effects of the Proposed Action are projected to be the same or different under the assumed climate change influenced hydrologic conditions.

As noted earlier, the historically-based hydrologic results presented in Chapter 5 already represent somewhat conservative conditions with regard to the frequency of dry years included. Incorporating the projected effects of extreme climate change on top of this dry period very likely over-estimates the effects of dry conditions on Project operations.

Under the Proposed Action, the Recommended Flows in the White River Reservation Reach would be achieved as frequently as under the No Action Alternative. However, the Recommended Flows might not be met on as many days (particularly in the late summer) as under historical conditions. Similarly, under climate-change-influenced conditions, minimum recreational water levels in Lake Tapps Reservoir could be achieved less frequently. In addition, the reliability of the Project's municipal water supply could be reduced under climate-change-influenced conditions. These are all indications of the effects of one set of potential climate changes on the operation of the White River–Lake Tapps Reservoir system. However, the potential climate change effects reviewed here are only one set of projections and estimates of unknown future conditions. Actual conditions are likely to be different.

Table 12-2. Effect of the Proposed Action (compared to No Action) under Historical Conditions and under Climate-Change-Influenced Conditions

Condition	Estimated Effect of Proposed Action Under Historical Hydrologic Conditions (compared to No Action)	Range of GCC Effects Possible	Projected Effect of Proposed Action Under Assumed Climate Change Influenced Hydrologic Conditions (compared to No Action)
Flow in Reservation Reach	Decreased by 3%	Small to significant decrease possible	Decreased by 3%
Days of MF Compliance in Reservation Reach	No change or slight improvement	Slight improvement to significant non-compliance possible	No change or slight improvement
Lake Tapps Reservoir average summer water level	No change	No change to significant decrease possible	Small decrease possible
Recreation Impacts (number of days in Historical Recreation Season lake level is above 541 feet)	No change	No change to significant decrease possible	No change or slight decrease possible
Days of MF Compliance in Lower Puyallup River	Small decrease (12 percent)	Small to significant decrease possible	Small decrease (12%)
Reliability of Water Supply	Project water supply is delivered 99.6% of days	Project water supply may be significantly less reliable	Project water supply may be less reliable[6]

12.2.2 Indirect and Cumulative Effects

No significant indirect or cumulative effects would be anticipated under the No Action Alternative or the Proposed Action.

12.3 Mitigation Measures

While future hydro-climate conditions are uncertain, Cascade would provide the mitigation measures listed in Table S-1 (Summary) and Section 1.4 of this Draft EIS. The use of an adaptive management process to deal with changes may be useful. Potential elements of an adaptive management process could include the following:

- Initiate efforts to modify operations of Mud Mountain Dam to allow a certain volume of water to be held in storage after the flood control season for use in improving Reservation Reach flow, diversions to Lake Tapps Reservoir, and Lake Tapps Reservoir recreational water levels.

[6] Climate change impact to Lake Tapps Reservoir supply reliability is estimated to be similar to the estimated impacts on the reliability of other Puget Sound region water supplies (Vano et al. 2009).

- Implement a White River flow forecasting system to project summer flows and to optimize Lake Tapps Reservoir water levels and deliveries to the water supply project.
- Evaluate opportunities to use Lake Tapps Reservoir water supplies conjunctively with other regional water supplies, relying more heavily on Lake Tapps Reservoir in certain years (when supplies are plentiful) and on other regional supplies when Lake Tapps Reservoir is drawn down.
- Develop or adjust a shortage management plan, including procedures to adjust Lake Tapps Reservoir operation during dry years.

12.4 Significant Unavoidable Adverse Impacts

There would be no significant unavoidable adverse impacts to the earth's global climate under the Proposed Action or under the No Action Alternative.

This page intentionally left blank.

Chapter 13: Lake Tapps Regional Reserved Water Program

13.1 Introduction

The municipal and industrial water rights applications submitted for this Project in 2000 were for average annual and peak instantaneous consumptive flows of 100 cfs (64.6 mgd) and 150 cfs (100 mgd), respectively. Through further tracking and analysis of future demand projections, Cascade has been able to significantly reduce its projected average and instantaneous future demands to 75 cfs (48.5 mgd) and 135 cfs (87.3 mgd), respectively.

Four municipalities located in the Lake Tapps Region that provide water to their respective service areas – the cities of Auburn, Bonney Lake, Buckley, and Sumner (Four Cities) – have been engaged in long-running discussions with Cascade focusing on their own future water demands and Cascade's municipal and industrial water rights applications. These discussions have resulted in the development of a mechanism to assist the water suppliers located in the Lake Tapps Region to meet their projected future demands for water supply consistent with Cascade's water rights applications, the Lake Tapps Reservoir Water Rights and Supply Project, and the mitigation steps identified in this Draft Environmental Impact Statement (Draft EIS). This mechanism is referred to as the "Lake Tapps Regional Reserved Water Program." The Lake Tapps Regional Reserved Water Program provides for a portion of the municipal and industrial water rights applications, as originally submitted in 2000, to be reserved for the use by the Four Cities to mitigate impacts on the White River of the Four Cities' new water rights or changes to existing water rights.

The Lake Tapps Regional Reserved Water Program designates the following portion of the flows requested in the 2000 water rights applications and refers to these flows as the "Regional Reserved Water": Qa (res) = 7 cfs (4.5 mgd) and Qi (res) = 10 cfs (6.5 mgd). The Regional Reserved Water would be available to the Four Cities to utilize as mitigation water for their own applications for new water rights or changes to existing water rights that would be submitted to and processed by Ecology independent of the Lake Tapps Reservoir Water Rights and Supply Project. The Regional Reserved Water would only be available for use by the Four Cities when minimum flows in the White River were being met, as measured downstream of Cascade's diversion to Lake Tapps Reservoir.

As explained below, the inclusion of the Lake Tapps Regional Reserved Water Program in the Proposed Action analyzed in this Draft EIS would not result in any additional impacts beyond those analyzed in Chapters 1 through 12 of this Draft EIS. The Regional Reserved Water would not be authorized for diversion or withdrawal from the White River by the Lake Tapps Reservoir Water Rights and Supply Project. The Regional Reserved Water would stay in the White River and is assigned an identifier of Regional Reserved Water at this time.

Any of the Four Cities desiring to access and beneficially use the Regional Reserve Water would be entirely responsible for filing application(s) and completing the requisite necessary application review and environmental analysis to support processing through Ecology of any applications for new water rights or changes to an existing water right. Cascade would not be involved or have any obligations with respect to these applications and environmental analysis.

13.2 Background

The Four Cities have expressed a desire to secure new water rights and/or secure changes to existing water rights for the purpose of providing for future municipal and industrial water needs for citizens located in their service areas. The Four Cities anticipate that Ecology will identify impacts to the White River arising from the Four Cities' proposed applications for new water rights or changes to existing water rights. The Four Cities further anticipate that Ecology would require mitigation for such impacts to the White River. Ecology may identify other impacts that require mitigation as well. The Regional Reserved Water provides one means for a City applicant to mitigate for impacts to the White River. The environmental analysis for any proposed water right application by any City applicant, as well as the mitigation of any impacts, would be the responsibility entirely of the City applicant and would be independent of the environmental review for Cascade's Lake Tapps Reservoir Water Rights and Supply Project contained in this Draft EIS.

13.3 Regional Reserved Water Mechanism

The geographical relationship of the White River with Cascade's Lake Tapps Reservoir Water Rights and Supply Project and the municipal limits of the Four Cities are shown in Figure 13-1. Also shown on Figure 13-1 are the current existing major groundwater sources of supply utilized by these Four Cities. An application for a new water right or an application for a change to an existing water right located in proximity to the White River by one of these Four Cities has the potential to adversely impact flows in the White River. The potential adverse impact would be a reduction of flow in the river, either immediate or delayed, caused by pumping by one of the Four Cities associated with a new or changed existing water right.

A dynamic, interconnected physical relationship exists between the groundwater system and the surface water system of each river. This applies to the White River basin discussed in this Draft EIS. This dynamic relationship is referred to as hydraulic connectivity. When a groundwater well is pumped and water is withdrawn from the ground, the groundwater system, and thus the surface water system, is altered. The assessment of how much the system is altered is a complex analysis and depends upon the physical characteristics of the ground's geology, the depth and proximity of the well to the surface water, the construction of the well, and the pumping rate that is applied to the well. Depending on all these factors, the impact to flow in the river will vary. If the hydraulic connectivity between the well and the river is strong, then the impacts occur more immediately and are more significant. If the hydraulic connectivity between the well and the river is weak, then the impacts occur on a more delayed basis and are less significant.

The actual hydraulic connectivity of a new well with the White River is a complex and challenging analysis requiring the well location, knowledge of the soils in the area of the well, and modeling and analysis. The requisite investigations and analyses required to perform such an assessment of hydraulic connectivity and its resulting impact on White River flows will be accomplished in the future by an individual City applicant. This analysis is beyond the scope of this Draft EIS. Cascade and the Four Cities, in consultation with Ecology, have developed this Lake Tapps Regional Reserved Water Program in an effort to provide a mechanism for the Four Cities to address some or all of the potential impacts to the White River from a City's proposed new or changed water right located in proximity to the White River.

13.4 Determination of Regional Reserved Water Quantities

If Cascade's three new municipal and industrial water rights applications are approved by Ecology, then Cascade would have the right to divert water from the White River at the location of the existing diversion dam and intake (RM 24.3). If such applications are approved with the Lake Tapps Reserved Water Rights Program, a portion of the flows requested in the 2000 municipal and industrial water rights applications would be allocated for use to mitigate impacts on the White River caused by the Four Cities' anticipated future new or changed water right applications as "Regional Reserved Water".

Based on information provided by the Four Cities, Regional Reserved Water has been designated in the following amounts: Qa = 7 cfs and Qi = 10 cfs.

13.5 Future Processing by Ecology

When a specific water right application submitted by one of the Four Cities is processed, a specific portion of the Reserved Water would be reserved for the use by that City to mitigate impacts on the White River of that City's new water rights or changes to existing water rights. Each City applicant would be responsible for demonstrating the mitigation value of the Regional Reserved Water for a specific water right application and for providing any additional mitigation of any kind that is required.

Beneficial use of the Regional Reserved Water would commence as required by the conditions of a Report of Examination (ROE) issued by Ecology approving a specific water right to one of the Cities. Cascade would, on behalf of such a City applicant, allow the specific quantity of Regional Reserved Water identified in an ROE to flow down the White River. Cascade contemplates that any such ROE issued to any of the Four Cities would contain a development schedule for the beneficial use of its water and a portion of the Regional Reserved Water. Any portion of the Regional Reserved Water not authorized for use in a water right by December 31, 2030, would revert to Cascade.

D:\GISDATA\projects\wash\CWA_LakeTappsEIS\map_docs\mxd\for_leanne.mxd - 12/2/2009 @ 1:42:35 PM

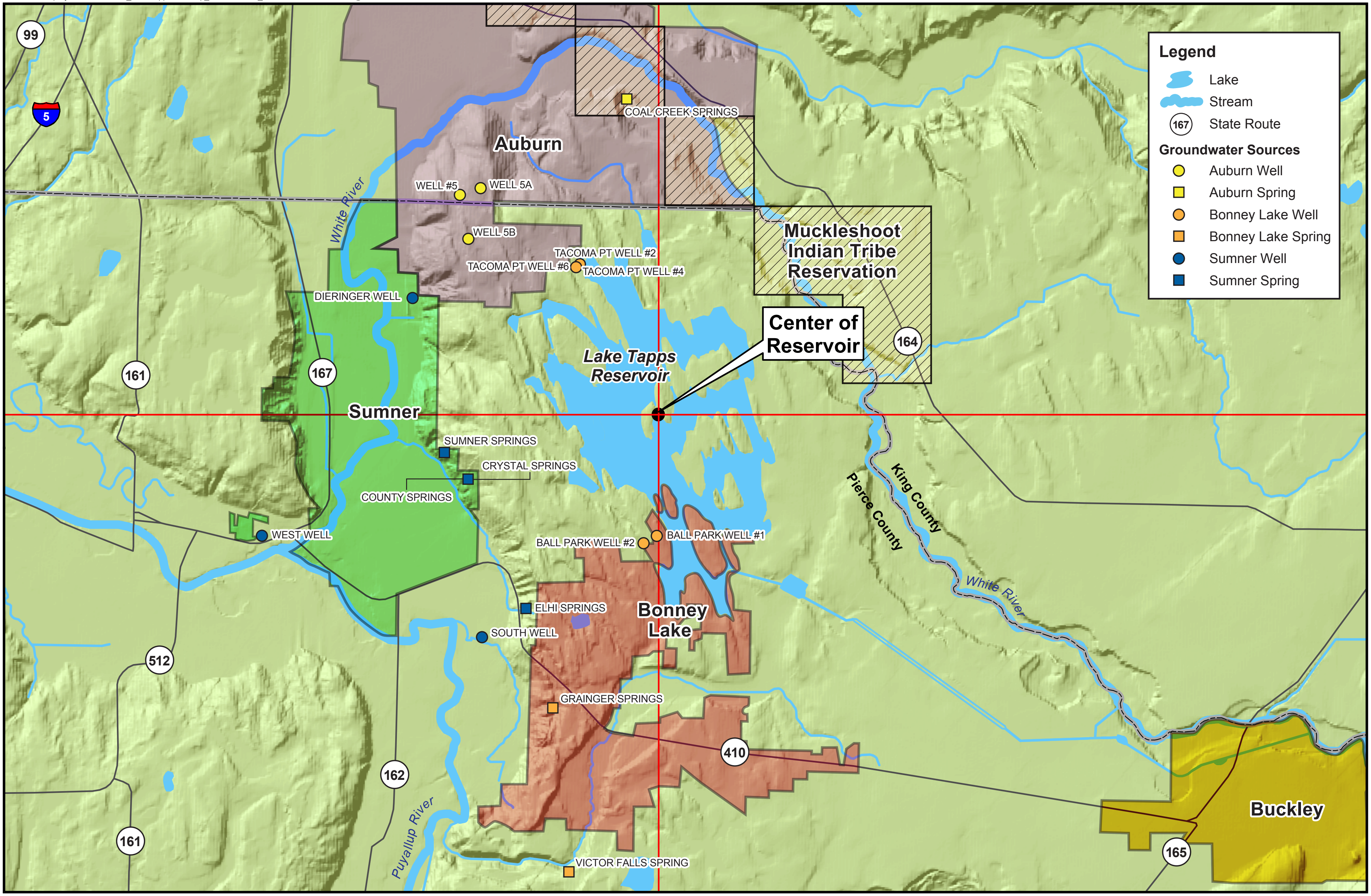


Figure 13-1

Tribal & Municipal Boundaries and Large Municipal Wells and Springs Located Near Lake Tapps Reservoir

Lake Tapps Water Rights and Supply Project

CASCADE WATER ALLIANCE

0 0.5 1 2
Miles

N

Chapter 14: References

Aero-Metric, Inc. 2009. Letter regarding the survey of USGS Lake Tapps Gaging Station 12101000, Sumner, Washington. Addressed to Robert D. King, HDR Engineering, Inc., from Jim Crabtree, Aero-Metric, Inc. July 17, 2009.

Aspect (Aspect Consulting, LLC). Unpublished. Water Quantity and Water Quality Analyses for the Lake Tapps Water Right Applications.

Ball, Joseph Andre. 2004. *Impacts of Climate Change on the Proposed Lake Tapps – White River Water Supply*. Draft master's thesis. University of Washington, Department of Civil and Environmental Engineering. http://www.tag.washington.edu/papers/papers/Ball_Thesis_DRAFT_2004.pdf.

Berger, A. and K. Williamson. 2005. *Puyallup River Juvenile Salmonid Production Assessment Project 2005*. Puyallup Tribe Fisheries Division, Puyallup, WA.

Bhowmik, Nani G., Ta Wei Soong, W.F. Reichelt, and Noha M. L. Seddik. 1991. *Waves Generated by Recreational Traffic on the Upper Mississippi River System*. Research Report 117. Illinois State Water Survey.

Booth, D. and Goldstein, B. 1994. *Patterns and Processes of Landscape Development by the Puget Lobe Ice Sheet*. WDNR Bulletin 80, Washington Department of Natural Resources Geology Division, Olympia, WA.

Caromile, Steve. 2009. Fisheries Biologist, Washington State Department of Fish and Wildlife. Personal communication with Bill Mavros, Fisheries Biologist, HDR Engineering, Inc. July 22, 2009.

Cascade (Cascade Water Alliance). 2003a. *Lake Tapps Storage Reservoir Water Right Proposal Environmental Checklist*. February 10, 2003.

Cascade (Cascade Water Alliance). 2003b. SEPA Mitigated Determination of Nonsignificance (MDNS) for the Lake Tapps Storage Reservoir Water Rights Proposal. February 13, 2003.

Cascade (Cascade Water Alliance). 2005. *2004 Transmission and Supply Plan*. September 29, 2005.

Cascade (Cascade Water Alliance). 2007. *Final Environmental Impact Statement, Tacoma-Cascade Pipeline*. April 26, 2007.

Cascade (Cascade Water Alliance). 2008a. *Environmental Checklist and SEPA Mitigated Determination of Nonsignificance (MDNS) for the Lake Tapps Reservoir Water Supply Project*. February 2008. http://www.cascadewater.org/PDFs/sepachecklist080222.pdf.

Cascade (Cascade Water Alliance). 2008b. *Lake Tapps Reservoir Issuance of New Municipal Water Rights and Change of Use for Existing Claim No. 60822, Determination of Significance and Request for Comments on Scope of Environmental Impact Statement and Environmental Checklist*. June 30, 2008. http://www.cascadewater.org/PDFs/Lk_Tapps_ChkList_DS_June_2008.pdf.

Cascade (Cascade Water Alliance). 2008c. White River Management Agreement Between The Puyallup Tribe of Indians, The Muckleshoot Indian Tribe and Cascade Water Alliance. August 6, 2008.

Cascade (Cascade Water Alliance). 2008d. Natural Resources Enhancement Agreement between the Puyallup Tribe of Indians and the Cascade Water Alliance. August 6, 2008.

Cascade (Cascade Water Alliance). 2008e. Lake Tapps Reservoir Water Rights Settlement Agreement. August 6, 2008. (Agreement with the Muckleshoot Indian Tribe).

Cascade (Cascade Water Alliance). 2008f. Letter from Michael A. Gagliardo, Director of Planning, to Thomas Loranger, Water Resources Supervisor, Southwest Regional Office, Washington State Department of Ecology. August 12, 2008.

Cascade (Cascade Water Alliance). 2008g. Cascade Approves Agreement to Purchase Lake Tapps. Press release, March 26, 2008. http://www.cascadewater.org/PDFs/news/03-26-08laketappspurchase.pdf.

Cascade (Cascade Water Alliance). 2009a. 2009 Agreement Regarding Lake Tapps between Cascade Water Alliance and the Lake Tapps Community. May 13, 2009.

Cascade (Cascade Water Alliance). 2010. E-mail from Scott Hardin, Director of Finance & Administration, Cascade, to Bob King, Project Manager, HDR Engineering, Inc. January 26, 2010.

CAT (Climate Action Team). 2008. *Leading the Way: Implementing Practical Solutions to the Climate Change Challenge.* http://www.ecy.wa.gov/climatechange/2008CATdocs/ltw_app_v2.pdf. Accessed December 2008.

Cederholm, C.J., D.H. Johnson, R.E. Bilby, L.G. Dominguez, A.M. Garrett, W.H. Graeber, E.L. Greda, M.D. Kunze, BG. Marcot, J.F. Palmisano, R.W. Plotnikoff, W.G. Pearcy, C.A. Simenstad, and P.C. Trotter. 2000. *Pacific Salmon and Wildlife – Ecological Contexts, Relationships, and Implications for Management*. Special Edition Technical Report, prepared for D.H. Johnson and T.A. O'Neil (Managing Directors), Wildlife–Habitat Relationships in Oregon and Washington. Washington Department of Fish and Wildlife; Olympia, WA.

Central Puget Sound Water Suppliers' Forum. 2001. 2001 Central Puget Sound Regional Water Supply Outlook. July 2001. http://watersuppliersforum.org/Home/Default.asp?ID=18.

CH2M HILL. 2006. *White River Diversion, Conveyance, and Storage Facilities*. Engineering Report. September 2006.

CIG (Climate Impacts Group). n.d. Hydrology and Water Resources, Key Findings. Joint Institute for the Study of the Atmosphere and Ocean (JISAO), University of Washington. http://cses.washington.edu/cig/res/hwr/hwrkeyfindings.shtml. Accessed November 2008.

CIG (Climate Impacts Group). 2009. Climate Variability. Joint Institute for the Study of the Atmosphere and Ocean (JISAO), University of Washington. http://cses.washington.edu/cig/pnwc/clvariability.shtml. Accessed September 2009.

City of Auburn. 1986. City of Auburn Comprehensive Plan. Originally adopted August 1986; amended 1995. http://www.auburnwa.gov/business/Planning___Development/Comprehensive_Plan.asp.

City of Auburn. 2007. Auburn Water Utility 2007 Water Quality Report. http://www.ci.auburn.wa.us/_media/docs/Water_Quality_Report-07.pdf.

City of Auburn. 2008. City of Auburn Draft Shoreline Master Program. http://www.auburnwa.gov/Assets/PCD/AuburnWA/Docs/shoreline_master_program.pdf.

City of Auburn. 2009a. City of Auburn Comprehensive Land Use Map, Map ID# 1142. January 9, 2009. http://www.auburnwa.gov/Assets/IS/AuburnWA/Docs/LandUse.pdf.

City of Auburn. 2009b. City of Auburn Comprehensive Zoning Map, Map ID# 1016. June 18, 2009. http://www.auburnwa.gov/Assets/IS/AuburnWA/Docs/Zoning+Atlas.pdf.

City of Auburn. 2009c. Draft Comprehensive Water Plan. http://weblink.auburnwa.gov/ElectronicFile.aspx?docid=149077. August 2009.

City of Bonney Lake. 1975. Shoreline Management Master Plan. April 23, 1975. http://www.citybonneylake.org/UserFiles/File/Government_Downloads/Community_Development/Shoreline_Master_Plan_1975retyped.pdf.

City of Bonney Lake. 2006a. Bonney Lake 2006 Water Quality Report. http://www.citybonneylake.org/section_government/departments/public_works/water.shtml.

City of Bonney Lake. 2006b. City of Bonney Lake Comprehensive Water System Plan. Planning Commission Review. March 2006.

City of Bonney Lake. 2008a. Comprehensive Plan. http://www.ci.bonney-lake.wa.us/section_business/community_development/comprehensive_plans.shtml#proposed_amendments.

City of Bonney Lake. 2008b. City of Bonney Lake Future Land Use Map. December 2008. http://www.citybonneylake.org/UserFiles/File/Maps/future_land_use_2008.jpg.

City of Bonney Lake. 2008c. City of Bonney Lake Comprehensive Water System Plan. Final. October 2008. http://www.ci.bonney-lake.wa.us/UserFiles/File/Business_Downloads/Comprehensive_Plans/DRAFTCWSP_2009.pdf.

City of Bonney Lake. 2009. City of Bonney Lake Official Zoning Map. April 8, 2009. http://www.citybonneylake.org/UserFiles/File/Maps/Zoning_Map.pdf.

City of Buckley. 1999. City of Buckley Shoreline Master Program. Adopted by Ordinance 21-99. June 1999.

City of Buckley. 2005a. City of Buckley Comprehensive Plan. November 2005.

City of Buckley. 2005b. City of Buckley Water System Comprehensive Plan. May 2005.

City of Buckley. 2007. Personal communication between Sara Twitchell, HDR Engineering, Inc., and City of Buckley Planning Department. February 2, 2007.

City of Buckley. 2008. Letter to Michael Gagliardo, Cascade Water Alliance, from Dave Schmidt, City Administrator. RE: Lake Tapps Reservoir Water Supply: SEPA Comments. March 22, 2008.

City of Pacific. 1974. City of Pacific Shoreline Master Program Map. Adopted 1974.

City of Pacific. 2004. City of Pacific Comprehensive Plan.

City of Pacific. 2008a. Personal communication between Sara Twitchell, HDR Engineering, Inc., and City of Pacific Planning Department November 5, 2008.

City of Pacific. 2008b. City of Pacific Draft Water System Plan. February 2008.

City of Sumner. 2002. City of Sumner Shoreline Master Program. Adopted November 7, 2002.

City of Sumner. 2005. City of Sumner Comprehensive Plan. December 2005. http://www.ci.sumner.wa.us/Documents/Comp%20Plan/000-2005_COMP_PLAN-DECEMBER.pdf.

City of Sumner. 2008. Water Quality. Web site accessed September 2008. http://www.ci.sumner.wa.us/Living/Water.htm.

City of Sumner. 2009. Draft City of Sumner Water System Plan. September 2009.

Committee on Sanitary Engineering Research. 1960. Solubility of Atmospheric Oxygen in Water. *Journal of the Sanitary Engineering*. American Society of Civil Engineers. 86(4): 41-53.

Cooke, G.D., E.B. Welch, S.A. Peterson and P.R. Newroth. 1993. *Restoration and Management of Lakes and Reservoirs*. 2nd Edition, Lewis Publishers, Chelsea, MI.

CPNWS (Center for Pacific Northwest Studies). n.d. Puget Sound Power & Light Company Records, Organizational History. http://www.acadweb.wwu.edu/CPNWS/puget/pugethist.htm.

DOH (Washington State Department of Health). 2008. Geographic Information System data.

Dorpat, Paul and Genevieve McCoy. 1998. *Building Washington: A History of Washington State Public Works*. Excerpt from Chapter: Power. University of Washington Libraries, Digital Collections. http://content.lib.washington.edu/ww-spwsweb/essay.html. Accessed September 4, 2008.

Dragovich, J. D., Pringle, P. T., and Walsh, T. J. 1994. Extent and Geometry of the Mid-Holocene Osceola Mudflow in the Puget Lowland – Implications for Holocene Sedimentation and Paleogeography. *Washington Geology* 22: 3-26. Cited in PGG 1999.

Dunne, T. 1986. *Sediment Transport and Sedimentation Between RMs 5 and 30 Along the White River, Washington*. Appendix 2b, Puget Sound Power and Light, Additional Information Response, FERC Project No. 2494. August 1987.

Dunston, W. 1955. White River downstream migration. *Puget Sound Stream Studies (1953-1956)*. Washington Department of Fisheries, Olympia, WA.

Ebbert, J.C. et al. 1987. Water Quality in the Lower Puyallup River Valley and Adjacent Uplands, Pierce County, Washington. *USGS Water Resources Investigations Report 86-4154*. Tacoma, WA.

Ebbert, J.C. 2002. Concentrations of Dissolved Oxygen in the Lower Puyallup and White Rivers, Washington, August and September 2000 and 2001. *USGS Water Resources Investigations Report 02-4146*. Tacoma, WA.

Ebbert, J.C. 2003. Water Temperature, Specific Conductance, pH and Dissolved Oxygen Concentrations in the Lower White River and the Puyallup River Estuary, Washington, August-October 2002. *USGS Water Resources Investigations Report 03-4177*. Tacoma, WA.

Ecology (Washington State Department of Ecology). n.d.(a). Water Right Information. http://www.ecy.wa.gov/programs/wr/rights/water-right-home.html. Accessed October 2008.

Ecology (Washington State Department of Ecology). n.d.(b). Surface Water Quality Standards. http://www.ecy.wa.gov/programs/wq/swqs/index.html. Accessed August 2009.

Ecology (Washington State Department of Ecology). n.d.(c). Non-Native Invasive Freshwater Plants. http://www.ecy.wa.gov/programs/wq/plants/weeds. Accessed August 2009.

Ecology (Washington State Department of Ecology). 1996. Major Lakes of Washington. Vector Digital Data, Olympia, WA. http://www.ecy.wa.gov/services/gis/data/data.htm#lakes.

Ecology (Washington State Department of Ecology). 1999. *Review Draft, Assimilative Capacity Study for Nutrient Loading in the White River*. Olympia, WA.

Ecology (Washington State Department of Ecology). 2003. Introduction to Washington's Shoreline Management Act (RCW 90.58). Ecology Publication 99-113.

Ecology (Washington State Department of Ecology). 2005. *Puyallup and White Rivers Temperature and Dissolved Oxygen July – November 2004 Monitoring Report*. Publication Number 05-10-053. Olympia, WA.

Ecology (Washington State Department of Ecology). 2006a. *Draft Report of Examination, Lake Tapps Reservoir Water Supply Project Application S2-29934*. September 22, 2006. http://www.ecy.wa.gov/programs/WR/swro/images/pdf/lktapps_draft_roe_09202006.pdf.

Ecology (Washington State Department of Ecology). 2006b. Lake Tapps Reservoir (Pierce County) Monitoring. Final Data Report, Publication Number 06-03-006.

Ecology (Washington State Department of Ecology). 2006c. Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC. Amended November 20, 2006. Publication Number 06-10-091. November 2006. http://www.ecy.wa.gov/pubs/0610091.pdf.

Ecology (Washington State Department of Ecology). 2006d. *Waters Requiring Supplemental Spawning and Incubation Protection for Salmonid Species*. Publication Number 06-10-038. Olympia, WA.

Ecology (Washington State Department of Ecology). 2008a. Surface Water Criteria. http://www.ecy.wa.gov/programs/wq/swqs/criteria.html. Updated April 2008.

Ecology (Washington State Department of Ecology). 2008b. Temperature Standards and Criteria. http://www.ecy.wa.gov/programs/wq/swqs/temperature.html. Updated April 2008.

Ecology (Washington State Department of Ecology). 2008c. *Puyallup and White River Dissolved Oxygen and Temperature Data Summary Report*. Publication No. 08-03-013. Olympia, WA.

Ecology (Washington State Department of Ecology). 2008d. Current Water Right & Water Right Change Applications Pending with Ecology. Water Rights Tracking System. Pierce County report, April 7, 2008. http://www.ecy.wa.gov/programs/wr/info/wrats/Wria_pierce.pdf.

Ecology (Washington State Department of Ecology). 2008e. Washington Water Resources Explorer. Web site accessed October 2008.

Ecology (Washington State Department of Ecology). 2009a. Letter regarding acceptance of Cascade's temporary donation to the Washington State Trust Water Right Program. Addressed to Michael Gagliardo, Cascade Water Alliance, from Thomas Loranger, Ecology. October 26, 2009.

Ecology (Washington State Department of Ecology). 2009b. 2002, 2004, and 2008 White River Monitoring Data. http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?theyear=&tab=temperature&scrolly=0&sta=10C095.

Embrey, S.S. 1991. Available habitat for salmon and steelhead trout in the lower Puyallup, White, and Carbon Rivers in western Washington. *Water Resources Investigations Report 89-4125*. U.S. Geological Survey, Denver, CO.

Erickson, K. 1999. *Review Draft Assimilative Capacity Study for Nutrient Loading in the Lower White River*. Washington State Department of Ecology Publication No. 00-03-001.

FERC (Federal Energy Regulatory Commission). n.d. History of FERC. http://www.ferc.gov/students/whatisferc/history.htm. Accessed October 15, 2008.

FERC (Federal Energy Regulatory Commission). 1992. *Environmental Assessment for Hydropower License, White River Hydroelectric Project, FERC Project No. 2494-002*. Washington, D.C. October 9, 1992.

FERC (Federal Energy Regulatory Commission). 2004. *Compliance Handbook*. March 2004. http://www.ferc.gov/industries/hydropower/gen-info/handbooks/compliance_handbook.pdf.

Ford, M.J., Lundrigan, T., and Baird, M. 2004. *Population Structure of White River Chinook Salmon*. Draft Report. Northwest Fisheries Science Center, Conservation Biology Section. Seattle, WA.

Franklin, J. F. and C. T. Dyrness. 1988. *Natural Vegetation of Oregon and Washington*. Oregon State University Press. Corvallis, OR.

Grette, G.B. and E.O. Salo. 1986. *The Status of Anadromous Fishes of the Green/Duwamish River System*. Prepared for the U.S. Army Corps of Engineers, Seattle District. Prepared by Evans-Hamilton, Inc., Seattle, WA.

Hadley, Jane. 1999a. A Drain on Waterfront Land Values Residents Fear Lake Tapps May Be Left To Dry Up. Seattle Post-Intelligencer. February 26, 1999. http://seattlepi.nwsource.com/archives/1999/9902260035.asp.

Hadley, Jane. 1999b. Lake Tapps Fans Wearing a More Contentious Face. Seattle Post-Intelligencer. August 12, 1999. http://seattlepi.nwsource.com/archives/1999/9908120094.asp.

Hamlet, A., D. Fluharty, D. Lettenmaier, N. Mantua, E. Miles, P. Mote, L. Whitley Binder. 2001. *Effects of Climate Change on Water Resources in the Pacific Northwest: Impacts and Policy Implications*. JISAO Climate Impacts Group, University of Washington. Seattle, WA. July 3, 2001.

HDR (HDR Engineering, Inc.). 2002. Lake Tapps Water Right Feasibility, Technical Memoranda Volumes I and II. March and April 2002; updated March 2003.

HDR and Golder (HDR Engineering, Inc. and Golder Associates). 2002. *Lake Tapps Reservoir Water Right Technical Memorandum No. 27 – Groundwater Analysis*. Prepared for Puget Sound Energy and Cascade Water Alliance.

Herrera (Herrera Environmental Consultants). 2006. *Hydraulic Analysis, White River Bypass Reach, River Mile 3.6 to 24.3*. Prepared for the Puyallup Tribe of Indians. Seattle, WA. April 2006.

Herrera (Herrera Environmental Consultants). 2007. *Hydraulic and Geomorphic Analysis, River Mile 12.9 to 14.4 within the Lower White River Bypass Reach*. Prepared for the Puyallup Tribe of Indians. Seattle, WA. December 2007.

Hilgert, P. J. and S. W. Madsen. 1998. *Evaluation of Potential Stranding and Trapping of Juvenile Salmonids as a Result of Flow Fluctuations in the Lower White River, Washington*. Prepared for Puget Sound Energy, Inc. Bellevue, WA.

Horne, A.J. and C.R. Goldman. 1994. *Limnology*. 2nd Ed. McGraw Hill, Inc., New York.

Hruby, T. 2004. *Washington State Wetland Rating System for Western Washington – Revised*. Washington State Department of Ecology Publication # 04-06-025.

Interagency Task Force. n.d. *Report on Agency Recommendations, Conditions, and Prescriptions Under Part I of the Federal Power Act*. http://www.fws.gov/habitatconservation/fpa_final.pdf.

Jones, M.A., 1999. *Geologic Framework for the Puget Sound Aquifer System, Washington and British Columbia*. Professional Paper 1424-C, U.S. Geological Survey.

Kerwin, J. 1999. *Salmon Habitat Limiting Factors Report for the Puyallup River Basin (Water Resource Inventory Area 10)*. Washington Conservation Commission; Olympia, WA.

Keta Waters. 2006. Memorandum to Nancy Rapin, Muckleshoot Indian Tribe Re: Relationship between flows and temperatures in the White River. Draft. April 5, 2006.

King County. 1978. King County Shoreline Management Master Program. Adopted by Ordinance 3692 on May 1, 1978.

King County. 1988. The White River and the Inter-County River Improvement District. Surface Water Management Division, Seattle, WA.

King County. 2006. King County Comprehensive Plan Atlas. Adopted October 2006. Ordinance No. 15607.

King County. 2008a. King County iMap – GIS Center. http://www.metrokc.gov/gis/Mapportal/iMAP_main.htm.

King County. 2008b. King County Comprehensive Plan 2008. Adopted October 2008.

Kramer, Arthur. 1986. *Among the Livewires, 100 Years of Puget Power*. Creative Communications; Edmonds, WA.

Ladley, R. C. 2008. Fisheries Biologist, Puyallup Tribe Fisheries Division. Personal communication with Bill Mavros, Fisheries Biologist, HDR Engineering, Inc.

Ladley, R.C., B.E. Smithy, and M.K. MacDonald. 1996. *White River Spring Chinook Migratory Behavior Investigation*. Puyallup Tribe Fisheries Division.

Ladley, R. C., E. L., Marks, M. Parnel, A. Berger, B. E. Smith, and T. G. Sebastian. 2007. *Movement and Spawning Distribution of Bull Trout within the White River, Washington*. Puyallup Tribes, Puyallup, WA.

Leider, S. A. 1997. Status of Sea-run Cutthroat Trout in Washington. *In* J. D. Hall, P. A. Bisson, and R. E. Gresswell (eds), *Sea-Run Cutthroat Trout Biology, Management, and Future Conservation*. Oregon Chapter, American Fisheries Society, Corvallis, OR.

LPWMC (Lower Puyallup Watershed Management Committee). 1992. *Lower Puyallup Watershed Phase 1 Report – A Report on Nonpoint Water Pollution Issues, Goals, and Objectives Toward Preparation of a Watershed Action Plan*. Prepared under the direction of the Lower Puyallup Watershed Management Committee in conformance with Chapter 400-12 WAC, Local Planning and Management of Nonpoint Source Pollution. March 1992.

Luzier, J.E. 1969. *Geology and Groundwater Resources of Southwestern King County, Washington*. Washington Department of Water Resources, Water Supply Bulletin No. 28.

Manning, Jay. 2008. Letter from Jay Manning, Director, Washington Department of Ecology, to SEPA Responsible Officials and Administrators. Re: Climate Change – SEPA Environmental Review of Proposals. Sent April 30, 2008.

Marks, Eric L., R.C. Ladley, B.E. Smith, T.G. Sebastian. 2007. *2006-2007 Annual Salmon, Steelhead, and Bull Trout Report: Puyallup/White River Watershed Water Resource Inventory Area 10*. Puyallup Tribe of Indians Fisheries Division, Puyallup, WA.

Marks, Eric L., R.C. Ladley, B.E. Smith, T.G. Sebastian. 2008. *2007–2008 Annual Salmon, Steelhead, and Bull Trout Report: Puyallup/White River Watershed Water Resource Inventory Area 10*. Puyallup Tribe of Indians Fisheries Division. August 2007 – June 2008.

Marks, Eric L., R.C. Ladley, B.E. Smith, T.G. Sebastian. 2009. *2008–2009 Annual Salmon, Steelhead, and Bull Trout Report: Puyallup/White River Watershed Water Resource Inventory Area 10*. Puyallup Tribe of Indians Fisheries Division. August 2008 – July 2009.

Maughan, O.E. and P.J. Barrett. 1991. An Evaluation of the Instream Flow Incremental Methodology (IFIM). *Journal of the Arizona-Nevada Academy of Science* 24-25: 75-77. Abstract. http://www.jstor.org/pss/40021297.

Mote, P.W., A.K. Snover, L. Whitely Binder, A.F. Hamlet, and N.J. Mantua. 2005. *Uncertain Future: Climate change and its effects on Puget Sound – Foundation Document*. Climate Impacts Group, Center for Science in the Earth System, JISAO, University of Washington, Seattle, WA.

Mueller, K.W. 1997. *1997 Lake Tapps Survey: the Warmwater Fish Community of a Reservoir Managed for Hydropower*. Washington Department of Fish and Wildlife, Olympia, WA.

NMFS (National Marine Fisheries Service). 2005. Letter from D. Robert Lohn, Regional Administrator, NMFS, to Colonel Debra M. Lewis, U.S. Army Corps of Engineers, Seattle District. March 10, 2005.

NOAA (NOAA Fisheries Service). 2003. *Draft Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation, White River Hydroelectric Project, FERC Project Number 2494-002*. Northwest Region, Hydropower Division. October 31, 2003.

NOAA Fisheries. 2009. ESA Salmon Listings. http://www.nwr.noaa.gov/ESA-Salmon-Listings/.

Palmer, R.N. and A. Polebitski. 2009. *Impacts of Future Climate Conditions and Population Growth on the Proposed Lake Tapps System.* Prepared for King County Department of Natural Resources and Parks, Department of Civil and Environmental Engineering, University of Massachusetts, Amherst, MA.

PCHB (Pollution Control Hearings Board). 2004. Puyallup Tribe Of Indians, Muckleshoot Indian Tribe, City Of Auburn, City Of Buckley, and Robert Cook v. State Of Washington, Department of Ecology, Puget Sound Energy and Cascade Water Alliance, Order Remanding Case. PCHB Nos. 03-105, 03-106, 03-107, 03-109, and 03-118. August 12, 2004. http://www.eho.wa.gov/searchdocuments/2004%20Archive/pchb%2003-105%20remand.htm.

PGG (Pacific Groundwater Group). 1999. *1999 Hydrogeologic Characterization Report, City of Auburn*. Prepared for the City of Auburn, Department of Public Works Water Utility Engineering, Auburn, WA.

PGG (Pacific Groundwater Group). 2000. *Groundwater Model Construction and Calibration, City of Auburn*. Prepared for the City of Auburn, Department of Public Works Water Utility Engineering, Auburn, WA.

Pierce County. 1974. Shoreline Master Program for Pierce County, Phase I. Adopted March 4, 1974.

Pierce County. 1994a. Pierce County Comprehensive Plan Land Use Designations Map PCC 19A.30.230. Adopted November 29, 1994 – Ordinance No. 94-82s. Updated October 1, 2008.

Pierce County. 1994b. Pierce County Comprehensive Plan. Adopted November 29, 1994. Effective January 1, 1995. Pierce County Code Title 19.

Pierce County. 2001. Pierce County Coordinated Water System Plan and Regional Supplement 2001.

Pierce County. 2005. Lake Tapps Boat Management Plan. April 2005.

Pierce County. 2007. Pierce County Buildable Lands Report. September 1, 2007.

Pierce County. 2008a. 2008 Pierce County Noxious Weed List. http://piercecountyweedboard.wsu.edu/noxious_weeds_2008.pdf.

Pierce County. 2008b. Pierce County Public GIS. http://matterhorn.co.pierce.wa.us/PublicGIS/presentation/map.cfm?Cmd=INIT.

Polebitski, A., M.W. Wiley, and R.N. Palmer. 2007a. *Technical Memorandum #2: Methodology for Downscaling Meteorological Data for Evaluating Climate Change*. A report prepared by the Climate Change Technical Subcommittee of the Regional Water Supply Planning Process, Seattle, WA.

Polebitski, A., L. Traynham, and R.N. Palmer. 2007b. *Technical Memorandum #4: Approach for Developing Climate Impacted Meteorological Data and its Quality Assurance/Quality Control*. A report prepared by the Climate Change Technical Subcommittee of the Regional Water Supply Planning Process, Seattle, WA.

Pratt, K.L. 1992. A Review of Bull Trout Life History. *In* P.J. Howell and D.V. Buchanan, (eds). *Proceedings of the Gearhart Mountain Bull Trout Workshop*. Oregon Chapter, American Fisheries Society, Corvallis, OR.

PSCAA (Puget Sound Clear Air Agency). 2009. http://www.pscleanair.org/airq/windrose/default.aspx.

Puget (Puget Sound Power & Light Company). 1920. *Hydro-Electric Development, an Illustrated Story of the Power Properties of the Puget Sound Power & Light Company, Showing How the Forces of Nature Have Been Harnessed and Made to Serve Useful and Productive Industry*. Souvenir Edition, Celebrating the Forty-Third Annual Convention of the National Electric Light Association, May 18 to 22, 1920, at Pasadena, California. University of Washington Libraries, Special Collections. http://content.lib.washington.edu/cdm4/document.php?CISOROOT=/ww-swps&CISOPTR=724&REC=20&CISOSHOW=660.

Puget (Puget Sound Power & Light Company). 1954. Deed conveying real property to Lake Tapps Development Co., Inc. June 22, 1954. Recorded with the Pierce County Auditor in Volume 1063, pages 485-495.

Puget (Puget Sound Power & Light Company). 1993. 1993 Annual Report, Form 10-K. http://www.secinfo.com/d2f63.b2.htm#1stPage.

Puget (Puget Sound Energy Inc.). 1997. 1997 Annual Report, Form 10-K. http://www.getfilings.com/o0000081100-98-000002.html.

Puget (Puget Sound Energy Inc.). 1998. 1998 Annual Report, Form 10-K. http://www.secinfo.com/d2f63.6b.htm#1stPage.

Puget (Puget Sound Energy Inc.). 1999. 1999 Annual Report, Form 10-K. http://www.getfilings.com/o0000081100-00-000005.html.

Puget (Puget Sound Energy Inc.). 2004. 2004 Annual Report, Form 10-K. http://www.secinfo.com/d113uv.z13.htm#1stPage.

Puget (Puget Sound Energy). 2008. Company History. http://www.pse.com/insidePSE/corporateinfo/Pages/CorporateInfo_History.aspx.

Puget Sound LiDAR Consortium. 2004. Pierce County Lowlands 2004 - All Returns LiDAR ASCII Points. Tabular Digital Data. www.pugetsoundlidar.org.

Puyallup Tribe. 1994. Water Quality Standards for Surface Waters of the Puyallup Tribe. http://www.epa.gov/waterscience/standards/wqslibrary/tribes/puyallup_10_wqs.pdf.

Quinn, T.P. 2005. *The Behavior and Ecology of Pacific Salmon and Trout*. University of Washington Press, Seattle, WA.

R2 Resource Consultants, Inc. 1995. *Site Specific Habitat Suitability Curves for the White River, Washington: 1993-1994 Study Results*.

R2 Resource Consultants, Inc. 2005. *Lake Tapps and White River Data Evaluation Report*. Prepared for Puget Sound Energy, Puyallup Tribe of Indians, and Cascade Water Alliance, Bellevue, WA.

Ramey, M. 2004. Memorandum to Tom McDonald, Perkins Coie. Analysis of changes in wetted surface area in the lower White and Puyallup rivers associated with the implementation of Lake Tapps Water Supply Project under the Non-hydro option. October 14, 2004.

Save Lake Tapps Coalition. n.d. http://www.savelaketapps.com.

Shumway, Dean L. 1992. Letter to Agencies Addressed from Dean L. Shumway, Director, Division of Project Review, Federal Energy Regulatory Commission. List of Addressees: National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fisheries, and Washington Department of Wildlife. October 15, 1992.

Stein, Alan J. 2001a. Howard Hanson Dam. HistoryLink.org Essay 3549. September 10, 2001. http://www.dev.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=3549.

Stein, Alan J. 2001b. Mud Mountain Dam. HistoryLink.org Essay 3584. September 23, 2001. http://www.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=3584.

Stimac, M.V. 1983. *A Measure of TRITIUM in Water Samples and Precipitation from the Vicinity of the Once Proposed Skagit Nuclear Power Project*. M.S. Thesis, University of Washington, Seattle, WA.

Stuart, D.L. 2002. *A Study of Periphyton Induced pH Spikes on the White River, Washington*. M.S. Thesis, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA.

The News Tribune. 2008. Unlike last year, Lake Tapps is already full again. Mike Archbold. May 19, 2008. http://www.thenewstribune.com/new/local/v-printerfriendly/story/356046.html.

The Seattle Times. 1999. Panel Gets Time to Save Lake Tapps. July 29, 1999. http://seattletimes.nwsource.com/cgi-bin/PrintStory.pl?slug=2974367&date=19990729.

USACE (U.S. Army Corps of Engineers). 1992. *Automated Coastal Engineering System, User's Guide*. Coastal Engineering Research Center.

U.S. Court of Appeals, Ninth Circuit. 1981. Puget Sound Power & Light Company, Petitioner, v. Federal Energy Regulatory Commission, Respondent, and Washington State Department of Fisheries, Washington State Department of Game, Muckleshoot Indian Tribe, and Secretary of the Interior, Intervenors. 644 F.2d 785. May 4, 1981. http://cases.justia.com/us-court-of-appeals/F2/644/785/358921.

USDA (U.S. Department of Agriculture). 2006. National Agriculture Imagery Program.

USEPA (U.S. Environmental Protection Agency). 2008a. *National Water Program Strategy, Response to Climate Change*. September 2008. http://www.epa.gov/water/climatechange/docs/TO5_DRAFT_CCR_Revised_10-16.pdf. Accessed November 2008.

USEPA (U.S. Environmental Protection Agency). 2008b. Climate Change, Basic Information. Updated October 29, 2008. http://www.epa.gov/climatechange/basicinfo.html. Accessed November 2008.

USFWS (U.S. Fish and Wildlife Service). 1992. Determination of Critical Habitat for the Northern Spotted Owl. Federal Register (57):1796-1838. https://ecos.fws.gov/docs/frdocs/1992/92-874.pdf.

USFWS (U.S. Fish and Wildlife Service). 2008. Wetlands Online Mapper. http://wetlandsfws.er.usgs.gov/wtlnds/launch.html.

USFWS (U.S. Fish and Wildlife Service). 2009. Species Profile: Bull Trout. http://ecos.fws.gov/speciesProfile/SpeciesReport.do?spcode=E065.

USGS (U.S. Geological Survey). 2001. *A Primer on Water Quality*. http://pubs.usgs.gov/fs/fs-027-01. March 2001. Accessed August 2009.

USGS (U.S. Geological Survey). 2009. Letter regarding the survey of the USGS Lake Tapps Gaging Station 12101000. Addressed to Michael Gagliardo, Cascade Water Alliance, from Robert Kimbrough, USGS. November 9, 2009.

UW (University of Washington). n.d. White River Power Plant. University of Washington Libraries, Digital Collections. http://content.lib.washington.edu/cdm4/results.php?CISOOP1=all&CISOBOX1=white%20river&CISOFIELD1=descri&CISOOP2=exact&CISOBOX2=&CISOFIELD2=creato&CISOOP3=any&CISOBOX3=&CISOFIELD3=author&CISOOP4=none&CISOBOX4=&CISOFIELD4=type&CISOROOT=/ww-swps.

Vano, Julie A., Nathalie Voisin, Lan Cuo, Alan F. Hamlet, Marketa McGuire Elsner, Richard N. Palmer, Austin Polebitski, and Dennis P. Lettenmaier. 2009. *Climate Change Impacts on Water Management in the Puget Sound Region, Washington, USA*. March 2009.

Walters, K.L. and Kimmel, G.E. 1969. *Groundwater Occurrence and Stratigraphy of Unconsolidated Deposits, Central Pierce County, Washington*. Washington Department of Water Resources, Water Supply Bulletin No. 22.

Washington State Legislature. 1980. Chapter 173-510 Washington Administrative Code (WAC), Instream Resources Protection Program – Puyallup River Basin, Water Resource Inventory Area (WRIA) 10. Updated June 9, 1988. http://apps.leg.wa.gov/wac/default.aspx?cite=173-510.

Washington State Noxious Weed Control Board. 2008. Class B Noxious Weeds. http://www.nwcb.wa.gov/weed_list/Class_B_weeds.htm.

Washington Supreme Court. 1913. *Sumner Lumber & Shingle Co. v. Pacific Coast Power Co.*, 72 Wash. 631, 131 P. 220 (1913). Cited in 644 F2d 785 Puget Sound Power Light Company v. Federal Energy Regulatory Commission. http://openjurist.org/644/f2d/785.

WDFW (Washington Department of Fish and Wildlife). 2005. Management Recommendations for Washington's Priority Species for Use to Guide Site Specific Management of Priority Species: Pileated Woodpecker (*Dryocopus pileatus*).

WDFW (Washington Department of Fish and Wildlife). 2008. Letter dated August 14, 2008, from Lori Guggenmos, Washington Department of Fish and Wildlife, to Marc Auten, HDR Engineering, Inc.

WDFW (Washington State Department of Fish and Wildlife). 2009a. SalmonScape. http://wdfw.wa.gov/mapping/salmonscape/index.html.

WDFW (Washington State Department of Fish and Wildlife). 2009b. Species of Concern in Washington State. http://wdfw.wa.gov/wlm/diversty/soc/soc.htm.

WDFW (Washington State Department of Fish and Wildlife), Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. *1992 Washington State Salmon and Steelhead Stock Inventory*. Olympia, WA.

WDFW (Washington State Department of Fish and Wildlife), Puyallup Indian Tribe, and Muckleshoot Indian Tribe. 1996. *Recovery Plan for White River Spring Chinook Salmon*. Olympia, WA.

WDNR (Washington Department of Natural Resources). 2007. Sections that Contain Natural Heritage Features. Data current as of October 31, 2007.

Welch, G. 2005. Effects of Volume Flow on Lake Tapps Water Quality. PowerPoint presentation prepared by Gene Welch for the Muckleshoot Indian Tribe. Updated March 6, 2006.

Welch, G. 2006. *Draft Summary of Conclusions Regarding Water Quality in Lake Tapps*. Draft report prepared by Gene Welch for the Muckleshoot Indian Tribe.

White River Valley Museum. 2001. Diversion of the White River (excerpts from contemporary newspaper articles). White River Journal, January 2001. http://www.wrvmuseum.org/journal/journal_0101.htm.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. *A Catalog of Washington Streams and Salmon Utilization*. Volume 1, Puget Sound Region. Washington State Department of Fisheries, Olympia, WA.

Wing, Robert C. 1987. *A Century of Service, the Puget Power Story*. Puget Sound Power & Light Company.

Woodward, D.G. Packard, F.A., Diron, N.P., and Sumioka, S.S. 1995. Occurrence and Quality of Ground Water in Southwestern King County, Washington. *U.S. Geological Survey Water Resources Report 92-4098*. Prepared in cooperation with State of Washington Department of Ecology, Regional Water Association of South King County, and Seattle King County Department of Public Health.

WOW (Water on the Web). 2007. University of Minnesota, Duluth, and Lake Superior College. http://waterontheweb.org/under/waterquality/oxygen.html. Updated December 7, 2007.

WRCC (Western Regional Climate Center). 2009. Historical Climate Information. http://www.wrcc.dri.edu/CLIMATEDATA.html.

Wydoski, R.S. and R. L. Whitney. 2003. *Inland Fishes of Washington*. University of Washington Press. Seattle, WA.

Zulauf, A. S. 1979. *Soil Survey of Pierce County Area, Washington*. USDA, Soil Conservation Service, in cooperation with the Washington Agricultural Experiment Station.

This page intentionally left blank.